Sunday, October 15, 8:00 AM - 9:15 AM

SA01

CC-North 120A

A Practitioner's Guide to Digital Twin Development

Tutorial Session

Session Chair: Ebru Korular Bish, University of Alabama, Tuscaloosa, AL

1 A Practitioner's Guide to Digital Twin Development

Bahar Biller[1], Stephan Biller[2], Jinxin Yi[3], [1]SAS Institute, Carmel, IN, [2]Purdue University, West Lafayette, IN, [3]SAS Institute, Inc., Cary, NC

This tutorial describes industrial digital twin development including advanced analytics. Using factory and supply chain digital twins as example applications, we present two different digital twin frameworks that serve as a guide for practitioners interested in developing digital twin solutions. The resulting digital twins are expected to help understand what did happen, predict what may happen and prescribe actions to address future problems before they happen. We conclude with examples of digital twin use cases and challenges of their implementations.

Sunday, October 15, 8:00 AM - 9:15 AM

SA03

CC-North 120D

Missouri University of Science & Technology

Technology Tutorial

1 AI-enabled Models to Assist and Optimize the Decision-making Process in the Kidney Transplantation Network

Cihan H. Dagli, University of Missouri-Rolla, Wildwood, MO, Contact: dagli@mst.edu

Discover the game-changing potential of AI-powered models in optimizing the decision-making process for deceased donor kidney transplantation. Unleash the power of advanced deep learning techniques to revolutionize patient care with streamlined processes. Experience the real-time identification of key features that can confidently leverage decision-making and significantly reduce the non-utilization of deceased donor kidneys. Join us in embracing the future of healthcare with AI-powered models.

Sunday, October 15, 8:00 AM - 9:15 AM

SA04

CC-North 121A

Revenue Management, Online Platforms, and Perishability

Community Committee Choice Session

Session Chair: Nasser Barjesteh, Rotman School of Management, University of Toronto, Toronto, ON, Canada

Session Chair: Sajjad Najafi, HEC Paris, VERSAILLES, France

1 Optimizing Fees for Restaurants and Customers and Payments to Drivers by a Food Delivery Platform

Candace Arai Yano[1], Gabriel Deza[2], [1]University of California-Berkeley, Berkeley, CA, [2]Tel Aviv University, Tel Aviv, Israel. Contact: yano@ieor.berkeley.edu

Restaurant food delivery platforms need to decide service charges for customers and restaurants, and how much to pay drivers for delivery. A restaurant's willingness to participate on the platform depends on the platform's service charge. Increasing payments to drivers increases their supply and thereby reduces waiting times for customers whose demands are affected by the number and variety of participating restaurants, the platform's service charge, and waiting times. We take a step in analyzing these complicated multi-party interactions, focusing on the platform's problem of setting service charges for restaurants and customers as well as driver pay when restaurants and customers also seek to maximize their net utility, and the platform must compete for drivers.

2 A Data Marketplace with Privacy-Aware Sellers Under Endogenous Privacy Costs

Diptangshu Sen, Juba Ziani, Georgia Institute of Technology, Atlanta, GA

We study an online data ecosystem comprised of an online platform, users on the platform, and downstream learners. Learners buy data from the platform's users to perform a machine-learning task; users decide whether to join the platform by trading off their benefit from joining the platform and the privacy costs they incur from sharing their data. Our first contribution is to introduce a novel modeling element in that the privacy costs of the users are endogenous and depend on how much of their data is collected by the downstream learners. We then characterize the equilibria of the marketplace in terms of i) the platform's price for each data point, ii) the data collected by each buyer, and iii) the users' participation decisions.

3 Inventory Record Inaccuracy Explains Price Rigidity in Perishable Groceries

Naveed Chehrazi[1], Ioannis Stamatopoulos[2], Robert E. Sanders[3], [1]Olin Business School, SAINT LOUIS, MO, [2]The University of Texas at Austin, McCombs School of Business, Austin, TX, [3]UC, San Diego, Beverly Hills, CA, Contact: naveed.chehrazi@wustl.edu

Grocery retailers cannot engage in inventory-based pricing without physically auditing their shelves, because their inventory records are inaccurate and incomplete. We argue that this informational friction, known in the literature as inventory record inaccuracy (IRI), is much more powerful than physical menu costs in explaining price rigidity in perishable groceries.

Sunday, October 15, 8:00 AM - 9:15 AM

SA05

CC-North 121B

Portfolio Optimization

Contributed Session

Session Chair: Ruijing Yang, Stevens Institute of Technology, Hoboken, NJ

1 Portfolio Diversification Based on Trading Strategies

WenYi Lee, Cheng-Wei Ke, National Taipei University of Business, Taipei City, Taiwan. Contact: wy.lee@ntub.edu.tw

Raising invested number is efficient in decreasing portfolio risk. Studies have considered a naive portfolio, which invests stocks equally, or Shannon and Yager's entropy to increase the investment number of portfolios. However, studies have underestimated the importance of featured stocks while constructing a portfolio with diversification. We should enforce profitable stocks instead of all the alternatives, even though increasing investment is crucial for lower portfolio risk. Thus, this study proposes a diversified portfolio based on mixing benchmark portfolio models and trading strategies, such as momentum and reversal. We apply a parametric policy to better mix the benchmark portfolio and trading strategies as a convex problem.

2 Performance of Active Portfolio Managers when the Benchmark is Not Observed

Luis Chavez-Bedoya, ESAN Graduate School of Business, Lima, Peru. Contact: lchavezbedoya@esan.edu.pe

In the framework of active portfolio management, we propose a methodology to evaluate the performance of active portfolio managers when the benchmark portfolio cannot be either observed or determined by the agent performing the analysis. The suggested methodology assesses performance with respect to a combination of funds that minimizes residual risk; and, it is well-suited for evaluating the performance of pension-fund managers in defined-contribution pension systems, especially those operating in Latin America. We also provide numerical results when our methodology is applied to appraise the historical performance of the pension fund administrators of the Peruvian Private Pension System.

3 Optimal Goal-Based Wealth and Retirement Management

Jeffrey Choy[1], Ben Wang[2], Abdullah AlShelahi[3], Romesh Saigal[1], [1]University of Michigan, Ann Arbor, MI, [2]Univerisity of Michigan, Ann Arbor, MI, [3]University of Michigan, Ann Arbor, MI, Contact: jeffchoy@umich.edu

We examine an investor with multiple spending and retirement goals who must choose the optimal portfolio allocation, retirement account contribution, and consumption under taxes, stochastic income, and market-income correlation. We find the optimal portfolio and income allocation that maximize the investor's expected discounted lifetime utility as a function of his or her portfolio value, retirement account value, and income. Taking a martingale perspective of future investor utility, we find continuous-time solutions to this problem. We demonstrate the model's general applicability with a series of numerical experiments solving discrete-time problems for hypothetical investors. The model highlights how decision-making changes under a variety of investment conditions, including different income levels, goal priorities, and duration to retirement.

4 Optimal Portfolio Execution Strategies Under Chance Constraints on Capital Ratio Requirement

Ruijing Yang, Zachary Feinstein, Somayeh Moazeni, Stevens Institute of Technology, Hoboken, NJ, Contact: ryang13@stevens.edu

We investigate the optimal portfolio liquidation problem under capital adequacy requirements. In this setting, selling risky assets induces temporary and permanent price impacts which need to be considered. We formulate this problem with chance constraints for the regulatory requirements.

We present a conservative reformulation for the problem and establish sufficient conditions for its convexity. Our study shows that in general the optimal portfolio liquidation strategy under the capital ratio requirement constraints differs from the optimal strategy in the absence of the constraints.

Sunday, October 15, 8:00 AM - 9:15 AM

SA06

CC-North 121C

Data-driven Bundling and Assortment Optimization

Community Committee Choice Session

Session Chair: Xiaobo Li, National University of Singapore, Singapore, Singapore

1 The Benefit Of Learning

Lan Wu[1], Changchun Liu[2], Chung Piaw Teo[3], Zhang Xun[4], [1]The National University of Singapore, Singapore, Singapore; [2]National University of Singapore, Singapre, Singapore; [3]National University of Singapore Business School, Singapore, Singapore; [4]The National University of Singapore, Singapore, Singapore. Contact: lanwu@u.nus.edu

This paper addresses the evolving complexities in airline Revenue Management (RM), particularly in seat allocation given diverse ancillary services and fare types. Traditional Independent Demand Model (IDM) is seen as limited, suffering from customer ‘buy-down’ where higher paying customers opt for cheaper fare classes. We propose a mixed-fare customer demand model which combines IDM with the consideration of customer behavior based on product availability and prices. Our key contributions include the development of the Bayes Selector online learning algorithm for seat allocation, which offers a constant regret irrespective of time, and extensive performance testing using synthetic and real airline data. The algorithm’s applicability in various settings is also demonstrated.

2 Optimizing Size-Based Bundle Promotions

Ruijiu Mao[1], Xiaobo Li[2], Chung Piaw Teo[3], Shuai Jia[4], [1]University of Singapore, Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore; [3]National University of Singapore Business School, Singapore, Singapore; [4]The Hong Kong Polytechnic University, Hong Kong, Hong Kong. Contact: maoruijiu@u.nus.edu

Current size-based bundle promotions often overlook the diverse needs of customers and variations among products. Recognizing these limitations, we conducted a comprehensive exploration of size-based bundling promotions. We examined key elements such as determining promotion numbers, selecting product pools, setting bundle prices, and estimating customer utility for different products. We devised a discrete bilevel programming model and proposed an efficient MIP-based solution method. In addition, we delved deeply into the theoretical aspects of bundle pool selection. Our case study, based on data from a major Chinese e-tailing company, accurately predicted reservation prices and demonstrated a remarkable 41% increase in profits.

3 Assortment Optimization for General Multi-Item Choice Models

Wenhao Gu[1], Anton Braverman[2], Tarek Abdallah[3], [1]Northwestern University, Evanston, IL, [2]Northwestern University, Evanston, IL, [3]Northwestern University, Kellogg School of Management, Chicago, IL, Contact: wenhao.gu1@kellogg.northwestern.edu

Utility maximization choice models that capture customer behaviors in assortment optimization problems are generally hard to solve. While the single-choice setting is well studied, e.g., multinomial logit model, models where customers make multiple decisions have received less attention. We consider a multiple-choice utility maximization model with general utility distributions and study optimal assortment policies through an asymptotic lens.

Sunday, October 15, 8:00 AM - 9:15 AM

SA07

CC-North 122A

Assortment Optimization: Theory and Applications

Community Committee Choice Session

Session Chair: Omar El Housni, Cornell Tech, New York, NY

1 Placement of Substitutable Goods for a General Choice Model

Omar El Housni[1], Rajan Udwani[2], [1]Cornell Tech, New York, NY, [2]UC Berkeley, Berkeley, CA

Given a universe of substitutable goods and a set of display locations (for example, in a physical store), we consider the problem of picking an assortment of goods and placing at most one good at each location. A customer visiting the store looks at a subset of locations and picks at most one of the goods from the visited locations according to a choice model. We consider a very general setting of the problem and give an efficient algorithm for approximating revenue optimal product placement.

2 Maximum Load Assortment Optimization

Omar El Housni[1], Marouane Ibn Brahim[1], Danny Segev[2], [1]Cornell Tech, New York, NY, [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: mi262@cornell.edu

Motivated by applications in e-commerce and scheduling, we introduce and study the Maximum Load Assortment Optimization problem. We are given a universe of items and a set of users. Each user makes their choice among the offered items according to a multinomial logit model. We define the load of an item by the total number of users who select it. Our goal is to offer an assortment that maximizes the expected maximum load across all items. We study the static and the dynamic version of this problem. For the static version, we develop a polynomial-time approximation scheme (PTAS). Additionally, we prove that a weight-ordered policy yields a 1/2-approximation for the static problem. Furthermore, we establish that this same static policy gives 1/4-approximation of the dynamic problem. Finally, we design an adaptive policy that gives a (1-ε)-approximation in quasi-polynomial time.

3 Display Optimization Under the Multinomial Logit Choice Model: Balancing Revenue and Customer Satisfaction

Puping Jiang[1], Jacob Feldman[2], [1]Shanghai Jiao Tong University, Antai College of Economics and Management, Shanghai, China; [2]Olin Business School, Saint Louis, MO, Contact: jiang.p@wustl.edu

In this paper, we consider an assortment optimization problem in which a platform must choose pairwise disjoint sets of assortments to offer across a series of T stages. The goal is to choose the sequential displays of product offerings to maximize expected revenue. Additionally, we impose stage-specific constraints that ensure that as each customer progresses farther and farther through the T stages, there is a minimum level of "desirability" met by the collections of displayed products. We show that our assortment problem of interest is strongly NP-Hard. Our main algorithmic result consists of a polynomial-time approximation scheme (PTAS). We also provide an additional approximation scheme, which, under mild assumptions, can handle a cardinality constraint that enforces that an exact number of new products are introduced at each stage.

4 Revenue Management with Flexible Products

Wenchang Zhu, Huseyin Topaloglu, Cornell Tech, New York, NY, Contact: wz368@cornell.edu

We provide an approximation algorithm for network revenue management problems with flexible products. Flexible products allow delaying the assignment decision of which resources to use to serve each request, but also make it difficult to track the inventory state when designing algorithms. Our algorithm uses value function approximations constructed by solving an integer program with linear objective to reshuffle inventories at each time period. We show that if each route uses at most L resources, then the total expected revenue obtained by our approximate policy is at least 1/(1+L) of the optimal total expected revenue. Our computational experiments demonstrate that our policy performs quite well and flexible products do increase the total expected revenue by delaying the assignment decisions to the end of the time horizon.

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SA08

CC-North 122B

APS Special Session: Algorithms with Predictions

Award Session

Session Chair: Andrew Daw, University of Southern California, Marshall School of Business, Los Angeles, CA

Session Chair: Christina Lee Yu, Cornell University, Ithaca, NY

1 Algorithms with Predictions

Michael Mitzenmacher, Harvard University

We survey the recent introduction of and advances in algorithms that use predictions applied to the input, such as from machine learning, to circumvent worst-case analysis. We aim for algorithms that have near optimal performance when these predictions are good, but still maintain provable bounds (such as for worst-case performance) even when the predictions have large errors. We look at several examples showing how predictions can be used effectively while still allowing for theoretical guarantees, covering our own work in scheduling and Bloom filter data structures, as well as several other recent results. Bio: Michael Mitzenmacher is a Professor of Computer Science in the School of Engineering and Applied Sciences at Harvard University. Michael has authored or co-authored over 250 conference and journal publications on a variety of topics, including algorithms for the Internet, efficient hash-based data structures, erasure and error-correcting codes, power laws, and compression. He is an ACM and IEEE Fellow. He has co-authored a widely used textbook on randomized algorithms and probabilistic techniques in computer science published by Cambridge University Press.

Sunday, October 15, 8:00 AM - 9:15 AM

SA09

CC-North 122C

Experimental Design and A/B Tests in Marketplaces

Community Committee Choice Session

Session Chair: Zeyu Zheng, University of California, Berkeley, Berkeley, CA

Session Chair: Nian Si, University of Chicago Booth School of Business

1 Design of Panel Experiments with Spatial and Temporal Interference

Tu Ni[1], Iavor Bojinov[2], Jinglong Zhao[3], [1]NUS, Singapore, Singapore; [2]Harvard Business School, Somerville, MA, [3]Boston University, Boston, MA, Contact: nitu@u.nus.edu

One of the main practical challenges companies face when running experiments over a panel is interference. Existing literature has identified aggregating units into clusters as the gold standard to handle interference, yet the degree of aggregation remains an open question. In this work, we present a new randomized design of panel experiments and answer this question when all experimental units are modeled as vertices on a two-dimensional grid. Our proposed design has two features: the first feature is a notion of randomized spatial clustering that randomly partitions units into equal-size clusters; the second is a notion of balanced temporal randomization that extends the classical completely randomized designs to the temporal interference setting.

2 Measuring the Value of Boosting Algorithms in Online Advertising: A Two-Sided Randomized Ghost Ad Experiment

Zhihua Zhu[1], Zheng Cai[1], Chenglong Li[1], Yufei Shen[2], [1]Tencent, Shenzhen, China; [2]Nova School of Business and Economics, Lisbon, Portugal. Contact: yufei.shen@novasbe.pt

We propose a novel two-sided randomized ghost ad (TSR-GA) experimental design to reduce the bias and variance of the estimated effects of algorithmic intervention in online advertising. Our method is compatible with the TSR design that prevents various sources of interference, reducing the bias of estimates. It also incorporates the ghost ad design that allows us to identify and keep a very small fraction of observations relevant to statistical inferences, improving the precision of estimates. To validate the method, we conducted large-scale experiments on Tencent's ad platform. We show that the estimated effect of the algorithmic intervention would be insignificant if using TSR alone without ghost ads. By contrast, using our TSR-GA approach, we report a significant effect and the standard error of estimates decreased by 78%.

3 Switchback Experiments Under Geometric Mixing

Yuchen Hu[1], Stefan Wager[2], [1]Stanford University, Stanford, CA, [2]Stanford GSB, Stanford, CA, Contact: yuchenhu@stanford.edu

The switchback is an experimental design that measures treatment effects by repeatedly turning an intervention on and off for a whole system. Switchback experiments are a robust way to overcome cross-unit spillover effects; however, they are vulnerable to bias from temporal carryovers. In this paper, we consider properties of switchback experiments in Markovian systems that mix at a geometric rate. We find that, in this setting, standard switchback designs suffer considerably from carryover bias: Their estimation error decays as T^{-1/3} in terms of the horizon T, whereas in the absence of carryovers a faster rate of T^{-1/2} would have been possible. We also show, however, that judicious use of burn-in periods can considerably improve the situation, and enables errors that decay almost as fast as T^{-1/2}. Our formal results are mirrored in an empirical evaluation.

4 Machine Learning Assisted Experimental Design And Causal Effect Estimation

Yuhang Wu[1], Jinghai He[2], Zeyu Zheng[2], [1]University of California, Berkeley, Berkeley, CA, [2]University of California, Berkeley, Berkeley, CA, Contact: zyzheng@berkeley.edu

Utilizing covariate information has been a powerful approach to improve the efficiency and accuracy for experiment design and causal effects. However, state-of-art approaches can become practically challenging when the dimension of covariate is high. We propose a covariate representation learning approach that can effectively make use of historical experiment or observational data in similar scenarios to understand which lower dimensions can effectively represent the higher-dimensional covariate. We then propose design and estimation methods with the covariate representation. We prove statistically reliability and performance guarantees for the proposed methods.

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SA10

CC-North 123

Healthcare Applications of Probability Theory

Community Committee Choice Session

Session Chair: Arielle Elissa Anderer, The Wharton School, University of Pennsylvania, Philadelphia, PA

1 Personalized Breast Cancer Screening

Yu Ma, MIT, Cambridge, MA

Current national cancer screening guidelines heavily rely on age in cancer screening decisions, neglecting other important medical characteristics. This approach either delays screening or prescribes excessive screenings. The current approach is also unable to combine information across hospital systems due to the lack of a coherent records system. We propose to use claims data to develop a clinical support tool to supply supplemental insights and precautions for physicians to make more informed decisions. Furthermore, we propose a novel machine-learning framework to recommend personalized, data-driven, and dynamic screening decisions. We apply this new method to the study of breast cancer mammograms from 378,840 patients to demonstrate that across different risk populations, personalized screening reduces the average delay in a cancer diagnosis by 2-3 months.

2 The Impact of Hospital-Physician Integration on Hospital Volume Competition

Jong Myeong Lim, University of Miami Herbert Business School, Coral Gables, FL, Contact: jonglim@mbs.miami.edu

We model the impact of physician-hospital integration on hospital competition for volume. We find that preferential admission policies for integrated physicians can lead to suboptimal patient-hospital matches. We explore information disclosure and payment policy reforms as potential solutions.

3 Optimizing Sampling Plans for Detecting Dangerous Medical Products in a Supply Chain

Eugene Wickett, Northwestern University, Evanston, IL, Contact: eugenewickett2022@u.northwestern.edu

Substandard and falsified products are an urgent global issue, causing millions of cases of excess morbidity and mortality. Low and middle income countries face a disproportionate burden of these products. Regulators in these countries conduct post-market surveillance at consumer-facing supply chain locations to assess the prevalence of substandard and falsified products as well as infer sources of these products throughout the supply chain. This work discusses the development of sampling plans for surveillance that allocate tests to consumer-facing locations. These plans must account for supply-chain connections and provide high utility for regulatory objectives. Fast Bayesian approaches for calculating plan utility have been developed; here, we discuss how simulation optimization approaches can leverage fast utility calculation in regulatory contexts.

4 Estimating Treatment Effects from Observational Data Using a Hidden Markov Model

Tongqing Chen, John R. Birge, University of Chicago, Chicago, IL

Treatment effect plays an essential role in the medical decision-making process and is a critical criterion for drug testing and development. However, with unobservable confounders, the treatment effect estimation can be invalid. In this work, we develop a model using observational data in which the confounder is partially observable to estimate the treatment effect. Moreover, we assume that observability can be correlated with the treatment and confounder which relax the assumptions posted by the existing works. Using maximum likelihood estimators and a hidden Markov Chain structure, the model is proved to be identifiable under some general conditions.

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SA11

CC-North 124A

Behavioral Aspects of Donations

Community Committee Choice Session

Session Chair: Gloria Urrea, University of Colorado, Boulder, CO

1 Improving the Quality of In-Kind Donations: A Field Experiment

Sindy D. L. T. Pacheco[1], Mahyar Eftekhar[2], Chao Wu[2], [1]The Society of Saint Vincent de Paul, Tempe, AZ, [2]Arizona State University, Tempe, AZ, Contact: chaowu3@asu.edu

While in-kind donations contribute to charity's triple bottom line (i.e., generatingadditional revenue for the charity, contributing to social welfare, and reducing environmental waste through rechanneling used items), inappropriate material donations impose additional costs to sort, process, or discard them. Minimizing the amount of undesired in-kind donations, however, is a challenge given charities' sensitive relationship with their donors. This paper examines the effectiveness of behavioral interventions in improving the quality of in-kind donations gifted by individuals.

2 The Influence of Market Uncertainty on Donation Decisions

Gloria Urrea[1], Sebastian Villa[2], Eunae Yoo[3], Gordon Burtch[4], [1]University of Colorado Boulder, Superior, CO, [2]University of New Mexico, Albuquerque, NM, [3]Indiana University, Bloomington, IN, [4]Boston University, Boston, MA, Contact: yooeun@iu.edu

Cryptocurrency donations comprise an increasing proportion of charitable donations globally. Compared to cash donations, donors and charities find cryptocurrency appealing because it offers additional benefits, such as increased traceability, cost efficiency, and fast delivery. However, cryptocurrencies are more unpredictable and riskier assets than stocks and cash. While prior research has examined the impact of market changes for more stable assets (e.g., cash) on donors' behavior, it has not considered the context of a more unstable asset like cryptocurrency. Therefore, our research aims to shed light on how changes in the market value of cryptocurrency affect donor decision-making. We address this empirically by leveraging a combination of archival data from a platform for charitable cryptocurrency fundraising and a controlled online experiment.

3 Improving Volunteer Retention: Spillover Effect Of Recurring Volunteers

Vinit S. Tipnis[1], Christopher J. Chen[2], Fei Gao[3], [1]Kelley School of Business, Indiana University Bloomington, Bloomington, IN, [2]Indiana University Kelley School of Business, Bloomington, IN, [3]Indiana University Bloomington, Bloomington, IN, Contact: vtipnis@iu.edu

Nonprofit organizations rely on volunteers to alleviate some of the financial constraints around employing a large paid workforce. Low volunteer retention is costly and disruptive to operations. Using data from a food bank, we study how recurring volunteers improve the volunteering experience and increase the retention rate of new volunteers.

4 Behavioral Responses to Nonprofit Performance Metrics

Hasti Rahemi[1], Gloria Urrea[2], Leon Valdes[3], [1]University of Colorado Boulder, Boulder, CO, [2]University of Colorado Boulder, Superior, CO, [3]University of Pittsburgh, Pittsburgh, PA, Contact: hasti.rahemi@colorado.edu

Donors often want to evaluate the performance of nonprofit organizations (NPOs) before making their donation decisions. Among NPOs' performance metrics, the program spending ratio (PSR) - the percentage of an NPO's expenditures that goes to its programs - is highly pervasive. Heavily relying on PSR, though, can negatively impact operations, so NPOs are increasingly trying to provide additional metrics. In this study, we explore two *operational* metrics, namely outputs (the level of services provided by an NPO) and monetary value information (the value of these services). Using experiments, we shed light on how and why these metrics influence donors' willingness to donate to an NPO. We explore these questions under different levels of PSR.

Sunday, October 15, 8:00 AM - 9:15 AM

SA12

CC-North 124B

Decision Analysis for Public Policy

Community Committee Choice Session

Session Chair: Katharina Ley Best, The RAND Corporation, Pittsburgh, PA

1 A Real Options Methodology for R & D Portfolio Selection and Management

Jeremy Eckhause, RAND Corporation, Arlington, VA

An important class of portfolio management problems in public contexts is one in which investments are staggered in multiple stages and the projects' potential monetary value is not a first-order consideration. We present a robust real options approach to select a portfolio of proposals in each stage, applied to historic data from the NASA's Small Business Innovation Research (SBIR) portfolio using the aerospace standard Technology Readiness Level (TRL) to estimate the factors of interest. We demonstrate the flexibility of our approach by proposing different specifications and tradeoffs.

2 Deep Reinforcement Learning for Assessing the Cost-Effectiveness of Epidemic Response

Giovanni S. P. Malloy, RAND Corporation, Santa Monica, CA, Contact: gmalloy@rand.org

During an infectious disease outbreak, it can be difficult for policymakers to determine which intervention(s) will be cost-effective due to changing disease dynamics and human behavior. Commonly, interventions of interest include prevention (such as vaccines or prophylaxis) and treatment, but efficacy and cost can vary by disease and geography. Deep reinforcement learning can help identify the cost-effective intervention for a disease over a given parameter space and simulated outbreak. Using a custom SIR reinforcement learning environment, monetary benefit as reward, and a trained deep learning model based on the A2C algorithm, I developed a novel method to assess the cost-effectiveness of interventions at different coverages and timing.

3 Depot Engine Planning and Allocation Readiness Tool (Depart)

Frank Wallace, Center for Naval Analysis

Depot Engine Planning and Allocation Readiness Tool (DEPART). CNA produced the Depot Engine Planning & Allocation Readiness Tool (DEPART), an interactive Program Objective Memorandum (POM) planning tool, to support the 1A5A Engine Maintenance account, Aviation Depot Maintenance. DEPART combines depot engine requirements generation, maintenance pricing, and resource allocation decisions into a unified framework. The tool processes data inputs within each component, calculates the desired component output, and passes that output to the next stage to ultimately arrive at a preliminary resourcing decision. The tool makes resourcing allocation choices using predicted requirement and pricing decisions that balances funding with readiness. DEPART is built in R and Shiny and is hosted in the Navy's Jupiter enclave of the DOD's Advana cloud environment.

4 Optimizing Portfolio Level Modernization Investments

Katharina Ley Best[1], Jeremy Eckhause[2], [1]The RAND Corporation, Pittsburgh, PA, [2]RAND Corporation, Arlington, VA, Contact: kbest@rand.org

We introduce the Aim Point Investment Model, an optimization model for portfolio-level resource allocation across U.S. Army programs and time. The model is the result of a study that was looking to develop a method and tool to support quick-turn exploration of modernization investment portfolios in light of changing budget constraints and operational priorities. The study explored alternative approaches to extracting the information needed about programs' relative utility and any constraints on the Army's ability to procure the capability from existing Army data sources. We describe one of these approaches, which uses Army prioritization guidance combined with plausible constraints to produce resource allocation solutions that are consistent with the Army's stated modernization strategy.

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SA13

CC-North 125A

Judgmental Forecasting

Community Committee Choice Session

Session Chair: Jens Witkowski, Frankfurt School, Frankfurt, Germany

1 An Equivalence Between Fair Division and Wagering Mechanisms

Rupert Freeman[1], Jens Witkowski[2], Jennifer Wortman Vaughan[3], David M. Pennock[4], [1]University of Virginia, Charlottesville, VA, [2]Frankfurt School, Frankfurt, Germany; [3]Microsoft Research New York City, New York, NY, [4]Rutgers University, Plainsboro, NJ, Contact: freemanr@darden.virginia.edu

We draw a surprising and direct mathematical equivalence between the class of fair division mechanisms, designed to allocate divisible goods without money, and the class of weakly budget-balanced wagering mechanisms, designed to elicit probabilities. While this correspondence has applications in both settings, we focus on its implications for the design of incentive-compatible fair division mechanisms. In particular, we show that applying the correspondence to Competitive Scoring Rules, a class of wagering mechanisms based on proper scoring rules, yields the first non-trivial incentive-compatible fair division mechanism that is proportional and envy-free. Moreover, for two agents, we show that Competitive Scoring Rules characterize the whole class of non-wasteful and incentive-compatible fair division mechanisms, subject to mild technical conditions.

2 A Heterogeneous Bias-Information-Noise Model of Forecasting Skill and Event Predictability

Ville Satopaa[1], Marat Salikhov[2], [1]INSEAD, Paris, France; [2]New Economic School, Moscow, CT, Russian Federation. Contact: ville.satopaa@insead.edu

The BIN (Bias-Information-Noise) model decomposes differences in predictive performance between two groups of forecasters in terms of bias (systematic deviations from the base rate), information (use of relevant cues), and noise (use of irrelevant cues). In this work, we propose a new model that generalizes the insights of the BIN model by allowing bias, information, and noise to depend on the characteristics of the target event (e.g., the topic, geographical region, etc.) and the forecaster (e.g., intelligence test scores, open-mindedness, gender, etc.). This allows us to understand what kind of forecasters' predictions tend to have low noise, low bias, or high information, and whether certain types of events can exacerbate the negative effects of bias, (lack of) information, or noise.

3 Full Accuracy Scoring Accelerates the Discovery of Skilled Forecasters

Pavel Atanasov[1], Ezra Karger[2], Philip Tetlock[3], [1]IE University, Madrid, Spain; [2]Federal Reserve Bank of Chicago, Chicago, IL, [3]University of Pennsylvania, Philadelphia, PA

Reliable identification of skilled forecasters is time-consuming—learning which forecasters are consistently accurate, rather than lucky—may take months or years. To accelerate skill-spotting, we propose the Full Accuracy Score (FAS). It combines classic Brier scores on resolved questions with proper proxy scores on unresolved ones. The latter involve comparing individual with consensus estimates. Using data from two forecasting tournaments (ACE & HFC), we show that FAS outperforms classic Brier scores in predicting final performance scores from early data. FAS is also more effective at early spotting of top forecasters. Using elite crowds and advanced algorithms for deriving consensus estimates further improves FAS performance.

4 Willingness to use Ai and Algorithmic Dss in Judgment and Reasoning

Johannes Müller-Trede[1], Gwendolin Sajons[2], Elena Shvartsman[3], [1]IESE Business School, Barcelona, Spain; [2]ESCP Business School, Berline, Germany; [3]WHU Business School, Vallendar, Germany. Contact: jmuller@iese.edu

We report a series of experiments that assess people's reliance on AI and other algorithmic decision support systems in a judgment and a reasoning task. Our results suggest that people willingly rely on AI/DSS when they expect that doing so should improve their performance on the task. In contrast with prior findings, we do not find evidence for a generalized aversion to using AI/DSS or evidence for people avoiding AI/DSS (more so than decision support coming from another person) after observing the AI/DSS make mistakes. Our findings indicate that people's reliance on AI and other algorithmic decision support systems may be both simpler in theory and more diverse in practice than suggested by previous research.

5 Necessary and Sufficient Winners of Forecasting Competitions

Gerdus Benade[1], Jens Witkowski[2], [1]Boston University, Brookline, MA, [2]Frankfurt School, Frankfurt, Germany. Contact: j.witkowski@fs.de

Forecasting competitions rank forecasters by the accuracy of their probabilistic judgments. Accuracy is typically measured by a proper scoring rule. It is known that different proper scoring rules lead to different rankings. But how much wiggle room is there? Will the same forecaster typically win no matter the choice of proper scoring rule or can practically every forecaster be made the winner for the right choice of proper rule? I report on work in progress addressing this question both theoretically and empirically, devising an algorithm to evaluate it on real-world data.

Sunday, October 15, 8:00 AM - 9:15 AM

SA14

CC-North 125B

Renewable Power, Energy Innovation, and Storage

Community Committee Choice Session

Session Chair: Christian Kaps, Harvard Business School, Boston, MA

1 Low Battery: Exploring Paths Toward a Renewable Electric Grid

Thomas Palley[1], Asa Palley[2], Oguz Cetin[3], R. Andrew Butters[4], Jackson Dorsey[5], [1]Indiana University, Bloomington, IN, [2]Indiana University, Bloomington, IN, [3]Kelley School of Business, Bloomington, IN, [4]Indiana University, Bloomington, IN, [5]University of Texas at Austin, Austin, TX, Contact: tpalley@iu.edu

Policymakers and utilities have set near-zero carbon targets over the next few decades for electricity generation, indicating substantial investments in renewables and utility-scale storage. We evaluate the cost side of decarbonization transition paths, constructing a model of both short-term operational decisions and long-term capacity investment. Using detailed data from the Texas Interconnection, we model optimal operational and investment decisions for a range of carbon taxes. Our results suggest that the costs associated with moderate to high targets of 70-80% reduction in carbon emissions are low and consistent with recent estimates of the social cost of carbon. However, costs rise exponentially for higher targets. Surprisingly, battery storage remains too expensive to justify investment for any emissions reduction target below 90% over the next 20 years.

2 Quality Adjusted Power Value: A New Way To Locate Renewable Energy Generation

Vishrut Rana[1], Christian Kaps[2], Serguei Netessine[1], [1]The Wharton School, Philadelphia, PA, [2]Harvard Business School, Cambridge, MA, Contact: vishrut@wharton.upenn.edu

Global investments in renewable energy generation are expected to rise due to growing policy support, energy security concerns, and cost competitiveness. In this scenario, selecting renewable generation plant locations using existing ad-hoc approaches poses challenges arising from the failure to capture impacts of time and location of electricity generation. As a remedy, we propose a new site selection metric - Quality Adjusted Power Value - which accounts for time and location of generation and measures impacts on electricity market clearing prices. We validate this

methodology to locate wind turbines in Texas under different development goals using high-granularity wind-speed and transmission infrastructure data.

3 Electricity Pricing Rules for Residential Solar Plus Storage: Economic and Environmental Impacts

Sinan Yorukoglu[1], Nur Sunar[1], Jayashankar M. Swaminathan[2], [1]University of North Carolina at Chapel Hill, Chapel Hill, NC, [2]University of North Carolina Chapel Hill, Chapel Hill, NC

We analyze the impacts of common pricing rules for residential solar plus storage customers on environment, utility profit and customer benefit. Using a large-scale dataset from California, we quantify these impacts. Our paper shows that prominent practical insights may fail depending on the adoption level of residential solar-plus-storage technology.

4 Distributed Energy Orchestration: Models And Empirics

Margaret Redfield, Omer Karaduman, Xu Kuang, Stanford Graduate School of Business, Stanford, CA, Contact: margred@stanford.edu

The alignment of energy demand and supply is expected to be increasingly challenging in the presence of intermittent renewable generation. Distributed energy orchestration (DEO), the management of demand-colocated generation and storage, presents a promising solution. We build a model to study the best practices when deploying and operating these systems. Using a highly granular household-level dataset from Australia, we quantify the value of DEO under different policy and operating scenarios. Our main results highlight the value of real-time price exposure and show that the value of coordination among storage units heavily depends on price signal precision.

Sunday, October 15, 8:00 AM - 9:15 AM

SA15

CC-North 126A

Cybersecurity Analytics

Community Committee Choice Session

Session Chair: Ankit Shah, 1</sup

Session Chair: Soumyadeep Hore, USF IMSE, Tampa, FL

1 A Deep Reinforcement Learning Framework for Adversarial Example Generation to Deceive Network Intrusion Detection Systems

Soumyadeep Hore[1], Jalal Ghadermazi[1], Diwas Paudel[1], Ankit Shah[1], Tapas K. Das[1], Nathaniel D. Bastian[2], [1]University of South Florida, Tampa, FL, [2]United States Military Academy, West Point, NY, Contact: soumyadeep@usf.edu

Advancements in AI/ML algorithms have enhanced the security posture of cybersecurity operations centers (CSOCs). Concurrently, adversaries' abilities to evade security have also increased with the support of AI/ML models. Therefore, CSOCs must proactively prepare for evasion attacks exploiting ML-based network intrusion detection systems (NIDS). In this talk, we present an AI framework powered by deep reinforcement learning to generate adversarial examples that can deceive ML-based NIDS while maintaining functionality. Insights from our study on the AI-enabled adversary's ability to make specific evasive perturbations can help CSOCs enhance the robustness of their NIDS against evolving adversarial attacks.

2 Towards Real-Time Network Intrusion Detection with Image-Based Sequential Packets Representation

Jalal Ghadermazi[1], Ankit Shah[1], Nathaniel D. Bastian[2], [1]University of South Florida, Tampa, FL, [2]United States Military Academy, West Point, NY

In this talk, we propose a novel AI-enabled framework for a packet-based network intrusion detection system that effectively analyzes packet data while considering temporal connections among packets. Our framework transforms packets into images and passes them through a network intrusion detector model. Experiments using publicly available data sets indicate that our approach detects various network attacks earlier than flow-based approaches, with a detection rate of 97.7% to 99%.

3 A Novel Team Formation Framework Based on Performance in a Cybersecurity Operations Center

Ankit Shah[1], Rajesh Ganesan[2], [1]University of South Florida, Tampa, FL, [2]George Mason University, Fairfax, VA

A cybersecurity operations center defends an organization from cyber threats through collaborative efforts of different personnel. Ad hoc team formation leads to imbalance and increased risk. We present a framework integrating optimization, simulation, and scoring methods that forms effective and balanced teams with a new collaborative score metric. Our approach selects individuals to form effective teams that meet requirements for each shift. Results from simulated experiments show the formation of effective teams whose collaborative scores are maximized and balanced. Our approach is also able to identify high and low performers within the first few months of implementing the framework.

Sunday, October 15, 8:00 AM - 9:15 AM

SA16

CC-North 126B

MSOM Data-Driven Research Challenge

Panel Session

Session Chair: Tugce Martagan, Eindhoven University of Technology, Eindhoven, Netherlands

Session Chair: Marc Baaijens, Merck Animal Health, Boxmeer, Netherlands

1 Merck: Biomanufacturing Data for the MSOM Data Driven Research Challenge

Tugce Martagan, Eindhoven University of Technology, Eindhoven, Netherlands

To support the MSOM Data Driven Research Challenge, Merck is providing biopharmaceutical manufacturing data to the MSOM community and hosting a research competition. This session will be an interactive session organized by Merck and the MSOM Society. We will begin with a brief introduction to biomanufacturing and discuss current industry needs and challenges. We will then provide an overview of the production data to be shared with the MSOM community, and suggest future research directions at the intersection of operations management and biomanufacturing.

2 Panelist

Coen Dirckx, Merck Animal Health, Boxmeer, Netherlands

3 Panelist

Bram van Ravenstein, Merck Animal Health, Boxmeer, Netherlands

Sunday, October 15, 8:00 AM - 9:15 AM

SA17

CC-North 127A

Human-Algorithm Interaction in OM

Community Committee Choice Session

Session Chair: Eirini Spiliotopoulou, Tilburg University, GH Amsterdam, Netherlands

1 Human Planners with AI Recommendations

Lijia Tan[1], Eirini Spiliotopoulou[2], Willem van Jaarsveld[1], [1]Eindhoven University of Technology, Eindhoven, Netherlands; [2]Tilburg University, Tilburg, Netherlands. Contact: l.tan1@tue.nl

How does an algorithm help human planners' decisions in supply chains? This study focuses on the interaction between human planners and an AI algorithm. We use a laboratory experiment to investigate the effect of the AI algorithm on planners' decisions in a complex decision environment. Our behavioral evidence contributes to the understanding of in which condition the AI would be effective in improving the performance of the human planners.

2 An Empirical Analysis of the Interaction Between Managers and Algorithms

Han Oh[1], Rogelio Oliva[2], [1]Tilburg University, Tilburg, Netherlands; [2]Texas A&M University, College Station, TX

Our research explores the interaction of retail managers and algorithms in a complex, dynamic decision-making environment involving inventory restocking decisions. Using data from a retailer that allows managers to manage and modify the automated stock ordering system, we investigate whether and how store managers influence store performance by interacting with the retailer's information system.

3 GPT and CLT: The Impact of ChatGPT's Abstraction Bias on Consumer Recommendations

Sam Kirshner, UNSW Business School, Sydney, Australia. Contact: s.kirshner@unsw.edu.au

I explore how ChatGPT interprets information through the lens of Construal Level Theory (CLT). My findings show that ChatGPT exhibits an abstraction bias, generating responses consistent with a high-level construal. This abstraction bias results in ChatGPT prioritising high-level construal features (e.g., desirability) over low-level construal features (e.g., feasibility) in consumer evaluation scenarios. Thus, ChatGPT recommendations differ significantly from traditional results based on human decision-making. Applying CLT concepts to large language models provides essential insights into how markets and consumer behaviour may evolve with the increasing prevalence and capability of AI.

4 The Impact of the Fear of Being Replaced by AI on AI-Augmented Decision-Making

SEYYED IMAN MOOSAVI[1], Jan C. Fransoo[2], Prisca Brosi[3], [1]Tilburg University, Tilburg, Netherlands; [2]Tilburg University, Tilburg, Netherlands; [3]Kühne Logistics University, Hamburg, Germany. Contact: s.i.moosavi@tilburguniversity.edu

In addition to various behavioral biases and contextual factors affecting AI-augmented decision-making, emotions play an important role. Across different emotions, the fear of being replaced by an AI system is one of the most reported ones among those who are working with it. Our study draws on psychological literature to explore how the fear of being replaced by an AI system for operations decision-making affects reliance on AI recommendations and decision-making performance. Using an online experiment, we manipulate this emotion by varying the likelihood of the AI system to replace participants in a demand-forecasting task. Participants are informed that they may lose their job and the opportunity for additional bonuses if they fail to improve on the algorithm's suggestion. Our results suggest a significant effect of fear on the AI-augmented decision making process.

5 The Return of "Optimal" Algorithms and Managerial Insight

Blair Flicker, University of South Carolina, Columbia, SC

Human newsvendors have been shown to place suboptimal orders due to several biases (e.g., pull-to-center and overconfidence). But human managers may also be able to *improve* inventory decision making by incorporating insights about the world that are missed by algorithms. I introduce this feature into the newsvendor setting by modeling managerial insight as private demand information accessible to humans but not algorithms. I then develop a method called FIND that consistently mitigates biases and earns more profit than (1) an automated store ordering system (ASOS) that cannot access managerial insight, (2) participants' direct orders, and (3) participants' adjustments to ASOS-generated orders.

Sunday, October 15, 8:00 AM - 9:15 AM

SA18

CC-North 127B

OR Models in Healthcare Systems

Community Committee Choice Session

Session Chair: Ankit Bansal, State University of New York, Binghamton, Binghamton, NY

1 Effective Ways to Evaluate Sources of Infeasibility in Healthcare Scheduling Problems

Daiwen Zhang[1], Amy Cohn[2], [1]University of Michigan, Ann Arbor, Ann Arbor, MI, [2]University of Michigan, Ann Arbor, MI, Contact: dwzhang@umich.edu

Healthcare scheduling problems often have true "hard constraints" (e.g. laws-of-physics like a provider cannot be in two places at one time, regulatory policies governing rest, etc.). In addition, there may be additional constraints that are "required...unless you can't satisfy them." That is, the clinical setting strongly desires certain restrictions, but in rare cases these cannot be achieved. In such cases, "hard constraints" must be violated (with the clinical manager adjusting accordingly, e.g. by hiring moonlighters). Often, there are may different ways to achieve feasibility, i.e. many different subset of feasible constraints that could be honored. We present an integer programming-based algorithm to identify and assist the decision maker in evaluating these sets.

2 Incentives in Outcome-Based Regulation for Lung Transplantation

David Mildebrath[1], Saumya Sinha[2], Taewoo Lee[3], Andrew J. Schaefer[4], Howard J. Huang[5], Ahmed O. Gaber[5], [1]Amazon, Seattle, WA, [2]University of Minnesota, Minneapolis, MN, [3]University of Pittsburgh, Pittsburgh, PA, [4]Rice University, Houston, TX, [5]Houston Methodist Hospital, Houston, TX, Contact: saumya@umn.edu

Transplant programs in the US are subject to outcome-based regulations, whereby federal agencies evaluate them based on their patients' post-transplant survival. Clinical evidence indicates that such regulations induce programs to reject high-risk transplant candidates to avoid penalization. We present a game-theoretic model to study the incentives created by these outcome-based regulations. We show that harsh penalization, more than other factors, incentivizes programs to engage in adverse patient selection. We then propose a pay-for-performance reimbursement scheme that not only penalizes programs with below-average outcomes, but also pays a bonus to those with above-average outcomes. We demonstrate that our proposed scheme can incentivize programs to improve post-transplant outcomes, without inducing adverse patient selection.

3 Minimizing Nurse Anesthetist Intraoperative Handovers

Abhishrut Sinha[1], Ankit Bansal[2], Osman Ozaltin[3], Michael Russell[4], [1]State University of New York, Binghamton, Binghamton, NY, [2]State University of New York, Binghamton, Binghamton, NY, [3]North Carolina State University, Raleigh, NC, [4]West Virginia University School of Medicine, Morgantown, WV

Intraoperative handovers among Certified Registered Nurse Anesthetists (CRNAs) are susceptible to medical errors that can result in adverse health outcomes. We present a two-stage stochastic optimization model for assigning CRNAs to Operating Rooms. The model aims to minimize the number of intraoperative handovers by considering the operational constraints of the system and uncertainty in surgery times. Computational results using real data from a hospital system are presented to demonstrate the effectiveness of the proposed approach.

4 Optimizing Health and Social Care for Individuals in Complex Care Programs

Sindhoora Prakash, Hari Balasubramanian, University of Massachusetts, Amherst, MA

Patients with multiple chronic conditions, as well as unmet social needs, have significantly higher healthcare costs and utilization. Holistic, person-centered care interventions, often led by a multidisciplinary team consisting of nurses, community health workers, and social workers, have emerged as a strategy to engage with and help improve the health and well-being of such patients. The objective of these interventions is to reduce the occurrence of unnecessary hospitalizations and overall healthcare costs. In this talk, we highlight the potential benefits of using simulation, patient similarity, and mixed integer linear programming to estimate and optimize the allocation of health and social care services to patients, while minimizing their waiting times and the week-to-week (or day-to-day) variation in staff hours required.

Sunday, October 15, 8:00 AM - 9:15 AM

SA19

CC-North 127C

Funding HAS Research

Panel Session

Session Chair: Amin Khademi, Clemson University, Clemson, SC

1 Funding HAS Research

Amin Khademi, Clemson University, Clemson, SC

We will have a Panel discussion on health care research funding, collaboration, and future trends and opportunities.

2 Panelist

Andrew J. Schaefer, Rice University, Houston, TX

3 Panelist

Maria Esther Mayorga, North Carolina State University, Raleigh, NC

4 Panelist

Oguzhan Alagoz, University of Wisconsin-Madison, Madison, WI

5 Panelist

Ozlem Ergun, Northeastern University, Newton, MA

Sunday, October 15, 8:00 AM - 9:15 AM

SA20

CC-North 128A

Clinical Decision Making for Chronic Disease

Community Committee Choice Session

Session Chair: Jennifer Mason Lobo, University of Virginia, Charlottesville, VA

Session Chair: Hyojung Kang, University of Illinois at Urbana-Champaign, Champaign, IL

1 Optimize the Utilization of Peer Recovery Support Services with Limited Capacity: Take a New Patient or Follow up Existing Patients?

Qiushi Chen, Siyi Huang, Paul Griffin, The Pennsylvania State University, University Park, PA, Contact: q.chen@psu.edu

Over 100,000 Americans are dying from drug overdoses in one year. Although there are evidence-based treatments for substance use disorders, treatment initiation and retention remain low. Certified peer recovery support specialists are underutilized resources for improving the quality of substance use services in the hospital setting. In this study, we study a capacity management problem in peer recovery support services. We develop a Markov decision process model to optimize the early discharge decisions, aiming to efficiently utilize the limited capacity of peer recovery specialists to maximize the total treatment outcomes for patients with substance use disorders who had a hospital encounter. We analyze the optimal structure of discharge policy and evaluate multiple policies via a detailed simulation model in the computational study.

2 Estimating Chronic Kidney Disease Stages For Patients With Small Renal Masses And Influential Factors Using The Expectation-Maximization Algorithm

Wendy Qi[1], Jennifer Mason Lobo[2], Noah S. Schenkman[3], [1]University of Virginia, Charlottesville, VA, [2]University of Virginia, Charlottesville, VA, [3]University of Virginia, Charlottesville, VA, Contact: wq3vn@virginia.edu

Management of small renal masses involves cancer control and preservation of renal function. Estimation of future renal function values is challenging given that measurements are taken at uneven intervals. We employ the Expectation-Maximization algorithm to estimate the renal function transition probabilities, and extend our study to analyze how age, gender, Charlson Comorbidity Index, obesity, diabetes, and cardiovascular disease affect transition rates. Results illuminate the dynamic interplay between these factors and renal function transitions. Our findings improve understanding and interpretation of renal function transitions for patients and clinicians, enhancing clinical decision-making and informing treatment planning.

3 Prediction of Anti-Diabetic Medication Adherence Using Temporal Machine Learning Models

Peng Zhang[1], Hyojung Kang[2], Min-Woong Sohn[3], Jennifer Mason Lobo[4], [1]University of Illinois Urbana-Champaign, Urbana, IL, [2]University of Illinois at Urbana-Champaign, Champaign, IL, [3]University of Kentucky, Lexington, KY, [4]University of Virginia, Charlottesville, VA, Contact: pengz3@illinois.edu

Medication adherence rates are suboptimal among individuals with diabetes. Using Medicare data for patients with diabetes, this study aims to develop temporal machine learning models to predict anti-diabetic medication non-adherence and identify related risk factors. Study findings will help identify high-risk patients for medication non-adherence and inform targeted patient management strategies.

4 Analytical Modeling In The Emergency Department When The Class Of Interest Is Dynamic

M Gabriela Sava[1], Jerrold H. May[2], Ronald G. Pirrallo[3], [1]Clemson University, Clemson, SC, [2]University of Pittsburgh, Skokie, IL, [3]Prisma Health System / University of South Carolina School of Medicine Greenville, Greenville, SC, Contact: msava@clemson.edu

Diabetic screening of Emergency Department (ED)/Urgent Care (UC) patients can proactively improve health outcomes, but it is uneconomic to screen all such patients. We present a data-driven analytical approach, using near-time EHR data and clinical predictors recommended by the ADA, that could assist physicians with the yes/no diabetes screening decision. The approach is capable of dynamically switching among the appropriate statistical models as resource availability and patient frequency utilization change over time.

Sunday, October 15, 8:00 AM - 9:15 AM

SA21

CC-North 128B

Emerging Topics in Empirical Healthcare

Community Committee Choice Session

Session Chair: Yuqian Xu, UNC-Chapel Hill Kenan-Flagler Business School, Chapel Hill, NC

Session Chair: Shuai Hao, University of Illinois Urbana-Champaign, Champaign, IL

1 Matching Patients with Surgeons: Heterogeneous Effects of Surgical Volume on Surgery Duration

Behrooz Pourghannad[1], Guihua Wang[2], [1]Lundquist College of Business, University of Oregon, Eugene, OR, [2]The University of Texas at Dallas, RICHARDSON, TX, Contact: behroozp@uoregon.edu

This paper explores the potential of utilizing patient-specific information to enhance a hospital's operational efficiency, focusing on abdominal surgery as the clinical setting. We use the causal forest approach to obtain patient-specific volume effects, which are then used in an optimization model to evaluate the potential value of patient-specific information in improving a hospital's operational efficiency. We show that considering patient-specific volume effects in matching patients with surgeons could reduce surgery duration by 3% to 18%.

2 The Impact of Online Self-Scheduling on Patient Access to Hospital Services

Lesley Meng[1], Hummy Song[2], Christian Terwiesch[3], [1]Yale School of Management, Yale University, New Haven, CT, [2]The Wharton School, University of Pennsylvania, Philadelphia, PA, [3]University of Pennsylvania, Philadelphia, PA, Contact: lesley.meng@yale.edu

Recent innovation in healthcare access has led to the launch of online patient platforms where patients are now able to digitally schedule and manage their own medical appointments within a health system. In many large academic medical centers, digital scheduling has become the default method for patients to request and schedule appointments, and many medical appointments are now made this way. In this study, we examine the impact of online self-scheduling access on patient scheduling and visit behavior at a large academic medical center.

3 What Drives Algorithm Use? An Empirical Analysis of Algorithm use in Type 1 Diabetes Self-Management

Wilson Lin[1], Song-Hee Kim[2], Jordan D. Tong[3], [1]Santa Clara University, Santa Clara, CA, [2]Seoul National University, Gwanak-gu, Korea, Republic of; [3]University of Wisconsin Madison, Madison, WI

Advancements in algorithms hold promise to better operations by improving users' decision-making. However, people sometimes fail to use algorithms, which could be a barrier from achieving such improvements. Using the bolus calculator (algorithm) use behavior from a field experiment on type 1 diabetes self-management, we show that 1) previous algorithm use increases future algorithm use, 2) being out of target with self-driven decisions increases subsequent algorithm use, while being out of target with algorithm-driven decisions does not impact algorithm use, 3) increasing the number of measurements provided to the user for a single algorithm input decreases algorithm use, 4) increasing one's need for precision increases algorithm use and 5) previous deviations from algorithm recommendations decrease future algorithm use.

4 Acquisition Of AI And Analytics Capabilities: Shareholder Value For Biopharmaceutical Firms

Jiatao Ding[1], Michael Freeman[1], Niyazi Taneri[2], [1]INSEAD, Singapore, Singapore; [2]Cambridge Judge Business School, Cambridge, United Kingdom

Biopharmaceutical companies are increasingly venturing into collaborations involving AI and analytics. These strategic alliances, aimed at improving drug candidate selection, speeding up development, and augmenting sales, are especially crucial in an industry challenged by low success rates and the patent cliff. Our in-depth analysis reveals that such AI-analytics partnerships not only bolster shareholder value on average but show particularly strong returns when centered on prelaunch R&D or targeting multiple indications. Furthermore, firm-specific traits, like R&D intensity and asset turnover, significantly moderate these outcomes. Our findings provide guidance to biopharmaceuticals seeking to optimize operations through AI and analytics.

Sunday, October 15, 8:00 AM - 9:15 AM

SA22

CC-North 129A

Empirical Healthcare

Community Committee Choice Session

Session Chair: Christopher J. Chen, Indiana University Kelley School of Business, Bloomington, IN

Session Chair: Kraig Delana, University of Oregon, Eugene, OR

1 Can Employees' Past Helping Behavior be Used to Improve Shift Scheduling? Evidence from ICU Nurses

Zhaohui Jiang[1], John M. Silberholz[2], Yixin Iris Wang[3], Deena Costa[4], Michael Sjoding[5], [1]Carnegie Mellon University, Pittsburgh, PA, [2]University of Michigan Ross School of Business, Ann Arbor, MI, [3]University of Illinois at Urbana-Champaign, Champaign, IL, [4]Yale School of Nursing, New Haven, CT, [5]Michigan Medicine, Ann Arbor, MI

Employees routinely make valuable contributions at work that are not part of their formal job description, such as helping a struggling coworker. However, the degree to which the past helping behavior of employees scheduled to a shift impacts that shift's operational outcomes remains an under-explored question. Our empirical results indicate that shift-level past helping measures are predictive of patient length of stay (LOS), more so than the broadly studied notion of team familiarity. Counterfactual analysis shows that relatively small changes in shift composition can yield a significant reduction in total LOS. Overall, our study suggests the potential value of shift scheduling using data on past helping behaviors, which may have promise far beyond the selected application to ICU nursing.

2 The Role of Physician Integration in Alternative Payment Models: The Case of the Comprehensive Joint Replacement Program

Christopher J. Chen[1], Kraig Delana[2], [1]Indiana University Kelley School of Business, Bloomington, IN, [2]University of Oregon, Eugene, OR

U.S. physicians are increasingly unifying (both horizontally and vertically) while transitioning from fee-for-service to alternative payment models (APM). We empirically examine the role of both horizontal and vertical integration of orthopaedic surgeons in driving heterogeneity in the impact of the Comprehensive Joint Replacement (CJR) alternative payment program. We find CJR hospitals with high horizontal and vertical integration see an increase in both hospital costs and risk-adjusted complication rates of 3.17% & 1.18, respectively. Moreover, we present evidence showing integration affects physician care decisions regarding length-of-stay and discharge disposition. Our findings provide novel insights into provider integration and clinical decisions that are relevant for policymakers, payors, and healthcare providers.

3 Community/Committee'S Choice Submission

Lina Song, University College London School of Management, London, United Kingdom

4 Improving Family Authorizations for Organ Donation via Budget-Neutral Contracts

Paola Martin[1], Diwakar Gupta[2], [1]Indiana University, Bloomington, IN, [2]University of Texas, Austin, TX, Contact: martipa@iu.edu

The successful recovery of deceased-donor organs depends on whether the donor hospital (DH) referred on time. Whereas Organ Procurement Organizations (OPOs) receive a standard fee for each transplanted organ, DHs do not receive compensation for referring in a timely manner.

We analyze a budget-neutral incentive scheme that could increase the proportion of timely referrals. A calibrated numerical study shows that, depending on the DH's cost of effort required to increase the proportion of timely referrals, the proposed contract could lead to 1.3% more viable donors annually. Extending the same approach to all referrals received by the OPO could increase the number of viable donors by 9% annually.

Sunday, October 15, 8:00 AM - 9:15 AM

SA23

CC-North 129B

OM-Marketing Interface

Community Committee Choice Session

Session Chair: Michael Galbreth, University of Tennessee, Knoxville, TN

Session Chair: Bikram Ghosh, 1</sup

1 Social Product Feedback and Consumer Returns

Michael Galbreth[1], Bikram Ghosh[2], [1]University of Tennessee, Knoxville, TN, [2]University of Arizona, Tucson, AZ

We present insights from an analytical model of consumer returns that explicitly considers the impact of social product feedback (e.g. online user reviews) on consumer purchase and return decisions. Our results provide guidance regarding how the social feedback posted, and the manner in which consumers process that feedback, should impact optimal retailer strategies.

2 Product Return Policies: The Impacts of Vertical Bargaining and Contracting with Retail Competition

Chengzhang Li[1], Yufei Huang[2], Tingliang Huang[3], [1]Shanghai Jiao Tong University, Shanghai, China; [2]Trinity Business School, Trinity College Dublin, Dublin, Ireland; [3]The University of Tennessee-Knoxville, Knoxville, TN, Contact: cz.li@sjtu.edu.cn

We study the money-back guarantee (MBG) policies in distribution channels consisting of a manufacturer and two competing retailers. We adopt a multi-unit bilateral bargaining framework to flexibly capture the unbalanced power distributions among firms. We find that both bargaining power and contract forms are the key determinants of MBG policies. In symmetric distribution channels, i.e., both retailers possess the same bargaining power, while both retailers offer MBGs under the wholesale-price contract, the asymmetric MBG decisions arise when retailers are relatively powerful under the two-part tariff contract. When the retailers possess different bargaining powers, the retailer is less powerful in negotiation with the manufacturer than the other provides an MBG while the other may not.

3 A Field Experiment on AI-Assisted Physicians

Ting Hou[1], Meng Li[2], Yinliang Tan[2], Huazhong Zhao[3], [1]University of Science and Technology of China, Pearland, TX, [2]University of Houston, Houston, TX, [3]City University of Hong Kong, Kowloon, NY, Hong Kong

We collaborate with a leading healthcare platform to run a field experiment in which we compare physicians' adoption behavior, i.e., adoption rate and adoption timing, of smart and automated AI assistants under transparent and non-transparent conditions.

Sunday, October 15, 8:00 AM - 9:15 AM

SA24

CC-North 130

MSOM Student Paper Competition Session 1

Award Session

Session Chair: Ersin Korpeoglu, University College London, London, United Kingdom

1 Should We All Work in Sprints? How Agile Project Management Improves Performance

Tobias Lieberum, Technical University of Munich, München, Germany

2 Sooner or Later? Promising Delivery Speed in Online Retail

Zhikun Lu, Emory University, Decatur, GA

Problem definition: Online retailers have to provide customers with an estimate of how fast an order can be delivered before they decide to make the purchase. Retailers can strategically adjust this delivery speed promise online without changing offline infrastructure, and doing so may fundamentally impact business outcomes. It can influence consumers' purchasing decisions and postpurchase experiences, often in the opposite direction. On one hand, an aggressive (i.e., faster) delivery estimate could ensure that more customers meet their deadlines and thus, may increase their purchases ex ante. On the other hand, an aggressive estimate tends to overpromise, potentially leading to a longer than expected wait time, which can lower customer satisfaction and increase product returns ex post. In this research, we estimate the causal effect of retailers' delivery speed promise on customer behaviors and business performance. Methodology/results: Collaborating with Collage.com, an online retailer that sells customized photo products across the United States, we exogenously varied the disclosed delivery speed estimates online while keeping the physical delivery speed unchanged. Using the difference-in-differences identification strategy, we find that a faster promise increases sales and profits, but it also increases product returns and reduces customer retention. In addition, we propose a data-driven model that uses the estimated parameters to optimize delivery promises to maximize customer lifetime value. Managerial implications: Our findings provide managerial insights and a data-driven policy that retailers can leverage to optimize and customize their delivery promises.

3 Food Subsidies at the Base-of-the-Pyramid: Take-up, Substitution Effects and Nutrition

Alp Sungu, London Business School, London, United Kingdom

Sunday, October 15, 8:00 AM - 9:15 AM

SA25

CC-North 131A

Issues in Retail Operations Management

Community Committee Choice Session

Session Chair: Eda Kemahlioglu Ziya, NC State University, Raleigh, NC

Session Chair: Mert Çetin, IESE Business School, Barcelona, Spain

1 Store-Specific Assortments in the Presence of Product Constraints

Mert Cetin, Victor Martinez de Albeniz, IESE Business School, Barcelona, Spain. Contact: MCetin@iese.edu

When allocating products to brick-and-mortar stores, retailers face product availability constraints which force them to balance product offerings across stores. We model this problem and show that the product-store assignment problem is NP-complete under a multinomial logit (MNL) type demand. We develop a tractable continuous relaxation of the problem which has a unique local maximum and allows us to build near-optimal solution algorithms. We then apply our algorithms to mixed-MNL and nested-MNL type demand structures, and conduct extensive numerical analyses on their performances. We further offer an application using real data from a large multinational apparel retailer where we estimate model parameters and run the approximation algorithms. We identify a significant revenue increase potential by matching the right products with the right stores.

2 Online Product Display Optimization

Alara Tasçioglu, Gürhan Kok, Selcuk Karabati, Koc University, Istanbul, Turkey

We consider an online retailer with a diversified product portfolio serving multiple customer segments. Our goal is to determine optimal product rank, location and page layout in the first page of an online store to maximize expected profit margin per consumer. We allow product locations to be of different sizes and shapes within the first page of the online store by "combining" the smallest sized locations into "combined locations".We model the revenue impact of product rank, location and page layout with an extended Multinomial Logit Model. Our model's parameters include a location weight and a space elasticity weight that helps us determine larger positions' weights. We then approximate our model with a simpler profit margin-based search heuristic. Our numerical study shows a 34.7% increase in expected profit margin per customer by introducing "combined locations".

3 Inventory Reservation and Allocation for Multi-Item Orders with Uncertain Supply Lead Times and Demand Patterns

Aaron Huang Jinjia[1], Stanley Lim[2], Chung Piaw Teo[3], [1]Institute of Operations Research and Analytics, Singapore, Singapore; [2]Michigan State University, East Lansing, MI, [3]National University of Singapore Business School, Singapore, Singapore. Contact: oraahj@nus.edu.sg

We develop an efficient inventory reservation and allocation policy to fulfill multi-item orders in a warehouse. We account for correlated demand patterns and forecast order-level supply lead times by using machine learning techniques. We demonstrate the efficacy of the proposed approach using transaction and supply data from a furniture retailer.

Sunday, October 15, 8:00 AM - 9:15 AM

SA26

CC-North 131B

Risk Management in Production and Agriculture Supply Chains

Community Committee Choice Session

Session Chair: Mert Hakan Hekimoglu, Rensselaer Polytechnic Institute, Troy, NY

1 Cascading Effects of Climate Change in Production Networks: Evidence from Extreme Weather Events

Sai Palepu[1], Brian Clark[2], Bill Francis[1], [1]Rensselaer Polytechnic Institute, Troy, NY, [2]Lally School of Management, RPI, Troy, NY, Contact: paleps@rpi.edu

We investigate climate change-induced economic spillovers in the production networks. We exploit the billion-dollar hurricanes as natural exogenous shocks to these networks. We demonstrate the role of supply-chain linkages in the propagation of climate change-induced economic spillovers and highlight the role of network centrality in moderating these negative effects in production networks. Our event studies during hurricanes show that customers who have suppliers in the disaster-affected zone experience a 15% decline in average cumulative abnormal returns compared to customers who do not have suppliers in the same zone. However, the centrality of the firms in the networks moderates this relative decline by approximately 3.5%. Further, we find that climate risk spillovers are unidirectional and propagate from suppliers to customers and not vice-versa.

2 VinTech: Robo-Advising Using Wine Analytics

Mert Hakan Hekimoglu[1], Burak Kazaz[2], [1]Rensselaer Polytechnic Institute, Troy, NY, [2]Syracuse University, Syracuse, NY, Contact: hekimm@rpi.edu

This paper examines a comprehensive path regarding how analytics can be employed for automated trading of wine. We coin this as VinTech. The paper highlights the essential components of data analytics necessary for robo-advising. We first develop a pricing algorithm to represent the realistic value of a wine. Using this algorithm, we then compare the price evolution of underpriced wines to overpriced wines. Last, our robo-advising algorithm constructs wine portfolios for different investment goals and risk preferences. We demonstrate the performance of our algorithm using out-of-sample testing. This paper aims to convert an opaque market into a transparent and efficient investment market.

3 Developing Smart Supply Chain Contracts Using Data Analytics and Block Chain Models

Sevilay Onal[1], Sanchoy Das[2], Chandra Adhikari[1], Tripathi Shashank[1], [1]University of Illinois Springfield, Springfield, IL, [2]New Jersey Institute of Technology, Newark, NJ, Contact: sevilayonal@gmail.com

The three main elements of a supply chain contract are price, quantity, and supply lead time. Supply chain risk is a function of these three elements and managers are constantly monitoring this to minimize supply risks. A smart supply chain contract is designed to monitor several data parameters across the supply chain, and then use intelligent decision models to trigger actions before the perceived risk causes supply chain disruptions. This research will use a survey method to (i) Identify risk sensitive data parameters that can be tracked in real-time at one or more supply chain nodes (Examples: inventory levels, market price data), and (ii) Develop decision triggers models that relate the tracked data to risk quantification models. The trigger models are amenable to blockchain analysis, and the research will investigate how this approach will provide superior results.

4 Risk Sharing in a Two-Level Supply Chain with Variable Capacity and Random Yield

Xiao Xiao[1], Xiang Fang[2], [1]University of Wisconsin Milwaukee, Milwaukee, WI, [2]University of Colorado Denver, Denver, CO

The research on production uncertainty in the supply chain holds tremendous significance in the complex and interconnected business environment. Supply chains are affected by various uncertainties, including demand fluctuations and supply disruptions. Based on three centralized supply chains and three decentralized supply chains, this study examines two types of production uncertainty: Variable Capacity (VC) and Random Yield (RY), and the impact they have on supply capability, relationships among supply chain members, behavior, and performance. RY arises from imperfect processes and is predictable and measurable. In contrast, VC is caused by random factors like unforeseen interruptions and unplanned maintenance, making it uncontrollable. Our research findings indicate that VC and RY do not always affect production and ordering decisions in certain cases.

Sunday, October 15, 8:00 AM - 9:15 AM

SA27

CC-North 131C

Managing Customer/Patient Experience in Service

Community Committee Choice Session

Session Chair: Nan Liu, Boston College, Chestnut Hill, MA

1 Under-Promising and Over-Delivering to Improve Patient Satisfaction at Emergency Departments

Sina Ansari[1], Laurens G. Debo[2], Maria R. Ibanez[3], Seyed Iravani[4], [1]Driehaus College of Business, DePaul University, Chicago, IL, [2]Dartmouth College, Hanover, NH, [3]Kellogg School of Management at Northwestern University, Evanston, IL, [4]Northwestern University, Evanston, IL,

Contact: sina.ansari@depaul.edu
The study explores how emergency departments (EDs) can improve patient satisfaction and financial performance by communicating wait times. By providing patients with personalized estimated wait times, the study finds that patients report 21% higher satisfaction. Overestimating wait times moderately (70th percentile) can further improve patient satisfaction and can be a cost-effective strategy for EDs. This approach can be especially useful in settings where queues are partially observable.

2 Queueing Causal Models for Comparative Analytics in Service Systems

Opher Baron[1], Dmitry Krass[2], Mark van der Laan[3], Arik Senderovich[1], Zhenghang Xu[1], [1]University of Toronto, Toronto, ON, Canada; [2]Rotman School of Management, University of Toronto, Toronto, ON, Canada; [3]University of California, Berkeley, Berkeley, CA, Contact: zhenghang.xu@mail.utoronto.ca
Simulation is a powerful tool for comparative analysis of queueing models. With expert knowledge of underlying system structure, simulator can be constructed to predict intervention effects. However, such manual construction is time- and skill-demanding. It could also be subjective - if expert failed to note an important system feature (e.g. different customer types receiving different service priorities), the model will not be accurate. As an alternative, we propose a data-driven representation of system building blocks, justified by G-computation formula. We describe the queueing data generation process with structural equations and apply machine learning models to fit the equations. Through numerical experiments, we show that this approach can replace the explicit queueing dynamics and capture intervention effect in overtake-free queues.

3 The Role of Artificial Intelligence (AI) Technologies in Service Process Design

Chia-Chun Yang, Craig Froehle, University of Cincinnati, Cincinnati, OH, Contact: yangcc@mail.uc.edu
As organizations deploy AI-powered "chatbot" technologies in customer-facing service roles, we need to better understand how they affect customers' experiences. Historically, customers have tended to be wary of automated service technologies as they often perceive them to offer little value. Modern chatbots promise previously unrealized levels of personalization and responsiveness, which may convince customers they are reasonable substitutes for human reps in many cases. How will customers' expectations of, and experiences with, chatbots drive their satisfaction with the service experience? This research empirically investigates this behavioral operations issue using a mix of survey and experimental methodologies across multiple studies.

4 Design of Patient Visit Itineraries in Tandem Systems

Nan Liu[1], Guohua Wan[2], Shan Wang[3], [1]Boston College, Chestnut Hill, MA, [2]Shanghai Jiao Tong University, Shanghai, China; [3]Sun Yat-sen University, Guangzhou, China. Contact: nan.liu@bc.edu
Multi-stage service is common in healthcare. One widely adopted approach to manage patient visits in multi-stage service is to provide patients with visit itineraries, which specify individualized appointment time for each patient at each service stage. We develop the first optimization modeling framework to design such visit itineraries. We show that a well-designed patient visit itinerary, which carefully addresses the interdependence among stages, can significantly improve patient experience and provider utilization. A case study populated by data from a large cancer institute shows that our approach makes a remarkable 27% cost reduction over practice on average.

Sunday, October 15, 8:00 AM - 9:15 AM

SA28

CC-North 132A

Incentives, Contracts, and Mechanisms for Service Operations

Community Committee Choice Session

Session Chair: Xiaohan Zhu, University of Florida, Gainesville, FL

1 Creating an Incentive Compensation Plan for a Project

Xiaohan Zhu, University of Florida, Gainesville, FL, Contact: zhuxiaohan@ufl.edu
This presentation investigates a principal-agent problem that arises in a collaborative project between a principal and an agent. The project is sponsored by the principal, who hires an agent to dedicate effort towards managing the project. The project does not have a fixed deadline but rather a predetermined target. Once the project reaches the target, it is considered complete. The principal's revenue is generated upon the completion of the project, while the agent is entitled to a lump-sum payment upon its completion as well. The agent's effort can be categorized into two types: base and additional effort. The base effort represents the minimum effort required by the principal, whereas the agent

has the freedom to determine the level of additional effort he chooses to contribute. The more additional effort the agent puts in, the faster the project is expected to be completed.

2 Customer Scheduling in Large Service Systems Under Model Uncertainty

SHIWEI Chai, GAINESVILLE, FL

Current studies on scheduling in the context of many-server queues typically rely on simplified assumptions such as exponential and class-independent service time, which is usually inconsistent with real-world data. While relaxing these assumptions can result in a high-fidelity model, it can be complex and difficult to solve. In this paper, we present a new approach for decision makers to generate high-quality scheduling policies through a robust formulation. We demonstrate through a numerical study based on a US call center dataset that our approach can achieve cost savings of 10% to 20% compared to an established benchmark in the literature.

3 Optimal Contract Design with Two-Layer Signals

Qingye Wu, Xiaoshuai Fan, Southern University of Science and Technology, Shenzhen, China

Live commerce contract emerge on platforms like Taobao.com. An implication of such contract is retailers grant hosts authority to send product signal to consumers by paying commission costs. We build a game-theoretical model to explore when and why a retailer contracts with a host. Without the contract, the retailer personally conveys product signal at no extra cost. Signal affects senders' reputation, defined as consumers' perception of signal accuracy. Our findings indicate that when the retailer possesses a low initial reputation, a high-quality retailer can effectively differentiate his type himself. Moreover, when retailer's reputation is moderate, a high-quality retailer can prevent imitation through contract adoption while a low-quality retailer chooses not to contract to mitigate reputation loss especially when consumers lack confidence in high quality.

4 Partial Information Sharing In Competitive Markets

Xiao Wei, Tsinghua University, Beijing, China

This paper studies a Cournot competition problem with two firms, each of which can observe a private signal about the uncertain market demand and decide how to share this signal. We formulate a linear optimization problem to model incentive compatible information sharing mechanisms based on the framework of Bayesian games with communication. We propose a specific information sharing mechanism to provide guidance on firms' operations. To evaluate whether our proposal is close to optimal, we also construct an upper bound for the optimal result. We show that generally, it is nearly optimal for firms to share nothing. However, when the signal is accurate, the market uncertainty is high, and the prior belief of high demand is low, our mechanism provides firms an approach to implement partial information sharing that can outperform no sharing.

Sunday, October 15, 8:00 AM - 9:15 AM

SA29

CC-North 132B

Supply Chain: Security/Sustainability Information/ Disclosure

Community Committee Choice Session

Session Chair: Hyoduk Shin, UC-San Diego, La Jolla, CA

1 How Do Producers Fare with Fair Trade?

Yen-Ting (Daniel) Lin[1], Adem Orsdemir[2], Ying Zhang[3], [1]University of San Diego, San Diego, CA, [2]University of California Riverside, Riverside, CA, [3]Clemson University, Clemson, SC, Contact: linyt@sandiego.edu

In this paper, we examine the impact of fair trade certificate on a fair trade retailer's decisions, profitability and participating producers' welfare. We also examine a retailer's choice between fair trade and direct trade, which is another common socially responsible sourcing strategy.

2 Understanding the Competitive Sales Impact of Automobile Features in New and Used-Car Markets

Hojun Choi[1], Ahmet Colak[2], Sina Golara[3], Achal Bassamboo[1], [1]Northwestern University (Kellogg), Evanston, IL, [2]Clemson University, Clemson, SC, [3]Kennesaw State University, Marietta, GA

The automotive industry is highly competitive, prompting manufacturers and dealerships to constantly make efforts to cater to consumer preferences and lifestyles through features. These features are optional and increase product attractiveness. However, the impact of these features on sales performance remains uncertain. This study examines the influence of car features on revenue rates and sales times for new and used-car segments, using Cars.com dataset. We propose an economic framework to quantify feature values and estimate their impact. Results indicate that features explain 70% price variations. New cars with lower feature values yield higher revenue rates, contrasting with used cars. Higher feature values reduce new-car sales times but increase used-car sales times. This study contributes to product variety and inventory management literature.

3 An Empirical Investigation of Investment Substitutability and Complementarity Between Flexible and Intermittent Electricity Generation

Ahmet Colak[1], Seyed Amin Seyed Haeri[2], Safak Yucel[3], [1]Clemson University, Pendleton, SC, [2]Clemson University, Clemson, SC, [3]Georgetown University, Washington

In this study we evaluate the role of the operational flexibility on capacity investment decisions made in electricity grids. We adopt an empirical approach and evaluate this role using a unique panel data set of United States electricity grid spanning across 2002-2019. We particularly evaluate how investment in a particular generation technology can influence future investments in other types of generation technologies. We essentially shed light on the evolving nature of the electricity generation portfolio from an operations management perspective while informing policy makers in designing more effective technology-specific policies that facilitate the transition toward renewable generation.

Sunday, October 15, 8:00 AM - 9:15 AM

SA30

CC-North 132C

Agricultural and Environmental Operations

Community Committee Choice Session

Session Chair: Canberk Ucel, Bilkent University, Philadelphia, PA

1 Agricultural Index Insurance: An Optimization Approach

Jose Velarde Morales, Linwei Xin, University of Chicago, Chicago, IL, Contact: jvelarde@chicagobooth.edu

Index insurance is a popular way of providing agricultural insurance in low-income countries, and it is estimated that tens of millions of farmers worldwide are covered by index insurance programs. However, these programs are very costly and have to be heavily subsidized by governments in most cases. We develop an optimization-based approach to designing index insurance contracts that improves its cost effectiveness.

2 Health Coverage and Farmworker Productivity

Zachariah Rutledge[1], John Lowrey[2], Timothy Richards[3], [1]Michigan State University, East lansing, MI, [2]Northeastern University, Boston, MA, [3]Arizona State University, Mesa, AZ

Farmworkers are often subject to hazardous working conditions, experience a disparity in health insurance coverage and are vulnerable to chronic health conditions and injury. Many agricultural employers still do not offer coverage for their employees. We quantify the economic value of offering health coverage to farmworkers using a structural search, match, and bargaining model. We find that farmworkers with employer-provided health coverage are significantly more productive than those without and, on average, generate an additional $0.78 in economic surplus for each hour worked. Employers who offer health coverage retain an additional $0.60 of economic surplus for each hour of work performed by their employees due to a health productivity premium.

3 Predicting Demand for Wildfire Suppression Resources

Yasser Zeinali[1], Ilbin Lee[1], Mostafa Rezaei[2], [1]University of Alberta, Edmonton, AB, Canada; [2]ESCP Business School, Parisa, France. Contact: yzeinali@ualberta.ca

Between 2013 and 2022, an average of 61,410 wildfires occurred annually, burning an average of 7.2 million acres per year in the United States. As a result of the significant costs and damages incurred by these wildfires, there is immense pressure on wildfire management agencies to devise a more effective resource allocation strategy for fighting fires. However, a model predicting the demand of firefighting resources in the coming days has not been developed in literature. We propose a newsvendor formulation and quantile regression models to generate distributional forecasts for the demand. Our results indicate that the proposed models outperform baselines mimicking the strategy currently in use.

4 Profitable Nitrogen Loss Mitigation in the U.S. Midwest Through Farm Management, New Policies and "Lean" Technologies

Canberk Ucel[1,2], [1]Bilkent University, Ankara, Turkey; [2]INSEAD, Singapore, Singapore. Contact: canberk.ucel@bilkent.edu.tr

Use of "precision" farming practices have remained persistently low in the US Midwest, despite extant research demonstrating vast economic, environmental benefits, particularly associated with the prevention of N loss. While our analysis of crop yield and novel nutrient applications data from a large sample of fields corroborates previous findings that spatiotemporal variation in yields is strongly predicted by topography-weather interactions, we find that a significant portion of the variance in N loss is driven by disproportionately large losses on a few fields. We find the economic returns to proposed practices to be 90.5% of the net profits on average, but that these returns are only 6.9% of the operating profits, which may be prohibitive. Based on these findings, we propose technologies and policies to enable the profitable adoption of N loss mitigation measures.

Sunday, October 15, 8:00 AM - 9:15 AM

SA31

CC-North 221A

Amazon Last Mile Resources Optimization

Community Committee Choice Session

Session Chair: Liron Yedidsion, Amazon, Redmond, WA

1 Muti-Stage Newsvendor Optimization for Capacity Planning

Gah-Yi Ban[1], Chinmoy Mohapatra[2], Liron Yedidsion[3], Abhilasha Katariya[4], [1]Imperial College Business School, London, United Kingdom; [2]Amazon, Bellevue, WA, [3]Amazon, Redmond, WA, [4]Amazon, Issaquah, WA, Contact: g.ban@imperial.ac.uk

Labor constitutes one of the most expensive resources within the supply chain, necessitating careful advanced planning. Adjusting labor capacity entails the processes of recruitment and training, which consume both time and resources. The demand for labor is subject to fluctuations, encompassing seasonal patterns and variations occurring throughout the week. Actual demand often manifests itself long after a plan has been formulated and committed to. Excessive planning leads to the payment for unnecessary routes, while insufficient planning results in higher delivery costs to uphold the commitment of timely customer deliveries. We approach this issue by modeling it as a multi-stage newsvendor optimization problem, with the aim of minimizing expected overage and underage costs, alongside labor change expenses.

2 Mobile Fueling at Amazon Last Mile

Anish Dhananjay Khare[1], Monchen Kao[1], Chinmoy Mohapatra[2], Lois Nersesian[1], Liron Yedidsion[3], [1]MIT, Cambridge, MA, [2]Amazon, Bellevue, WA, [3]Amazon, Redmond, WA, Contact: lirony@amazon.com

Refueling for internal combustion engines (ICE) vehicles and charging electric vehicles (EV)s are none value adding operation for last mile deliveries. Amazon decouples such operations and outsources them from the driver. Mobile refueling services, handled by external agents while vehicles are parked, are a newer approach. However, these contracts charge a fixed cost for each operation, regardless of tank level. Amazon aims to reduce unnecessary refueling while keeping the risk of on-road refueling low. We compare two refueling policies: cyclic refueling every fixed number of days and refueling on fixed days of the week. The former is more efficient, while the latter is more practical. We prove an approximation ratio of 1.76 for the day-of-week policy with respect to cyclic refueling and demonstrate a tight actual ratio of 1.065 through simulation.

3 Hierarchical Consensus Planning for Amzl Operations

Mahdieh Allahviranloo[1,2], Chinmoy Mohapatra[3], Rohit Malshe[4], [1]Amazon, New York, NY, [2]CUNY, New Yrok, NY, [3]Amazon, Bellevue, WA, [4]Amazon, Seatle, WA, Contact: allahvir@amazon.com

A hierarchical consensus planning framework is proposed to model the consensus process across Amazon delivery stations and third-party carriers. This framework is set to come up with planning targets for various components of the system while respecting the corresponding constraints of each agent within the delivery stations and between the delivery stations. We propose a bi-level consensus planning structure where the coordinator at the top-level coordinates the operation of stations. And, at the lower level, each station has its own consensus planning structure across its agents.

4 Last Mile Operations Planning Optimization at Amazon

Louis Faugère, Amazon, Seattle, WA

Efficient package delivery throughout the year requires the seamless coordination of last mile carriers with network topology and resource planning. This coordination is particularly important when continuously striving to meet increasing delivery capacity and speed requirements amidst seasonality and uncertainty. In this presentation, we will discuss challenges and provide practical insights regarding a range of activities aimed at guiding the allocation of delivery workloads and resources across last mile nodes through the lens of optimization.

Sunday, October 15, 8:00 AM - 9:15 AM

SA32

CC-North 221B

Conic Optimization and Machine Learning

Community Committee Choice Session

Session Chair: Swati Padmanabhan, University of Washington, Seattle, Seattle, WA

1 Solving Tall Dense SDPs in the Current Matrix Multiplication Time

Shunhua Jiang, Columbia University, New York City, NY, Contact: sj3005@columbia.edu

In this talk I will introduce a new interior point method algorithm that solves semidefinite programming (SDP) with variable size n×n and m constraints in the (current) matrix multiplication time m^[illegible] when m=Ω(n^2). This suggests solving SDP is nearly as fast as solving the linear system with equal number of variables and constraints. This is the first result that tall dense SDP can be solved in the nearly-optimal running time, and it also improves the state-of-the-art SDP solver. Our algorithm maintains the inverse of a Kronecker product using lazy updates, and we design a general amortization scheme for positive semidefinite matrices. Based on joint work with Baihe Huang, Zhao Song, Runzhou Tao, and Ruizhe Zhang.

2 Optimization via Semidefinite Programming Hierarchies

Goutham Rajendran, Carnegie Mellon University, Pittsburgh, PA, Contact: gouthamr@cmu.edu

The Sum of Squares (SoS) hierarchy is a powerful optimization technique that harnesses the power of semidefinite programming (SDP) and has achieved tremendous success for various problems in combinatorial optimization, robust statistics and machine learning. In particular, SoS is a family of SDPs that can be applied to general polynomial optimization and it lets us smoothly trade off running time for approximation guarantees. In this talk, I will introduce SoS from an optimization viewpoint, present some highlights and breakthroughs of SoS, e.g. robust clustering, and finally discuss various threads of fascinating research it has led to, e.g. hypothesis testing with limited power.

3 Large-Scale Portfolio Optimization Using Graph Attention Networks

Kamesh Korangi[1], Christophe Mues[1], Cristian Bravo[2], [1]University of Southampton, Southampton, United Kingdom; [2]University of Western Ontario, London, ON, Canada. Contact: cbravoro@uwo.ca

In addition to assessing individual firm performance, investors in financial markets must also consider how their set of firms performs together as a portfolio. Portfolio optimisation is essential for mid-cap firms, which are riskier and more volatile than large-caps, while also being more numerous. We empirically test a novel method of deploying Graph Attention networks (GATs) that exploit high-dimensional network data to find intricate relationships between firms. Benchmarked against established models over a large-scale portfolio of over five thousand firms, the results show that the portfolio produced by the GAT-based model outperforms them significantly and provides stronger diversification, while being more robust.

Sunday, October 15, 8:00 AM - 9:15 AM

SA33

CC-North 221C

Large Scale Supply Chain Network Optimization

Community Committee Choice Session

Session Chair: Chun Ye, Amazon.com, Seattle, WA

1 Optimizing Large Scale Temporal Multi-Commodity Capacitated Flow Problem

Arash Haddadan[1], Cristiana L. Lara[2], Jochen Koenemann[3], [1]Modeling and Optimization, Amazon, Bellevue, WA, [2]Amazon, Bellevue, WA, [3]University of Waterloo, Waterloo, ON, Canada

We study the temporal fixed-charge multi-commodity flow problem. This problem arise when modeling large scale fulfillment networks where timing impacts both consumer experience as well as operations in the network. To this end, we wish to maximize the volume of the flow that arrive within the promised times while obeying capacity and cost constraints. Due to the sheer size of this problem, it cannot be solved directly even on moderate size transportation networks. In this work, we propose a light-weight combinatorial heuristic algorithm that can produce high-quality solutions for this problem while significantly reducing the computation time when compared to previous solution methods. The simplicity of the combinatorial algorithm allows straightforward interventions to ensure that solutions are aligned with operations expectations.

2 Designing Partially Timing-Aware Network Topologies

Daniel Ulch, Amazon, Bellevue, WA, Contact: danulch@amazon.com

Large scale service network design is a core problem faced by E-retailers and parcel express companies. Even the static version of the problem, where the geographic flow of goods is determined, is difficult to solve. In practice these companies require timed-solutions to determine linehaul schedules and resource requirements. This work focuses on bridging the gap between static and dynamic network design optimization models. We introduce time-window constraints into the static network design model to prevent timing-infeasible consolidations without using a time-expanded network. We then focus on solving the resulting problem efficiently.

3 A Solution Framework for a Multi-Period Uncapacitated Topology Optimization

Myunseok Cheon, Amazon, Bellevue, WA

In this talk, we discuss a multi-period uncapacitated facility location problem. The unique characteristic is that the model needs to consider the backlog level and its incurring cost. The multi-period aspect is to capture the backlog behavior over time and the uncapacitated perspective is to represent the fact that each facility can receive more units than its capacity by utilizing the backlog capability. This talk discusses two main technical topics. One is a surrogate model technique to transform the multi-period model into a single period topology optimization model. The other is a hierarchical large-neighborhood search approach to solve the resulting problems, which have over 3 to 5 million variables. We will discuss the efficacy of the proposed approach compared to a commercial solver and the accuracy of the surrogate modeling approach.

4 Launch Policies for a Multiperiod Capacitated Facility Location Problem Considering Demand Uncertainty

Francisco Trespalacios, Amazon, BELLEVUE, WA

Launch planning defines the evolution of network topology over a forward-looking planning horizon. Sophisticated methodologies have been proposed in the literature, most notably leveraging stochastic facility location models. However, many of these are not used in practice due to the difficulty for planners to comprehend and implement their solutions. In this work, we propose a launch policy approach to generate practical plans considering demand uncertainty. Our methodology is based on a capacitated facility location-allocation model and a three-staged solution approach using neighborhood search routines.

5 Decision Alignment Across Different Business Entities via a Large Scale Min-Cost Network Flow Model

Zihao Li[1], Rohit Injeti[2], Kamalesh Somani[1], [1]Amazon, Bellevue, WA, [2]Amazon, El Paso, TX

In this talk, we solve a business problem using a large-scale multi-period min-cost network flow problem with cross-period constraints, in which decisions are currently being made in a decentralized fashion by different business entities. Our work focus on aligning the decision-making processes of the different business entities and provide an optimal solution at the network level. We present various techniques to limit the solution space to better fit the business practice the model is trying to serve, and discuss the implication of the model results on business decisions.

Sunday, October 15, 8:00 AM - 9:15 AM

SA34

CC-North 222A

Decentralized Learning and Optimization

Community Committee Choice Session

Session Chair: Ceyhun Eksin, Texas A&M University, College Station, TX

Session Chair: Sarper Aydin, Texas A&M University, College Station, TX

1 Policy Gradient Play over Time-Varying Networks in Markov Potential Games

Sarper Aydin, Ceyhun Eksin, Texas A&M University, College Station, TX

We design a multi-agent and networked policy gradient algorithm in Markov potential games. Each agent has its own rewards and utility as functions of joint actions and a shared state among agents. The state dynamics depend on the joint actions taken. Agents implement continuous parameterized policies defined over the state and other agents' parameters to maximize their utilities against each other. Agents share their parameters with neighbors over a time-varying network. Agents compute their stochastic gradients to update their parameters with respect to their local estimates of Q-functions and joint parameters. We prove the convergence of joint parameters to a first-order stationary point of the potential function in probability for any type of state and action spaces. Numerical results validate the convergence in the lake game.

2 Optimal Control of Spatially Exponential Decaying Linear Quadratic Regulator

Runyu Zhang[1], Weiyu Li[2], Na Li[3], [1]Harvard University, Cambridge, MA, [2]Harvard University, Allston, MA, [3]Harvard University, Cambridge, MA, Contact: runyuzhang@fas.harvard.edu

This talk focuses on network LQR problems with system matrices being spatially-exponential decaying (SED) between nodes in the network. The major topic is to study whether the optimal controller also enjoys a SED structure, which is an appealing property for ensuring the optimality of decentralized control over the network. We start with studying the open-loop asymptotically stable system and show that the optimal LQR state feedback gain is `quasi'-

SED in this setting. Then the result is further generalized to unstable systems under a stabilizability assumption. Further, the results are obtained by analyzing the structure of disturbance response control, thus as a side result, it also proves the `quasi'-SED property of the optimal disturbance response control.

3 Independent Natural Policy Gradient for Markov Potential Games with Provable Fast Convergence

Youbang Sun, Northeastern University, Boston, MA, Contact: sun.youb@northeastern.edu

Reinforcement Learning (RL) has shown remarkable success in solving complex tasks in the field of robotics, economic decision making, autonomous driving, etc. Typically, RL is considered to be single-agent, with the environments formulated as Markov Decision Processes (MDPs). However, many problems in practice can not be formulated as single-agent systems, these challenges have motivated recent studies for multi-agent reinforcement learning (MARL). However, due to the unique geometry of the problem and complex relationships between agents, the theoretical aspects of MARL are faced with many challenges, with most works showing slow convergence results for algorithms when compared to their single-agent versions. We study the NPG update in multi-agent systems and propose novel analysis in order to find a better convergence speed for the algorithm.

4 Fedbc: Calibrating Global and Local Models via Federated Learning Beyond Consensus

Amrit Singh Bedi[1], Chen Fan[2], Alec Koppel[3], Anit Kumar Sahu[4], Brian Sadler[5], Furong Huang[1], Dinesh Manocha[1], [1]university of maryland, College Park, MD, [2]UBC, Canada, VANCOUVER, BC, Canada; [3]JP Morgan Chase & Co., New York, NY, [4]Amazon, Seattle, WA, [5]US Army Research Lab, Adelphi, MD, Contact: amrit0714@gmail.com

We quantitatively calibrate the performance of global and local models in federated learning through a multi-criterion optimization-based framework, which we cast as a constrained program. The objective of a device is its local objective, which it seeks to minimize while satisfying nonlinear constraints that quantify the proximity between the local and the global model. We develop a novel primal-dual method called Federated Learning Beyond Consensus (FedBC). Theoretically, we establish that FedBC converges to a first-order stationary point at rates that matches state of the art, up to an additional error term that depends on a tolerance parameter introduced to scalarize the multi-criterion formulation. Finally, we demonstrate that FedBC balances the global and local model test accuracy metrics across a suite of datasets (Synthetic, MNIST, CIFAR-10, Shakespeare).

5 Learning Trust over Directed Graphs in Multiagent Systems

Orhan Eren Akgün, Harvard University, Cambridge, MA, Contact: erenakgun@g.harvard.edu

We address the problem of learning the legitimacy of other agents in a multiagent network when an unknown subset is comprised of malicious actors. We specifically derive results for the case of directed graphs and where stochastic side information, or observations of trust, is available. We refer to this as "learning trust" since agents must identify which neighbors in the network are reliable, and we derive a learning protocol to achieve this. We also provide analytical results showing that under this protocol i) agents can learn the legitimacy of all other agents almost surely, and ii) the opinions of the agents converge in mean to the true legitimacy of all other agents in the network. Lastly, we provide numerical studies showing that our convergence results hold for various network topologies and variations in the number of malicious agents.

Sunday, October 15, 8:00 AM - 9:15 AM

SA35

CC-North 222B

Recent Advances in Large-scale Optimization

Community Committee Choice Session

Session Chair: Mateo Diaz, 1</sup

1 Any-Dimensional Convex Sets

Eitan Levin, Caltech, Pasadena, CA

Classical algorithms are defined on inputs of different sizes. In contrast, algorithms learned from data may only be defined on inputs of the same size as the data. What does it mean for an algorithm to be defined on infinitely-many input sizes? How do we describe such algorithms? We tackle these questions for convex optimization-based algorithms, whose description reduces to describing convex sets. We show that descriptions of convex sets defined in any dimension often arise from (a) group invariance and the recently-identified phenomenon of representation stability; (b) relations between different-sized problem instances. We combine these ingredients to parametrize families of any-dimensional convex sets.

2 Higher-Order Newton Methods

Amir Ali Ahmadi[1], Abraar Chaudhry[2], Jeff Zhang[3], [1]Princeton University, Princeton, NJ, [2]Princeton University, Princeton, NJ, [3]Carnegie Mellon University, Pittsburgh, PA, Contact: azc@princeton.edu

We present generalizations of Newton's method that incorporate derivatives of arbitrarily high order, but maintain a polynomial dependence on dimension in their cost per iteration. At each step, our algorithms use semidefinite programming to construct and minimize a convex approximation to the Taylor expansion of the function we wish to minimize. We analyze the convergence rates of our higher-order Newton methods and compare their basins of attraction around local minima to those of the classical Newton method.

3 Asynchronous Gradient Play in Zero-Sum Multi-Agent Games

Shicong Cen, Yuejie Chi, Carnegie Mellon University, Pittsburgh, PA, Contact: shicongc@andrew.cmu.edu

Finding equilibria via gradient play in competitive multi-agent games has been attracting a growing amount of attention, with emphasis on designing efficient strategies where the agents operate in a decentralized and symmetric manner with guaranteed convergence. Despite recent activities, the performance in zero-sum multi-agent games remains inadequately explored, especially in the presence of delayed feedbacks, leaving the scalability and resiliency of gradient play open to questions. In this paper, we make progress by studying asynchronous gradient plays in zero-sum polymatrix games under delayed feedbacks. To the best of our knowledge, this work is the first that aims to understand asynchronous gradient play in zero-sum polymatrix games under a wide range of delay assumptions, highlighting the role of learning rates separation.

4 Stochastic Approximation with Decision-Dependent Distributions: Asymptotic Normality and Optimality

Mateo Díaz, Johns Hopkins University, Baltimore, MD, Contact: mateodd@jhu.edu

We analyze a stochastic approximation algorithm for decision-dependent problems, wherein the data distribution used by the algorithm evolves along the iterate sequence. The primary examples of such problems appear in performative prediction and its multiplayer extensions. We show that under mild assumptions, the deviation between the average iterate of the algorithm and the solution is asymptotically normal, with a covariance that nicely decouples the effects of the gradient noise and the distributional shift. Moreover, building on the work of H\'ajek and Le Cam, we show that the asymptotic performance of the algorithm is locally minimax optimal.

Sunday, October 15, 8:00 AM - 9:15 AM

SA36

CC-North 222C

Optimal Traffic Control Session

Community Committee Choice Session

Session Chair: Qichao Wang, National Renewable Energy Laboratory

1 The Green Light Sonata: Foundations for Musical Control of Traffic Signals

Montasir M. Abbas, Virginia Polytechnic Institute, Blacksburg, VA

The goal of this research is to improve signal operation and reduce delay through an innovative transdisciplinary integration of traffic signal control and music theories. The main hypothesis in this research is that "the underlying sense that musicians exhibit during improvisation can be utilized to better synchronize signal control with internal traffic rhythm." In this work, we developed and used a novel Signal Operation with Neuro-fuzzy Acoustic Tuning Application (SONATA) interface to control a simulated traffic signal. Three musicians utilized the SONATA framework to control their respective traffic signal using visual/auditory information and auditory only information to minimize queues. This presentation lays out the foundation for a new area of research and proves that harmonization of control and traffic with music-based control has merits.

2 Deep Learning Traffic State Estimation in a Connected Vehicle Traffic Control Systems

Larry Head[1], Debashis Das[2], [1]The University of Arizona, Tucson, AZ, [2]Argonne National Laboratory, Chicago, IL, Contact: klhead@arizona.edu

Connected vehicle technologies are idea for the design and development of adaptive traffic signal control systems. They provide the location, speed, heading, and other critical vehicle data that can be used to make traffic signal control decision. Unfortunately, the market penetration of connected vehicles is low and will likely remain low as the technology is introduced thought new vehicles design and sales. A few connected vehicles in the traffic stream can be used to estimate the location of non-connected vehicles. This paper presents a deep learning model that uses connected vehicle data to estimate the location of all vehicles in the traffic stream. This data is used by a dynamic programming based optimization algorithm to provide adaptive signal control, priority for special classes of connected vehicles, and traffic signal coordination.

3 Optimal Traffic Signal Control with VPL Model

Qichao Wang, National Renewable Energy Laboratory,

Golden, CO, Contact: Qichao.Wang@nrel.gov

The Virtual Phase-Link (VPL) model describes the dynamics of vehicle distributions across a road network which can be used to optimize the traffic intersections signal control. The states of the model are the number of vehicles in every VPLs at each time step. The control variables of the model are the active green times and the green splits. The optimal traffic signal control problem can be solved as a nonlinear programming problem with linear constraints and quadratic objective function. This presentation will present the mathematical formulation of the VPL model and the applications in simulations and real-world deployments.

4 Making Smart Traffic Signals Smarter, Safer and More Sustainable Through Real-Time Connectivity with Travelers

Stephen Smith, Carnegie Mellon University

This talk describes work aimed at utilizing traveler-to-infrastructure communication in three ways: (1) to improve the throughput of a real-time adaptive traffic signal control system, (2) to make its operation safer for vulnerable road users, and (3) to enable more sustainable models for urban infrastructure funding. We focus specifically on what might be possible in the near-term, when the number of connected travelers on the road can be expected to be relatively small. We present results obtained both in simulation studies and in field test experiments with connected autonomous vehicles and pedestrians with disabilities that demonstrate progress across each of the three objectives mentioned above.

Sunday, October 15, 8:00 AM - 9:15 AM

SA37

CC-North 223

Applications of Mathematical Models to Inform Decision Making in Healthcare

Community Committee Choice Session

Session Chair: Iakovos Toumazis, The University of Texas MD Anderson Cancer Center, Houston, TX

1 Assessing the Loss in Effectiveness and Efficiency of Lung Cancer Screening by Enforcing a Structure on the Screening Policy

M. Soheil Hemmati[1,2], Andrew J. Schaefer[2], Iakovos Toumazis[1], [1]The University of Texas MD Anderson Cancer Center, Houston, TX, [2]Rice University, Houston, TX, Contact: soheil.hemmati@rice.edu

Current annual lung cancer screening recommendation by the US Preventive Services Task Force enjoys high degree of practicality, yet with no account for the optimality of the screening effectiveness. In contrast, the recently proposed ENGAGE framework, a partially observable Markov decision process model, derives optimal lung cancer screening schedules that achieve highest effectiveness level. In this study, we assessed the effectiveness and efficiency of alternative screening policies with fixed screening frequencies and compared their performance against the ENGAGE-derived optimal schedules. Through simulations, we found that the screenings with fixed, predetermined frequencies may achieve reasonable levels of either effectiveness or efficiency but not both and quantified how much benefit we sacrifice to achieve practicality.

2 Calibration of Histology-Specific Natural History Models for Ovarian Cancer Using Simulated Annealing

Sayaka Ishizawa[1], Jiangong Niu[1], Maddie Tumbarello[2], Mehdi Hemmati[2], Larissa A. Meyer[1], Iakovos Toumazis[1], [1]The University of Texas MD Anderson Cancer Center, Houston, TX, [2]Rice University, Houston, TX, Contact: sishizawa@mdanderson.org

Ovarian cancer is the leading cause of death from gynecological cancers accounting for approximately 13,200 cancers in 2023. Well validated natural history models could provide insights on the natural disease progression. In this study, we develop natural history models for the seven most common histologies of ovarian cancer using Markov models that share the same overall structure. Each model consists of 13 health states and 39 transition probabilities. We calibrate 133 parameters total (ranging from 18-23 per model) using an adaptive simulated annealing algorithm such that the natural history models reproduce observed incidence and mortality rates from the Surveillance, Epidemiology, and End Results (SEER) registry.

3 Development of an Ovarian Cancer Risk Prediction Model

Seyyed Mostafa Mousavi Janbeh Sarayi[1], Jiangong Niu[1], Martin Tammemagi[2], Larissa Meyer[1], Iakovos Toumazis[1], [1]The University of Texas MD Anderson Cancer Center, Houston, TX, [2]Brock University, St. Catharines, ON, Canada

Ovarian cancer is the leading cause of death from gynecological cancers. Screening for ovarian cancer at the population was shown to be ineffective in reducing ovarian cancer mortality. Targeting screening on high-risk individuals has the potential to be more effective, but existing risk prediction models have modest predictive performance in selecting individuals for screening. We used data from the Prostate, Lung, Colorectal, and Ovarian (PLCO) randomized screening trial to develop a risk prediction model with sufficient predictive performance. Supervised machine learning methods were trained, and model's discrimination and calibration was evaluated. We present the model's performance on the training and the testing dataset and the methodology we used to develop the model.

Sunday, October 15, 8:00 AM - 9:15 AM

SA38

CC-North 224A

Learning and Optimization Algorithms

Contributed Session

Session Chair: Dinesh Krishnamoorthy, Eindhoven University of Technology, Eindhoven, Netherlands

1 A Multi-Agent Reinforcement Learning-Based Branch-And-Price Algorithm for Resource Allocation with Trimming Allowance and Batching Requirements

Baiyang He, Ying Meng, Lixin Tang, National Frontiers Science Center for Industrial Intelligence and Systems Optimization, Northeastern University, Shenyang, 110819, China, Shenyang, China. Contact: hebaiyangneu@163.com

In this study, we address a resource allocation problem with trimming allowance and batching requirements. We formulate the problem as a set-covering model, and then develop a branch-and-price algorithm to obtain the optimal solutions. In the algorithm, a label-correcting method is designed to optimally solve pricing problems, whose efficiency is guaranteed by dominance rules. In addition, a hybrid-rules branching strategy is proposed to enhance branching efficiency. Finally, we propose an adaptive cutting plane procedure based on multi-agent reinforcement learning to find cutting planes that can tighten the model. The numerical experiments show that our algorithm outperforms the state-of-the-art branch-and-price algorithms, especially regarding the effectiveness of the adaptive cutting plane procedure.

2 Aggregate Then Predict and Optimize: Addressing Uncertainties in Multi-Item Spare Part Inventory Systems

Alireza Sheikh-Zadeh, Texas Tech University, Lubbock, TX

This research addresses this issue of the inconsistency between the criteria we train learning algorithms and decision-making by simultaneously capturing the objective costs of the prediction and prescription problem and utilizing aggregation and disaggregation approaches to ensure tractability. The solution approach is applied to a multi-item spare-part replenishment problem.

3 Optimizing Package Storage In Amazon Mechlite Delivery Stations

ROHIT MALSHE, Marc Anderson, Sourabh Puri, Dipal Gupta, Liron Yedidsion, Amazon.com, Kirkland, WA, Contact: malshe.rohit@gmail.com

AMZL's Mechlite delivery stations (DS) in various countries handle daily shipments of Non-Oversized (Non-OV) and Oversized (OV) packages. To improve space utilization and reduce labor costs, we present novel techniques for packaging and storing these items. Our 3D bin packing and set cover algorithms enable efficient Non-OV bin allocation and assignment, while our Dynamic Rack Optimization Program (DROP) algorithm optimizes the storage of OV packages by minimizing volume variation, spillover, picker search time, and maximizing aisle use. These approaches increase station capacity by up to 5%, decrease labor by 3.6%, and lower storage space requirements by up to 4%. To further enhance space utilization, our fungible racks also use a set of algorithms that can increase space usage efficiency by up to 25%, enabling sustainable operation for up to three additional years.

4 Leveraging Parametric Sensitivities to Accelerate Distributed Optimization Algorithms

Dinesh Krishnamoorthy, Eindhoven University of Technology, Eindhoven, Netherlands

Large-scale optimization problems, common in applications, such as optimal resource allocation and multi-agent networks, can be decomposed into several smaller subproblems that take coordinated actions. This work focuses on addressing the computational burden of repeatedly solving the subproblems arising in wide range of distributed optimization problems. Noting that in most decomposition strategies (both centralized/decentralized coordination), the subproblems solved between consecutive iterations differ only by a few variables, the key idea of this work is to exploit the parametric nature of the subproblems to reduce the computation time of the subproblems in each iteration. Convergence Guarantees for a class of ADMM problems will be presented, along with numerical examples including flow routing, resource allocation, and distributed learning problems.

Sunday, October 15, 8:00 AM - 9:15 AM

SA39

CC-North 224B

Smart Urban Mobility and Logistics: Emerging Technologies and Innovative Solutions

Community Committee Choice Session

Session Chair: Meng Zhao, Dalian University of Technology, Dalian, China

2 PPP Contract Design for Smart Road Infrastructure

Zhuo Feng, Jinbo Song, Dalian University of Technology, Dalian, China. Contact: zhfeng@dlut.edu.cn

The aging road infrastructure is deterring the wide-scale deployment of autonomous vehicles (AVs). In this study, we focus on the provision of smart road infrastructure through public-private partnerships (PPPs). Considering congestion time reduced by AVs compared to human-driving vehicles (HVs) with the help of the smart road, we investigate the firm's decisions on (differentiated) toll prices and road capacity as well as the allocation of it between AVs and HVs. We also discuss the government's subsidy design to improve social welfare.

1 Community/Committee'S Choice Submission

Bo Lu, 1</sup

Sunday, October 15, 8:00 AM - 9:15 AM

SA40

CC-North 225A

Delivery Systems Modeling with Emerging Vehicle Technologies

Community Committee Choice Session

Session Chair: Tom Shi, 1</sup
Session Chair: Zhiwei Chen, Drexel University, Philadelphia, PA
Session Chair: Qianwen Li, University of South Florida, Tampa
Session Chair: Xiaopeng Li, University of Wisconsin-Madison, WI

1 Integrated Truck and Drone Delivery Systems

Juan Zhang[1], James F. Campbell[2], Donald C. Sweeney II[3], [1]University of Wisconsin - Eau Claire, Eau Claire, WI, [2]University of Missouri - St. Louis, Saint Louis, MO, [3]University of Missouri - St. Louis, St. Louis, MO

Unlike most studies considering either truck-drone tandems or drone standalone delivery operations, our research provides a strategic analysis for the optimal design of an integrated drone delivery system in which customers in a service region can be served by a combination of truck-drone (TD) delivery, drone-only (DO) delivery, and truck-only (TO) delivery. We formulate and optimize continuous approximation models to identify the optimal delivery service combination that minimizes the total delivery costs including truck and drone operating and stop costs. We evaluate the impact of a wide range of operating characteristics and delivery environments on the optimal delivery system and the benefits of using drones. Our results suggest that an optimal delivery system design often uses a mix of DO and TD, but TD is the dominant delivery service in most scenarios.

2 Modular Autonomous Vehicle Operations for Airport Baggage Transportation

Xiaowei(Tom) Shi, University of Michigan, Ann Arbor, MI

Modular autonomous vehicles (MAV) are an emerging transportation technology that allows vehicles to adjust their capacity flexibly. This technology offers us a new perspective on solving baggage transport problems for airports. To investigate this possibility, this study proposes an operational design and a corresponding MAV scheduling model to optimize baggage transport. The objective of the optimization model is to minimize MAV operating cost while transporting baggage from the terminal to the aircraft without delay. To solve the proposed problem efficiently, a fast construction-merging heuristic algorithm is proposed based on property analysis of the feasible solutions. A series of case studies at Tampa International Airport were conducted to evaluate the performance of the proposed operational design and the heuristic algorithm.

3 A Continuous Approximation Model for Urban Electric Robotic Deliveries with Maintenance Costs

Joseph Y J Chow[1], Hai Yang[1], Tho Le[2], [1]New York University, Brooklyn, NY, [2]Purdue University, Lafayette, IN

With the rise in demand for local deliveries and e-commerce, robotic deliveries are being considered as more sustainable and efficient solutions. However, the deployment of such systems can be highly complex due to numerous factors involving stochastic demand, stochastic charging and maintenance needs, etc. We propose a continuous approximation model for evaluating service trade-offs that consider unique characteristics of sidewalk robots. Synthetic data as well as real world deployment data are used to calibrate such a model to evaluate potential deployment in neighborhoods in NYC.

Sunday, October 15, 8:00 AM - 9:15 AM

SA41

CC-North 225B

Traveling Salesperson and Repairman Problems

Community Committee Choice Session

Session Chair: Albert Schrotenboer, Eindhoven University of Technology, Eindhoven, -, Netherlands

1 An Exact Method for the Time Window Assignment Traveling Salesperson Problem with Stochastic Travel Times

Sifanur Celik[1], Layla Martin[2], Albert Schrotenboer[1], Tom Van Woensel[2], [1]Eindhoven University of Technology, Eindhoven, Netherlands; [2]Eindhoven University of Technology, Eindhoven, Netherlands. Contact: a.h.schrotenboer@tue.nl

We consider optimization problems often modeled as stochastic programming problems with mixed binary and continuous first- and second-stage decision variables. This paper introduces Scenario Clustered Benders Dual Decomposition (SCBDD) as a general methodology for solving such stochastic programs. The method combines and generalizes Benders Dual Decomposition, Partial Benders Decomposition, and Scenario Clustering techniques and does so within a novel two-step decomposition along the binary and continuous first-stage decisions. We apply SCBDD to jointly assign time windows and determine a vehicle tour for stochastic travel times, i.e., optimally solving the Time-Window Assignment Traveling Salesperson problem. Extensive experiments show that SCBDD is superior to state-of-the-art approaches in the literature.

2 A Scalable and Adaptable Supervised Learning Approach for Solving the Traveling Salesman Problems

Zefeng Lyu, Andrew J. Yu, The University of Tennessee, Knoxville, Knoxville, TN

This paper addresses the challenges of scalability and generalization in learning-based approaches for solving TSPs. We propose a supervised learning approach that leverages local information to make predictions, using the concept of "anchors" to represent nodes that should connect to their nearest neighbors. Unlike previous approaches, our model relies solely on surrounding nodes for predictions, enabling it to handle large-scale instances without sacrificing accuracy. Experimental results show successful identification of anchors with high precision for both generated and TSPLIB instances. Integrating predicted anchors into established methods improves solution quality. Our approach demonstrates scalability and adaptability for solving TSPs.

3 The K Traveling Repairman Problem with Stochastic Service Requests

Thomas B. Cassidey[1], Iman Dayarian[2], [1]California State University, East Bay, Hayward, CA, [2]The University of Alabama, Tuscaloosa, AL

We investigate the problem of designing a set of routes to service a combination of deterministic and stochastic customers with known and unknown service request times at the beginning of an operational period, respectively. Our problem considers the routing of k service agents to minimize the expected total latency of customers in the system. We develop a branch and price approach to solve the problem. We present an analysis of the general expected latency calculation which allows for a novel recourse rule we call the *maximum wait-to time* and present a novel set of dominance rules. We perform a factorial experiment over numbers and types of customers as well as numbers of service agents. We find that our proposed approach outperforms both a greedy approach and an approach which uses only the point estimates of service request times and quantify the tradeoff with solution time.

Sunday, October 15, 8:00 AM - 9:15 AM

SA42

CC-North 226A

Exploring the Intersection of Metaverse and AGI: Applications and Challenges

Community Committee Choice Session

Session Chair: Yuan Zhang, 1</sup

1 Through Many Faces: How Virtual Influencer Appearance Changes Impact User Engagement

Hongjun Ye[1], Yuan Zhang[2], Tianwen Du[3], Zhiya Zuo[4], [1]University of Pittsburgh, Pittsburgh, PA, [2]University of Memphis, Memphis, TN, [3]University of Georgia, Athens, GA, [4]City University of Hong Kong, Kowloon Tong, China. Contact: hongjun.ye@katz.pitt.edu

As digital humans, virtual influencers are fundamental to the emerging metaverse. Though easily modifiable by creators, should their appearance be changed? This study explores how altering a virtual influencer's appearance affects user engagement and examines the underlying mechanisms. This research not only guide creators in enhancing audience engagement but also contribute to discussions on identity, ownership, and accountability in the context of metaverse.

2 Open For U? The Effects of Openness on Initial Exchange Offering Multihoming

Zhiya Zuo[1], Jie Zhou[2], Xi Wang[3], Xiuhua Zhang[2], [1]City University of Hong Kong, Kowloon Tong, Hong Kong; [2]Harbin Engineering University, Harbin, China; [3]Central University of Finance and Economics, Beijing, China

Initial exchange offerings (IEOs) have emerged as a reliable blockchain startup fundraising model, with exchanges serving as intermediaries. However, exchanges' control over IEO projects can limit their growth. Multihoming - listing projects on multiple exchanges - offers advantages, including greater investor access and protection. Integrating the theoretical lens of legitimacy, resource-based view, and open innovation, this study explores the role of project openness in achieving multihoming, with implications for blockchain startups.

3 Does Collaboration Pay off for Individuals? Virtual Team Formation and Individual Performance

Yihan Deng[1], Zhiya Zuo[2], [1]City University of Hong Kong, Hong Kong, Hong Kong; [2]City University of Hong Kong, Kowloon Tong, China. Contact: yihandeng2-c@my.cityu.edu.hk

Crowdsourcing contest platform has been a prevalent channel for organizations to gain access to the wisdom of crowds for novel ideas effectively and efficiently, in which solution seekers launch complex tasks with monetary reward, and the users compete for the prize by sole participation or voluntary collaboration with other competitors. This study uncovers the effects and mechanisms through which team formation influences individual performance outcomes by conducting Difference-In-Differences (DID) with multiple time periods. We find that team formation positively affects an individual's performance. Heterogeneous effects manifest within specific subgroups defined by individual capital characteristics. Specifically, individuals with high-level capital outperform those with low-level capital when forming teams.

4 The Rise Of Generative AI Art: How Do Text-to-Image Models Affect Artist Productivity And Artwork Novelty?

Yumeng Miao, Qinglai He, Sung S. Kim, University of Wisconsin-Madison, Madison, WI, Contact: ymiao38@wisc.edu

Generative AI models have transformed work and occupations. While emerging literature has started exploring generative models and their societal impacts, little research explores text-to-image models and how they affect artwork creation using data from real-world settings. We seek to quantify the impacts of DALL-E 2 on artist productivity and their artwork novelty by analyzing data from an online artist community using difference-in-differences analyses. We measure artwork novelty regarding two essential image elements: subject and style. Our results indicate that DALL-E 2 boosts user productivity and encourages users to explore more distinct artistic styles in image creation. However, DALL-E 2 shows no influence on image subjects. The effects vary among artists with distinct characteristics. We also conduct secondary analyses to obtain deeper insights.

5 When Digital Meets Reality: Examining the Impact of Featuring Digital Humans Alongside Real Ones

Zhiya Zuo[1], Yuan Zhang[2], Tianwen Du[3], Hongjun Ye[4], [1]City University of Hong Kong, Kowloon Tong, China; [2]University of Memphis, Memphis, TN, [3]University of Georgia, Athens, GA, [4]University of Pittsburgh, Pittsburgh, PA, Contact: tianwen.du@uga.edu

Virtual influencers are digital humans that often blend virtuality with reality. Drawing from identity theories and user engagement literature, we analyzed the impact of featuring these influencers alongside real humans on social media. By examining audience reactions to this phenomenon, our research findings provide insights into what transpires when the digital and the real world converge.

Sunday, October 15, 8:00 AM - 9:15 AM

SA43

CC-North 226B

AAS Best Student Presentation Competition I

Award Session

Session Chair: Gianmarco Andreana, 1</sup

1 Distributionally Robust Airport Ground Holding Problem Under Wasserstein Ambiguity Sets

Haochen Wu, University of Michigan, Ann Arbor, Ann Arbor, MI

The airport ground holding problem seeks to minimize flight delay costs due to airport capacity reductions. However, the critical input of future airport capacities is often difficult to predict, presenting a challenging yet realistic setting. Even when airport capacity predictions provide a distribution of possible capacity scenarios, such distributions may themselves be uncertain (e.g., due to distribution shifts, or due to mis-specification of an underlying assumed parameterized distribution). To address the problem of designing airport ground holding policies under distributional uncertainty, we formulate and solve the airport ground holding problem using distributionally robust optimization (DRO). We address the uncertainty in the airport capacity distribution by defining ambiguity sets based on the Wasserstein distance metric. We propose reformulations which integrate the ambiguity sets into the airport ground holding problem structure. Faced with the problem that the Wasserstein distance of two probability distributions is non-convex, we introduce a conditional distribution to represent the joint distribution of the empirical distribution and an arbitrary distribution in the ambiguity set. Based on the Wasserstein ambiguity set, we use the Lagrangian dual function and the duality theorem to derive the deterministic equivalent formulation of distributionally robust single airport ground holding problem(dr-SAGHP). We also extend the dr-SAGHP to distributionally robust multi-airport ground holding problem(dr-MAGHP) and discuss dicretization properties of the proposed models, which demonstrate the existence of the worst-case distribution of the dr-SAGHP & dr-MAGHP and the performance of dr-SAGHP & dr-MAGHP with discretized support. We discuss comparisons (via numerical experiments) between ground holding policies and optimized costs derived through the deterministic, stochastic, and distributionally robust airport ground holding problems. Our experiments show that the dr-MAGHP outperforms the stochastic MAGHP and deterministic MAGHP when there is a significant difference between the empirical airport capacity distribution and the realized airport capacity distribution. As shown in Figure 1, when the radius of the Wasserstein ambiguity set is 0.5, the dr-MAGHP has the lowest expected total delay cost for each sample size compared with that of d-MAGHP and s-MAGHP. We note that DRO can be a valuable tool for decision-makers seeking to design airport ground holding policies, particularly when the available data regarding future airport capacities are highly uncertain.

2 Estimating Airport Leakage with Connected and Automated Vehicle Adoption

Shriya Karam, Massachusetts Institute of Technology, Boston, MA

Through the 2021 $1.2 trillion Bipartisan Infrastructure Law, The U.S. Department of Transportation aims to create and sustain equitable and accessible intercity transportation systems. However, in accessing the intercity transportation system through airports, individuals' ability to access airports through a reliable ground transportation mode may inhibit their travel ability. Using a cohort-based optimization approach, we determine the optimal allocation of a limited supply of buses to serve an airport from a particular bus station by maximizing accessibility for low and high income census tracts. The findings of the study indicate that incorporating financial disadvantage impacts the allocation of transit which thus provides a framework for examining the impact of ground access improvements on accessibility for low and high income groups.

Sunday, October 15, 8:00 AM - 9:15 AM

SA44

CC-North 226C

Artificial Intelligence in Clinical Decision Supports

Community Committee Choice Session

Session Chair: Samie Tootooni, Loyola University Chicago, Maywood, IL

1 Rapid Diagnosis of Stroke Through EMS Data

Samie Tootooni[1], Grant Hiura[1], Paula de la Pena[1], Nafiseh Mollaei[1], Daniel Heiferman[2], Oguz Akbilgic[3], [1]Loyola University Chicago, Maywood, IL, [2]Edward-Elmhurst Health, Naperville, IL, [3]Wake Forest University, Winston-Salem, NC, Contact: mtootooni@luc.edu

Timely triage and transport to an appropriate stroke center are crucial for providing life-saving treatments for stroke patients. Early identification of stroke patients is crucial for EMS teams to transport them to the most appropriate health center, which may sometimes involve traveling a greater distance. Our goal in this study is to develop a machine learning model, using retrospective EMS data, to detect stroke during the early stage of EMS care. By analyzing the geographic disparity factors, we will also identify how patients from underrepresented areas are disproportionately affected by delays in stroke diagnosis and treatment, and how our developed AI solution can help address these disparities.

2 Mitigating Emergency Overcrowding Using Machine Learning and Simulation

Abdulaziz Ahmed[1], Khalid Y. Aram[2], James Booth[3], Brittany Lindsey[4], [1]University of Alabama Birmingham, Birmingham, AL, [2]Emporia State University, Emporia, KS, [3]UAB Medicine-University of Alabama at Birmingham, Birmingham, AL, [4]University of Alabama at Birmingham Health System, Birmingham, AL

Full capacity protocol (FCP) is a tool proposed by the American College of Emergency Physicians (ACEP) to mitigate emergency department (ED) overcrowding.

However, this tool is reactive as it depends on real-time values of patient flow measures (PFM). In this project, we study the possibility of making FCP proactive by predicting PFM using machine learning. Then, we build discrete event simulation (DES) models to assess the effectiveness of the proactive FCP by comparing it with a reactive FCP. The proactive FCP will be integrated into a clinical decision support system to be used by the hospital management.

3 Inherent Test Variability As A Limit For Model Accuracy. Predicting Cochlear Implant Eligibility Using Routine Hearing Test Data.

Santiago Romero-Brufau, Mayo Clinic, Brookline, MA

In this session we will discuss common pitfalls when training machine-learning algorithms for clinical decision support, and how to avoid them. They will be exemplified with a recent project at Mayo's Department of ENT predicting cochlear implant eligibility using the results of routine audiograms. Eligibility was based on two separate clinical tests. Our final model achieved an accuracy of 87% (Sensitivity: 90%; precision: 80%) Our discussion will include: tailoring accuracy metrics to the clinical context and intended use; reformulating models that may seem insufficiently accurate.

Sunday, October 15, 8:00 AM - 9:15 AM

SA45

CC-North 227A

Robust and Fair Machine Learning in The Presence of Distribution Shifts

Community Committee Choice Session

Session Chair: Sina Baharlouei, University of Southern California, Los Angeles, CA

1 A Stochastic Alternating Balance K-Means Algorithm for Fair Clustering

Suyun Liu[1], Luis Nunes Vicente[2], [1]Amazon.com Services LLC, Sunnyvale, CA, [2]Lehigh University, BETHLEHEM, PA

In the application of data clustering to human-centric decision-making systems, the clustering outcome might discriminate against people across different demographic groups, leading to unfairness. A natural conflict occurs between the clustering cost and the balance representation of all demographic groups across the clusters, leading to a nonconvex and nonsmooth bi-objective optimization problem. To determine the complete trade-off between these two competing goals, we design a novel stochastic alternating balance fair k-means (SAfairKM) algorithm, which consists of alternating classical mini-batch k-means updates and group swap updates. Our numerical experiments show that the proposed SAfairKM algorithm is robust and computationally efficient in constructing well-spread and high-quality Pareto fronts both on synthetic and real datasets.

2 Understanding New Tasks Through the Lens of Training Data via Exponential Tilting

Subha Maity, University of Michigan, Ann Arbor, MI, Contact: smaity@umich.edu

Deploying machine learning models on new tasks is a major challenge due to differences in distributions of the train (source) data and the new (target) data. However, the training data likely captures some of the properties of the new task. We consider the problem of reweighing the training samples to gain insights into the distribution of the target task. Specifically, we formulate a distribution shift model based on the exponential tilt assumption and learn train data importance weights minimizing the KL divergence between labeled train and unlabeled target datasets. The learned train data weights can then be used for downstream tasks such as target performance evaluation, fine-tuning, and model selection. We demonstrate the efficacy of our method on Waterbirds and Breeds benchmarks.

3 Domain Adaptation Meets Individual Fairness, and They get Along

Debarghya Mukherjee, Boston University, Boston, MA, Contact: mdeb@umich.edu

Many instances of algorithmic bias are caused by distributional shifts. For example, machine learning (ML) models often perform worse on demographic groups that are underrepresented in the training data. In this paper, we leverage this connection between algorithmic fairness and distribution shifts to show that algorithmic fairness interventions can help ML models overcome distribution shifts, and that domain adaptation methods (for overcoming distribution shifts) can mitigate algorithmic biases. In particular, we show that (i) enforcing suitable notions of individual fairness (IF) can improve the out-of-distribution accuracy of ML models under the covariate shift assumption and that (ii) it is possible to adapt representation alignment methods for domain adaptation to enforce individual fairness.

Sunday, October 15, 8:00 AM - 9:15 AM

SA46

CC-North 227B

Equity, Fairness in Digital Systems

Community Committee Choice Session

Session Chair: Brittany Green, 1</sup
Session Chair: Nehir Tanyel, University of Cincinnati

1 Systematic Differences in Graders in Automated Hiring Solutions: A Machine Learning Fairness Approach

Mike H. M. Teodorescu[1], Nailya Ordabayeva[2], Marios Kokkodis[3], Abhishek Unnam[4], Varun Aggarwal[4], [1]University of Washington, Seattle, WA, [2]Dartmouth College, Chestnut Hill, MA, [3]Boston College, Chestnut Hill, MA, [4]SHL, New Delhi, India

Organizations routinely utilize natural language processing combined with other machine learning (ML) tools to assess prospective employees through automated resume classification based on pre-codified skill databases. The rush to automation can however backfire by encoding unintentional bias against groups of candidates. We run two experiments with human evaluators from two different countries to determine how cultural differences may affect hiring decisions. We use hiring materials provided by an international skill testing firm which runs hiring assessments for Fortune 500 companies. The company conducts a video-based interview assessment using machine learning, which grades job applicants automatically. We find that systematic differences can exist across human graders and that some can be reversed by algorithms if accounted for at training time.

2 AI Oversight to Promote Fairness in Finance: A Win-Win for Lenders and Borrowers

Amber Young, Wenwen Ding, University of Arkansas, Fayetteville, AR

Lending firms rely on artificial intelligence systems to determine credit worthiness. These systems draw on ‘big data’ from diverse sources and may systematize cultural biases. To combat bias, firms can implement oversight strategies such as ‘fairness through unawareness’, ‘demographic parity’, and ‘equalized opportunity.’ Using the data of a Chinese lending firm, we developed four models (Wide & Deep, Light GBM, XG Boost, and linear regression) to predict repayment. We identified rural borrowers as at-risk based on the weight of predictor variables. We then implemented the strategies above to determine which interventions enhanced fairness in loan approval outcomes for rural borrowers. We found that the Wide & Deep model promoted such fairness to a greater extent than the less sophisticated models. While the interventions reduced wrongful denials of rural loan seekers when applied to the less sophisticated models, results for rightful approvals were mixed. In some cases, interventions applied to the Wide & Deep model resulted in less just decisions for rural loan seekers. Notably, we found that most of the interventions would result in net gains for the firm. Our study indicates that carefully chosen and contextually appropriate fairness interventions could offer a beneficial outcome for both lenders and loan seekers, potentially reducing bias and resulting in financial gains. However, the effectiveness of these interventions can be model-dependent, underscoring the need for a nuanced approach in their implementation.

3 Till Tech Do Us Part: Betrayal Aversion and Its Role in Algorithm Use

Cameron Kormylo[1], Idris Adjerid[1], Sheryl Ball[1], Can Dogan[2], [1]Virginia Tech, Blacksburg, VA, [2]Radford University, Radford, VA, Contact: ckormylo@vt.edu

Failing to follow expert advice can have significant consequences. One potential mechanism that restricts the acceptance of expert advice is betrayal aversion, or the strong dislike for the violation of trust norms. This study explores whether the introduction of algorithms in place of human experts can attenuate betrayal aversion and lead to higher rates of advice seeking. We answer this question through an experimental financial market where there is an identical risk of betrayal from either a human or algorithmic advisor. We find that the willingness to utilize human experts is significantly reduced by betrayal version, while no betrayal aversion is exhibited towards algorithmic experts. The resulting unwillingness to take the advice of the human expert leads to a 20% decrease in subsequent earnings, while no loss in earnings is observed in the algorithm condition.

4 Longitudinal Examination of Bias and Generative AI on Online Labor Markets

Brittany Green, University of Louisville, Louisville, KY

While online labor markets (OLMs) provide many benefits including flexibility and data driven AI matching systems, gender and other social biases have been shown on OLMs, and research demonstrates AI can also perpetuate bias. Recently, generative AI systems have been used to provide profile recommendations to freelancers to increase their chances of getting noticed by AI ranking systems and employers on the platform. To help design OLMs that minimize the detrimental impact of biases on marginalized social groups, we investigate generative AI systems and its role in empowering or furthering bias for marginalized groups. We focus on investigating the long-term effects of this system using an agent-based simulation model, since bias is not static over time or independent of AI systems.

5 Exploring the Emancipatory and Hegemonic Potential of Social Media in Facilitating Connective Grief

Nehir Tanyel, University of Cincinnati, Cincinnati, OH, Contact: tanyelin@mail.uc.edu

Devastating subsequent earthquakes struck 12 major cities in southeastern Turkey on February 6, 2023, leaving 13.5 million people in need of assistance. As social media has been instrumental in crisis response, this study explores its role in facilitating the process of long-term crisis response such as collective grief in the aftermath of a humanitarian disaster. Specifically, we examine the impact of social media on shaping collective identity and mobilizing for collective action, with a particular focus on the upcoming elections. Through a case study of the Kahramanmaras earthquake in Turkey, our study sheds light on the potential contributions of social media to the theoretical understanding of whether social media could be an emancipatory or hegemonic technology during the collective grief process, and how it can influence social and political transformation.

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CC-North 227C

Advanced Data Analytics for Reliability and Maintenance

Community Committee Choice Session

Session Chair: Jaesung Lee, Texas A&M University, College Station, TX

Session Chair: Akash Deep, University of Wisconsin - Madison, Stillwater, OK

Session Chair: Congfang Huang, UW Madison, Madison, WI

1 Distributional Robust Partially Observable Markov Decision Processes Optimization with Distance-Based Uncertainties

Yisha Xiang[1], Tong Li[2], [1]University of Houston, Housy, TX, [2]University of Houston, Houston, TX

In this paper, we consider distributional robust partially observable Markov decision processes (DR-POMDP). We prove that the optimal value still has the piece-wise linear and convexity property under some assumptions of the uncertainty sets. We further adapt the heuristic search value iteration (HSVI) algorithm to solve the proposed DR-POMDPs. Computational studies are conducted to investigate the performance of the DR-POMDP.

2 Need-Based Sampling for Machine Learning with Application to All-Terminal Network Reliability Assessment Leveraging a Quantum Computing Approximation

Seyyed Farid Hashemian[1], Jose Azucena[2], Haitao Liao[1], [1]University of Arkansas, Fayetteville, AR, [2]University of Arkansas-IE Department, Fayetteville, AR, Contact: sfhashem@uark.edu

Since the effort of calculating the exact all-terminal reliability grows exponentially, approximation methods are often applied. The performance of such data-driven models is highly dependent on the selected training samples. In this work, we consider using additional samples to augment the observations used to fit a model and develop a method for effective improvement through active learning under a budget constraint. Moreover, we implement an algorithm based on quantum computing to approximate the desired all-terminal network reliability and leverage this estimation as an input to our surrogate model used in our active learning scheme.

3 Strata Design In Stochastic Simulations With Multivariate Inputs

Jaeshin Park[1], Young Myoung Ko[2], Sara Shashaani[3], Eunshin Byon[4], [1]University of Michigan - Ann Arbor, Ann arbor, MI, [2]Pohang University of Science and Technology, Pohang, Korea, Republic of; [3]North Carolina State University, Raleigh, NC, [4]University of Michigan, Ann Arbor, MI, Contact: jaeshin@umich.edu

Stratified sampling is one of the powerful variance reduction methods for analyzing system performance, such as reliability, with stochastic simulation. It divides the input space into disjoint subsets, called strata, to draw samples from each stratum. Strata design faces the curse of dimensionality and data scarcity as the input dimension increases. We analytically derive the optimal stratification structure that minimizes the estimation variance for univariate problems. Further, reconciling the optimal stratification into decision trees, we devise a robust algorithm for multi-dimensional problems.

4 Privacy-Preserving Location Scale Regression Based on Differential Privacy Approach

Jiewen Sheng, Xiaolei Fang, North Carolina State University, Raleigh, NC, Contact: jsheng4@ncsu.edu

Data privacy protection is an important yet challenging topic in industrial federated learning. In this talk, we present (log)-location-scale (LLS) regression models that can achieve epsilon-differential privacy based on the functional mechanism. We specifically discuss models whose response variable follows several most common distributions in the LLS family: Smallest Extreme Value, Weibull, Logistic, and Loglogistic. Numerical studies have demonstrated that the proposed approach can effectively provide privacy protection while maintaining a relatively high accuracy of the regression model.

5 Component-Wise Markov Decision Process for Solving Condition Based Maintenance of Large Multi-Component Systems with Economic Dependence

Vipul Bansal, University of Wisconsin - Madison

Condition-based maintenance of multi-component systems is a prevalent engineering problem due to its effectiveness in reducing the operational and maintenance costs of the system. However, developing the exact optimal maintenance decisions for the large multi-component system is computationally challenging, even not feasible, due to the exponential growth in system state and action space size with the number of components in the system. To address the scalability issue in CBM of large multi-component systems, we propose a Component-Wise Markov Decision Process and an Adjusted Component-Wise Markov Decision Process to obtain an approximation of the optimal CBM decision policy for large heterogeneous systems. Further, extensive numerical studies demonstrate the effectiveness of component-wise solutions for solving large multi-component systems.

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CC-North 228A

Emerging Machine Learning in Manufacturing and Operations

Community Committee Choice Session

Session Chair: Jia Liu, 1</sup

1 Enhancing Patient Similarity Learning with a Graph Generative Model for Multiple Chronic Conditions

Julian Carvajal Rico, Adel Alaeddini, The University of Texas at San Antonio (UTSA), San Antonio, TX, Contact: julian.carvajal@utsa.edu

Chronic diseases present a substantial healthcare challenge, particularly when dealing with Multiple Chronic Conditions (MCCs). In this context, we present a generative model that effectively utilizes individual patient-level risk factors and existing conditions to tackle the intricacies of optimizing graph representations for MCCs. Furthermore, we harness the potential of Graph Neural Networks (GNNs) derived from these representations to comprehend the intricate progression of MCCs. Our method's validity is established through its application to a dataset from the Cameron County Hispanic Cohort (CCHC), encompassing five chronic conditions and ten patient-level risk factors.

2 Wind Power Forecasting Based on Spatial-Temporal Graph Convolution Network with Limited Engineering Knowledge

Luo Yang, Kaibo Wang, Tsinghua University, Beijing, China. Contact: yangluo18@mails.tsinghua.edu.cn

Wind power forecasting is of crucial importance to improve the reliability of wind power systems. Extensive sensors installed on the wind turbine can collect multivariate time series of various variables in the turbine. The correlation between some variables can be described based on engineering knowledge. In this work, we propose a hierarchical multivariate time series forecasting based on spatial-temporal graph convolution network (HMTGCN) to forecast the wind power by taking full advantage of engineering knowledge.Spatial-temporal graph neural networks are utilized to extract features from subsystems of turbine and a graph convolution network integrates these features to perform prediction. The performance of the proposed method is evaluated by the real-life wind power dataset, and the results prove the effectiveness and superiority of the proposed method.

3 Process-Informed Gaussian Process Regression for Thick Layer Quality Assessment in Large-Scale Metal Additive Manufacturing

Cesar Ruiz[1], Qiang Huang[2], [1]University of Oklahoma, Norman, OK, [2]University of Southern California, Los Angeles, CA

Large-scale metal additive manufacturing (LMAM) is gaining popularity for sustainable on-demand near-net shape fabrication of complex parts. However, LMAM-built parts suffer from significant distortion due to unstable high-temperature deposition processes. Predictive models are being developed to predict and control LMAM geometric accuracy. These methods rely on accurate product qualification, which is challenging due to high surface roughness, layer remelting, and out-of-plane layer displacement. To enable accurate layer segmentation, we propose an efficient Gaussian process regression algorithm to identify layer boundaries by leveraging knowledge of idealized layers and geometry of previous layers. Numerical and experimental studies validate the effectiveness of the proposed Gaussian process segmentation algorithm in assessing layer quality.

4 A Federated Data Fusion-Based Prognostics Model for Applications with Incomplete Signals

Madi Arabi, Xiaolei Fang, North Carolina State University, Raleigh, NC, Contact: sarabi@ncsu.edu

Two of the most significant analytical challenges when constructing prognostic models for real-world industrial applications include missing data and limited training samples. Missing data means degradation signals are incomplete (i.e., some observations are missing, or the data are irregularly sampled due to varying sampling intervals), and limited training samples implies there are not enough historical samples for modeling training. This paper proposes a federated prognostics model, which allows multiple users to jointly construct a failure time prediction model using their incomplete data while keeping each user's data local and confidential. Numerical results verify effectiveness of introduced methods.

5 Clustering Raman Spectrum Data via Heterogeneity Extraction from Sequential CP Decomposition

Shenghao Xia, Jian Liu, University of Arizona, Tucson, AZ, Contact: jianliu@email.arizona.edu

Raman spectrum fluence has been used to evaluate the quality of products from the ultraviolet curing process. Traditional Raman spectrum analysis methods are ineffective due to sampling uncertainty and process uncertainty. In this research, an unsupervised learning method is proposed to investigate the curing process and the process variation by clustering Raman spectrum data. CP decomposition is adapted to extract both homogeneous and heterogeneous features from noisy Raman Spectrum data of a sample of cured products. Based on heterogeneous features, products are clustered to indicate physical process variation. The effectiveness of the proposed method is demonstrated with a case study.

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CC-North 228B

Data Driven Approaches for Cyber Physical Systems

Community Committee Choice Session

Session Chair: jihoon Chung, Virginia Tech, Blacksburg, VA
Session Chair: Raghav Gnanasambandam, Virginia Tech, Blacksburg, VA

1 Provable Convergence of Tensor Decomposition-Based Neural Network Training

Bo Shen, Chenyang Li, New Jersey Institute of Technology, Newark, NJ, Contact: bo.shen@njit.edu

In this research, a holistic framework is proposed for tensor decomposition-based NN training by formulating TT decomposition-based NN training as a nonconvex optimization problem. This problem can be solved by the proposed tensor block coordinate descent (tenBCD) method, which is a gradient-free algorithm. The global convergence of tenBCD to a critical point at a rate of O(1/k) is established with the Kurdyka Łojasiewicz (KŁ) property, where k is the number of iterations. The theoretical results can be extended to the popular residual neural networks (ResNets). The effectiveness and efficiency of our proposed framework are verified through an image classification dataset, where our proposed method can converge efficiently in training and prevent overfitting.

2 Diffusion Implicit Model-Enabled Ultrasound Images Analysis to Advance Tumor Treatment

Emmanuel Yangue, Oklahoma State University, Stillwater, OK

Enabling effective drug delivery is an important field in cancer treatment studies that has witnessed tremendous growth and technological advancements over the years. However, the current biomedical imaging technologies used in this field, such as MRI and CT scans, although accurate, are expensive and sometimes may expose patients to radiation and potential side effects. This work presents an approach using a diffusion implicit model to analyze real-time ultrasound images, which are more affordable and accessible than other imaging technologies. The current results suggest a potential for using this approach for data augmentation and segmentation for ultrasound image applications.

3 Multi-Laser Scanning Planning and Scheduling Optimization for Large Scale Metal Additive Manufacturing

Yuxin Yang[1], Lijing Yang[2], Yu Jin[3], [1]Binghamton University, Binghamton, NY, [2]University of Southern California, Los Angeles, CA, [3]Binghamton University, Binghamton, NY

Metal additive manufacturing (AM) is gaining significant attention for large-scale end-product fabrication, but the limited efficiency hinders its implementation. Concurrent AM with multiple independently driven lasers is a promising technique for rapid fabrication of large metal products. To maximize fabrication efficiency while ensuring quality for multi-laser AM processes, an optimization problem is proposed for multi-laser scanning planning and scheduling. The goal is to minimize the makespan while considering the factors that may affect the quality of metal parts as constraints, such as special geometric features and inter-hatch travel time. A deep reinforcement learning model is structured to solve this NP-hard problem. Numerical studies are conducted to demonstrate the effectiveness of the proposed methods.

4 Bayesian Inference for Survival Prediction of Childhood Leukemia

Yuning Cui, University of Okalhoma, Norman, OK, Contact: Yuning.Cui-1@ou.edu

Childhood Leukemia is the most common type of cancer among children. The painful morality and mobility rates catalyze researchers to perform predictive modeling for childhood Leukemia. Existing survival predictions rely on a single best model. However, the prediction from a single model is brittle with model uncertainty neglected, leading to serious ethical and economic consequences. Therefore, in this paper we predict patient-specific survivals for childhood Leukemia through Bayesian inference to account for model uncertainty. Experimental results indicate that the proposed model is robust and accurate in patient-specific survival predictions. Moreover, the accurate predictions can also help clinicians track the contribution of multiple clinical attributes, thereby enabling well-informed intervention and timely medical care for childhood Leukemia.

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CC-North 229A

Natural Resource Optimization in Heavy Industry

Community Committee Choice Session

Session Chair: Alexandra M. Newman, Colorado School of Mines, Golden, CO

1 Predicting Roll Force at a Continuous Casting Steel Mill

Edikan Udofia, Colorado School of MInes, Golden, CO

We develop regression model to improve prediction of roll forces in a large, hot-roll steel mill at industrial scale. Based on real-world plant data, we derive information from a constitutive physical model and include variable transformations, variable selection and model comparisons. We show how our model can help inform mill best practice in their scheduling operations.

2 A Heuristic for Design and Dispatch of Distributed Energy Systems

James Grymes[1], Alexander Zolan[2], Alexandra M. Newman[3], Dinesh Mehta[4], [1]United States Military Academy, West Point, West Point, NY, [2]National Renewable Energy Laboratory, Austin, TX, [3]Colorado School of Mines, Golden, CO, [4]Colorado School of Mines, Golden, CO

The adoption of distributed energy resources that incorporate renewable energy and storage technologies is growing, partly due to significant reductions in the cost of photovoltaic systems. However, modeling these systems often require complicated mathematical expressions. We present a *Matheuristic* for solving these non-convex mixed-integer linear programs. Our methodology yields objective function value improvements over the traditional optimization solvers across multiple test cases for practical time limits.

3 Optimizing Haul Trucks Maintenance Scheduling in Open Pit Mines

Bart Maciszewski[1], Jose Santiago Rodriguez Osorio[2], Anuraj Grewal[1], Christine Viljoen[1], Amber Mckay[1], Ervin Balleza[1], Andrew Milne[1], [1]Imperial Oil, Calgary, AB, Canada; [2]ExxonMobil, Houston, TX, Contact: bart.m.maciszewski@exxonmobil.com

We present a problem of scheduling maintenance for heavy haul trucks in an oil sands mine. The trucks require periodic preventive maintenance based on operating hours and in addition to break-in work. There is a need to schedule close to due dates while grouping activities to minimize the number of truck visits to the shop. Activities need to be performed on compatible bays and need to respect the amount of available resources. We formulate the problem as a special case of the Dual Constrained Flexible Job Shop Problem (DCFJSP) with a preprocessing step to group orders. We solve and compare performance using constraint programming and MIP. We show how the model has uncovered important business insights and improves over current approaches.

4 Bilevel Optimization for Unconventional Field-Wide Constrained Oil Production

Benjamin Spivey, Keith Zorn, Neil Adair, Amr El-Bakry, Brock Argyle, ExxonMobil Technology and Engineering Company, Spring, TX

Oil and gas production can be optimized by adjusting well choke valves and artificial lift to increase field-wide oil and gas flowrates within production constraints. For unconventional production, a field-wide model may be needed to represent how operations decisions affect field-wide production constraints. A field-wide model-based optimization problem can become computationally challenging to solve and maintain due to the large number of wells, steep decline curves, and continuously changing infrastructure. This paper describes a bilevel optimization architecture that separates field-wide pipeline network optimization from well-level optimization to make maintaining model accuracy more feasible and to reduce computational time.

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CC-North 229B

Representation of Hydrogen in Capacity Expansion Modeling

Community Committee Choice Session

Session Chair: Brian Sergi, 1</sup

1 Techno-Economic Analysis of Hydrogen Storage in Wind and Solar Electricity Systems

Jacqueline A. Dowling, California Institute of Technology, Pasadena, CA

We analyzed the tradeoff between capital cost reductions and efficiency improvements of hydrogen conversion and storage in different electricity systems with varying levels of dispatchable fossil power and otherwise-curtailed wind and solar generation. In the systems featuring abundant zero-cost electricity (resulting from wind and solar generation exceeding mean demand), hydrogen storage systems were not highly sensitive to an efficient utilization of otherwise-curtailed power, but they were sensitive to capital cost reductions. Our results suggest that innovation priorities for hydrogen storage technologies should differ depending on the characteristics of the electricity system in which the technology is utilized, with some cases placing greater value on technology cost reductions and in other cases efficiency improvements.

2 On the Representation of Hydrogen Supply and Demand for Policy Analysis

John Bistline, 1</sup

Hydrogen consumption and production raise computational challenges for energy system optimization models, given their cross-sector dynamics and power system interactions for electrolytic hydrogen pathways. This talk will highlight recent model advances in representing end-use demand for hydrogen and supply-side technological options, highlighting how model representations of supporting policies can alter hydrogen's projected role. Motivating examples will focus on two recent U.S. policies—incentives in the Inflation Reduction Act (IRA) and proposed power plant performance standards.

3 Hydrogen in the Reeds Model

Brian Sergi, National Renewable Energy Laboratory, Golden, CO, Contact: bsergi@nrel.gov

This presentation will provide an overview of the current hydrogen representation in the Regional Energy Deployment System (ReEDS) model, a capacity expansion model used for long-term planning of the U.S. power sector. The presentation will include a discussion of the formulation of key modeling features, such as storage costs and constraints, electrolyzer operations, coupling with intersectoral demand, and policy incentives. Discussion on results will center on the impact of different formulations on hydrogen deployment in the context of pathways to a zero-carbon system, and on current challenges for modeling hydrogen.

4 The Impact of Spatial Resolution on the Optimal Planning of Net-Zero Hydrogen Supply Chains

Alissa Ganter, Paolo Gabrielli, Giovanni Sansavini, ETH Zurich, Zurich, Switzerland. Contact: aganter@ethz.ch

Low-carbon hydrogen plays a key role in the decarbonization strategies of hard-to-abate industries. However, the widespread use of hydrogen is currently hampered by the lack of hydrogen supply chains, and by the uncertainty of optimal production pathways in different geographical conditions and at different spatial scales. We investigate the optimal planning of hydrogen supply chains to decarbonize hard-to-abate industries in Europe. We focus on the impact of spatial resolution on the preferred hydrogen production technologies and hydrogen supply chain structure. Our findings highlight the importance of spatial resolution to reliably design net-zero hydrogen supply chains that rely on large shares of spatially distributed renewable resources.

Sunday, October 15, 8:00 AM - 9:15 AM

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CC-North 230

GO Competition Performers

Community Committee Choice Session

Session Chair: Richard Paul O'Neill, ARPA-E, Silver Spring, MD

1 Scaling Security Constrained Optimal Power Flow to Multi-Timestep

Constance Crozier[1], Javad Mohammadi[2], Kyri Baker[3], [1]Georgia Tech, Atlanta, GA, [2]The University of Texas at Austin, Austin, TX, [3]University of Colorado Boulder, Boulder, CO

This talk will cover the approach of the Electric Stampede team in Challenge 3 of the ARPA-E Grid Optimization (GO) competition. The focus will be on the challenges of adapting the team's previous code to accommodate the multiple time step format of Challenge 3 - which includes 18-48 times more variables than the previous formulation.

2 GravityX: The Last Challenge

Hassan Hijazi, LANL, NM

In this talk, we will go over the Challenge 3 modeling and solution methods used by the GravityX team. This will include time decomposition and convexification approaches. We will discuss lessons learned and future research directions.

3 Experiences In Solving Multi-period UC-ACOPF In GO Competition

Andy Sun[1], Matthew Brun[2], Dirk Lauinger[3], Thomas Lee[4], Xin Chen[5], [1]MIT, Cambridge, MA, [2]Operations Research Center, MIT, Cambridge, MA, [3]MIT, Cambridge, MA, [4]Massachusetts Institute of Technology, Cambridge, MA, [5]Texas A&M University, College Station, TX, Contact: sunx@mit.edu

In this talk, we will present our experiences of participating in the ARPA-E's GO competition, especially the Third Challenge on solving large-scale problems of multi-period unit commitment, AC optimal power flow, and branch switching. We will discuss the challenges posed by such problems in the operation and short-term planning of electric power systems. Some efforts in developing effective algorithms and computational packages will be discussed.

4 Heuristics for the GO Competition

Daniel Bienstock, Columbia Univ, NY

We describe the approach used in last year's and this year's GO competition. Joint work with Richard Waltz.

Sunday, October 15, 8:00 AM - 9:15 AM

SA53

CC-North 231A

Advanced Learning and Optimization for Carbon-Neutral Electricity

Community Committee Choice Session

Session Chair: Xin Chen, 1</sup

Session Chair: Luo Xu, 1</sup

1 Toward Net Zero Emissions by Optimizing Building Setpoints: A Graph Neural Network-Based Deep Reinforcement Learning Approach

You Lin, Green Daisy, Leslie Norford, Jeremy Gregory, Audun Botterud, Massachusetts Institute of Technology, Cambridge, MA

Building energy consumption from HVAC systems causes around 28% of global energy related carbon emissions. In this study, a setpoint optimization model is proposed to reduce carbon emissions using a graph neural network-based deep reinforcement learning (DRL) algorithm considering thermal exchanges among various zones within buildings. By intelligently scheduling the day-ahead temperature setpoints and adjusting the real-time setpoints, DRL-based controllers can optimize setpoints while reducing carbon emissions and considering thermal comfort of occupants. Testing on MIT campus buildings demonstrates the effectiveness of the proposed model in reducing energy consumption and carbon emissions.

2 Quantitative Opportunity Costs Of Demand Response In Real-time Markets: A Multi-parametric Programming Approach

Kiyeob Lee[1], Dustin Kenefake[1], Le Xie[1], Efstratios Pistikopoulos[2], [1]Texas A&M University, College Station, TX, [2]Texas A&M Energy Institute, College Station, TX

This paper presents security constrained economic dispatch and demand response through the lens of multi-parametric programming (MPP). The goal is to leverage MPP to provide valuable system and market information in terms of demand, which is necessary to address scarcity pricing and price forecasting mechanisms. In electricity markets, self-interested market participants are coordinated by system operators through price signals, namely locational marginal price (LMP). The proposed approach enhances this coordination by providing tangible incentives, such as an enumeration of all possible LMP values. To solve the proposed MPP problem, various algorithms are introduced to understand the computational complexity and scalability. All algorithms are evaluated for numerous test systems, and detailed case study is performed on a synthetic Texas 2000-bus grid.

3 Carbon-Aware Optimal Power Flow

Xin Chen[1], Andy Sun[2], Na Li[3], Wenbo Shi[4], [1]Texas A&M University, College Station, TX, [2]MIT, Cambridge, MA, [3]Harvard University, Cambridge, MA, [4]Singularity Energy, Somerville, MA, Contact: xinch512@mit.edu

Decarbonization of the electricity sector is essential to achieve carbon neutrality. To enable effective decarbonization decision-making, this paper proposes the carbon-aware optimal power flow (C-OPF) method as the theoretical foundation. Built upon the classic optimal power flow (OPF) technique, this proposed C-OPF method incorporates carbon flow equations, constraints, and carbon-related objective components to co-optimize power flow and carbon flow. In particular, this paper proposes reformulation approaches to handle the issues of undetermined power flow directions and bilinear terms. Numerical simulations demonstrate the characteristics and effectiveness of the C-OPF method.

4 Learning to Optimize Macro-Energy Systems

Filippo Pecci, Amarasinghage T. Perera, Jesse D. Jenkins, ZERO Lab, Princeton University, Princeton, NJ

Due to the need for high temporal and spatial resolution, optimization-based planning models for macro-energy systems are often slow. This prevents planners from exploring the full range of parameter uncertainties and policy scenarios. Although supervised learning has been used to speed-up optimal power flow, optimal sizing of energy technologies, and optimal planning of urban energy systems, it has not been applied to macro-energy system planning models, taking into account generation and transmission capacity expansion, and system operation. We propose a supervised learning architecture to approximate solutions of macro-energy system planning models, where investment and operation decisions are jointly optimized to minimize total cost, subject to physical, economical, and policy constraints.

Sunday, October 15, 8:00 AM - 9:15 AM

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CC-North 231B

Optimization and AI in Environment and Sustainability

Community Committee Choice Session

Session Chair: Wenquan Dong, University of Tennessee-Knoxville, Knoxville, TN

1 Nationwide Network Design for Circular Biomass-to-Bioenergy and Biofuel with Carbon Capture and Conversion

Rui Zhou, University of Tennessee, Knoxville, knoxville, TN

Biomass-bioenergy and biofuel have great potential in alternative renewable energy production and carbon reduction. Biomass can be converted into various bioenergy and biofuels via fermentation, pyrolysis, gasification, or combustion with carbon capture and storage. In this paper, we evaluate the techno-economic feasibility and the environmental impacts of those conversion technologies for the primary terrestrial and aquatic biomass feedstocks with biochar recycling and develop a programming model to incorporate spatial and techno-economic data for the renewable bioenergy and biofuels supply chain network optimization. The model economically optimizes the geographic distribution and scale of biomass resources, conversion refineries, and the primary fuel consumers in the United States for a 20 years life span.

2 Exploring Nutritional Equity in Food Bank Supply Chains

Nowshin Sharmile[1], Lauren Berrings Davis[2], [1]North Carolina A&T State University, Greensboro, NC, [2]North Carolina A&T State University, Greensboro, NC, Contact: nsharmile@aggies.ncat.edu

This project aims to optimize the foodbank supply chain while considering the nutritional quality, storage requirements, and equity of the food available for distribution. The Healthy Eating Research Guideline is incorporated into our research to encourage a better understanding of nutritious foods in the foodbank distribution network.

3 A Heuristic Solution to the Single Depot Electric Vehicle Scheduling Problem

Taner Cokyasar[1], Omer Verbas[1], Amir Davatgari[2], Abolfazl Kouros Mohammadian[2], [1]Argonne National Laboratory, Lemont, IL, [2]University of Illinois Chicago, Chicago, IL, Contact: omer@anl.gov

Transit is the backbone of the transportation sector that not only mitigates traffic congestion and environmental impact but also provides equity through an affordable mobility service. Transit electrification has an utmost importance to achieve global net-zero economy goals. In this study, we revisit a decades-old single depot vehicle scheduling problem (SDVSP) to address the operational constraints bus electrification brings in. To this end, we follow a two-stage modeling approach: In the first stage, we solve an SDVSP model to form vehicle blocks, and we solve a block chaining problem in the second stage. An analysis conducted using this solution framework found that electric vehicle range plays a key role in determining the fleet size.

Sunday, October 15, 8:00 AM - 9:15 AM

SA55

CC-North 231C

Managing Resources in Marketplaces

Community Committee Choice Session

Session Chair: Deniz Akturk, University of Chicago Booth School of Business, Chicago, IL

Session Chair: Ozan Candogan, University of Chicago, Chicago, IL

1 Managing Resources for Shared Micromobility: Approximate Optimality in Large-Scale Systems

Deniz Akturk[1], Ozan Candogan[2], Varun Gupta[3], [1]Washington University in St. Louis Olin School of Business, St. Louis, MO, [2]University of Chicago, Chicago, IL, [3]University of Chicago Booth School of Business, Chicago, IL

We consider the problem of managing resources in shared micromobility systems (bike-sharing and scooter-sharing). An important task in managing such systems is periodic repositioning/recharging/sourcing of units to avoid stockouts or excess inventory at nodes with unbalanced flows. We consider a discrete-time model: each period begins with an initial inventory at each node in the network, and then customers (demand) materialize at the nodes. Each customer picks up a unit at origin node and drops it off at a randomly sampled destination node given origin-specific probability distribution. We introduce a mean-field approximation and prove that the mean-field optimal policy is asymptotically optimal. We then provide an algorithm to compute a near-optimal policy for the mean-field system. Using micromobility data, we show the strong performance of our algorithm.

2 Driver Pre-Allocation Problem via Transfer Payment

Bomin Bian[1], Zhenyu Hu[1], Long He[2], JUN JIANG[1], [1]National University of Singapore, Singapore, Singapore; [2]George Washington University, Washington

We consider a driver pre-allocation problem faced by an on-demand platform that earns commission from trips. To maximize the expected profit, the platform provides monetary incentives to pre-allocate drivers to potential demand locations. Given incentives, the drivers' choice behaviors are captured by the multinomial logit (MNL) choice model that endogenizes other drivers' choices via the probability of matching with a demand. We show that the drivers' equilibrium choice probability exists, and the platform's problem and the optimal incentive are independent of the platform's commission rate. Moreover, computationally, the profit maximization problem can be reformulated as an exponential cone program (ECP). Finally, we conduct numerical studies using real data from a taxi operator in Singapore to demonstrate the solution and discuss managerial implications.

3 An Analysis of Hierarchical Randomized Experiments with Network Inference

Yiming Jiang, He Wang, Georgia Tech, Atlanta, GA, Contact: yjiang463@gatech.edu

We consider designing randomized experiments under network interference. The goal is to estimate the global average treatment effect, which compares outcomes under the counterfactuals that all or no units are treated, without knowing the magnitude of the spillover effect between the treatment and the control groups. We analyze a hierarchical experiment design that simultaneously runs both a completely randomized experiment and a cluster-based randomized experiment. We show that this design allows for an unbiased estimate of the global average treatment effect, and bound the variance of the estimator by a clustering problem. Using a simple clustering algorithm, the hierarchical estimator achieves better efficiency than the state-of-the-art cluster-based experiment designs.

4 On the Supply of Autonomous Vehicles in Open Platforms

Daniel Freund[1], Ilan Lobel[2], Jiayu (Kamessi) Zhao[1], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]New York University, New York, NY, Contact: kamessi@mit.edu

Autonomous vehicle (AV) technology may fundamentally change the transportation landscape. Due to the high cost of AV hardware, the most likely path to widespread AV use is via open platforms that sustain high-utilization, outsource the high capital burden, and complement the network with human drivers who join as individual contractors (ICs). In my talk, I present a supply chain game between a platform, an outside AV supplier, and the ICs. Such a setting is subject to the risk of AV underutilization as the platform needs to maintain a sufficiently high IC utilization to keep them engaged. In a decentralized supply chain, this can have a disastrous effect on supply chain efficiency, which can be alleviated through contracting solutions.

Sunday, October 15, 8:00 AM - 9:15 AM

SA56

CC-North 232A

AI for a Better World

Community Committee Choice Session

Session Chair: Leonard Boussioux, MIT, Operations Research Center, Cambridge, MA

Session Chair: Cynthia Zeng, Massachusetts Institute of Technology, Cambridge, MA

1 How to Solve the United Nations' Sustainable Goals in 5 Minutes

Leonard Boussioux, MIT, Operations Research Center,

Cambridge, MA

We present a transformative approach to solving the United Nations Sustainable Development Goals using Generative AI, focusing specifically on its potential to create innovative solutions for sustainable, circular economies. We compared the efficacy of human-driven innovation with AI-generated solutions by initiating a crowdsourcing challenge attracting solvers from diverse backgrounds worldwide and employing GPT-4 with calibrated prompts. From 1,885 evaluator-solution pairs, our results indicated comparable quality between human and AI-generated solutions. Interestingly, while human ideas were perceived as more novel, AI solutions demonstrated superior environmental and financial value. Overall, we set the stage for a multimodal, integrative approach, where human-AI collaboration can lead to actionable solutions across the 17 goals.

2 Catastrophe Insurance: An Adaptive Robust Optimization Approach

Cynthia Zeng, Massachusetts Institute of Technology, Cambridge, MA

Climate change leads to more frequent and costly natural disasters worldwide. In light of this, insurance can play a pivotal role in supporting recovery and incentivizing investments in hazard mitigation. In this talk, I will present our work on an Adaptive Robust Optimization (ARO) framework for catastrophe insurance premium pricing, applied to flood insurance using data from the US National Flood Insurance Program (NFIP). To the best of our knowledge, this is the first work to use an ARO approach to set disaster insurance premiums. These premiums are designed to protect against both historical flooding risks and forward-looking forecasted risks obtained through machine learning models, thus incorporating the elevated risks posed by climate change. Our research demonstrates that a data-driven optimization approach can lead to a more efficient and fair insurance scheme. This talk is intended to extend an open invitation on how we can incorporate new technologies to improve our financial instruments and aid in climate adaptation.

3 Road Speed Prediction in Developing Regions: Leveraging Data Scarce GPS Trajectory Data, Weather and Satellite Information

Valentijn Stienen[1], Dick Den Hertog[2], Joris Wagenaar[1], Joann de Zegher[3], [1]Zero Hunger Lab, Tilburg University, Tilburg, Netherlands; [2]University of Amsterdam, Amsterdam, Netherlands; [3]MIT Sloan, Cambridge, MA

In developing, data scarce, environments, inaccurate digital road networks pose significant challenges for the use of analytics. Travel time/speed information is crucial but often unknown, especially in developing regions where the speed may also depend on weather conditions. Existing methods for speed prediction are inadequate due to the inaccuracy or unavailability of data. This paper introduces a novel deep learning approach that utilizes GPS trajectory data and satellite imagery to predict average travel speeds for roads under specific circumstances (time of day and recent weather). A case study conducted in collaboration with the organization PemPem demonstrates the effectiveness of the proposed method in predicting road speeds.

Sunday, October 15, 8:00 AM - 9:15 AM

SA57

CC-North 232B

Optimization of Logistics Operations for Autonomous Drones and Collaborative Robots

Community Committee Choice Session

Session Chair: Sharan Srinivas, University of Missouri, Columbia, MO

1 Human-Robot Teaming for Intralogistics Operations in Dynamic Environments

Shitao Yu[1], Surya Ramachandiran[2], Sharan Srinivas[1], [1]University of Missouri, Columbia, MO, [2]Penn State University

To serve increased customer orders and expectations, warehouses seek to optimize their order picking and improve responsiveness. In this study, we propose a Collaborative Human-Robot Order Picking System, where the pickers are only responsible for the pick and place operations, while the robots undertake the transportation tasks. Further, we propose Interventionist and Select-Interventionist algorithms to serve the dynamic incoming customer orders. Unlike most existing dynamic approaches, these strategies allow updating the pick list during the picking cycle of a robot. Our results show that the collaborative system consistently outperforms the traditional picking strategy. Further, the interventionist approach resulted in the lowest tardiness and completion time, while the select-interventionist approach ensured that the workers traveled the least.

2 Maximizing Service Level in Drone Transportation Networks: A Robust Scenario-Based Model for Battery-Swapping Station and Hub Location

Nima Golghamat Raad, University of Missouri, Columbia,

MO, Contact: nima.golghamatraad@mail.missouri.edu
Drones will revolutionize point-to-point transportation, including commercial, medical, emergency, and food supplies. However, their limited flight range and the unique challenges of aerial transportation necessitate novel approaches to the network design of charging/battery-swapping stations. To address these challenges, this research introduces a stochastic scenario-based model for locating battery-swapping stations and drone hubs. It considers uncertain factors like service demand, payload weight, and wind conditions and maximizes the service level. The model is efficiently solved using the sample average approximation (SAA) technique and a hybrid metaheuristic algorithm that combines the shortest path method with Augmented Large Neighborhood Search. Numerical experiments confirm the competitiveness and effectiveness of the proposed approach.

3 Route-Sequence Decisions for Truck-Drone Delivery System Considering En Route Operations

Teena Thomas[1], Sharan Srinivas[2], Chandrasekharan Rajendran[3], [1]Indian Institute of Technology Madras, Chennai, India; [2]University of Missouri, Columbia, MO, [3]IIT Madras, India, Chennai, India. Contact: annateenathomas@gmail.com
This study considers a single-truck multi-drone delivery system with en route drone launch and recovery operations. An optimization model is proposed to minimize the total delivery time, addressing truck routing and truck-drone scheduling decisions. A model variant is proposed to minimize the vehicle operating costs. The model can optimally solve problem sizes of up to 20 customers in less than 500s. A two-phase relax-and-fix with recouple-refine-and-optimize heuristic is designed to solve large size problems. A multi-truck model variant is also developed with a deep learning enabled clustering and routing solution technique. Computational experiments are conducted for problem sizes of up to 100 customers. The results ensure great savings in delivery completion time and vehicle operating costs for the respective variants, with the inclusion of en route operations.

Sunday, October 15, 8:00 AM - 9:15 AM

SA58

CC-North 232C

Towards More Environmental Friendly Operations

Contributed Session

Session Chair: Fuzhen LIU, The Hong Kong Polytechnic University, Hong Kong, China

1 Risk Tradeoffs in Supplier Selection: A Discrete Choice Experiment

Behnam Fahimnia[1], Andrew Collins[1], Brent Motitz[2], [1]The University of Sydney, Darlington, Australia; [2]Pennsylvania State University, State College, PA
This paper investigates how supply managers evaluate environmental and social sustainability relative to cost and supply diversification. We engaged 217 practicing supply managers in a discrete choice experiment to calculate their willingness to pay for and trade-off between location diversification, environmental sustainability, and social sustainability. Managers were willing to incur slightly higher costs for suppliers with better environmental and social performance, but more importantly they were willing to substitute environmental performance for social performance. Managers were willing to pay more for increased geographic diversification of the suppliers, even if adding diversification resulted in poorer environmental performance.

2 Design of Logistics Infrastructure in Support of Naval Operations with use of Ammonia-Based Fuel

Jing Wang[1], Nathan Huynh[1], Josh Allen[2], Qing Hui[2], Roger A. Dougal[3], William E. Mustain[4], [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]University of South Carolina, Columbia, SC, [4]University of South Carolina, Columbia, SC
One of the U.S. Navy’s energy goals is to demonstrate and then deploy a “Great Green Fleet,” which will include ships and aircraft using alternative sources of energy. One such energy source is ammonia. A challenge with switching to using ammonia for fuel is reduced range. This study aims to assess the viability of utilizing ammonia as fuel to support naval operations. To this end, a mixed integer non-linear programming model is developed to determine ship routes taking into account factors such as ship speeds, refueling time, and the non-linear relationship between fuel consumption and the ship’s speed. The objective of the model is to minimize cost. To solve this model, a particle swarm optimization-based algorithm is developed. Preliminary results from several hypothetical fuel logistics scenarios are presented.

3 Stay or Move? the Impact of Environmental Regulation on Supply Chain Reconfiguration

Ruolei Liu[1], Yuxiao Ye[1], Di Fan[2], Baofeng Huo[1], [1]Tianjin University, Tianjin, China; [2]Hong Kong Polytechnic University, Hong Kong, China. Contact: lrlei@tju.edu.cn

Whether and how environmental regulation influence supply chain networks is theoretically ambiguous and warrants an empirical analysis. We empirically study the impact of the stringency of environmental regulation on firms' supply chain dynamic adjustment using firm-level panel data. Our results show a negative relationship between environmental regulation and supply chain involvement. Also, the main negative effect is moderated by several factors. These results are robust across many tests. These findings shed new light on how firms use supply chain to arbitrage across institutional environments.

4 Complementary or Substitutive Effects? A Resource-based Perspective on Green Manufacturing and Operational Efficiency

Fuzhen Liu[1], Ni Huang[2], Kee-hung Lai[1], [1]The Hong Kong Polytechnic University, Hong Kong, China; [2]University of Miami, Coral Gables, FL, Contact: fuzhen02.liu@connect.polyu.hk

The trade-off between environmental friendly policies and efficiency gains challenges the widespread adoption of green manufacturing. The existing literature has yet to reach a consensus on the operational efficiency of green manufacturing adoption. Drawing upon a resource-based view, this study examines the influence of green manufacturing on operational efficiency and the moderating role of organizational and technological characteristics on the said relationship. Based on a two-stage difference-in-differences analysis on 18,297 firm-year observations, this research adds new insights into the operations management (OM) literature by uncovering the complementary role of organizational characteristics and the substitutive role of technological characteristics on the link between green manufacturing and operational efficiency.

Sunday, October 15, 8:00 AM - 9:15 AM

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CC-West 101A

2023 MCDM Junior Researcher Best Paper Award

Award Session

Session Chair: Roman Słowiński, Poland

1 The use of the Success-Based Decision Rule to Support the Holistic Evaluation Process in Fitradeoff

Lucia Reis Peixoto Roselli[1], Adiel Teixeira De Almeida[2], [1]Center for Decision Systems and Information Development, Federal University of Pernambuco, Recife, Brazil; [2]Universidade Federal de Pernambuco, Recife PE, Brazil

The paper proposes the Success-Based Decision Rule (SBDR) to support the holist evaluation within the decision process with the FITradeoff method. The aim of this rule has been to assist the analyst in the advising process with Decision-Makers (DMs) concerning the holistic evaluation performed with graphical and tabular visualizations. Therefore, using this rule, the analyst can advise DMs to use or not use visualizations to express dominance relations between alternatives during the holistic evaluation. This rule transforms the FITradeoff Decision Support System. The Success-Based Decision Rule (SBDR) has been constructed using the probability of success and its standard deviation following the Bernoulli distribution.

2 A Novel Picture Fuzzy Critic & Regime Methodology: Wearable Health Technology Application

Elif Haktanır Aktaş[1], Cengiz Kahraman[2], [1]Bahcesehir University, Istanbul, Turkey; [2]Istanbul Technical University, Istanbul, Turkey. Contact: elif.haktaniraktas@eng.bau.edu.tr

Picture fuzzy sets (PFSs) are one of the most promising extensions of ordinary fuzzy sets with three parameters, namely positive membership, neutral membership, and negative membership, for defining the membership status of an element to a set. CRiteria Importance Through Intercriteria Correlation (CRITIC) & REGIME methods are recently developed multi criteria decision making (MCDM) methods for calculating the criteria weights and ranking alternatives, respectively. CRITIC method determines the criteria weights by using the values in the decision matrix. REGIME method is a compensatory MCDM method employing superiority and guide indices, superiority identifier and impacts, and REGIME matrices. In this paper, an integrated CRITIC & REGIME methodology is developed for the first time by using single-valued PFSs in order to use the advantage of PFSs in handling ambiguity and impreciseness. The main contribution of our study is to demonstrate theoretically and practically how to transform superiority and guide indices, superiority identifier and impacts, and REGIME matrices to the PF environment. A new interval valued Relative Magnitude Index scale and an original Percentile Rank under Vagueness function have been developed. The developed methodology is applied to the selection problem of wearable health technology (WHT). Comparative and sensitivity analyses are presented. These analyses show that CRITIC & REGIME methodology produces very effective and valid results, and unlike the other methods, it shows slight ranking differences due to the statistical-based calculations it contains.

Sunday, October 15, 8:00 AM - 9:15 AM

SA60

CC-West 101B
MIF/MSOM/DEIC Panel: DEI Research Opportunities in ORMS
Panel Session

1 DEI Research Opportunities In MSOM & Operations Engineering
Chris Parker, American University, Washington, DC, Contact: chris.parker@american.edu
This panel will discuss opportunities to incorporate Diversity, Equity, and Inclusion (DEI) in both business school and engineering research projects. Panelists will also talk about the challenges of doing this type of research.
Session Chair: Diana Gineth Ramirez-Rios, University at Buffalo, Buffalo, NY
Session Chair: Clara Novoa, Texas State University, San Marcos, TX

2 Panelist
Erin Baker, Univ of Massachusetts-Amherst, Amherst, MA

3 Panelist
Stephanie Kelley, Ivey Business School, The University of Western Ontario, London, ON, Canada

4 Panelist
Shannon Harris, Virginia Commonwealth University, Richmond, VA

5 Panelist
Dwaipayan Roy, University of Virginia Darden School of Business, Charlottesville, VA

Sunday, October 15, 8:00 AM - 9:15 AM

SA61

CC-West 101C
Empirical PSOR
Community Committee Choice Session
Session Chair: Anqi Wu, Florida International University, Miami, FL
Session Chair: Chunjie Zhao, Clark University, Worcester, MA

1 Is It the Way to Go for a Cleaner Environment? Lessons from Renewable Portfolio Standard
Chunjie Zhao[1], Anqi Wu[2], Ramanath Subramanyam[3], [1]Clark University, Worcester, MA, [2]Florida International University, Miami, FL, [3]Universality of Illinois Urbana-Champaign, Champaign, IL, Contact: ChuZhao@clarku.edu
Role of government policy in pursuing sustainable development has received increasing attention. Different types of policy design along with the firm's emission policy, play a crucial role in mitigating greenhouse gas (GHG) emissions. This paper utilizes a combination of data from the Carbon Disclosure Project (CDP) and the Renewable Portfolio Standard (RPS) policy to examine the causal effects of state-level policies and firm-level GHG emissions. By employing a staged difference-in-differences methodology, we have found a negative connection between policies and emissions. Furthermore, we have observed that states with lower and more progressive targets have the potential to achieve even lower emissions. These findings have significant implications for environmental regulations and public policies targeting emissions in firms operating in the United States.

2 Factors Affecting the Relationship Between Inspections and Quality Outcomes in the Pharmaceutical Industry
Zach Wright[1], John Gray[1], In Joon Noh[2], [1]Fisher College of Business, The Ohio State University, Columbus, OH, [2]Penn State University, University Park, PA, Contact: wright.2482@osu.edu
Regulatory inspections play an important role in maintaining acceptable quality standards for manufacturers in many industries. Contextual heterogeneity leaves it unclear as to when regulatory inspections will be most effective in driving quality improvement. This study aims to explore the effect of inspections on quality outcomes as well as moderating factors that influence this relationship.

3 Impact of Foodtech Platforms on Food Insecurity
Sandeep Srinivas[1,2], [12]University of Illinois at Urbana Champaign, Champaign, IL
Food insecurity is a serious problem globally, including in developed nations such as the US. One sustainable solution to the problem is - food recovery - which connects excess food to people in need. Although food recovery is traditionally done by food banks, a few for-profit "foodtech" platforms have recently emerged in this space. In this paper, we study the impact of one such platform, which works with supermarkets to provide an alternate sales channel for food that is near expiry. We find a statistically significant reduction in food insecurity in the local area after the platform introduction. The results are robust to alternate identification

strategies and subsample analyses. Our results establish a new mechanism in the push to reduce food insecurity - through for-profit businesses by leveraging technology, emphasizing the importance of sustainable business models.

4 Health Insurance and Labor Productivity in Us Manufacturing: Evidence from Medicaid Expansion

Yasaman Asayesh, Anant Mishra, Carlson School of Management, University of Minnesota, Minneapolis, MN, Contact: yasaman@umn.edu

Medicaid expansion program aims to improve healthcare access for Americans by reducing eligibility constraints and widening government-sponsored insurance coverage. However, the economic implications of this large-scale public health intervention are controversial. This study investigates the impact of Medicaid expansion on labor productivity in the manufacturing industry. Furthermore, the study explores variations in the aforementioned impact based on a range of socioeconomic and health factors.

Sunday, October 15, 8:00 AM - 9:15 AM

SA62

CC-West 102A

Redistricting

Community Committee Choice Session

Session Chair: Soraya Ezazipour, Oklahoma State University, Stillwater, OK

1 Fairness and Graph Algorithms for Political Redistricting

Rahul Swamy[1], Douglas M. King[2], Sheldon Jacobson[3], [1]University of Illinois at Urbana-Champaign, Urbana, IL, [2]U of Illinois at Urbana-Champaign, Urbana, IL, [3]UIUC, Urbana, IL, Contact: shj@illinois.edu

Political districting in the United States is a decennial process of redrawing the boundaries of congressional and state legislative districts. Fairness in political districting has been an important topic of subjective debate, with district plans affecting a wide range of stakeholders, including voters, candidates, and political parties. This talk covers Mixed Integer Programming formulations for fairness-based redistricting.

2 A New Metric For Evaluating Political Redistricting Plans

Brendan Ruskey, Lawrence V. Snyder, Lehigh Unversity Department of Industrial Engineering, Bethlehem, PA, Contact: bjr221@lehigh.edu

Every 10 years in the United States, lawmakers partition the citizens of each state into groups of roughly equal population in what is called a "redistricting plan". These districts are expected to be geographically compact, and should not unfairly disadvantage members of any demographic group or political party. In this project, we first propose a metaheuristic to create new redistricting plans from a previously proposed plan, improving its performance in one or more objectives. We then propose a metric for comparing the proposed plan against those generated by our metaheuristic. In the context of legal challenges to redistricting plans, our proposed metric could be used to show that a plan may be unfit for use in future elections by demonstrating that making small changes to the plan's district boundaries leads to significant improvement in one or more objectives.

3 Political Districting to Optimize the Polsby-Popper Compactness Score

Pietro Belotti[1], Austin Buchanan[2], Soraya Ezazipour[2], [1]Polytechnic University of Milan, Milan, Italy; [2]Oklahoma State University, Stillwater, OK, Contact: sezazip@okstate.edu

In the academic literature and in expert testimony, the Polsby-Popper score is the most popular way to measure the compactness of a political district. Given a district with area A and perimeter P, its Polsby-Popper score is given by $(4 \pi A)/P^2$. This score takes values between zero and one, with circular districts achieving a perfect score of one. In this paper, we propose the first mathematical optimization models to draw districts with optimum Polsby-Popper score. Specifically, we propose new mixed-integer second-order cone programs (MISOCPs), which can be solved with existing optimization software. We investigate their tractability by applying them to real-life districting instances in the USA. Our techniques could be used by plaintiffs when seeking to overturn maps that dilute the voting strength of minority groups.

4 Multi-Balanced Redistricting and Within-Cycle Malapportionment in Computational Redistricting

Daryl Robert Deford, Washington State University, Pullman, WA, Contact: daryl.deford@wsu.edu

Tools from discrete optimization have become increasingly important for analyzing graph-based formulations of political redistricting. Given a partition of a state into a set of geographic units, such as census blocks or voting precincts, a districting plan becomes a labelled partition of the associated dual graph formed by connecting vertices representing adjacent units with the property that each induced subgraph is connected. Performing optimization in this context requires operationalizing legislative text and exploring complex Pareto frontiers. In this talk I will discuss recent work that considers multiple relevant population columns in an attempt to address natural within-cycle vote dilution. This includes theoretical bounds on worst-case behavior of partitioning methods and empirical optimization on data from the 2020 census.

Sunday, October 15, 8:00 AM - 9:15 AM

SA63

CC-West 102B

Service Science and Information Systems

Community Committee Choice Session

Session Chair: Yeongin Kim, Virginia Commonwealth University, Glen Allen

Session Chair: Seonjun Kang, VCU, Richmond, VA

1 Cross-Platform Comparison of Feature Differences and Their Effects on Content Production with Cryptocurrency Rewards

Tong Wu[1], Yeongin Kim[2], Tae Hun Kim[3], Stacie Petter[4], [1]Western Kentucky University, Bowling Green, KY, [2]Virginia Commonwealth University, Glen Allen, VA, [3]Ajou University, Suwon, Korea, Republic of; [4]Wake Forest University, Winston-Salem, NC

This paper aims to generate a systematic understanding of how various features on cryptocurrency reward-based social media platforms enhance user engagement in content production. This paper adopts technology affordance theory as the theoretical lens to analyze the effects of two main feature differences – cryptocurrency reward features and social interaction features – on user engagement across five cryptocurrency reward-based social media platforms. By utilizing difference-in-differences and propensity score matching methods, the findings suggest that platforms offering multiple cryptocurrencies and flag features are more likely to increase user engagement in posting production. However, offering cryptocurrency rewards for comments and providing a downvote feature to users can result in a decrease in posting production on these platforms.

2 Effects of Decentralization on Blockchain-Based Digital Platform Market Capitalization

Rongen Zhang, Baylor University, Waco, TX

Decentralization is a core principle for blockchain, but its overall effect remains controversial and inconclusive. Although Chen et al. (2021) proposed an inverted-u shape effect of decentralization, we still have insufficient theoretical understanding of different aspects and its mechanism. We introduce two unique decentralization dimensions—physical and development—and propose the mediating role of governance engagement, measured by proposal quantity and topic diversity. Analyzing historical data from 7 PoW blockchain platforms (2015-2020), we uncover distinct effects of decentralization aspects on platform market capitalization and partial mediation by governance engagement. This study contributes to the emerging blockchain literature and highlights the crucial mediating role of decentralized governance for blockchain platform designers.

3 User Engagement in Hyperlocal Content and Its Economic Contribution to Local Businesses

Myungsun Lee, Tae Hun Kim, Ajou University, Suwon, Korea, Republic of. Contact: micle619@ajou.ac.kr

People use mobile/social media platforms to share location-based information with others in real time. Such hyperlocal content impacts the economy by updating nearby users on local businesses. This research first addresses what motivates users of a social media platform, Nextdoor, to engage in sharing hyperlocal content on local businesses and related local events in New York City. The locational amount of content crowdsourced by nearby users and its user interaction density, the location-based numbers of comments on and reactions to each content are measured to address hyperlocal user engagement. Second, we propose the local economic consequences of such hyperlocal user engagement for restaurant and lodging businesses specifically. We discuss how hyperlocal user engagement contributes to the financial and marketing success of local businesses around urban areas.

Sunday, October 15, 8:00 AM - 9:15 AM

SA64

CC-West 102C

Developing and Managing Social Media Platforms and Networks

Community Committee Choice Session

Session Chair: Alice Jang, Virginia Tech, Blacksburg, VA

1 Knowledge Digitization and Causal Knowledge Analytics

Yuanyuan Song, University of Georgia

Scientific progress requires building upon exponentially expanding foundations, and this problem of synthesizing ideas across manifold publications needs a more efficient

methodology. While Google Scholar accelerates the discovery of possibly pertinent research, these approaches do not encode knowledge, and scholars have to extract the core knowledge from the results of their search. The failure to digitally encode knowledge inhibits the growth of many fields. As casual and process models are the foundation of scientific reasoning, the Theory Research Exchange (T-Rex) project is developing causal knowledge analytics methods that enable researchers to code causal and process models as graphs and synthesize the literature exhaustively and speedily. We invite scholars to discuss the next generation of methodologies for the analytics and synthesis of knowledge.

2 The Impact of Hyperbole on Product Sales in Short Video Platforms

Yutong Han[1], Bowen Yin[1], Fei Ren[1], Bin Gu[2], [1]Peking University, Beijing, China; [2]Boston University, Boston, MA, Contact: hanyutong19@pku.edu.cn

While short video has become popular in social media platforms, how to design video content to promote product sales still remains unclear. This study proposes a novel content strategy of utilizing hyperbole in short videos and investigates its potential for driving product sales. Hyperbole, which involves exaggerating multimodal features, can stimulate interest and capture the audience's attention, but may also negatively affect credibility if perceived as misleading. The study employs machine learning algorithms to measure multimodal hyperbole, and then assesses its impact on actual sales data. The findings indicate that hyperbole has a positive impact on sales conversion, particularly for products with lesser-known brands and influencers with lower indegree. This study contributes to the literature on advertising content and online purchase behavior.

3 The Effects of Quote Retweet on Subsequent Posting Behavior and Morality Expression on Social Media

Yan Wu[1], Qianzhou Du[1], Xiaohui Zhang[2], John Zhang[2], [1]Nanjing University, Nanjing, China; [2]Arizona State University, Tempe, AZ

Users are increasingly engaged in online discussions on social media platforms, while previous studies rarely explore their impacts on users' behaviors. To address this gap, guided by the Threshold model and Self-justification theory, we proposed a research model on the impact of online discussion on users' behaviors on social media. Utilizing data from Twitter, we empirically examined the positive effects of quote retweeting a tweet related to the topic of immigration policies and border issues on users' subsequent topic-related posting behaviors and morality expression. This impact is found to be strengthened among users with higher threshold levels or larger behavior-opinion inconsistency. Our findings have both theoretical and practical implications for social media platforms.

4 Leveraging Large Language Models (LLMs) for Effective Online Deliberation via Persuasion

Hazel Hyeseung Kang, Boston University, Boston, MA, Contact: hazelk@bu.edu

The rise of user-generated content on social media challenges productive and inclusive online deliberations, leading to echo chambers, polarization, and a lack of exposure to alternative viewpoints. We identify optimal argumentation schemes for online persuasion using Walton's compilation of existing persuasion literature from Cicero and Aristotle. Using ChangeMyView's dataset, we conduct a field experiment to establish causality, seeking to reduce polarization and facilitate opinion change. Our research has managerial implications for designing moderation strategies on social media platforms. Methodologically, our study contributes insights into optimal prompting techniques of large language models, including state-of-the-art LLMs such as GPT-3.5.

Sunday, October 15, 8:00 AM - 9:15 AM

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CC-West 103A

Emerging Themes in Product/Innovation Management

Community Committee Choice Session

Session Chair: Sina Khorasani, 1</sup
Session Chair: RAMAZAN Kizilyildirim, UCL, LONDON, United Kingdom
Session Chair: Ersin Korpeoglu, University College London, London, United Kingdom

1 Towards an Understanding of Nanostores' Operations, as Organized Retailers Expand

Syd Hashem Alavi[1], Glen M. Schmidt[2], [1]University of Utah, Salt Lake City, UT, [2]University of Utah, Salt Lake City, UT, Contact: syd.alavi@utah.edu

Nano-stores are small, privately owned, and operated grocery outlets common in emerging economies. The expansion of modern organized chain retail stores is challenging these traditional outlets. Using a survey and statistical analysis of sales databases, we study nanostores' operation in this market dynamic.

2 When Does Culture Outperform Formal Incentives in Innovation? A Culture Evolution Theory Approach

Konstantinos Ladas[1], Christoph H. Loch[2], Stylianos Kavadias[1], [1]University of Cambridge, Cambrige, United Kingdom; [2]Cambridge University, Cambridge, United Kingdom. Contact: s.kavadias@jbs.cam.ac.uk

Peter Drucker once famously remarked, "culture eats strategy for breakfast." We develop a Culture Evolution Theory (CET) model to compare top-down incentives for innovation with a bottom-up culture (where innovation ideas are imitated but the idea generators are given recognition by other employees) in a company that operates under competition. In this model, culture is a more robust environment for innovation. Moreover, we discuss how the CET modelling approach can address other problems in innovation and operations management.

3 The Value of Private Feedback in Trial-and-Error Innovation Contests

Zhi Chen[1], Zhenyu Hu[2], Yufei Zhu[3], [1]National University of Singapore, Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore; [3]National University of Singapore, Singapore, Singapore. Contact: e0253756@u.nus.edu

Providing interim feedback is common practice In innovation contests. In this paper, we study the effect of private feedback on innovation in multi-agent and multi-stage trial-and-error innovation contests. Prior literature has shown that in ideation projects, giving private feedback may not always be conducive to innovation, as compared to the case of no feedback. In contrast, we find that in trial-and-error projects, giving private feedback always improves both quantities and qualities of innovation.

4 Dynamic Development Contests

Sina Khorasani[1], Ersin Korpeoglu[2], Vish Krishnan[3], [1]University of Dayton, Dayton, OH, [2]University College London, London, United Kingdom; [3]University of California-San Diego, La Jolla, CA, Contact: skhorasani1@udayton.edu

We derive optimal dynamic development contests with enriched rank-based incentives and carefully-tailored information design that can help organizations leverage their suppliers for their development projects while seeking to minimize project lead time by stimulating competition among them.

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CC-West 103B

Innovative Endeavors: Assessment, Creation, Funding, and Breakup

Community Committee Choice Session

Session Chair: Moren Levesque, York University, Toronto, ON, Canada

1 Opportunity Judgment and Entrepreneurship Policy

Jacqueline Csonka-Peeren[1], Norris Krueger[2], [1]IBM, Toronto, ON, Canada; [2]Entrepreneurship Northwest, Boise, ID, Contact: jcsonka@uwaterloo.ca

An entrepreneur must assess an opportunity despite having a lack of information. Because of this lack of information, exact probabilities for success or loss cannot be known; this lack of information creates a condition of ambiguity. Although operational research methods to help with decision making under condition of risk are ubiquitous, entrepreneurs make decisions under condition of ambiguity. Theoretical development of research methods for attitude to ambiguity has led to two novel scores, "ambiguity-sum" and "ambiguity-ratio". We present a framework comprised of these scores to help inform policy supporting entrepreneurship and model the impact of this policy on entrepreneurship. We further describe how this research method can be extended to opportunity judgment between two opportunities.

2 Designing Reward Structure for Crowdfunding Campaigns

PARAM PAL SINGH Chhabra[1], Manpreet Singh Hora[2], Karthik Ramachandran[2], [1]University of Alberta, Edmonton, AB, Canada; [2]Georgia Institute of Technology, Atlanta, GA, Contact: param.chhabra@ualberta.ca

Rewards are crucial for the success of a campaign in reward-based crowdfunding. However, creators adopt hit and trial approach to design the reward structure. In this study, we empirically investigate the association between reward structure design and the campaign's performance to make recommendations for creators.

3 I Think We Should See Other People: Exploring Biotech-Pharma Partnership Breakups Following Successful Drug Launches

Pierre Gautreau[1], Moren Levesque[2], Annapoornima Subramanian[3], Vareska van de Vrande[4], [1]York University, Toronto, ON, Canada; [2]York University, Toronto, ON, Canada; [3]National University of Singapore, Costa Mesa,

CA, [4]Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands. Contact: gautreau@schulich.yorku.ca
Using a comprehensive database of new drug development projects, we investigate whether successful drug launches within an established pharmaceutical firm's portfolio influence the likelihood of the big pharma sustaining its partnerships with biotech start-ups. We also consider whether this influence is moderated by drug types or drug development phases.

4 New Venture Creation: The Role of Proprietary Resources

Moren Levesque[1], Saul Estrin[2], Andrea Herrmann[3], Tomasz Mickiewicz[4], Mark Sanders[5], [1]York University, Toronto, ON, Canada; [2]London School of Economics, London, United Kingdom; [3]Radboud University, Nijmegen, Netherlands; [4]Aston University, Birmingham, United Kingdom; [5]Maastricht University, Maastricht, Netherlands
New ventures trade off between being innovative and scaling up revenues or reaching the point that enables market valuation (speed-to-market) quickly. We present a formal model that illustrates why such tradeoffs arise. Then, we analyze 331 ICT ventures that completed the venture creation stage, using an empirical method that accounts for unobserved heterogeneity across ventures. This approach allows us to identify a strong tradeoff between innovativeness and speed-to-market, but the tradeoff is weaker between revenue levels and speed. We also find that proprietary resources (founder equity and founder labor) are the main drivers of new ventures' multidimensional success. Our results suggest that access to these resources can present a key bottleneck in the innovation process and explain the unexplained variation in venture creation efficiency across new ventures.

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CC-West 104A

Data Analytics in Manufacturing Industry

Community Committee Choice Session

Session Chair: Dohyun Kim, 1</sup

1 Process Parameters Optimization Using Neural Inversion

Ki Jeong Choi[1], Dohyun (Norman) Kim[2], [1]Myongji University, Yongin-si, Korea, Republic of; [2]Myongji University, Yong-In, Korea, Republic of
Effective control of process parameters such as pressure and temperature significantly impacts manufacturing yield. However, process parameters are typically adjusted based on the judgments of experienced experts, which can introduce uncertainty and potentially lead to significant issues. Therefore, we propose a novel approach that utilizes neural inversion to optimize manufacturing process parameters. Neural inversion tracks how specific patterns in process parameters affect characteristics, thereby enhancing manufacturing precision, efficiency, and advancing product quality and stability.

2 Prioritized Group Sparse Autoencoder

Jae Heon Jeong[1], Jisu Woo[1], Dohyun (Norman) Kim[2], [1]univ. myung-ji, Yong-in, Korea, Republic of; [2]Myongji University, Yong-In, Korea, Republic of. Contact: lhe339@mju.ac.kr
Autoencoder is an artificial neural network architecture designed to learn a compressed representation of data. However, a drawback of conventional autoencoders is that they require the utilization of all input variables. In this research, we aim to perform data compression by exclusively using the variables that are crucial for representing the data. Moreover, when dealing with pre-grouped input variables, our approach involves prioritizing the essential group and selecting the necessary variables within that group, resulting in an optimized compressed representation of the data.

3 Domain Invariant and Contrastive Representation for Sleep Dynamics

Seungyeon Lee, The Ohio State University, Columbus, OH
Sleep staging is a key challenge in diagnosing and treating sleep-related diseases. Many deep learning methods have been proposed for automatic sleep staging, but they face several challenges including the heterogeneity of patients' underlying health conditions and the difficulty modeling complex interactions between sleep stages. In this paper, we propose a neural network architecture named DREAM to tackle these issues. DREAM consists of (i) a feature representation network that generates robust representations for sleep signals and (ii) a sleep stage classification network that explicitly models the interactions between sleep stages in the sequential context at both feature representation and label classification levels.

4 Enhancing Prediction Model in Semiconductor Manufacturing Dataset: A Transformer with Statistical Feature-based Embedding

GyeongTaek Lee, Rutgers University/Department of Industrial System Engineering, Piscataway, NJ

In the realm of semiconductor manufacturing, the rapid advancement of process technology has led to swift changes in the process recipe. Consequently, amassing an extensive volume of sensor data has become a challenge. Despite the impressive performance exhibited by recent deep learning models in tasks like fault detection and virtual metrology, it is difficult to apply the models in the field due to model capacity. To address this, this research introduces a Transformer-based predictive model designed to function effectively even with a limited quantity of sensor data. The novel approach involves transforming sensor data into embeddings based on statistical features. Empirical evaluation on an actual semiconductor manufacturing dataset demonstrates that the proposed model enhances predictive performance compared to previous models. The proposed method can be utilized in real-world scenarios where only a small amount of data is available.

5 Reliability Prediction and Control of Semiconductor Chips Using Mass Production Burn-In Data

Kilsoo Kim, Soheon Choi, Eunji Lee, Nohseok Park, Ilsang Park, Samsung Electronics, Hwaseong, Korea, Republic of. Contact: ks1.kim@samsung.com

It is very important to predict the probability of field failure and control before semiconductor chips are shipped to customers. To this end, sampling-based product reliability tests are being additionally conducted after burn-in test. However, this way has several problems such as large statistical error due to a lack of sample quantity compared to what is required to check a very low defective rate and high evaluation costs due to scrap of samples tested. This paper presents the field failure prediction model using mass production burn-in data. Next, this work describes how to set the product control limits for abnormal lot considering a field failure risk. Finally, the real case study is included to illustrate our proposed procedures.

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Business Data Analytics

Community Committee Choice Session

Session Chair: Sophie Zhai, 1</sup

1 On the Influence of Online Conversations - a Human Dignity Perspective

Sophie Zhai, Heshan Sun, University of Oklahoma, Norman, OK

Digital platforms are becoming an increasingly integral part of everyday life. In this study, we introduce the concepts of embedded conversational intentions and digital dignity. We examine how online communications from information senders can impact the digital dignity of information receivers. Using user-generated videos and comments, we construct a model to demonstrate the relationship between embedded conversational intentions and human digital dignity. As well, we contribute to the literature on using information and communication technologies to build a bright society.

2 Discovering Supply Chain Issues from Sec 10-K Reports Through Topic Modeling

Kara Li Liu, Zhu(Drew) Zhang, University of Rhode Island, Kingston, RI

IT firms are more driven by the supply-side economy regarding customized products or services and compatible operations. Managers seek to identify major issues and accelerate the interaction with their suppliers due to the dynamics of supply chains in recent years. However, it is challenging for IT firms to identify those issues from the great number of unstructured texts. In this study, we utilize topic modeling, a text-mining approach, to analyze SEC filings of IT firms and discover topics associated with supply chain issues. Our study contributes to the application of topic modeling approach in supply chains. The findings provide insights into supply chains from the IT industry and improve managers' decision-making.

3 Now You See It, Now You Don't: Leveraging Transient Content Alongside Permanent Content to Foster Social Media Engagement

Lucy Shen[1], Byungyeon Kim[2], Elie Ofek[1], [1]Harvard Business School, Boston, MA, [2]University of Minnesota, Minneapolis, MN, Contact: lushen@hbs.edu

This study explores whether influencers can enhance follower engagement by differentiating permanent content (Posts) and transient content (Stories), which is viewable for only 24 hours, in the context of Instagram. We find that influencers publish Stories that are lower visual quality than and topically different from Posts. Followers respond positively to this distinction. Higher similarity in Posts correlates with more likes on Posts, while lower similarity between Posts and Stories also leads to higher engagement. This suggests that influencers can boost engagement by strategically dividing their content, publishing consistent, professional content to permanent channels and sharing authentic, personal content to transient channels.

4 Corporation Between Brands and Influencers in Livestream

Jingyun Hu, Clemson University, Clemson, SC, Contact: jhu3@clemson.edu

The matching problem is a pervasive issue examined within empirical industrial organization field. Hitsch(2010) use the Gale-Shapley algorithm to predict stable matches in dating market. Similar to dating market, the livestream market operates on the principle of matching firms with suitable influencers for product promotion. Douyin the social media platform, the chinese version of Tiktok has established a dedicated space for influencers and brands to connect and collaborates on promotion activities through "JuLiangXingTu". What I doing is get 411 influencers who have over 10 million influencers and their livestream performance, product performance, and their price fee for promotion. My model is to use historical livestream performance and current price, to solve the matching problem if firm want to find a big influencer in Douyin.

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Applications in Market Design

Community Committee Choice Session

Session Chair: Ashu Thakur, 1</sup

1 Optimal Liver Exchange with Equipoise

Alex Chan, Harvard University, Cambridge, MA

The practical and ethical needs of liver exchange is different from kidney exchange, a new mechanism is proposed. Instead of just maximizing the number of exchanges, clinicians prioritize liver transplant candidates with the highest medical urgency as measured by MELD score first. Donation of the right liver lobe is five-fold riskier than the left lobe for the donor. An exchange that involves donors giving different lobes is deemed unfair. Existing mechanisms are not suited to identify optimal matchings for the organ exchange problem that needs to flexibly meet a finite exchange cycle-length constraint, accommodate indifferences in preferences, maximize transplants for highest priority patients and keep risk balanced for donors. The proposed mechanism yields optimal allocations, respects balanced donor risk, maximizes priority and is incentive compatible.

2 An Empirical Framework for Waitlists with Endogenous Priority: Evaluating the Heart Transplant Waitlist

Kurt Sweat, Stanford, CA

Waitlists that prioritize specific agents to achieve certain policy goals are common in practice, but policy makers often use endogenous characteristics of agents to assign waitlist priority. I study the heart transplant waitlist in the United States where the treatment that a patient receives is used to assign waitlist priority. Policy makers recently changed the prioritization in an attempt to reduce waitlist mortality by assigning higher priority to patients receiving specific treatments associated with high waitlist mortality. I document a significant response to waitlist incentives and demonstrate that this has had an effect on observed survival. I develop an empirical framework to evaluate the life-years gained by a patient from entering a waitlist with a given design. The model is used to evaluate the recent change to the heart transplant waitlist.

3 Evolution of Institutional Designs: Theory and Empirics

Ashutosh Thakur, National University of Singapore, Singapore, Singapore. Contact: adthakur@nus.edu.sg

In many organizations, members need to be assigned to certain positions, whether these are legislators to committees, executives to roles, or workers to teams. In such settings, the design of the assignment procedure becomes an institutional choice that is influenced and agreed upon by the very members being assigned. Will these agents seek to reform the assignment procedures by voting in favor of some alternative allocation over their current allocation? I explore this question of institutional stability by bringing together matching theory and social choice. I introduce institutional stability under majority rule and juxtapose it with other voting rules an organization might use to resolve internal conflict. The theoretical insights are used empirically to explain the historical evolution of assignment procedures of elite civil servants to states in India.

4 Matching with Costly Interviews: The Benefits of Asynchronous Offers

Akhil Vohra, University of Georgia, GA

We analyze the welfare implications of costly interviewing in a model of worker-firm matching. Centralized matching leads to coordination issues in the interview stage. Each firm must incorporate the externality imposed by the interview decisions of the firms ranked above it when deciding on its interview list. As a result, low-ranked firms often fail to interview some candidates that ex-ante have high match quality. A decentralized setting with exploding offers generates, at a minimum, the same welfare as a centralized system. Total welfare is maximized with a system that ensures firms interview and match in sequence, clearing the market for the next firm. Such asynchronicity reduces interview congestion. This can be implemented by encouraging top firms to interview and match early and allowing candidates to renege on offers.

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CC-West 105B

Machine Learning for Heterogeneous Data Fusion

Community Committee Choice Session

Session Chair: Hyunsoo Yoon, Yonsei University, Seoul, Korea, Republic of

1 A Patch-Wise Fault Diagnosis Framework with Self-Supervised Learning in Limited Data Scenarios

Beomgyo Shin, Hyunsoo Yoon, Yonsei University, Seoul, Korea, Republic of. Contact: beomgyo.shin@yonsei.ac.kr

Fault diagnosis plays an important role in industrial settings. Recently, deep learning-based methods have shown promising results in this area. However, acquiring a significant number of labeled data for real-world industrial scenarios poses a challenge. This study proposes a self-supervised learning approach for diagnosing faults in unlabeled signal data. The proposed method extracts feature vectors from signals through self-supervised learning techniques and employs clustering algorithms for fault type classification, eliminating the need for extensive fine-tuning. Experimental results demonstrate exceptional performance in predictive clustering on entirely unlabeled data and robustness against variations in fault type ratios and noise levels.

2 An Explainable Deep Neural Network for Extracapsular Extension Identification in 3d Head and Neck Cancer Computed Tomography Images

Haifeng Wang, Mississippi State University, Mississippi State, MS

Extracapsular extension (ECE) is a strong predictor of patients' survival outcomes with head and neck cancer. In this study, a gradient-weighted class activation mapping (Grad-CAM) technique is proposed to guide the deep learning algorithm to focus on the regions that are highly related to ECE. The proposed framework includes an extractor and a classifier. In the joint training process, informative volumes of interest (VOIs) are extracted by the extractor without labeled lymph node region information, and the classifier learns the pattern to classify the extracted VOIs into ECE positive and negative. The results were compared with different existing models and further confirmed by a clinic study. The presence or absence of ECE has been analyzed and correlated with ground truth histopathological findings.

3 Pseudo Supervised Metrics: Evaluating Unsupervised Image to Image Translation Models in Unsupervised Cross-Domain Classification Frameworks

Firas Al-Hindawi, Arizona State University, Tempe, AZ, Contact: falhinda@asu.edu

Unsupervised cross-domain classification frameworks were developed to handle the data domain shift problem by utilizing unsupervised image translation models. For lack of annotations, it is not possible to use traditional supervised metrics to evaluate these translation models to pick the best-saved checkpoint model. In this work, we introduce Pseudo Supervised Metrics, designed specifically to support unsupervised cross-domain classification applications contrary to other typically used metrics such as the FID which was designed to evaluate the model in terms of the quality of the generated image from a human-eye perspective. Our method outperforms the FID, is robust, explainable and highly correlated with the true supervised metrics.

4 Semi-supervised Domain Adaptation Via Statistics Invariant Adversarial Training

Yu Jun Yang, Hyunsoo Yoon, Yonsei University, Seoul, Korea, Republic of. Contact: diddbwns1025@yonsei.ac.kr

Rotating machinery is pivotal in industry. However, the substantial domain gaps hinder cross-machine adaptation. In light of this challenge, we propose a cross-machine semi-supervised domain adaptation framework for real-world scenarios. Conventional statistical features from sensors notably contribute to inter-machine domain gaps. To address this, we design a domain-invariant framework diverging from the statistical features. This effectively mitigates inter-machine domain gaps originating from distinct machines, enhancing performance with few target labels.

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CC-West 105C

Emerging Topics in FinTech Empirical Research

Community Committee Choice Session

Session Chair: Tian Lu, Arizona State University

1 Inclusive Decision Making Via Contrastive Learning And Domain Adaptation

Xiyang Hu, Carnegie Mellon University, Pittsburgh, PA

Achieving inclusiveness in decision-making is of utmost importance for advancing social justice and mitigating inequality. This is especially critical in high-stakes decisions, where decisions can have profound and long-lasting effects on individuals. In this study, we propose to leverage contrastive learning and domain adaptation to improve inclusion in algorithmic decision-making. We empirically examine our method in a high-stakes micro-lending context. We propose a new Transformer-based sequential loan screening model with self-supervised contrastive learning and domain adaptation to achieve this objective. Our experiment results show that our model significantly promotes the inclusiveness of funding decisions, while also improving loan screening accuracy and lender profit.

2 Understanding the Drivers of Digital Assets Investment: An Investigation of Sustainable Cryptocurrencies

Wenya Shen, Arizona State University, Tempe, AZ

Cryptocurrency is a decentralized digital asset that has recently gained growing attention from researchers and practitioners. Increasingly, the high energy consumption from mining PoW-based coins has raised concerns and debates on creating harmful environmental impacts. The rise of environmental concerns has led to the introduction of more environmental-friendly crypto coins using the proof-of-stake (PoS) consensus mechanism. This study aims to investigate the drivers of sustainable cryptocurrency investment and adoption.

3 Unmasking Inequality In The Virtual Realm: A Study Of Skin-tone Bias In The Cryptopunks Market

(Selena) Sungeun Han, Arizona State University, Tempe, AZ, Contact: sungeunh1024@gmail.com

The metaverse offers lifelike personal and business experiences through the integration of VR/AR, and other advanced technologies. Despite of positive benefits of it, there are emerging concerns related to data privacy and the ethical implications of avatar representation. This research project explores the potential bias in the digital collectible market and its impact on DEI in the metaverse. Digital collectibles are often used for expressing self-identity (e.g., avatars), and transferring value across platforms in the metaverse. This research will specifically examine racial and gender discrimination in this market and how they could potentially lead to intentional or unintentional colorism and sexism in the metaverse. The goal is to better understand the implications of DEI and develop strategies to promote inclusive governance in this emerging digital space.

4 Concrete Achievements and Coherent Plans: Linguistic Properties in Initial Coin Offerings (Icos)

Ziyi Xiong, Yan Chen, Rong Liu, Chihoon Lee, Stevens Institute of Technology, Hoboken, NJ, Contact: rliu20@stevens.edu

Initial Coin Offerings (ICOs) have emerged as an innovative crowdfunding method for technology start-ups. Effective communication between start-ups and investors is critical to the fundraising success. We draw on construal level theory to examine business roadmaps, an important but often overlooked type of disclosures for ICOs. We suggest that achievements and plans in the roadmap differ in hypothetical distances, tend to trigger mental construals at different levels, and thus should be communicated through different linguistic features. Our empirical results show that fundraising performance is positively associated with the concreteness of achieved activities and the coherence of planned activities. Furthermore, the concreteness of achieved activities has a greater impact on older projects, and the value of coherent plans increases with market sentiment.

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CC-West 106A

Novel Analytics and Machine Learning Approaches with Manufacturing Applications

Contributed Session

Session Chair: Golnoush Javan, University of Toledo, Toledo, OH

1 Global Sensitivity Analysis of Input Uncertainties in the Thermal Fluid Model of Metal Additive Manufacturing

Amanda Giam, National University of Singapore, Singapore, Singapore. Contact: amandagiam@u.nus.edu

Computational multi-physics models play an integral role in Laser Powder-Bed Fusion (L-PBF) metal additive manufacturing as they streamline the qualification cycle of the L-PBF products. However, the models involve a large number of input factors with uncertainties, and incur high computational cost. Thus we focus on a preliminary screening experiment via global sensitivity analysis to reduce input dimensionality, and guide the construction of a surrogate model. We demonstrate the effectiveness of the Elementary Effects method with space-filling trajectories in characterizing input uncertainties in the thermal-fluid model, providing valuable physics-based insights, and identifying the most influential inputs. This facilitates factor fixing and targeted follow-up experimentation with Latin Hypercube Sampling, achieving efficient resource allocation.

2 Machine Learning Applications in Predicting Solder Joint Characteristic Life: A Comparative Analysis

Seyed Soroosh Alavi[1], Daniel F. Silva[2], [1]Auburn University, Auburn, AL, [2]Auburn University, Auburn, AL, Contact: sza0147@auburn.edu

This research explores the use of machine learning (ML) in predicting the characteristic life of solder joints, typically estimated through time-consuming, costly empirical methods. ML models offer the potential to consolidate diverse test conditions into a single, universal model by using data from isothermal aging and thermal cycling tests on solder joints obtained from past research at Auburn University. A comparative analysis between ML and empirical modeling reveals comparable accuracy, with the ML model demonstrating cost and time efficiencies. Results suggest that the application of ML in this area is promising, providing a streamlined, cost-effective approach for solder joint life prediction.

3 Data-Driven Predictive Maintenance in Counter Pressure Casting Process

Jaebong Cho[1], Jihoon Nam[2], Minjoo Park[1], [1]Pohang University of Science and Technology, Pohang, Korea, Republic of; [2]Pohang University of Science and Technology, Pohang, Korea, Republic of. Contact: jaycho00@postech.ac.kr

Counter pressure casting (CPC) is a process technology used to manufacture aluminum automotive parts, where the mold is filled by having a slight pressure differential. Predictive maintenance of CPC equipment is crucial to avoid quality degradations such as air entrapment and porosity inside the parts. The operating conditions characterized by high temperature and pressure, coupled with the inaccessibility of internal components hinder the adaptation of pre-emptive management. This study proposes an autoencoder-based operational anomaly detection method for the data-driven CPC equipment maintenance to address this challenge. The result looks promising, expecting that the manufacturers may achieve the reduction of maintenance costs and improved quality of the parts by adapting the predictive maintenance methods.

4 Text Mining in Manufacturing: A Systematic Literature Review

Golnoush (Julie) Javan[1], Nima Molavi[2], [1]University of Toledo, Toledo, OH, [2]California State University, San Bernardino, San Bernardino, CA, Contact: sjoreim@rockets.utoledo.edu

With the emergence of cyber-physical manufacturing systems, the manufacturing industry has generated one of the largest shares of data in recent years and is projected to grow significantly in the upcoming years, according to IDC. Structured data makes up a small portion of the total, while the majority consists of semi-structured and unstructured data like text documents. Text mining (TM) can be used to extract information from manufacturing unstructured data; however, comprehensive reviews of TM applications in manufacturing are limited. This study systematically reviews articles published on TM applications in manufacturing, analyzing prime application fields, identifying key challenges, and proposing future research directions. The findings inform the research community about the novel TM applications in manufacturing and research opportunities.

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CC-West 106B

Big Data Methods and Applications to Finance

Community Committee Choice Session

Session Chair: Agostino Capponi, Columbia University, New York, NY

1 A Matrix Balancing Perspective on Choice Modeling

Zhaonan Qu, Stanford University, Stanford, CA

This paper studies some optimization aspects of choice modeling, a popular subject in econometrics and social choice. For a broad class of choice and ranking models based on Luce's choice axiom, we show that the associated maximum likelihood estimation problems are equivalent to a classic matrix balancing problem with target row and column sums. This perspective allows us to unify existing algorithms in the choice modeling literature as special instances or analogs of the celebrated Sinkhorn's algorithm. We then resolve an open problem by characterizing the linear rate of convergence of Sinkhorn's algorithm for non-negative matrices in terms of the algebraic connectivity. Lastly, we provide a discussion on the interesting trade-off between computational and statistical efficiencies of maximum likelihood estimation in the context of choice models.

2 Bridge the Gap Between Financial Engineering and Finance Communities: Opportunities and Challenges Led by Big Data

Mao Ye, Cornell University, Ithaca, NY

The big data revolution creates many opportunities for collaboration between the OR/Financial Engineering and finance communities. As a researcher in the finance community, I would like to discuss several potential topics that may benefit from collaboration with the OR/Financial Engineering community, such as high-frequency trading, algorithmic trading, quantitative investing and regulations of trading algorithms.

3 Optimal Transport and Risk Aversion in Kyle's Model of Informed Trading

Ibrahim Ekren, Florida State University, Tallahassee, FL

We establish connections between optimal transport theory and the dynamic version of the Kyle model, including new characterizations of informed trading profits via conjugate duality and Monge-Kantorovich duality. We use these connections to extend the model to multiple assets, general distributions, and risk-averse market makers. With risk-averse market makers, liquidity is lower, assets exhibit short-term reversals, and risk premia depend on market maker inventories, which are mean reverting. We illustrate the model by showing that implied volatilities predict stock returns when there is informed trading in stocks and options and market makers are risk averse. Based on joint work with Kerry Back, Francois Cocquemas and Abraham Lioui.

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CC-West 106C

Economics and Computation I

Award Session

Session Chair: Yeganeh Alimohammadi, Stanford University, Stanford, CA

1 Welfare-Maximizing Pooled Testing

Francisco Marmolejo-Cossío[1], Simon Finster[2], Edwin Lock[3], Michelle González Amador[4], Evi Micha[5], Ariel Procaccia[1], [1]Harvard University, Boston, MA, [2]CREST-ENSAE & CNRS/ Université Grenoble Alpes, Grenoble, France; [3]University of Oxford, Oxford, United Kingdom; [4]UNU-MERIT & Maastricht University, Maastricht, Netherlands; [5]University of Toronto, Toronto, ON, Canada. Contact: fjmarmol@ seas.harvard.edu

In an epidemic, how should an organization with limited testing resources safely return to in-person activities after a period of lockdown? We study this question in a setting where the population at hand is heterogeneous in both utility for in-person activities and probability of infection. In such a period of re-integration, tests can be used as a certificate of non-infection, whereby those in negative tests are permitted to return to in-person activities for a designated amount of time. Under the assumption that samples can be pooled, the question of how to allocate a limited testing budget in the population to maximize the aggregate utility (i.e. welfare) of negatively-tested individuals who return to in-person activities is non-trivial, with a large space of potential testing allocations.

We show that non-overlapping testing allocations, which are both conceptually and (crucially) logistically more simple to implement, are approximately optimal, and we design an efficient greedy algorithm for finding non-overlapping testing allocations with approximately optimal welfare. In computational experiments, we highlight the efficacy and viability of our greedy algorithm in practice. To the best of our knowledge, we are also first to implement and provide causal evidence on the benefits of utility-weighted pooled testing in a real-world setting. Surprisingly, our pilot study at a higher education research institute in Mexico finds no evidence that performance and mental health outcomes of participants in our testing regime are worse than under the first-best counterfactual of full reopening without testing.

2 Finding the Right Curve: Optimal Design of Constant Function Market Makers

Mohak Goyal, Geoffrey Ramseyer, Ashish Goel, David Mazieres, Stanford University, Stanford, CA, Contact: mohakg@stanford.edu

Constant Function Market Makers (CFMMs) are a tool for creating exchange markets, have been deployed effectively in prediction markets, and are now especially prominent in the Decentralized Finance ecosystem. We show that for any set of beliefs about future asset prices, an optimal CFMM trading function exists that maximizes the fraction of trades that a CFMM can settle.We formulate a convex program to compute this optimal trading function. This program, therefore, gives a tractable framework for market-makers to compile their belief function on the future prices of the underlying assets into the trading function of a maximally capital-efficient CFMM.

Our convex optimization framework further extends to capture the tradeoffs between fee revenue, arbitrage loss, and opportunity costs of liquidity providers. Analyzing the program shows how the consideration of profit and loss leads to a qualitatively different optimal trading function.

Our model additionally explains the diversity of CFMM designs that appear in practice. We show that careful analysis of our convex program enables inference of a market-maker's beliefs about future asset prices, and show that these beliefs mirror the folklore intuition for several widely used CFMMs. Developing the program requires a new notion of the liquidity of a CFMM, and the core technical challenge is in the analysis of the KKT conditions of an optimization over an infinite-dimensional Banach space.

3 Fundamental Bounds on Online Strategic Classification

Saba Ahmadi[1], Avrim Blum[1], Kunhe Yang[2], [1]Toyota Technological Institute at Chicago, Chicago, IL, [2]UC Berkeley, Berkeley, CA

Strategic classification has received increasing interest over the years, where the understanding of how agents manipulate their observable features to gain advantageous classifications directly affects the effectiveness and fairness of the marketplace. We focus on the problem of online binary classification, where strategic agents can manipulate their observable features in predefined ways, modeled by a manipulation graph, in order to receive a positive classification. We show this setting differs in fundamental ways from classic (non-strategic) online classification. For instance, whereas in the non-strategic case, a mistake bound of ln|H| is achievable via the halving algorithm when the target function belongs to a known class H, we show that no deterministic algorithm can achieve a mistake bound o(Δ) in the strategic setting, where Δ is the maximum degree of the manipulation graph (even when |H|=O(Δ)). We complement this with a general algorithm achieving mistake bound O(Δ ln|H|). We also extend this to the agnostic setting, and show that this algorithm achieves a Δ multiplicative regret (mistake bound of O(Δ(OPT+ln|H|)), and that no deterministic algorithm can achieve o(Δ) multiplicative regret.
Next, we study two randomized models based on whether the random choices are made before or after agents respond and show they exhibit fundamental differences. In the first fractional model, at each round, the learner deterministically chooses a probability distribution over classifiers inducing expected values on each vertex (probabilities of being classified as positive), which the strategic agents respond to. We show that any learner in this model has to suffer linear regret. On the other hand, in the second randomized algorithms model, while the adversary who selects the next agent must respond to the learner's probability distribution over classifiers, the agent then responds to the actual hypothesis classifier drawn from this distribution. Surprisingly, we show this model is more advantageous to the learner, and we design randomized algorithms that achieve sublinear regret bounds against both oblivious and adaptive adversaries.

4 Robust Auction Design with Support Information

Jerry Anunrojwong, Santiago R. Balseiro, Omar Besbes, Columbia Business School, New York, NY

The seller wants to sell an item to n i.i.d. buyers and only the support [a,b] is known; a/b quantifies relative support information (RSI). The seller either minimizes worst-case regret or maximizes worst-case approximation ratio. We show that i) with low RSI, second-price auctions (SPA) is optimal; ii) with high RSI, SPA is not optimal, and we introduce a new mechanism, the "pooling auction" (POOL), which is optimal; iii) with moderate RSI, a combination of SPA and POOL is optimal. Under POOL, whenever the highest value is above a threshold, the mechanism still allocates to the highest bidder (just like SPA), but otherwise the mechanism allocates to a uniformly random buyer, i.e., pools low types.

5 Incentive Compatibility in the Auto-Bidding World

Yeganeh Alimohammadi[1], Andres Perlroth[2], Aranyak Mehta[3], [1]Stanford University, Stanford, CA, [23]Google, Mountain View, CA

Auto-bidding has recently become a popular feature in ad auctions. This feature enables advertisers to simply provide high-level constraints and goals to an automated agent, which optimizes their auction bids on their behalf. These auto-bidding intermediaries interact in a decentralized manner in the underlying auctions, leading to new interesting practical and theoretical questions on auction design, for example, in understanding the bidding equilibrium properties between auto-bidder intermediaries for different auctions.
In this paper, we examine the effect of different auctions on the incentives of advertisers to report their constraints to the auto-bidder intermediaries. More precisely, we study whether canonical auctions such as first price auction (FPA) and second price auction (SPA) are auto-bidding incentive compatible (AIC): whether an advertiser can gain by misreporting their constraints to the autobidder.
We consider value-maximizing advertisers in two important settings: when they have a budget constraint and when they have a target cost-per-acquisition constraint. The main result of our work is that for both settings, FPA and SPA are not AIC. This contrasts with FPA being AIC when auto-bidders are constrained to bid using a (sub-optimal) uniform bidding policy. We further extend our main result and show that any (possibly randomized) auction that is truthful (in the classic profit-maximizing sense), scalar invariant and symmetric is not AIC. Finally, to complement our findings, we provide sufficient market conditions for FPA and SPA to become AIC for two advertisers. These conditions require advertisers' valuations to be well-aligned. This suggests that when the competition is intense for all queries, advertisers have less

incentive to misreport their constraints.
From a methodological standpoint, we develop a novel continuous model of queries. This model provides tractability to study equilibrium with auto-bidders, which contrasts with the standard discrete query model, which is known to be hard. Through the analysis of this model, we uncover a surprising result: in auto-bidding with two advertisers, FPA and SPA are auction equivalent.

Sunday, October 15, 8:00 AM - 9:15 AM

SA75

Session.Location:CC-West 208A

Optimization of Logistics Delivery Systems

Contributed Session

Session Chair: Vahid Eghbal Akhlaghi, Georgia Institute of Technology (H. Milton Stewart School of Industrial and Systems Engineering), Atlanta, GA

1 City Logistics in Megacities: The Two-Echelon Pickup-And-Delivery Problem with Time Windows and Deadlines

Muchammad Arya Zamal[1], Albert Schrotenboer[2], Tom van Woensel[1], [1]Eindhoven University of Technology, Eindhoven, Netherlands; [2]Eindhoven University of Technology, Eindhoven, Netherlands. Contact: m.a.zamal@tue.nl

This paper presents the Two-Echelon Pickup-and-Delivery problem with Time Windows and Deadlines (2E-PDPTW-D), a new and emerging routing variant addressing the operations of logistics companies connecting consumers and suppliers in megacities. The 2E-PDPTW-D integrates reverse flow, route flexibility, and vehicle time-synchronization aspects such as parcel time windows, satellite synchronization, and hub deadlines. A proposed matheuristic approach combines a set-partitioning model and an Adaptive Large Neighborhood Search (ALNS) to create cost-efficient vehicle routes satisfying all constraints. Computational studies in collaboration with a logistics service provider in Indonesia reveal that early pickup deadlines may require additional vehicles, emphasizing the need to consider the marginal costs of extra fleets for megacity logistics operations.

2 A Delivery Workers Assignment Problem for the Distribution of Goods in Urban Areas

Antonia Ilabaca, Germán Paredes-Belmar, Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile. Contact: antonia.ilabaca.c@mail.pucv.cl

This paper addresses the delivery workers assignment problem with time-dependent and time windows constraints in urban areas for efficient distribution of goods. The purpose is determining routes for a set of vehicles that serves a set of demand points, taking characteristics of city logistics such as traffic congestion and distribution in different buildings. Unlike the traditional vehicle routing problem, our focus is on efficiently crew assignment for delivery vehicles. The crew composition can consist of drivers, delivery workers, or a multifunctional worker who perform both driving and delivery tasks. To solve this problem, we propose a mixed integer linear programming model that minimized the total transportation costs. The resulting set of efficient routes and crew vehicle assignments can support decision-making and improve customer service.

3 Load Balancing for Online Truck Routing

Tanvir Ibna Kaisar[1], Maged M. Dessouky[2], [1]University of Southern California, Los Angeles, CA, [2]University of Southern California, Los Angeles, CA, Contact: kaisar@usc.edu

In the absence of coordination, individual truck drivers act selfishly to minimize their travel time, resulting in a user equilibrium (UE) solution that is not necessarily system optimum (SO). In this study, we propose an algorithm that encourages collaboration among individual truck drivers. Route requests are received online from drivers who do not necessarily have the same value of time (VOT). The algorithm provides routing instructions and distributes the benefits of collaboration among the drivers resulting in a solution close to the SO solution. We provide some experimental results that showcase the effectiveness of our algorithm.

4 Combined People-And-Freight Delivery Problem with Request Incompatibility

Yu Syuan Chang, Chin Sum Shui, National Yang Ming Chiao Tung University, Hsinchu City, Taiwan. Contact: boice89821@gmail.com

In recent years, combined people and freight sharing systems are developed to have better vehicle utilization, but no study deals with the incompatibility among passenger and parcel requests (e.g., passengers with pets or parcels with odors). This study presents a variant of the combined people-and-freight delivery problem, formulated as a mixed integer linear programming problem, which aims to design a set of profit-maximizing routes for a heterogeneous fleet given a set of passenger and parcel requests while considering their compatibility and time windows. Numerical experiments demonstrate the effectiveness of the formulation in handling their incompatibility, while the cost of incompatibility is analyzed to offer managerial insights.

5 Optimizing Truck Fleet Scheduling for Fuel Deliveries

Vahid Eghbal Akhlaghi[1], Hongzhao Guan[1], Jason Lu[1], Pascal Van Hentenryck[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA, Contact: vahid.eghbal@gatech.edu

In this paper, we optimize the delivery schedules for a fleet of trucks with specified availability time windows to meet fuel replenishment needs at various sites. A mixed-integer programming model is proposed, incorporating a two-stage optimization algorithm: firstly, ensuring sufficient deliveries to maintain site operations, and secondly, enhancing driver shift and truck utilization while minimizing total traveled distance. The problem is refined via techniques to make it computationally tractable. A case study in Estonia provides valuable insights, including cost savings, improved customer satisfaction, enhanced business resilience, and reduced fuel consumption and emissions. This approach offers a compelling alternative to current manual drag-and-drop tools, underscoring the potential for automation in fleet scheduling.

Sunday, October 15, 8:00 AM - 9:15 AM

SA77

Session.Location:CC-West Lecture Hall

Stochastic Systems

Contributed Session

Session Chair: Vishwakant Malladi, Indian School of Business, Mohali, Punjab, India

1 Sojourn Times in Bernoulli Feedback Queues Subject to Disasters

George C. Mytalas[1], Michael A. Zazanis[2], [1]UTH, Lamia, Greece; [2]Athens University of Econ & Business, Athens, Greece. Contact: gmytalas@uth.gr

We consider a queueing system with batch Poisson arrivals andBernoulli feedback which is subject to disasters occurring according to an independent Poisson process. Each disaster is followed by a repair period. The server, when idle, takes repeated vacations of random length and, while the server is under repair or on vacation, disasters cannot occur. We analyze this system and obtain the Laplace transform of the system time distribution for a typical customer completing service. A special case where the system parameters follow the exponential distribution is provided.

2 Queue-Based Service-Level Estimation a Finite-Interval Lookahead Predictor for the Erlang-A Model with Customer Abandonment

Ling Zhang, Yunan Liu, Amazon Corporate LLC, Seattle, WA, Contact: lzhangn@amazon.com

In this article, we develop effective methodologies and algorithms for estimating the service-level (SL) for Amazon customer service contact center. Our SL metric is the fraction of all customer arrivals in an interval [0,T] experiencing a shorter-than-w waiting time (e.g., T=24 hours and w=60 seconds). Our algorithm predicts the SL in a forward-looking fashion using input parameters including the future demand forecast, future agent capacity, average handling time, average abandonment time and real-time queue information.

3 Markov Persuasion Processes With Endogenous Agent Beliefs

You Zu[1], Krishnamurthy Iyer[1], Haifeng Xu[2], [1]University of Minnesota, Minneapolis, MN, [2]University of Chicago, Chicago, IL, Contact: zu000002@umn.edu

We consider a repeated persuasion setting where a long-lived sender persuades short-lived receivers by sharing payoff-relevant state information. The state transitions are Markovian conditional on the receivers' actions, and the sender seeks to maximize the long-run average reward by committing to a signaling mechanism. We analyze the setting where the receivers may have limited historical information and show that solving this problem requires solving a large non-linear program. To overcome this difficulty, we propose a robust history-independent signaling mechanism that is persuasive even when receivers have some historical knowledge, and it approximates the optimal payoff in settings where the receivers have no historical information.

4 T-Estimation of Controlled Markov Chains via Randomised Hellinger Distances Using Histograms

Imon Banerjee, Purdue University, West Lafayette, IN, Contact: ibanerj@purdue.edu

In this work, we estimate the transition functions "s" of a controlled Markov chains using histograms. We define a randomised Hellinger distance and prove that our estimator satisfies minimax risk bounds with respect to that distance. We produce a testing functional "T" to evaluate two distinct estimates of "s", and describe a model selection procedure for choosing the best estimator by representing it as a constrained minimisation problem. We then illustrate the applicability of our problem by providing oracle risk bounds for estimating the transition densities of an offline reinforcement learning (RL) algorithm with minimal assumption on the policy.

5 Modeling Inter-Temporal Correlation Between Stochastic Processes

Vishwakant Malladi, Indian School of Business, Mohali, Punjab, India. Contact: vishwakant_malladi@isb.edu

Inter-temporal correlation is present in multiple areas where the state of a process at one time affects the state of another later. Such examples can be found in queuing, disruption propagation, delay proliferation, etc. Given its prevalence, a convenient model for inter-temporal correlation could be advantageous to aid in managerial decision-making. We propose a new approach using time-subordinated Markov chains whereby inter-temporal correlation can be modeled in a mathematically tractable fashion. We also extend the approach to model propagation in networks. We demonstrate the applicability of our approach using examples from route optimization in road networks and delay propagation in airlines.

Sunday, October 15, 8:00 AM - 9:15 AM

SA78

Session.Location:CC-West 211A

Optimization for Smart Grids

Contributed Session

Session Chair: Ali AlArjani, Prince Sattam Bin Abdulaziz University, AlKharj, Saudi Arabia

1 Effect of Optimally Pooling Diverse Wind Generation Sources on Resulting Operational Costs

Alexander Vinel[1], Chanok Han[2], [1]Auburn University, Auburn, AL, [2]Auburn University, AUBURN, AL

It is widely accepted that combining together geographically or technologically diverse energy sources can significantly reduce generation variability. Since variability directly translates into increased cost of wind and solar energy, being able to better understand ways to control it can be important. In previous efforts we have demonstrated that by a priori employing advanced optimization techniques (specifically, risk-averse portfolio modeling), it is possible to design energy generation portfolio that exhibits significantly lower intermittency and higher generation forecasting accuracy. In this talk we will discuss our efforts to model the extent to which this reduction in variability can directly translate to reduction in operational costs and grid efficiency.

2 Optimization Models for Residential Electricity Usage Under Net-Metering Programs in a Smart Grid

Shahab Sadri, Lihui Bai, University of Louisville, Louisville, KY, Contact: shahab.sadri@louisville.edu

This research aims to study residents' electricity consumption behavior and the resulting system-level consumption profile in a smart grid. We assume that each household is equipped with a system consisting of solar panels and battery storage and, under the net metering program, is allowed to sell excess electricity back to the grid. We study electricity consumption from two different perspectives. The System Optimal (SO) model minimizes the total system cost, while the User Equilibrium (UE) model describes the individual households' behavior in a Nash Equilibrium. Under certain convexity assumptions, we prove the existence and uniqueness of the solution. Numerical experiments using a simulated network and extensive sensitivity analysis will be reported.

3 Optimal Computation of Fixed Charges for Efficient Electricity Tariffs in Future Distribution Networks

Quentin Lété, Gabriela Hug, ETH Zürich, Zürich, Switzerland. Contact: qulete@ethz.ch

With the increasingly important role of distribution networks in the energy transition, electricity tariffs should evolve to become more cost reflective. This implies resorting more and more to fixed charges to recover residual network costs. At the same time, higher fixed charges increase the incentive of prosumers to go off grid while decreasing costs of DER will only increase the risk of grid defection in the future. In this work, we propose a model that endogenize the computation of fixed charges in distribution tariffs that accounts for the possibility of grid defection by prosumers in the network. Based on this framework, we propose illustrative results on small instances as well simulations on realistic cases, and comment on the implication of the increasing risk of grid defection for the design of distribution tariffs.

4 Biux2x2

Ali AlArjani, Prince Sattam Bin Abdulaziz University, AlKharj, Saudi Arabia. Contact: a.alarjani@psau.edu.sa

Wind energy plays a crucial component in the contest to fulfill environmental control objectives. Wind energy, on the other hand, will only be able to fulfill its essential importance if the wind turbines work efficiently. The paper aims to analyze the application of artificial intelligence (AI) algorithms in wind speed. In this paper, three network parameter optimization algorithms, AdaGrad, RMSprop, and Adam, are implemented and compared in the context of wind speed forecasting. This paper employs wind speed data obtained from Saudi Arabia. Mean absolute error (MAE), mean square error (MSE), root mean square error (RMSE), and R-squared are the four metrics used to assess performance. The experiment results show that the Adam algorithm outperforms the other optimization algorithms regarding forecasting accuracy and training time.

Sunday, October 15, 8:00 AM - 9:15 AM

SA79

Session.Location:CC-West 211B

Doing Good with Good O.R. I

Award Session

Session Chair: Justin J. Boutilier, University of Wisconsin - Madison, Madison, WI

Session Chair: Robert G. Randall, Princeton Consultants, Inc., Greenville, SC

Sunday, October 15, 8:00 AM - 9:15 AM

SA80

Session.Location:CC-West 212A

Case Competition

Award Session

Session Chair: Dessislava Pachamanova, Babson College, Wellesley, MA

1 Racial Bias in Automated Traffic Law Enforcement and the Price of Unjustness

Chrysafis Vogiatzis[1], Eleftheria Kontou[2], [1]University of Illinois Urbana-Champaign, Urbana, IL, [2]University of Illinois at Urbana-Champaign, Urbana, IL

This case study has been developed for students to practice their data analysis and optimization skills in a contemporary societal issue: that of injustice in automated traffic law enforcement. Specifically, this case study is for students of modern data analysis and statistical modeling courses that focus on hypothesis testing; it also has a component for students in optimization and mathematical modeling courses that focus on linear and network optimization. The case study has been used since Spring 2023 in two courses within the Industrial Engineering and Civil Engineering curricula.

2 Three Mountain Communications: Fairness Considerations for Workplace Task Allocation

Saurabh Bansal, Wei Wu, Rashmi Sharma, Penn State University, State College, PA

The case has two objectives: incorporating fairness considerations in managerial decision-making and introduce task allocation using optimization. The case focuses on a call center that faces the issue of daily task allocation. The current self-selection-based allocation has created friction among employees. The call center must develop an allocation model that is perceived to be fair by employees. Students believed the case provided them skills to combine modeling focused methods with qualitative considerations for workplace fairness. This case is based on an industry project with National.

3 Mobismile Bike-Sharing

Deniz Akturk[1], Ozan Candogan[2], [1]Washington University in St. Louis, St. Louis, MO, [2]University of Chicago, Chicago, IL

This case examines possible expansion strategies for a bike-sharing firm from an operations perspective. The case aims to guide readers in constructing a process flow diagram and illustrate how operational metrics identify critical drivers of cost, revenue, and depreciation. First, the case provides a historical overview and widely adopted revenue models in bike-sharing. Later, the case highlights the main cost items in the bike-sharing industry. These costs are then visualized through the Mobismile bike-sharing system, a hypothetical bike-sharing company operating in Chicago.

Sunday, October 15, 8:00 AM - 9:15 AM

SA81

Session.Location:CC-West 212B

INFORMS: Creating Value for Graduate Students

Panel Session

Session Chair: Richard C. Staats, ZE, LLC, Mclean, VA

1 INFORMS: Creating Value for Graduate Students

Richard C. Staats, ZE, LLC, Mclean, VA

The INFORMS Education Outreach Committee for Graduate Students shares insights and best practices for helping graduate students get the most out of INFORMS. Hosted by the Committee members.

2 Panelist

Matthew Lanham, Purdue, Lafayette, IN

3 Panelist

Goutam Chakraborty, Oklahoma State University, Stillwater, OK

4 Panelist
Richard C. Staats, ZE, LLC, Mclean, VA

Sunday, October 15, 8:00 AM - 9:15 AM

SA82

Session.Location:CC-West 212C

Machine Learning Models for Patient Readmission and Follow-up

Contributed Session

Session Chair: Lihui Bai, University of Louisville, Louisville, KY

1 A Hybrid Analytics Framework Toward Better Explanations: The Case of Survival After Lung Transplantation
Ali Bagheri[1], Mostafa Amini[1], Dursun Delen[2], [1]Oklahoma State University, Stillwater, OK, [2]Oklahoma State University, Tulsa, OK, Contact: ali.bagheri@okstate.edu
We propose a hybrid analytics framework for improving the interpretability of black-box ML models. Using a feature selection strategy, supervised and unsupervised learning, and explanation methods, our goal is to offer medical professionals a tool that, provides further insight into the most important factors involved in a prognostic or survival analysis and, also, adds flexibility to the development of effective clinical decision support systems. We apply the proposed framework to investigate the factors involved in patients' short- and long-term survival after lung transplantation. The results can assist in developing more effective indicators for lung allocation decisions, ultimately leading to improved transplantation benefits.

2 Multi-Stage Heart Failure Readmission Prediction
Xinyu Yao[1], George Huaien Chen[2], Karmel S. Shehadeh[3], Rema Padman[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Carnegie Mellon University, Pittsburgh, PA, [3]Lehigh University, Bethlehem, PA, Contact: xinyuyao@andrew.cmu.edu
Hospital readmissions are burdensome for heart failure patients as well as the healthcare system. In this paper, we propose an interpretable model that predicts whether a patient will be readmitted to the hospital or die within 30 days after being discharged based on data available at different admission stages. Our model is an attention-based neural network model, where the features available at different time steps vary. We demonstrate our framework on heart failure admission data from a major health system, where we find that our proposed framework can achieve competitive prediction accuracy while identifying how the importance of features varies over stages.

3 Risk Factors Associated with Stroke Readmissions: A Systematic Literature Review
Eddah Mauti[1], Niyousha Hosseinichimeh[2], Vida Abedi[3], Ramin Zand[4], [1]Virginia Tech, Blacksburg, VA, [2]Virginia Tech, Falls Church, VA, [3]Penn State College of Medicine, Hershey, PA, [4]Pennsylvania State University, Hershey, PA
Hospital readmissions impose a substantial burden on the healthcare system in the United States, costing Medicare about $26 billion per year. The Centers for Medicare and Medicaid Services defined readmission as an indicator of poor hospital care and has made reducing readmission rates a national healthcare reform goal. This study performs a systematic literature review to identify the risk factors associated with stroke readmissions between 30 days to 5 years. Web of Science and PubMed were searched for studies related to stroke readmissions, and 365 articles met the inclusion criteria. The study found stroke readmission risk factors and interventions to reduce stroke readmissions. The results of this study can assist in designing interventions to reduce stroke readmission.

4 Prediction of Unplanned 30-Day Readmission in Patients with Heart Failure Using Machine Learning
Sonia Jahangiri, Nasibeh Azadeh-Fard, Rochester Institute of Technology, Rochester, NY, Contact: sj1374@rit.edu
Heart failure (HF) is a major cause of US hospital admissions with high readmission rates. This study extracted HF patient data from the Nationwide Readmission Database (NRD). We employed machine learning techniques to develop a new prediction model for all-cause readmission within 30 days and in-hospital mortality. The model incorporated patient demographics, comorbidities, and utilized both traditional machine learning methods and neural networks for comparison.

5 Predicting and Managing Hypotension in Perioperative Medicine
Xiaoyu Chen[1], Lihui Bai[1], Guanghui Lan[2], Jiapeng Huang[3], [1]University of Louisville, Louisville, KY, [2]Georgia Institute of Technology, Atlanta, GA, [3]University of Louisville, Louisville, KY, Contact: lihui.bai@louisville.edu
Perioperative hypotension can cause postoperative complications such as renal insufficiency, myocardial injury, and increased mortality. Predicting hypotension prior to the episode and taking preventative measures early can be crucial to improving patient outcomes. In this paper, we use

both pre-operative and intra-operative medical record data to predict hypotension using Bayesian inference with mixed responses, and to optimize pre-operative and intra-operative decisions using decision analysis as well as reinforcement learning methods. Numerical results based on high-fidelity multi-parameter vital signs in the open source VitalDB database will be reported.

Sunday, October 15, 8:00 AM - 9:15 AM

SA83

Session.Location:CC-West 213A

Managing Supply Chains during Pandemics

Contributed Session

Session Chair: Marta J Ventura, Penn State, State College, PA

1 Designing a Sustainable-Resilient-Responsive Supply Chain Network Considering Uncertainty in the Covid-19 Era

Amir Hossein Moadab[1], Ghazale Kordi[2], Mohammad Mahdi Paydar[3], Ali Divsalar[4], Mostafa Hajiaghaei-Keshteli[5], [1]Washington State University, Pullman, WA, [2]University of Helsinki, Helsinki, Finland; [3]Babol Noshirvani University of Technology, Babol, Iran, Islamic Republic of; [4]Babol Noshirvani University of Technology, Babol, Iran, Islamic Republic of; [5]Tecnologico de Monterrey, Puebla, Mexico. Contact: amirhossein.moadab@wsu.edu

COVID-19 has presented significant challenges to supply chains, making PCR testing a vital product during the pandemic. This paper proposes a multi-objective mathematical linear model to optimize a sustainable, resilient, and responsive supply chain for PCR diagnostic tests. The model aims to minimize costs, negative societal impact, and environmental impact, using a scenario-based approach with stochastic programming. The model is validated by investigating a real-life case study in one of Iran's high-risk supply chain areas. The proposed model is solved using the revised multi-choice goal programming method. Lastly, sensitivity analyses based on effective parameters are conducted to analyze the behavior of the developed MILP. To enhance the design of the supply chain network, this paper has considered various COVID-19 variants and their infectious rates.

2 Understanding Dynamics of Restaurant Foot-Traffic Recovery: A Case Study of the Covid-19 Pandemic

Mohsen Bahrami, Amir Tohidi, Alex Pentland, Massachusetts Institute of Technology, Cambridge, MA, Contact: bahrami@mit.edu

Considering the importance of the restaurant industry for economic stability, it is crucial to investigate factors associated with restaurants' disaster recovery. We utilize large-scale Mobility and Place datasets to study the temporal dynamics of restaurants' foot traffic in NYC and Boston MSA. We show that restaurants' customer education level has a negative association with their Recovery Index (RI), while there is a positive association between customer income level and restaurants' RI. The most important finding of our analyses is the significant negative association of customers' geographic diversity with restaurants' RI. This is counterintuitive, as many previous studies have shown that the diversity of customers can potentially help businesses. Finally, we show that restaurants which adapted mask mandates were more likely to recover faster.

3 Rethinking Supply Chain Trade-Offs to Face Pandemic Outbreaks: Current Decision Support Models and Insights for Future Directions

Suzan Alaswad, Zayed University, Abu Dhabi, United Arab Emirates. Contact: salaswa@gmail.com

The recent COVID-19 had severely impacted supply chains that companies are still recovering from the shock it caused to their supply chains almost four years after the pandemic first started. The pandemic has exposed many flaws in modern supply chains forcing companies to reassess their existing supply chain strategies. In this paper, we review current research on supply chain management during epidemics and discuss how pandemic outbreaks lead to the rethinking of supply chain decisions. We mainly analyze existing supply chain models deployed for epidemic control and assess them from the perspective of the new challenges imposed by COVID-19. We focus on decision support models and quantitative methodologies used in supply chain management pre- and post-COVID-19 and identify modeling gaps to address and improve response in future pandemics.

4 Efficient Vaccine Management in Response to Covid-19 and Emerging Infectious Diseases: An Integer Programming Approach with Discrete-Event Simulation

HyungJu Kim, Taesu Cheong, Korea University, Seong Buk gu, Seoul, Korea, Republic of. Contact: hjkim1013@korea.ac.kr

Efficient vaccine distribution and administration are critical during pandemics, but challenges exist. We propose an integer programming methodology based on the newsvendor model, validated by a discrete-event simulation and economic analysis. Our approach aims to increase efficiency and address issues surrounding vaccine wastage and missed opportunities. It can be applied to COVID-19 and other infectious diseases to improve vaccine management.

5 Structure Methodology for Optimizing Public Health and Economic Impact of Covid-19 Vaccination

Marta J Ventura, Penn State, State College, PA, Contact: mxv176@psu.edu

When vaccines became available, the limited logistics available to manage the manufacturing and distribution of vaccines led to new challenges. Such challenges involved increasing production capacity and distributing vaccines to medical facilities in different regions to reach herd immunity in a timely manner. We propose a mathematical framework that coordinates all the necessary activities for selecting the locations and capacities of temporary medical facilities that need to be installed, purchasing of single-dose and two-dose of vaccines by medical facilities in an orderly manner, and generating a vaccination timetable for residents. The mathematical framework also involves the computation of an effective time window for the minimum immunization time.

Sunday, October 15, 8:00 AM - 9:15 AM

SA84

Session.Location:CC-West 213B

Advances in Delivery Service Operations

Contributed Session

Session Chair: Sunil Chopra, Northwestern University, Evanston, IL

1 Utilizing Crowdsourced Delivery Data for Chain Store Location Selection

Jiana-Fu Wang, Yu-Sheng Wu, National Chung Hsing University, Taichung, Taiwan. Contact: jfwang@dragon.nchu.edu.tw

The outbreak of COVID-19 epidemic has increased the usage of crowdsourced food deliveries. This research utilizes the delivery system-generated data at a chain store's end to measure each store's service boundary. Together with the Retail gravity model, the Huff model, the Central Place theory, and the information of local competitors and potential number of customers, we build a novel model for the chain store to evaluate potential locations for new stores.

2 Analysis the Factors of the Customer's Satisfaction and Importance of Delivery Applications

Jaejun Hwang, Hosun Rhim, Korea university, Seoul, Korea, Republic of. Contact: jjyw2648@naver.com

The delivery app market in South Korea continues to grow while competition among companies intensifies. This study explores the attributes that a competitive delivery app should have by utilizing IPA analysis on various attributes of delivery apps in Korea. By exploring attributes that are expected to further increase customer satisfaction, new directions for service development in related industries are presented.

4 Fast Food Stores with a Drive-Through Option Recovered from Covid-19, Stores Without Did Not

Sunil Chopra[1], Partha S. Mishra[2], Ioannis Stamatopoulos[3], [1]Northwestern University, Evanston, IL, [2]Kellogg School of Management, Northwestern University, Evanston, IL, [3]The University of Texas at Austin, McCombs School of Business, Austin, TX, Contact: s-chopra@kellogg.northwestern.edu

Comparing the foot-traffic data for popular fast-food customers before and after the COVID-19 pandemic, we empirically show that customer preference shifted from stores without a drive-through option to stores with one. In particular, we show that this shift in preference for a drive-through is consistent across the US. Moreover, we find evidence of signs of persistence in this shift in the future.

3 Integral Optimization of Robotic Mobile Fulfilment Systems

Lu Zhen[1], Zheyi Tan[1], René B.M. De Koster[2], Shuaian Wang[3], [1]Shanghai University, Shanghai, China; [2]Erasmus University-Rotterdam, Rotterdam, Netherlands; [3]Department of Logistics & Maritime Studies, Hong Kong Polytechnic University, Kowloon, Hong Kong, Kowloon, China. Contact: rkoster@rsm.nl

Parts-to-picker, robotic mobile fulfillment (RMF) systems are used in many e-commerce warehouses. Scheduling orders, robots, and storage pods in interaction with manual workstations is critical to obtaining high performance. This scheduling problem is complicated due to interactions between decisions. This paper models all such scheduling decisions in combination to minimize order fulfillment time. We conduct numerical experiments based on a real-world case to validate the model and solutions. Our model provides near optimal solutions for instances with 14 workstations, 400 orders, 300 stock-keeping units (SKUs), 160 pods, and 160 robots, within four minutes. We use our model to obtain different managerial and design insights.

Sunday, October 15, 9:30 AM - 10:35 AM

SP01

CC-West 301ABC

Opening Plenary: IFORS Distinguished Lecture

Plenary Session

1 Distributionally Robust Optimization: The Science of Underpromising and Overdelivering

Daniel Kuhn, Ecole Polytechnique Federale de Lausanne (EPFL), Lausanne, Switzerland

Many decision problems in science, engineering and economics are affected by uncertain parameters whose distribution is only indirectly observable through samples. The goal of data-driven decision-making is to learn a decision from finitely many training samples that will perform well on unseen test samples. This learning task is difficult even if all training and test samples are drawn from the same distribution—especially if the dimension of the uncertainty is large relative to the training sample size. Wasserstein distributionally robust optimization (DRO) seeks data-driven decisions that perform well under the most adverse distribution within a certain Wasserstein distance from a nominal distribution constructed from the training samples. It has a wide range of conceptual, statistical and computational benefits. Most prominently, the optimal decisions can often be computed efficiently, and they enjoy provable out-of-sample and asymptotic consistency guarantees. This talk will highlight two recent advances in Wasserstein DRO. First, we will develop a principled approach to leveraging samples from heterogeneous data sources for making better decisions. In addition, we will prove the optimality of linear policies in Wasserstein distributionally robust linear-quadratic control problems with imperfect state observations, and we will show that these policies can be computed efficiently using dynamic programming, Kalman filtering and automatic differentiation.

Sunday, October 15, 10:45 AM - 12:00 PM

SB01

CC-North 120A

Incorporating Artificial Intelligence into Healthcare Workflow: Models and Insights

Tutorial Session

Session Chair: Ebru Korular Bish, University of Alabama, Tuscaloosa, AL

1 Incorporating Artificial Intelligence into Healthcare Workflow: Models and Insights

Tinglong Dai, Michale Abràmoff, Johns Hopkins University, Baltimore, MD

Artificial intelligence (AI) is poised to revolutionize healthcare delivery in the United States and around the world. As AI becomes an integral part of the healthcare workflow, it will change the way we model and analyze healthcare delivery and upend the paradigm that has dictated how operations research and management science researchers interact with healthcare practitioners. In this tutorial, we demonstrate how the integration of AI into the healthcare workflow will require a new set of models to guide rapidly changing healthcare practices, measure productivity gains in the industry, and reduce disparities in access to care. These models must be based on a thorough understanding of the variables that influence physician buy-in and patient acceptance. While medical AI promises to learn and adapt based on user interactions and data, the development, validation, and approval process also requires the creation of new models that generate useful insights. Finally, we discuss barriers and opportunities related to incentive design and ethical considerations for AI in healthcare.

Sunday, October 15, 10:45 AM - 12:00 PM

SB03

CC-North 120D

Nextmv

Technology Tutorial

1 The New OROps: Build More Decision Models, Not More Decision Tools

Sebastian Quintero, Nextmv, Bogato, Colombia. Contact: sebas@nextmv.io

Decision models save money. Decision tools save time. For decades, realizing business value from decision algorithms and operations research has often been hindered by the challenges with model definition, solver setup, testing, deployment, and collaboration. It's time for decision optimization technology to get out of its own way. Inspired by MLOps and software development approaches, a new platform is providing collaborative, opinionated tooling that empowers teams to move faster with less confusion and more access to the decision technology ecosystem. In this tech tutorial, we'll explore these tools and workflows and their impact on accelerating algorithm development cycles from months to weeks or less.

2 JD.com Uses Advanced Analytics to Enhance Supply Chain Capability

Zuo-Jun Max Shen, University of California Berkeley, Berkeley, CA, Contact: maxshen@berkeley.edu

Supply chain leaders have continuously tried to expand and enhance capabilities by using advanced techniques and analytics. JD.com, the largest retailer in China based on revenue, is committed to an intelligent, integrated, and resilient supply chain that creates value for all players within the retail ecosystem. Despite challenges in the complex and sophisticated retail supply chain, JD.com has strengthened its supply chain agility, and attained shared value by focusing on supply chain efficiency, supply chain resilience, and reducing supply chain uncertainty and volatility. This speech will help you to uncover more supply chain capabilities using advanced techniques with real-world cases adopted by JD.com.

Sunday, October 15, 10:45 AM - 12:00 PM

SB04

CC-North 121A

Advances in Data-Driven Operations

Community Committee Choice Session

Session Chair: Ruihao Zhu, Cornell University, Ithaca, NY

1 Robust Auction Design with Support Information

Jerry Anunrojwong, Santiago R. Balseiro, Omar Besbes, Columbia Business School, New York, NY, Contact: jerryanunroj@gmail.com

The seller wants to sell an item to n i.i.d. buyers and only the support [a,b] is known; a/b quantifies relative support information (RSI). The seller either minimizes worst-case regret or maximizes worst-case approximation ratio. We show that i) with low RSI, second-price auctions (SPA) is optimal; ii) with high RSI, SPA is not optimal, and we introduce a new mechanism, the "pooling auction" (POOL), which is optimal; iii) with moderate RSI, a combination of SPA and POOL is optimal. Under POOL, whenever the highest value is above a threshold, the mechanism still allocates to the highest bidder (just like SPA), but otherwise the mechanism allocates to a uniformly random buyer, i.e., pools low types.

2 Offline Pricing Analytics With High-dimensional Covariates

Mabel C. Chou[1], Jingren Liu[2], Hanzhang Qin[2], [1]National University of Singapore, SG, SG, Singapore; [2]National University of Singapore, Singapore, Singapore. Contact: hzqin@nus.edu.sg

We consider a feature-based offline pricing problem, where a firm needs to make a pricing decision to maximize its expected revenue. We employ a semi-parametric partially linear structure with shape-restricted constraint to model the empirical demand. We develop a Three-Step Semi-Parametric Estimation method to make data-driven pricing decisions. From a non-asymptotic perspective, we derive finite sample regret bounds, showcasing the efficacy of our data-driven pricing policy even under potential misspecification of the demand model. Moreover, when the demand model is well specified, we provide the explicit sample size guarantee to achieve near-optimal revenue. The effectiveness of the method is further validated through numerical experiments.

3 Temporal Fairness in Learning and Earning: Price Protection Guarantee and Phase Transitions

Ruihao Zhu[1], Qing Feng[1], Stefanus Jasin[2], [1]Cornell University, Ithaca, NY, [2]University of Michigan, Ann Arbor, MI, Contact: ruihao.zhu@cornell.edu

Motivated by the prevalence of "price protection guarantee", which helps to promote temporal fairness in dynamic pricing, we study the impact of such policy on the design of online learning algorithm for data-driven dynamic pricing with initially unknown customer demand. Under the price protection guarantee, a customer who purchased a product in the past can receive a refund from the seller during the so-called price protection period in case the seller decides to lower the price. We consider a setting where a firm sells a product over a certain time horizon. For this setting, we characterize how length of price protection period, can affect the optimal regret of the learning process. Our results reveal the surprising phase transitions of the optimal regret with respect to M.

4 Managing Perishable Inventory Systems With Positive Lead Times: Inventory Position Vs. Projected Inventory Level

Jinzhi Bu[1], Xiting Gong[2], Huanyu Yin[2], [1]The Hong Kong Polytechnic University, Hong Kong, China; [2]The Chinese University of Hong Kong, Hong Kong, China. Contact: xtgong@cuhk.edu.hk

We consider periodic-review perishable inventory systems with a fixed product lifetime and positive replenishment lead times. Demands are satisfied by on-hand inventories of different ages following a general issuance policy. Unsatisfied demand can be either backlogged or lost. The objective is to minimize the long-run average holding, penalty, and outdating costs. We study a simple class of projected inventory level (PIL) policies, which raises the expected on-hand inventory upon each order arrival to a constant level. Among other results, we prove that the best PIL policy is asymptotically optimal with large unit penalty costs under a large class of demand distributions. Our numerical study shows that it performs very well in these systems.

5 Posterior Sampling for Continuing Environments

Wanqiao Xu[1], Shi Dong[2], Benjamin Van Roy[1], [1]Stanford University, Stanford, CA, [2]Microsoft, Mountain View, CA, Contact: wanqiaox@stanford.edu

We develop an extension of posterior sampling for reinforcement learning (PSRL) that is suited for a continuing agent-environment interface and integrates naturally into agent designs that scale to complex environments. The approach, continuing PSRL, maintains a statistically plausible model of the environment and follows a policy that maximizes expected □-discounted return in that model. At each time, with probability 1-□, the model is replaced by a sample from the posterior distribution over environments. For a choice of discount factor that suitably depends on the horizon T, we establish an O(□ S√(AT)) bound on the Bayesian regret, where S is the number of environment states, A is the number of actions, and □ denotes the *reward averaging time*, which is a bound on the duration required to accurately estimate the average reward of any policy.

Sunday, October 15, 10:45 AM - 12:00 PM

SB05

CC-North 121B

Delayed Incentives and Digital Competition

Community Committee Choice Session

Session Chair: Serdar Simsek, The University of Texas at Dallas, Richardson, TX

Session Chair: Guang Li, Queen's University, Kingston, ON, Canada

1 Does Size Matter for Loyalty Points Redemptions?

Yang Chen, Anton Ovchinnikov, Nicole Robitaille, Smith School of Business, Queen's University, Kingston, ON, Canada. Contact: chen.y@queensu.ca

Prior research finds that redeeming loyalty points is associated with increased customer loyalty. However, numerous economic, behavioral, and psychological theories suggest that redemption size might matter, although the specific predictions are often conflicting. With a large proprietary data set from a major loyalty program (LP), we study the effect of redemption size on long-term loyalty. We find that size does matter in redemptions, so does the size metrics and prior redemption behaviors. Small redemptions are sometimes associated with increased loyalty, whereas medium redemptions are most consistently associated with increased loyalty. Large redemptions, however, can backfire. Our findings suggest that encouraging the right redemption size may increase LP revenue, and firms should actively manage redemption as a key control lever in revenue optimization.

2 Dual Value of Delayed Incentives

Bharadwaj Kadiyala[1], Serdar Simsek[2], Ozalp Ozer[3], [1]University of Utah, Salt Lake City, UT, [2]The University of Texas at Dallas, Richardson, TX, [3]Amazon, Richardson, TX

Gift card (GC) promotions reward customers who spend on regularly priced products with a promotional GC which can be redeemed by customers towards a future purchase at the retailer. Using a regression-discontinuity design, we causally investigate the impact of GC promotion on whether and how the promotion impacts customer purchase behavior. We find that GC promotion increases sales by 21.84% and 29.18% among customers with 4-month and 13-month purchase recency. A significant portion of these incremental sales are due to the advertisement effect of the promotion. GC promotion also changes the concentration of sales distribution as customers seek out niche product categories and high-end brands. Customers also spend more while redeeming their gift card, thus validating the dual value of delayed incentives.

3 Loyalty Currency and Mental Accounting: Do Consumers Treat Points like Money?

Freddy Lim[1], So Yeon Chun[2], [1]INSEAD, Singapore, Singapore; [2]INSEAD, Singapore, France. Contact: freddy.lim@insead.edu

We study how consumers decide to pay with loyalty points or money, and how their attitudes toward points and their payment choices are related to their point earning sources and characteristics. We develop a model of consumers' payment choices and estimate it on airline loyalty program data. We find that mental accounting, subjective perceived value, and reference exchange rate of points play important roles, and consumers' primary points earning source and total earning level are jointly associated with their attitudes toward points and money. We propose a probabilistic segmentation of consumers and show how a firm can implement pricing policies to efficiently target and influence consumers' payment choices through counterfactual analyses.

4 How Resilient are Warehouse Clubs to Digital Competition? The Role of Retail Agglomeration

Xiaodan Pan[1], Guang Li[2], Martin Dresner[3], Benny Mantin[4], [1]Concordia University, Montreal, QC, Canada; [2]Queen's University, Kingston, ON, Canada; [3]University of Maryland-College Park, College Park, MD, [4]University of Luxembourg, Luxembourg, Luxembourg

As digital commerce grows, traditional brick-and-mortar retailers confront challenges to stay resilient. Our study examines the effect of ecommerce on these entities, focusing on warehouse clubs. We analyze customer traffic data sourced from Costco, the leading WC chain in the U.S., to understand the relationship between retail clusters and ecommerce on customer visits. Findings show that dense clusters of general and narrow-range merchandise boost foot traffic. However, less dense areas, especially near rivals, see a decline. General merchandise ecommerce has a more negative impact on footfall than narrow-range ecommerce. These online activities disrupt the previous positive correlation between merchandise clusters and foot traffic. The study highlights the need for adept navigation of the evolving retail landscape to ensure future success.

Sunday, October 15, 10:45 AM - 12:00 PM

SB06

CC-North 121C

Demand Modeling and Price Optimization in Retail and Hospitality Industries

Community Committee Choice Session

Session Chair: Andrew Vakhutinsky, Oracle Labs, Burlington

1 Demand Estimation with Missing Data on Covariates: Imputation-Based Approach

Sanghoon Cho[1], Danhyang Lee[2], Andrew Vakhutinsky[3], [1]Texas Christian University, Fort Worth, TX, [2]University of Alabama, Tuscaloosa, AL, [3]Oracle Labs, Burlington

Discrete choice modeling is widely used in academia and industry to understand customer demand. However, practical data collection often provides only records of purchased products, which poses challenges for demand estimation. In industries like hotels, booking records typically include purchased rooms and their associated features and prices, while the prices and features of non-purchased rooms are not observed. This limits the applicability of discrete choice models unless imputation techniques are employed. To tackle this issue, we propose a novel method that simultaneously estimates the parameters of our demand model and imputes the prices of unsold products using our incomplete data. We demonstrate the effectiveness of our approach using a real hotel transaction dataset.

2 Assortment Design in Online Grocery Retail

Renjun Hu, University of Michigan, Ann Arbor, MI, Contact: renjunhu@umich.edu

Despite the growth of online grocery delivery in recent years, most supermarkets have not turned the growth into profitability. One reason is the high picking and delivery cost with a low margin. The advancement of the micro-fulfillment center (MFC) is promising to improve efficiency in picking operations but it has two limitations. First, the capacity is limited and can handle a subset of items sold at a supermarket. Second, cart abandonment prohibits an online grocer from only selling a limited selection of items. Considering these, a retailer must carefully choose which items are sold online and which items are picked from an MFC. In this research work, we consider the assortment decision for online groceries under the cart abandonment model fulfilled by MFCs. We provide an efficient and adaptive formulation that jointly optimizes the MFC and online assortment.

3 Multiple Discrete Choice Models with Copula: An Application to Hotel Standby Upgrades

Ovunc Yilmaz[1], Andrew Vakhutinsky[2], Ruxian Wang[3], Zifeng Zhao[4], [1]University of Colorado Boulder, Boulder, CO, [2]Oracle Labs, Burlington, [3]Johns Hopkins University, Carey Business School, Kensington, MD, [4]Mendoza College of Business, University of Notre Dame, Notre Dame, IN, Contact: ovunc.yilmaz@colorado.edu

Hotels often offer a set of upgrades to their guests right after the booking, and guests can request multiple of these upgrades. Since classical discrete choice models only allow one alternative per customer, we develop a novel multiple-discrete choice model that allows customers to choose more than one alternative and use copula to account for the potential dependence between the choices. We test this model in an industry partner's booking and upgrade data set and offer some insights on the price optimization for this setting.

4 Segmentation Framework for Personalizing Shopping Experience for Online Retail Shoppers

Pratik Mital[1], Liz Luo[2], Allison Feldman[2], [1]Amazon,

Atlanta, GA, [2]Amazon, Jersey City, NJ, Contact: mitalp@amazon.com

Segmenting customers into appropriate groups helps businesses provide better customer experience and gain more revenue. Deciding how to segment customers is highly dependent upon the experience being provided. In this work we tackle the problem of identifying shoppers who share similar purchasing behavior with other shoppers in order to provide personalized product recommendations to them while shopping. We first highlight the limitations of clustering based approaches for our use case and then propose a propensity score based framework to segment customers. We also propose new metrics to evaluate the performance of our approach.

Sunday, October 15, 10:45 AM - 12:00 PM

SB07

CC-North 122A

Frontiers of Algorithmic RM

Community Committee Choice Session

Session Chair: Vahideh Manshadi, Yale University, New Haven, CT

Session Chair: Rad Niazadeh, Chicago Booth School of Business, CHICAGO, IL

1 The Prophet Inequality With Buyback

Pranav Nuti[1], Farbod Ekbatani[2], Rad Niazadeh[3], Jan Vondrak[1], [1]Stanford University, Stanford, CA, [2]Chicago Booth School of Business, Chicago, IL, [3]Chicago Booth School of Business, CHICAGO, IL, Contact: pranavn@stanford.edu

Motivated by applications with overbooking and compensation fees upon service denial, we initiate the study of the prophet inequality problem with buyback. In the vanilla prophet inequality, we observe realizations of random variables in an online fashion, and we have to (irrevocably) accept one of the realizations with the goal of maximizing the expected value of our pick. In the prophet inequality with buyback, acceptances are no longer irrevocable. Instead, they can be cancelled at the cost of a fixed multiple f of the realization accepted. In this talk, I will elaborate upon some recent progress towards designing optimally competitive online algorithms for this problem, progress that has resulted in an improvement over a competitive ratio of 1/2 for all choices of the parameter f.

2 Non-Stochastic CDF Estimation Using Threshold Queries

Princewill Okoroafor, Vaishnavi Gupta, Robert Kleinberg, Eleanor Goh, Cornell University, Ithaca, NY

We present an algorithm to estimate the empirical distribution of a scalar-valued data set, when the data are adversarially generated and the algorithm can only ask a limited number of threshold queries about each data point rather than observing it directly. This problem models scenarios where a seller is experimenting with prices to estimate the distribution of consumers' willingness to pay. Our main result quantifies the sample complexity of estimating the empirical CDF of a sequence of numbers, up to an additive error, using one threshold query per sample. The complexity depends only logarithmically on n, extending previous results for noisy binary search to the more challenging setting where noise is non-stochastic. We also characterize the minimum number of simultaneous threshold queries required by deterministic CDF estimation algorithms.

3 Mobility Data in Operations: The Facility Location Problem

Yiding Feng, Ozan Candogan, University of Chicago, Chicago, IL, Contact: yidingfeng2021@u.northwestern.edu

The recent large scale availability of mobility data, which captures individual mobility patterns, poses novel operational problems that are exciting and challenging. Motivated by this, we introduce and study a variant of the facility location problem where each individual is endowed with two locations (hereafter, her home and work locations), and the connection cost is the minimum distance between any of her locations and its closest facility. We design a polynomial-time algorithm and show its approximation ratio is between 3.073 and 3.103. We show that there exists no polynomial-time algorithm with approximation ratio 2 – ?. We further extend our results and analysis to the model where each individual is endowed with K locations. Finally, we conduct numerical experiments over both synthetic data and US census data and evaluate the performance of our algorithms.

4 Secretary and Matroid Secretary Problems with Unknown Number of Candidates

Junhui Zhang[1], Patrick Jaillet[2], [1]MIT, Cambridge, MA, [2]M.I.T., Cambridge, MA

We study variants of the secretary and matroid secretary problems where the number of candidates N is random with distribution p.

For the secretary problem, we show that 1) when p is known, the optimal single-threshold strategy succeeds w.p. at least P^*/e, where P^* is the maximum probability of success among all strategies; 2) when N≤n and n is known,

or E[N]≤μ and μ is known, there are simple strategies which succeed w.p. Ω(1/log(n)) or Ω(1/log(μ)) respectively; 3) if p is uniformly sampled among distributions supported on {1,...,n}, there is an algorithm which succeeds w.p. at least $2/e^2$ with high probability.
For the rank-k matroid secretary problem where the size of the ground size N is random and satisfies $\underline{n}$≤N≤n, we provide a $\Omega((\log(n/\underline{n})\log(\log(k)))^{-1})$-competitive algorithm. We also apply our techniques to prophet inequalities and online LP where the time horizon is random.

Sunday, October 15, 10:45 AM - 12:00 PM

SB08

CC-North 122B

Queueing Theory and Applications

Community Committee Choice Session

Session Chair: Daniela Hurtado-Lange, William & Mary, Williamsburg, VA

1 Fork-Join Queues with Redundancy

Chutong Gao, Northwestern University, Evanston, IL, Contact: chutonggao2026@u.northwestern.edu

We consider an n-server fork-join queueing system with redundancy; in this system, n i.i.d. copies of each incoming job are sent to each of the n servers, with k copies required for job completion. We introduce an equivalent two-station tandem queue, in which the service-time distributions in the two stations are dependent, and derive the stability condition for that system. Further, the tandem queue can be represented as a quasi-birth-and-death (QBD) process, so that its stationary distribution can be efficiently computed via matrix-geometric algorithms. We also propose an algorithm to construct the generator of the QBD when the number of copies k is larger than 2, for which the generator has a complex form. Finally, we employ the QBD representation to solve an optimal-design problem.

2 Control of High-Dimensional Reflected Brownian Motion

Baris Ata[1], J. Michael Harrison[2], Nian Si[1], [1]The University of Chicago Booth School of Business, Chicago, IL, [2]Stanford University, Stanford, CA, Contact: baris.ata@chicagobooth.edu

Motivated by applications in queueing theory, we consider the control of Reflected Brownian Motion in the d-dimensional positive orthant. A system manager chooses a drift vector a(t) at each time t based on the history of Z, and the cost rate at time t depends on both Z(t) and a(t). In our initial problem formulation, the objective is to minimize expected discounted cost over an infinite planning horizon, after which we treat the corresponding ergodic control problem. We develop and illustrate a simulation-based computational method that relies heavily on deep neural network technology. For test problems studied thus far, our method is accurate to within a fraction of one percent, and is computationally feasible in dimensions up to at least d = 30.

3 Staff Sharing Under Uncertainty

Yuting Yuan, William & Mary, Williamsburg, VA

As the coronavirus pandemic exacerbates staff shortages, we propose a two-stage staff-sharing rule that effectively utilizes expensive capacities when the uncertainty in demand (e.g., patient arrivals to hospitals during the pandemic) is high. By representing a centralized service system with a queueing model consisting of several units, we derive the optimal sharing policy under the stochastic fluid approximation and quantify the performance gap between the sharing policy and a benchmark policy that staffs each unit independently. A case study using hospital data is provided to demonstrate the practical implementation of the staff-sharing strategy. The simulation results suggest that capacity sharing could have reduced annual Emergency Department costs for three hospitals by at least half a million dollars.

4 Efficient Algorithm For Transient Analysis Of Cox/M/m Queues

Daniela Hurtado-Lange[1], Pengyi Shi[2], [1]Northwestern University, Evanston, IL, [2]Purdue University, West Lafayette, IN

Cox processes have shown to be accurate models for patients arriving to hospitals during the pandemic and crime rates, among others. Due to its doubly stochastic nature, efficient algorithms for transient analysis of queues with Cox arrivals are limited. Existing work mainly focuses on steady-state analysis of queues with periodic arrival rates, infinitely many servers, or the many-server asymptotic regime. In this work, we focus on non-periodic arrival rates and analyze the number of jobs in the system X(t) in Cox/M/m queues with finite m. We develop an efficient algorithm to compute the transient pmf of X(t) and show that our approach is flexible and accurate in terms of the load, the number of servers, and the value of t. We also show that our algorithm provides an accurate pmf when the future arrival rate is unknown but needs to be predicted via some forecast models.

Sunday, October 15, 10:45 AM - 12:00 PM

SB09

CC-North 122C

Advances in Queueing Theory

Community Committee Choice Session

Session Chair: Martin Zubeldia, University of Minnesota, Minneapolis, MN

1 Steady-State Limit of a Particle System with Mean-Field Interaction

Alexander Stolyar, University of Illinois at Urbana-Champaign, Urbana, IL

We consider a system of *n* particles, moving forward in jumps on the real line. The jump sizes are i.i.d. The instantaneous jump rate of a particle depends on its location rank w.r.t. other particles. This is a model of peer-to-peer synchronization. Under very mild conditions, we prove that, as *n* becomes large, the limit of steady-states is such that the empirical distribution of particle locations evolves as a deterministic traveling wave. As ingredients of the proof, we obtain uniform steady-state moment bounds and a convergence to mean-field limit result.

2 Reinforcement Learning Algorithms for Queueing Systems

Lei Ying, The University of Michigan, Ann Arbor, Ann Arbor, MI

In this talk, I will present a new reinforcement learning algorithm for queueing networks.

3 The Benefits of Partial Priority

Mor Harchol-Balter, Isaac Grosof, Vanshika Chowdhary, Carnegie Mellon University, Pittsburgh, PA, Contact: harchol@cs.cmu.edu

We introduce the idea of a partial priority queue, where class 1 jobs have only partial priority over class 2 jobs. Specifically, whenever the server is free, it runs a job of class 1 with probability q and class 2 with probability 1-q. Here q can range from 0 to 1. In this talk we discuss analysis and applications for the partial priority queue.

4 Dynamic Routing in Queuing Networks via Differentiable Discrete Event Simulation

Ethan Che[1], Jing Dong[2], Hongseok Namkoong[2], [1]Columbia Business School, New York, NY, [2]Columbia University, New York, NY

Consider the problem of dynamically allocating jobs to servers in general multi-class multi-pool queuing networks. We develop a generic framework for policy optimization in these systems by modeling the environment as a discrete event simulation. This modeling approach can flexibly handle non-stationary and non-Markovian arrivals and services, requires only samples of these events, and accommodates batch parallelism with GPUs. Although these systems lack differentiability, we borrow tools from the machine learning literature to obtain pathwise gradients of performance metrics with respect to the routing actions, which enables the application of gradient-based algorithms for policy optimization. We derive a pathwise policy gradient algorithm and a gradient-based model-predictive controller which outperforms standard policies and is highly scalable.

Sunday, October 15, 10:45 AM - 12:00 PM

SB10

CC-North 123

Learning and Decision Making with Network Data

Community Committee Choice Session

Session Chair: Yeganeh Alimohammadi, Stanford University, Stanford, CA

1 Uniqueness of Low-Depth Neighborhoods and Implications for Learning in Networks

Miklos Racz, Northwestern University, IL

I will discuss recent progress on local canonical labeling algorithms on sparse random graphs and randomly perturbed graphs. I will also discuss implications of these results to average-case and smoothed analysis of graph isomorphism, as well as graph reconstruction problems.

2 On the Impact of Mass Screening for SARS-CoV-2 Through Self-Testing in Greece

Kimon Drakopoulos, University of Southern California, Data Sciences and Operations, Los Angeles, CA

We study the self-testing COVID-19 mass screening program that was implemented in Greece, involving large, susceptible populations taking tests routinely and pre-emptively so as to enable early detection of infections. Using a novel compartmental model we quantify the effectiveness of the program in curbing the COVID-19 pandemic. Conservative estimates indicate that the program reduced the reproductive number by 4%, hospital admissions by 25% and deaths by 20%, which translated into approximately 20,000 averted hospitalizations and 2,000 averted deaths between April-December 2021. Self-testing mass screening programs are efficient interventions with minimal social and financial burden, thus they are invaluable tools to be considered in pandemic preparedness.

3 Optimal Information Disclosure to Maintain Safe Activity Levels

Sohil Shah[1], Saurabh Amin[1], Patrick Jaillet[2], [1]MIT, Cambridge, MA, [2]M.I.T., Cambridge, MA, Contact: sshah95@mit.edu

We investigate the dynamic disclosure of information in non-stationary environments. A planner iteratively discloses information about the efficacy of an immunizing booster that stochastically evolves over time amid long-run spread of disease. Each time period, a heterogeneous mass of agents decide whether they should obtain the booster shot, and then whether to remain isolated or active. The planner's objective is to ensure that the active population remains above a minimum threshold each period. Greedy disclosure minimizes information disclosed subject to the planner maximizing the likelihood of achieving the active population threshold in the current period. We show that greedy disclosure becomes optimal in finite time for settings where the population's belief over the booster's efficacy becomes more pessimistic than the belief required in the long-run.

Sunday, October 15, 10:45 AM - 12:00 PM

SB11

CC-North 124A

Learning and Control for Stochastic Systems

Community Committee Choice Session

Session Chair: Debankur Mukherjee, ISyE Georgia Tech, Atlanta, GA

1 Learning to Schedule in Multiclass Many-Server Queues with Abandonment

Yueyang Zhong[1], John R. Birge[2], Amy R. Ward[1], [1]The University of Chicago Booth School of Business, Chicago, IL, [2]University of Chicago, Chicago, IL, Contact: yzhong0@chicagobooth.edu

We consider a learning variant of a canonical scheduling problem in a multiclass many-server queue with abandonment with general service time and patience time distributions (GI/GI/N+GI). The objective is to minimize the long-run average class-dependent expected linear abandonment costs when the distributional and parameter information are a priori unknown. We evaluate the performance by means of regret against the benchmark aμ rule with parameter knowledge. We propose a Learn-Then-Schedule algorithm over T periods, which is composed of a learning phase where statistical estimators of the parameters are formed, and an exploitation phase where an empirically learned aμ rule is followed. It is shown that the smallest achievable regret is $\Omega(\log T)$, and our proposed algorithm achieves a regret upper bound of $O(\log T)$, which matches the lower bound.

2 Control Policies for Telehealth: Connecting Patients to Doctors

Mark E. Lewis[1], Jamol Pender[2], Shuwen Lu[3], [1]Cornell University, Ithaca, NY, [2]Cornell University, Ithaca, NY, [3]Cornell University, Ithaca, NY, Contact: mark.lewis@cornell.edu

We consider a clearing system model for moving patients through a minute clinic equipped with a triage station, the potential for service to be completed with a nurse practitioner (NP) and the possibility of accessing a doctor through telehealth. After initial triage, in some cases, the NP needs to decide whether or not they prefer to connect with a general practitioner. We provide cases in which the optimal control follows intuition and show heuristics perform well when the optimal control is too complicated for implementation.

3 Asymptotic Product-Form Steady-State for Multiclass Queueing Networks with Static-Buffer-Priority Service Policies in Multi-Scale Heavy Traffic

Jim Dai[1], Lucy Huo[2], [1]Cornell University & CUHK-Shenzhen, Ithaca, NY, [2]Cornell University, Ithaca, NY

We establish that when subjected to a multi-scale heavy traffic condition, the stationary distribution of the scaled queue length vector process in multiclass queueing networks, operating under static-buffer-priority service policies, converges to a product-form limit. This convergence is achieved under the assumption of uniform moment bounds. Each component in the product form follows an exponential distribution.

Sunday, October 15, 10:45 AM - 12:00 PM

SB12

CC-North 124B

Socially Responsible Operations Decision

Community Committee Choice Session

Session Chair: Amy Williams, Irvine, CA

Session Chair: L. Robin Keller, University of California, Irvine, Corona del Mar, CA

1 Informing Socially Responsible Operations Decision with Stated Choice Data

Katherine Silz-Carson, Air force Academy, CO

Data about consumers' stated choices can sometimes provide useful information to inform socially responsible operations decision-making. However, some aspects of socially responsible operations have characteristics that resemble markets for public goods. In these settings, data about consumer choices can sometimes provide biased information and lead to sub-optimal decisions. This paper discusses potential problems with the validity of consumer choice data in various choice settings, the implications for socially responsible operations decision-making, and potential avenues for new research on consumer choices in these settings.

2 Behavioral Analysis Of Needs Reporting And Fund Allocation In Humanitarian Response

Bengisu Urlu[1], Karen L. Donohue[2], [1]INSEAD, Fontainebleau, France; [2]University of Minnesota, Minneapolis, MN, Contact: bengisu.urlu@insead.edu

When a disaster strikes, an accurate assessment of required funds for the response is crucial to utilize scarce resources for the greatest good. Humanitarian organizations (HOs) evaluate the needs of the crisis-affected population and report the required amount of funds for the response. Donors then allocate their budget based on these reports. In this study, we explore how environmental factors, such as the nature of private information, level of competition, and varying budget levels, influence HOs' reports and their display of trustworthy behavior. We also examine donor responses to these reports and their impact on humanitarian outcomes.

3 Environmentally Conscious Consumers and Retail Purchasing and Returning Behavior

Amy Williams[1], L. Robin Keller[2], [1]University of California, Irvine, Irvine, CA, [2]University of California, Irvine, Corona del Mar, CA

Product returns are environmentally taxing due to the transportation, repackaging, and waste costs accumulated by a returned item. Surprisingly, our first lab study found that more environmentally conscious participants are more likely to purchase multiple sizes of the same item at once and, consequently, return more frequently. Next we modeled this behavior analytically and confirmed that this purchasing behavior is, in fact, less environmentally friendly, in more cases. Through this analysis, we identified ways in which retailers might be able to curb this behavior: by offering more transparency around what will happen to a returned product. We then tested this in a second lab study and found that providing more transparency around what happens to a returned product does significantly reduce environmentally costly customer purchase habits.

Sunday, October 15, 10:45 AM - 12:00 PM

SB13

CC-North 125A

Understanding and Disrupting Illegal Supply Chains

Community Committee Choice Session

Session Chair: N. Orkun Baycik, Boston University, Boston, MA

1 Nation's Fight Against Illegal Fishing: A Research Agenda for OR/OM Community

Canan Gunes Corlu, N. Orkun Baycik, Alyssa Pierson, Greg McDaniel, Boston University, Boston, MA, Contact: canan@bu.edu

Illegal, Unreported, and Unregulated (IUU) fishing destroys our environment, economy, and society. It allows other illegal activities such as human trafficking and drug trafficking to take place in the ocean and onshore. The goal of this talk is to present the operational aspects of IUU fishing networks and discuss research opportunities for OM/OR scholars in fighting against these illegal activities.

2 Interdiction of Wildlife Trafficking Supply Chains: An Analytical Approach

Emily C. Griffin[1], Aaron Ferber[2], Burcu B. Keskin[3], Bistra Dilkina[4], Meredith Gore[5], [1]Babson College, Babson Park, MA, [2]University of Southern California, Los Angeles, CA, [3]University of Alabama, Tuscaloosa, AL, [4]USC, Los Angeles, CA, [5]University of Maryland, College Park, MD

Illicit Wildlife Trade (IWT) is a serious global crime that negatively impacts biodiversity, human health, national security, and economic development. Many flora and fauna are trafficked in different product forms. We investigate a network interdiction problem for wildlife trafficking and introduce a new model to tackle key challenges associated with IWT. We incorporate vital issues unique to IWT, including the need for training and difficulty recognizing illicit wildlife products, the impact of charismatic species and geopolitical differences, and the varying amounts of information and objectives traffickers may use when choosing transit routes. We present solutions for several key IWT supply chains using realistic data from conservation research, seizure databases, and international reports.

3 When or Meets the Street: Interdicting Interdependent Human Trafficking Networks
Felipe Aros-Vera, Ohio University, Athens, OH, Contact: aros@ohio.edu
This presentation will walk the audience through the challenges of implementing Network Interdiction Models (NIMs) in the real world. Starting from a solid theoretical foundation, NIMs promise to deliver new tools in the fight against Human Trafficking (HT). However, the implementation of such tools can be a great challenge when: data are unavailable, police enforcement does not see the value, and academics are seen as a liability more than a help. Funded by DOJ, the authors embarked on providing technology and methods to the Cuyahoga HT Task Force in its daily efforts to crack down on modern slavery in the streets of Cleveland.

4 Classification Methods for Decision Making in Illegal Drug Trafficking Networks
N. Orkun Baycik, Boston University, Boston, MA
This study focuses on a machine learning application in deciding law enforcement actions against illegal drug trafficking activities. In such illegal supply chains, there may be different types of criminals such as drug manufacturers, drug dealers, and drug users. Law enforcement may choose to arrest the "known" criminals as soon as they identify that they are indeed a criminal. On the other hand, they may decide to "target" them for a period of time with the goal of accessing higher ranked criminals. By using classification methods, our goal is to develop approaches to assist in this decision-making process. Computational experiments compare the resulting decisions with the optimal decisions.

Sunday, October 15, 10:45 AM - 12:00 PM

SB14

CC-North 125B

Data Driven Approaches in Social and Sustainable Operations

Community Committee Choice Session

Session Chair: Somya Singhvi, USC Marshall School of Business, Los Angeles, CA
Session Chair: Amrita Kundu, McDonough School of Business, Georgetown University

1 Optimal Design of Default Donations
Scott Rodilitz, UCLA Anderson School of Management, Los Angeles, CA
Nonprofit organizations commonly use *default* suggested donations to increase fundraising revenues, but they often determine these default options in an ad hoc way. Towards optimizing the design of nonprofits' default donation menus, we present a modeling framework where prospective donors have an ideal donation amount (determined by a concave utility function) and also derive a small utility gain from selecting a default option. We first characterize the optimal personalized default menu when the nonprofit has full information about the donor, including their ideal donation amount. We then take a competitive analysis approach and assess the maximum achievable revenue gain in the absence of personalization. For such settings, we also present a dynamic program to efficiently solve for the optimal default menu.

2 Towards Global, General-purpose Geographic Location Encoders
Konstantin Klemmer, Microsoft Research New England, Cambridge, MA
Geospatial data is common across a wide range of disciplines and modeling tasks, e.g. in ecology or urban analytics. Location features are often not readily available and need to be obtained via individual data collection and fusion. This opens the opportunity for a new class of "foundation models": global, general-purpose geographic location encoders, which provide vector embeddings summarizing the characteristics of a location for convenient usage in downstream tasks. I propose training such a location encoder using multi-spectral Sentinel-2 satellite data. I show that the trained encoder can be used for a broad range of predictive out-of-domain tasks like house price prediction and animal recognition. I then systemically compare this model to existing location encoders, ranging from models trained on natural images or semantic context to large language models.

3 Sustainable Sourcing Enhances Product Durability: Evidence Fromleadacid Batteries for Electric Three Wheelers in Bangladesh
Amrita Kundu[1], Erica Plambeck[2], Qiong Wang[3], [1]McDonough School of Business, Georgetown University, Washington, DC, [2]Stanford University, Stanford, CA, [3]University of Illinois Urbana-Champaign, Champaign, IL
We empirically assess the impact of informal recycling practices on product quality and durability of lead acid batteries (LABs). With increase in adoption of green technologies and due to weak regulatory capacity, informal recycling of LABs has become rampant in developing countries. In Bangladesh, 2 out of 3 children suffer from lead exposure, largely due to informal recycling of used LABs in

"open-pit bhattis". Our analysis of a large LAB manufacturer's warranty claim and lead sourcing data suggests that informal recycling of lead in the circular economy for LABs significantly decreases the quality and durability of batteries, resulting in direct warranty costs and indirect conformance quality costs for the manufacturer. This economic motivation for manufacturers to source sustainably can be used as a lever to increase formal recycling in developing countries.

4 A Data-Driven Approach to Improve Artisans' Productivity: Empirical Evidence from India

Divya Singhvi[1], Somya Singhvi[2], Xinyu Zhang[3], [1]New York University, New York, NY, [2]USC Marshall School of Business, Los Angeles, CA, [3]New York University Stern School of Business, New York, NY

Despite their vital role in rural economy, artisanal supply chains continue to be plagued by low productivity and the highly fragmented nature of their upstream. This study presents research conducted in close collaboration with a leading exporter of handmade rugs in India, aimed at improving artisans' productivity in distributed supply chains. We provide robust empirical evidence that frequent supervisor visits can play a crucial role in improving artisans' productivity. Our analysis also suggests that this impact is heterogeneous, with visits to more complex rugs, and visits that are more consistent, leading to maximum productivity gains. To capitalize on these insights, we propose a novel predict-then-optimize framework for optimizing supervisor visits in the supply chain and we see significant productivity improvement from extensive numerical analysis.

Sunday, October 15, 10:45 AM - 12:00 PM

SB15

CC-North 126A

Decision-making in a Contested Environment

Community Committee Choice Session

Session Chair: Stephen Donnel, Air Force Institute of Technology, WPAFB, OH

Session Chair: Carson Long, Air Force Institute of Technology (AFIT), Dayton, OH

1 Indiscriminate Disruption of Conditional Inference on Multivariate Gaussians

William Caballero[1], Alexander Fisher[2], Matthew LaRosa[1], Vahid Tarokh[2], [1]United States Air Force Academy, United States Air Force Academy, CO, [2]Duke University, Durham, NC

The multivariate Gaussian distribution is a fundamental probabilistic model underpinning myriad applications and, given recent advances in adversarial machine learning, it is important to revisit how a malicious actor may corrupt inference relying upon it. Therefore, we consider an attacker who wishes to disrupt a decisionmaker's conditional inference by corrupting a set of evidentiary variables while also maintaining attack plausibility. In this setting, we consider both whitebox and greybox conditions such that the attacker has complete and incomplete knowledge about the decisionmaler's distribution, respectively. The problems are shown to reduce to quadratic and stochastic quadratic programs. We derive proofs that explore the problems' structure. Benchmarking showcases the impacts of these attacks on multiple, realistic case studies.

2 A Stackelberg Framework for Disrupting Coordinated, Multi-Asset Routing and Sequential Servicing of Demand

Stephen Donnel, Air Force Institute of Technology, Dayton, OH

Complex, contested routing inspired the development of a bilevel multiple asset sequential routing problem. Wherein the lower-level route to minimize the total sum of final delivery of the penultimate asset type required at all demand nodes as the upper-level, given a limited budget for arc disruptions, seek to maximize the same objective. A Greedy Construction Heuristic finds an initial solution strategy by incrementally adding delaying actions. Two simulated-annealing-inspired solutions attempt to improve this initial solution. In the first, delaying actions are shifted, with predominantly random decisions. The second adjusts solutions by moving an action affecting routing least to an area where the current route is most affected.

3 A Multi-Objective, Bilevel Programming Methodology to Identify Transportation Distribution Network Vulnerabilities

Carson Long, Air Force Institute of Technology (AFIT), Dayton, OH

Transportation of material over ground distribution networks is subject to both man-made and natural disruptions. This research sets forth a multi-objective bilevel linear program to identify, quantify, and characterize network vulnerabilities for a defender solving a multi-objective material routing problem, given an adversary conducting a limited number of arc-specific, spatiotemporal attacks driven by competing objectives. Examining an instance comprised of real-world network topology, this research examines the efficiency of

NSGA-II to search the upper-level decision space and identify high quality solutions, subject to the defender's lexicographic prioritization over its multiple objective functions.

4 Preventing Double-Counting in Data Fusion: A Network Topology-Based Approach

Sangeeth Panthakkal Das, Alexander Nikolaev, University at Buffalo, Buffalo, NY, Contact: spanthak@buffalo.edu

Double-counting, or data incest, may occur when nodes (sensors) of a decentralized communication network make estimates based on shared signals forwarded with no overheads: when the same signals reach the nodes via multiple paths, such duplication leads to wrong estimation and waste of resources. This work introduces loop-graph based protocols that prevent double-counting, minimizing the network-wide communication delay and nodes' energy expenditures.

Sunday, October 15, 10:45 AM - 12:00 PM

SB16

CC-North 126B

Responding Climate Crisis with Data-Driven OM

Community Committee Choice Session

Session Chair: Ilgin Dogan, University of California, Berkeley, Berkeley, CA

Session Chair: Zuo-Jun Max Shen, University of California Berkeley, Berkeley, CA

1 Optimal Maintenance and Inspection Policy for Power Grids

Abolfazl Taghavi[1], Reza Ahmadi[2], Sriram Dasu[3], [1]UCLA Anderson School of Management, Los Angeles, CA, [2]UCLA, Los Angeles, CA, [3]University of Southern California, Los Angeles, CA

Wildfires have a significant impact on the environment, society, and infrastructures. During the last decades, the behavior of wildfires has changed significantly and become more severe. In addition, climate change and wildland-urban interface expansion made the wildfire problem even more challenging than it was in the past. As a result, wildfire management is becoming significantly important in the US and other countries. In 2018, PG&E, the largest utility company in California, almost went bankrupt because of igniting the campfire. Since then, utility companies have initiated several programs to reduce the fire ignition probability across their power grid, including maintenance and inspection of the power grid elements. In this project, we present an optimal inspection and maintenance policy for the utilities' power grid.

2 Do Noisy Customer Reviews Discourage Platform Sellers? Empirical Analysis of an Online Solar Marketplace

Herbie Huang[1], Nur Sunar[1], Jayashankar M. Swaminathan[2], Rahul Roy[1], [1]UNC Kenan-Flagler Business School, Chapel Hill, NC, [2]University of North Carolina Chapel Hill, Chapel Hill, NC

For this project, we collaborated with one of the largest online solar marketplaces in the U.S. that connects potential solar panel adopters with installers. We empirically study how the review dispersion affects a seller's activity level and the number of matches in an online marketplace with active sellers.

3 Estimating and Incentivizing Imperfect-Knowledge Agents with Hidden Rewards: An Example from Green Energy Aggregators

Ilgin Dogan[1], Zuo-Jun Max Shen[2], Anil Aswani[3], [1]University of California, Berkeley, Berkeley, CA, [2]University of California Berkeley, Berkeley, CA, [3]UC Berkeley, Berkeley, CA, Contact: ilgindogan@berkeley.edu

As opposed to many principal-agent models, incentive providers in practice often cannot observe the reward realizations of incentivized agents. This information asymmetry challenges principal to consistently estimate agent's unknown rewards and steer its choices by solely watching their actions - which becomes even more challenging when these actions carry the selfish agent's learning uncertainty. We explore this practically relevant scenario of repeated adverse selection game within a multi-armed bandit framework and design: i) a consistent estimator for agent's rewards from a bounded continuous space, ii) a low-regret adaptive incentive policy inducing incentive compatibility. We prove finite-sample concentration of our estimator and a rigorous regret bound of the proposed policy - supported by our numerical results for green energy aggregator contracts.

4 Estimating the Impact of Climate Change: An Empirical Analysis of Smart Thermostat Data

Saed Alizamir[1], Michael Blair[1], Shouqiang Wang[2], [1]Yale University, New Haven, CT, [2]The University of Texas at Dallas, Richardson, TX, Contact: saed.alizamir@yale.edu

Using a rich micro-level dataset, we empirically analyze smart thermostat data to understand the relationship between households' thermostat settings and their ambient environment. We combine a variety of methodological tools including Dynamic Linear Models, random effects, and Bayesian Statistics, to develop models for short- and long-term behavior. Using established models we create realistic estimates of future weather conditions under a variety of climate change scenarios. We combine these scenarios with our statistical model to estimate the impact of climate change. Specifically, we predict future household behavior and investigate the resulting changes in consumption. The insights derived from our research provide a valuable framework to evaluate and design interventions such as smart nudging or demand response management programs.

Sunday, October 15, 10:45 AM - 12:00 PM

SB17

CC-North 127A

Emerging Topics in Behavioral Service Operations

Community Committee Choice Session

Session Chair: Stephen Leider, University of Michigan, Ann Arbor, MI

Session Chair: Clare Snyder, University of Michigan - Ross School of Business, Ann Arbor, MI

1 Algorithm Reliance for Binary Classification Tasks: Implications for Fairness

Clare Snyder[1], Samantha Meyer Keppler[2], Stephen Leider[2], [1]Michigan Ross, Ann Arbor, MI, [2]University of Michigan, Ann Arbor, MI, Contact: claresny@umich.edu

Feedback plays a critical role in the way people use decision-support algorithms; people are averse to algorithms after seeing them err but may also learn from feedback over time when algorithms are helpful. But feedback from binary classification tasks is censored - true outcomes are only seen if an action is taken. For example, a lender can only know if a borrower will repay a loan if that loan is awarded. How will people use and learn about algorithms to make binary classifications? What implications does this have for algorithm design (i.e., about the false +/false - tradeoff)? We answer these questions with simulations and results from laboratory experiments. Our results have natural implications for algorithmic fairness, and we extend our work with a follow-up study on the consequences of “fair” algorithms for algorithm reliance, accuracy, and fairness outcomes.

2 Discretionary Task Under Operating and Peer Performance: Evidence from the Emergency Department

Diwas S. KC[1], Blair Liu[2], Bradley R. Staats[3], [1]Emory University, Atlanta, GA, [2]University of North Carolina at Chapel Hill, Chapel Hill, NC, [3]University of North Carolina at Chapel Hill, Chapel Hill, NC, Contact: Blair_Liu@kenan-flagler.unc.edu

This research examines operating factors affecting knowledge workers’ discretionary test ordering in an emergency department (ED), focusing on workload, remaining shift time, prior interactions, and relative peer performance. With data from a healthcare system’s ED in a major US city, we perform econometric analysis of over 50,000 patient observations over a year. The result shows workload and time remaining in shift significantly influence test ordering. Prior patient familiarity reduces test ordering, while relative peer performance also impacts this. The study highlights that an additional test decreases 30-day patient revisits but prolongs ED stays, offering managerial implications like standardizing test ordering, balancing workload and shift time, and incorporating past interactions and relative peer performance in staffing decisions.

3 Redesigning Shift Work to Incorporate Heterogeneous Worker Preferences

Harriet Jeon[1], Song-Hee Kim[2], Hummy Song[1], Kyeongsug Kim[3], Sangwoon Cho[3], Jeong Hee Hong[3], [1]The Wharton School, University of Pennsylvania, Philadelphia, PA, [2]Seoul National University, Gwanak-gu, Korea, Republic of; [3]Samsung Medical Center, Seoul, Korea, Republic of. Contact: hyjeon@wharton.upenn.edu

Shifts are the dominant way to work in many contexts requiring 24/7 coverage, including call centers, police departments, and hospitals. While the detriments of shift work are well-documented both at the individual and organizational levels, its deployment is often unavoidable given round-the-clock staffing needs. We explore a potential organizational lever—incorporating heterogeneous preferences over shift design—to mitigate ramifications of shift work in the context of acute care bedside nurses. Using survey, administrative, and shift data, we examine whether and the extent to which individual choice over dimensions of their shifts mitigates the impact of shift work on work (dis) satisfaction and turnover of nurses.

4 Incentive Design for Good Advice

Jing Li, Xiao Zhang, Fei Jia, Saint Louis University, Saint Louis, MO, Contact: fei.jia@slu.edu

Advice from those who have experience with a decision problem is often believed to be beneficial for decision making. However, if predecessors do not properly update their evaluation of decision options based on their experience, they may fail to pass the information obtained from their experience to their successors. This could lead to a worse outcome than in the absence of advice, since the entire group of decision-makers may herd on an inferior choice due to bad advice. We design (non-)monetary incentives to induce good advice in lab experiments. We also study the impact of risk preference on advice giving and taking behaviors. Our results shed light on how online advice/review systems could be improved.

Sunday, October 15, 10:45 AM - 12:00 PM

SB18

CC-North 127B

HAS Distinguished Speakers Session

Community Committee Choice Session

Session Chair: Jonas Oddur Jonasson, MIT Sloan School of Management, Somerville, MA

Session Chair: Mariel Sofia Lavieri, University of Michigan, Ann Arbor, MI

1 Modeling to Inform Strategies for Disease Eradication: The Case of Guinea Worm Disease

Pinar Keskinocak[1], Hannah Smalley[1], Tyler Perini[2], Christopher Hanna[3], Yifan Wang[4], Julie L. Swann[5], Adam Weiss[6], [1]Georgia Tech, Atlanta, GA, [2]Rice University, Houston, TX, [3]Global Project Partners, Chicago, IL, [4]Georgia Institute of Technology, Atlanta, GA, [5]North Carolina State University, Raleigh, NC, [6]Carter Center, Atlanta, GA, Contact: pinar@isye.gatech.edu

In the 1980s, WHO declared commitments to globally eradicate Guinea Worm disease and Polio. The prevalence of these diseases has dramatically decreased, but eradication efforts faced many challenges during the endgame or "last mile." We built an agent-based simulation model to analyze the disease transmission of Guinea Worm disease among dogs in Chad. We analyzed intervention strategies, namely, tethering, Abate®, and a potential diagnostic test. Our results show that tethering and Abate need to increase above historical levels to achieve disease elimination, and suggest how best to target limited resources and reach elimination faster. A diagnostic test could be successful in conjunction with these interventions and support elimination efforts; benefits of a test rely heavily on dog selection, frequency, and education about the importance of tethering compliance.

2 Modeling the Impact of Community First Responders

Shane G. Henderson[1], Pieter van den Berg[2], Oceane Fourmentraux[3], Caroline Jagtenberg[4], Hemeng Li[5], [1]Cornell University, Ithaca, NY, [2]Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands; [3]Rotterdam School of Management, Rotterdam, Netherlands; [4]NULL, NULL, [5]Cornell University, Ithaca, NY, Contact: sgh9@cornell.edu

Patient survival from out-of-hospital cardiac arrest (OHCA) can be improved by augmenting traditional ambulance response with the dispatch of community first responders (CFRs) who are alerted via an app. How many CFRs are needed, from where should CFRs be recruited, and how should they be dispatched? We use a combination of Poisson point process modeling and convex optimization to address the first two questions; the right areas from which to recruit are not always obvious, because CFRs recruited from one area may spend time in various areas across a city. We use a combination of dynamic programming and decision trees to answer the last question, balancing the goal of a fast response to the current patient with the need to avoid disengagement of CFRs that arises when multiple CFRs respond. A case study for Auckland, New Zealand demonstrates the ideas.

Sunday, October 15, 10:45 AM - 12:00 PM

SB19

CC-North 127C

Bonder Scholars Session

Community Committee Choice Session

Session Chair: Katherine Adams, University of Wisconsin-Madison, Monona, WI

1 Personalizing Tuberculosis Treatment Adherence

Justin J. Boutilier[1], Jonas Oddur Jonasson[2], [1]University of Wisconsin - Madison, Madison, WI, [2]MIT Sloan School of Management, Cambridge, MA

Tuberculosis (TB) is a global health emergency and low treatment adherence among patients is a major barrier to ending the TB epidemic. The WHO promotes digital adherence technologies as facilitators for improving treatment adherence in resource-limited settings. We propose analytical tools to personalize TB treatment adherence support and demonstrate their potential using data from Kenya.

2 Planning a Personalized Community Health Worker Intervention for Diabetes Care in Low- and Middle-Income Countries

Katherine B. Adams[1], Justin J. Boutilier[2], Sarang Deo[3],

Yonatan Mintz[4], [1]University of Wisconsin-Madison, Madison, WI, [2]University of Wisconsin - Madison, Madison, WI, [3]Indian School of Business, Hyderabad, India; [4]University of Wisconsin Madison, Madison, WI, Contact: kbadams@wisc.edu

Diabetes is a global health priority that disproportionately affects low- and middle-income countries (LMICs). In addition to being home to almost 90% of people with undiagnosed diabetes, it is estimated that fewer than 10% of people with diabetes in LMICs receive guideline-based diabetes treatment. Several studies have demonstrated the feasibility of using Community Health Worker (CHW) programs to provide affordable and culturally tailored solutions for early detection and management of diabetes. We propose an optimization framework to personalize CHW visits to maximize glycemic control at a community-level while trading off screening and management decisions. We present structural and computational results using real data from India.

3 Interpretable Policy Design with Application to Hypertension Treatment Planning

Gian-Gabriel P. Garcia[1], Lauren N. Steimle[2], Wesley Javier Marrero[3], Jeremy Sussman[4], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Tech ISyE, Atlanta, GA, [3]Dartmouth College, Hanover, NH, [4]Michigan Medicine, Ann Arbor, MI, Contact: giangarcia@gatech.edu

Effective hypertension management is critical for mitigating the consequences of atherosclerotic cardiovascular disease. Despite their potential for improved health outcomes, model-based treatment recommendations may be clinically unintuitive, limiting their acceptance in clinical practice. Hence, we formulate and solve the *interpretable treatment planning problem,* which aims to generate a clinically intuitive and dynamic treatment policy that maximizes patient health outcomes. In a case study on hypertension treatment planning, our interpretable treatment policies achieve 3,246 quality adjusted life years per 100,000 patients over clinical guidelines, are more intuitive than the optimal policy, and are less than 0.5% worse than the optimal policy.

4 Mass Vaccination Scheduling: Trading off Infections, Throughput, and Overtime

Shanshan Luo, Steven Shechter, University of British Columbia, Vancouver, BC, Canada. Contact: shanshan.luo@sauder.ubc.ca

Mass vaccination is essential for epidemic control, but long queues can increase infection risk. We focus on scheduling arrivals at mass vaccination sites to minimize a tri-objective function of infection risk, throughput, and overtime. Leveraging multi-modularity results from a related optimization problem, we construct a solution algorithm and find that our model-based policy significantly outperforms an equally-distributed, equally-spaced schedule. We also discuss managerial insights regarding the optimal schedule's structure and compare it to the well-known "dome-shaped" policies in appointment scheduling problems.

Sunday, October 15, 10:45 AM - 12:00 PM

SB20

CC-North 128A

Data-driven Healthcare Operations

Community Committee Choice Session

Session Chair: Paola Martin, Indiana University, Bloomington, IN

Session Chair: Diwakar Gupta, University of Texas, Austin, TX

1 Health Service Delivery: Does Robot-Assisted Surgery Play a Role?

Sung Joo Kim, Jianing Ding, Susan F. Lu, Purdue University, West Lafayette, IN, Contact: kim3245@purdue.edu

We investigate the role of an emerging AI-based clinical treatment method, robot-assisted surgery (RAS), in transforming the healthcare delivery. As an advanced technique to help diminish the human physical and intellectual limitations in surgeries, RAS is expected to but has not been empirically proven to improve clinical performance. In this study, we first examine the effect of RAS on clinical outcomes, controlling physicians' self-selection behavior in choosing whether or not to use RAS treatment methods. In particular, we focus on the accessibility of RAS and explore how physician and patient heterogeneity affect the adoption of the RAS method, including learning and using RAS. Investigating the decision making process on RAS implementation in both learning and using stages, we show the synergy of RAS implementation in alleviating healthcare racial disparity.

2 Learning from Unfolding Dynamics: Forecast-Driven Adaptive Scheduling in Multi-Service Non-Stationary Queues

Sohom Chatterjee, Youssef Hebaish, Hrayer Aprahamian, Lewis Ntaimo, Texas A&M University, College Station, TX

We consider the problem of scheduling scarce resources in multi-service queues with time-varying demand. As arrivals unfold, future estimates may shift, necessitating a schedule

update. Our approach combines optimization techniques with a novel forecasting method that learns from evolving dynamics, enabling the creation of adaptive policies. The auto-regressive model incorporates period-dependent trends and lagged orders, calibrated via a sub-optimization problem. The model can handle limited data, making it an attractive alternative to data-hungry methods. This is complemented by a tractable reformulation scheme, utilizing a pointwise transient approximation approach to reduce wait times. Through a case study on Texas A&M's counseling center, we illustrate the benefits of our methodology in enhancing students' access to vital mental health services.

3 Towards a New Kidney Transplant Allocation System

Elijah Pivo[1], James Alcorn[2], Dimitris Bertsimas[3], Sarah Booker[2], Keighly Bradbrook[2], Thomas Dolan[2], Nikolaos Trichakis[1], [1]MIT, Cambridge, MA, [2]UNOS, Richmond, VA, [3]Massachusetts Institute of Technology, Cambridge, MA, Contact: elipivo@gmail.com

We worked with the Organ Procurement and Transplantation Network (OPTN) Kidney Transplantation Committee to develop a new national kidney allocation policy, with the goal of making allocation more efficient and more equitable. We deployed a high-speed algorithm that enabled thousands of simulations, a powerful interactive web-based policy analysis tool, and advanced analytics for policy design using optimization. At the time of writing, four policies created with our methods are advancing towards becoming national policy. Compared to current policy, simulation results show significant gains in fairness metrics with no loss in utility metrics. We anticipate that by applying modern analytics, the transplantation system can produce fairer and better outcomes for patients.

44 Hotspots for Emerging Epidemics: Multi-Task and Transfer Learning over Mobility Networks

Mehmet Ahsen[1], Sebastian Souyris[2], Ujjal Kumar Mukherjee[3], Shuai Hao[4], Anton Ivanov[1], Sridhar Seshadri[5], [1]University of Illinois at Urbana-Champaign, Champaign, IL, [2]Rensselaer Polytechnic Institute, Troy, NY, [3]University of Illinois, Urbana-Champaign, Champaign, IL, [4]University of Illinois Urbana-Champaign, Champaign, IL, [5]University of Illinois, Champaign, IL

A new data-driven framework proposes identifying significant infection diffusion locations, known as hotspots, for effective epidemic mitigation like COVID-19. The framework employs advanced analytical methods, including interpretable long short-term memory models, multi-task learning, and transfer learning. It considers within- and across-location mobility as the primary driver of infection diffusion within a network of connected locations. Transfer learning from past influenza transmission data enhances infection diffusion and hotspot detection. Comparisons with infection load-based and state-wide lockdown policies demonstrate that the hotspot-based approach can reduce new infections by up to 21% while achieving performance similar to a state-wide lockdown. By incorporating transfer learning, hotspot prediction accuracy improves by 53.4%.

Sunday, October 15, 10:45 AM - 12:00 PM

SB21

CC-North 128B

Primary Care Treatment Allocation and Scheduling

Community Committee Choice Session

Session Chair: Alba Olivares Nadal, 1</sup

Session Chair: Daniel Adelman, University of Chicago, Booth School of Business, Chicago, IL

1 Optimizing Treatment Allocation to Maximize the Health of a Population

Daniel Adelman[1], Alba Olivares-Nadal[2], [1]University of Chicago, Booth School of Business, Chicago, IL, [2]University of New South Wales, New South Wales, Australia. Contact: dan.adelman@chicagobooth.edu

We use MDPs to model the task of optimally allocating treatment amongst patients while fulfilling capacity constraints. The complexity of such a problem may be very high because healthcare populations may be large enough that gathering information of the current status of each patient and tracking the evolution of their covariates is untenable. To address this challenge we develop the so-called measurized theory, which allows to model MDPs that optimize the distribution of treated and untreated patients instead of dealing with identifed patients. This abstraction transforms a complicated problem into an intuitive formulation and sets the stage for delivering clinically implementable solutions.

2 Primary Care Continuity, Frequency, and Regularity Associated with Reduced Medicare Spending

Dilara Sonmez[1], Dan Adelman[1], George Weyer[2], [1]The University of Chicago Booth School of Business, Chicago, IL, [2]The University of Chicago Medicine, Chicago, IL, Contact: dsonmez@chicagobooth.edu

Reducing Medicare expenditures is a key objective of Medicare's transition to value-based reimbursement models. Improving access to primary care is seen as an important way to reduce expenditures, yet less is known about how primary care visits should be organized to maximize patient-level savings. This retrospective cohort study aims to examine the relationship between outcomes (savings in Medicare expenditures, risk-adjusted number of emergency department visits, and risk-adjusted number of hospitalizations) and the primary care practice patterns (visit frequency, regularity, and continuity of care).

3 Robust Appointment Scheduling with Waiting Time Guarantees

Carolin Isabel Bauerhenne, Rainer Kolisch, Andreas S. Schulz, Technical University of Munich, Munich, Germany. Contact: carolin.bauerhenne@tum.de

Appointment scheduling under uncertainty encounters a fundamental trade-off between capacity utilization and customer waiting times. Most existing approaches tackle this trade-off using a weighted sum approach, resulting in a low consideration of individual waiting times and thus customer dissatisfaction. In contrast, we study how to maximize capacity utilization while guaranteeing acceptable waiting times. Therefore, we derive a mixed-integer linear program in a robust optimization framework. We prove that the general problem is NP-hard and present optimal polynomial-time scheduling and sequencing rules for special cases. A case study with real data from a large radiology demonstrates that our approach not only guarantees acceptable waiting times but, compared to existing weighted-sum approaches, can also reduce costs incurred by idle time.

Sunday, October 15, 10:45 AM - 12:00 PM

SB22

CC-North 129A

Causal Inference in Healthcare

Community Committee Choice Session

Session Chair: Kevin Smith, University of Michigan, Ann Arbor, MI

1 Estimating Activity and Sleep Goals for Bipolar Disorder Patients

Sidian Lin, Soroush Saghafian, Jessica M. Lipschitz, Harvard University, Cambridge, MA

The development of mobile health technologies gives rise to the possibility of long-term monitoring for chronic diseases such as mental disorders. In this study, we focus on bridging causal inference and offline reinforcement learning to give better treatment suggestions to bipolar disorder patients. We also share some insights on how to translate causal inference and offline RL techniques to the complex real-world data. Given that mood transitions widely exist in most mental disorders, such design can be easily applied to other mental illnesses where new policies can be learned and evaluated in a more accurate and safer way.

2 Out-of-Distribution Generalization in Health

Aahlad Puli, [1</sup]

Machine learning models can speed up diagnosis from radiological images which in turn can improve patient outcomes or reduce treatment-cost. However, models built on a fixed dataset from one hospital are known to lose performance, sometimes catastrophically, when deployed at a different hospital due to dependance on unstable correlations . We employ insights from causality to couple the data generating processes in training and in deployment into a family of distributions. We develop Nuisance-Randomized Distillation (NuRD) to build models that enjoy performance guarantees on every member of the family. NuRD builds representations that separate the spurious and non-spurious signals in the covariates and predicts the labels with non-spurious ones. NuRD improves test performance on Pneumonia and Cardiomegaly detection from chest X-rays.

3 Federated and Transfer Learning to Estimate Causal Effects of Underrepresented Populations

Larry Han[1,2], Yi Zhang[3], Sharon-Lise Normand[4], Rui Duan[1], [1]Harvard University, Boston, MA, [2]Northeastern University, Boston, MA, [3]Harvard University, Cambridge, MA, [4]Harvard Medical School, Boston, MA, Contact: larryhan@g.harvard.edu

Federated or multi-site studies can improve the power to estimate treatment effects for patient subgroups, but privacy constraints often preclude the sharing of patient-level data. We develop a novel causal inference framework to incorporate information from *multiple sites* and *multiple populations* to make inferences on the causal effect for an underrepresented target population of interest. Our method leverages *transfer learning* and *federated learning* to data-adaptively incorporate summary-level information from source populations and sites. In extensive simulations, we show that the proposed method substantially improves the estimation accuracy of treatment effects for underrepresented target populations. We illustrate our method through a study of surgical outcomes for congenital heart defects across all 120 congenital heart centers in the U.S.

4 Optimal Interpretable Sequential Decision Making

Kevin Smith, Siqian Shen, Brian T. Denton, Industrial and Operations Engineering, University of Michigan, Ann Arbor, MI, Contact: kvbsmith@umich.edu

In healthcare domains, experiments are often impractical or impossible. Therefore, models developed using accurate cause and effect relationships are crucial to achieve optimal policies; moreover, the interpretability of such policies is particularly important in the healthcare domain to achieve clinical buy in and successful implementation. Achieving these dual goals of accuracy and interpretability using models built based on observational data is challenging due to sources of confounding. In this presentation we discuss relevant factors in estimating accurate and interpretable policies in the context of health decisions making. We present a case study in the context of health interventions to motivate the importance of these considerations.

Sunday, October 15, 10:45 AM - 12:00 PM

SB23

CC-North 129B

Operations Management Downstream in the Supply Chain: Empirical Research Applications

Community Committee Choice Session

Session Chair: Elliot Rabinovich, Arizona State University, Tempe, AZ

Session Chair: Lina Wang, The Pennsylvania State University, State College, PA

Session Chair: Stanley Lim, Michigan State University, East Lansing, MI

1 Omnichannel Grocery Retail: Fulfillment Revenue Models and Operational Impact

Stanley Lim[1], Elliot Rabinovich[2], Rui Sousa[3], Park Sungho[4], [1]Michigan State, Lansing, MI, [2]Arizona State University, Tempe, AZ, [3]Catholic University Portugal, Porto, Portugal; [4]Seoul National University, Seoul, Korea, Republic of. Contact: elliot.rabinovich@asu.edu

We examine empirically the use of alternative fulfillment revenue models in omnichannel grocery retail and their effects on revenue, consumer purchasing behavior, and costs. we draw from these effects to develop prescriptive analyses on improvements to these revenue models. Our analyses are informed by a collaboration with a national grocery retail chain with store operations and direct-to-consumer deliveries across hundreds of urban and rural markets in their home country.

2 Do Virtual Showrooms Payoff? Evidence From A Quasi-experiment

Sina Golara[1], Nasim Mousavi[2], Subodha Kumar[3], Jesse Bockstedt[2], [1]Georgia State University, Atlanta, GA, [2]Emory University, Atlanta, GA, [3]Fox School of Business, Temple University, Philadelphia, PA

With increasing consumer interest in "research online, purchase offline" (ROPO), automobile dealerships retailers have increasingly introduced virtual showrooms. Yet research is not conclusion on how this strategy affects retailer performance. Notably, the pre-sale information revealed in virtual showrooms can attract more customers or encourage free-riding and hurt performance. We document a strong and positive effect following virtual showroom roll-out by analyzing a sample of 20,372 U.S. dealerships over 16 months using difference-in-difference and matching methods. Interestingly, we find different types of competition (within- and between-brand) moderate this effect in opposite ways. We also find a complementary relationship between online reputation and virtual showrooms, where "stars" rise even further post-adoption of this service.

3 Assessing the Impact of Brand-Level ESG Violations on Sales

Yao Chen[1], M. Serkan Akturk[1], Rakesh Reddy Mallipeddi[2], Arvind Mahajan[3], [1]Clemson University, Clemson, SC, [2]Th Ohio State University, Columbus, OH, [3]Texas A&M University, College Station, TX

Employing retail transaction data and firm-level environmental, social, governance (ESG) information, our research investigates the impact of firms' ESG violations on their operational performance. We show that ESG violations lead to decreased sales for brands. Furthermore, store location and customer demographics moderate the relationship between ESG violations and brand sales. We also conduct several robustness analyses to make sure that our results are consistent.

4 Modeling Drivers' Choices in a Crowdsourced Delivery System

Lina Wang[1], Stanley Lim[2], Elliot Rabinovich[3], [1]The Pennsylvania State University, State College, PA, [2]Michigan State University, East Lansing, MI, [3]Arizona State University, Tempe, AZ, Contact: lkw5428@psu.edu

Using a dynamic discrete choice model, we empirically evaluate the choices crowdsourced drivers make when selecting bundles of delivery work on a last-mile delivery platform. The results show the tradeoffs between effort and payout in terms of bundle attributes in drivers' decision-making process. In the counterfactual simulations, we consider how the platform can better incentivize drivers to choose bundles that require more effort.

5 C2C e-Commerce Platform Trust from the Seller's Perspective Based on Institutional Trust Theory and Cultural Dimension Theory

Yulu Sun[1], Haoyan Sun[2], Qixing Qu[1], [1]University of International Business and Economics (UIBE), Beijing, China; [2]Lehigh University, Allentown, PA, Contact: 438024837@qq.com

With the development of e-tailing in C2C e-commerce platforms, the issue of trust loss from sellers has worsened. How to improve their trust is urgent for platform. Based on institutional trust theory, we intend to examine the direct effects of cultural factors on platform trust, the moderating effects of structural assurances, and the relationships among cultural factors. We collected and analyzed 2,970 valid responses from individual sellers on Taobao. The results reveal that uncertainty avoidance is negatively associated with platform trust, while masculinity and long-term orientation are positively associated with platform trust. Significant associations are also found among cultural factors. Website quality and institutional guarantee weaken the correlation between uncertainty avoidance and platform trust, while security system strengthens it.

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SB24

CC-North 130

MSOM Student Paper Competition Session 2

Award Session

Session Chair: Ersin Korpeoglu, University College London, London, United Kingdom

1 UMOTEM: Upper Bounding Method for Optimizing over Tree Ensemble Models and its Applications

Leann Thayaparan, Massachusetts Institute of Technology, Cambridge, MA

2 Sequential Search with Acquisition Uncertainty

Cagin Uru, Duke University, Durham, NC

We study a variation of the classical Pandora's problem in which a decision-maker (DM) sequentially explores alternatives from a given set and learns their values while trying to acquire the best alternative. The variations in the model we study are (i) alternatives randomly become unavailable during exploration and (ii) the DM's ability to acquire a remaining alternative is uncertain and depends on a chosen offer price. Such acquisition uncertainties arise in many applications, including housing search, hiring problems, and e-commerce, but greatly complicate the search problem. We develop simple greedy policies based on static sequencing and a single threshold value. We show that our policies (a) are asymptotically optimal in high multiplicity regimes with many alternatives and (b) obtain at least 1-1/e ≈ 63.2% of the optimal value under a broad set of conditions.

3 The Impact of Social Nudges on User-Generated Content for Social Network Platforms

Zhiyu Zeng, Washington University in St. Louis, St. Louis, MO

To tackle the underprovision of user-generated content, we develop an intervention that leverages peer recognition. Via two field experiments (N=1,671,766) conducted on a video-sharing social network platform, we reveal that receiving peer recognition not only immediately boosts users' video production by 13.21% but also increases users' likelihood of giving recognition to others by 15.57%. Such effects last several days and are bigger when the recognition sender and recipients have a stronger tie. Our social network model, combined with the experimental data, shows that estimating and optimizing the overall impact of peer recognition on production over the entire platform requires accounting for its diffusion and over-time effects.

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SB25

CC-North 131A

Empirical Healthcare Operations

Community Committee Choice Session

Session Chair: Mohamad Soltani, University of Alberta, Edmonton, AB, Canada

1 Role of Monetary Incentives and Process Improvement in Improving Timeliness of Childhood Immunization

Sarang Deo[1], Sisir Debnath[2], Ashish Sachdeva[3], Abhishek Shreevastava[3], Puja Roy[3], Harish Kumar[3], [1]Indian School

of Business, Hyderabad, India; [2]Indian Institute of Technology, Delhi, India; [3]Indian School of Business, Hyderabad, India. Contact: sarang_deo@isb.edu

Vaccine preventable diseases continue to be major causes of child deaths in low-and-middle income countries despite increased vaccination rates. A key factor behind this phenomenon is delayed immunization potentially due to lack of explicit incentives for timeliness and complex workflows that make it difficult for frontline workers to assess delays. We conducted a field trial in the Indian state of Bihar to assess the effectiveness of a package of interventions (including automating workflow, additional incentives and reminder calls to parents) on the timeliness of first two sets of vaccines delivered after birth. We found that the fraction of infants receiving all the vaccines within stipulated time window increased from 41% to 62% and the fraction of infants getting all the recommended vaccines in the first two sets also increased from 55% to 75%.

2 Emergency Care Access vs. Quality: Uncovering Hidden Consequences of Fast-Track Routing Decisions

Shuai Hao[1], Yuqian Xu[2], Zhankun Sun[3], [1]University of Illinois Urbana-Champaign, Champaign, IL, [2]UNC-Chapel Hill Kenan-Flagler Business School, Chapel Hill, NC, [3]City University of Hong Kong, Kowloon, Hong Kong

We utilize a two-year dataset from two hospital EDs in Alberta, Canada, and adopt an instrumental variable (IV) approach to quantify the impact of the FT routing decisions on patient outcomes. Based on the empirical findings, we propose a multi-class queueing model to derive the optimal routing policy and then utilize a data-calibrated simulation to compare the performance of different routing policies. Our empirical findings call for immediate attention from healthcare practitioners to carefully balance the trade-off between the access to emergency care and the quality of care. Using the estimated effects of FT routing decisions on patient outcomes for different patient groups, we also propose potentially implementable routing policies for hospital EDs

3 The Impact of Primary Care Regularity on Health Outcomes

Yingchao Lan[1], Vishal Ahuja[2], Aravind Chandrasekaran[3], [1]University of Nebraska-Lincoln, Lincoln, NE, [2]Southern Methodist University, Dallas, TX, [3]The Ohio State University, Columbus, OH, Contact: yingchao.lan@unl.edu

The role of continuity of care is acknowledged in the healthcare delivery where patients seen by the same providers develop social ties that allows for increase in trust in their relationships. [illegible]

4 Ed Experiment in Displaying an Algorithmic Wait Time Prediction

Danqi Luo, UC San Diego, San Diego, CA, Contact: d1luo@ucsd.edu

In a hospital that aims to have fewer patients leave the Emergency Department without being seen by a physician (LWBS), we field-tested two approaches for displaying an algorithmic prediction of low-acuity patients' wait time to see a physician. The first approach is the prediction rounded to a multiple of 10 minutes, and the second is an interval designed to communicate that the wait time could be even 20 minutes longer. Relative to the control with no wait time information, both approaches significantly reduce the likelihood of LWBS, with the interval approach being more effective. Improved waiting satisfaction, as indicated by our incentivized satisfaction survey of ED patients, and a higher anticipated wait time with the interval approach, indicated by our online experiment, may contribute to these effects.

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SB26

CC-North 131B

FinTech Innovation in Supply Chain

Community Committee Choice Session

Session Chair: Panos Kouvelis, Washington University in St. Louis

Session Chair: Yunzhe Qiu, Washington University in St. Louis, St. Louis, MO

1 Multiperiod Joint Inventory and Pricing Decisions for Substitutable Products with Nonstationary Data

Jing-Sheng (Jeannette) Song[1], Zhengliang Xue[2], Xiaobei Shen[3], [1]Duke University, Durham, NC, [2]IBM Research Center, Ardsley, NY, [3]University of Science and Technology of China, Hefei, China. Contact: fayshen@ustc.edu.cn

We study optimal inventory-pricing decisions for substitutable products with backlogging and nonstationary data over a finite planning horizon. We characterize the optimal integrated policy, and establish conditions under which the optimal base-stock levels decrease in the overstock levels. The property enhances computation significantly. We construct exact algorithms to compute the optimal policy and computationally efficient heuristics. Our policy and algorithms enable companies to develop prescriptive analytics for multi-product dynamic inventory-pricing decisions with nonstationary costs and demand. We numerically show how the heuristics dynamically influence demands of substitutable products based on their inventory status, which can increase profit substantially, especially when overstock levels are high in a volatile environment.

2 The Theory of Supply Chain Resilience: From Mechanics to Supply Chain Finance

Yunzhe Qiu[1], Dongwei Xie[2], [1]Peking University, Beijing, China; [2]Peking University, Beijing, China. Contact: qiuyunzhe@pku.edu.cn

Our work presents the intrinsic mechanism of the firms' resilience in the supply chain under risk shocks from the perspective of Mechanics. We first analyze the firm's resilience in response to risk and specify the elasticity and plasticity intervals depending on its constrained capital structure and the optimal inventory and financing decisions of facing upstream and downstream risks. We extend the theory of resilience to a bilateral supply chain where trade credit or buyer financing contracts are available. We analyze the individual resilience and entire supply chain resilience and give measures to improve the resilience of the firm and the supply chain. We find that the chain's resilience depends on the weaker participant but can be improved via supply chain finance contracts by balancing the financial resilience between two participants.

3 Financial Hedging For A Data-Driven Newsvendor Selling New Products

Yulong Huang[1], Shaochong Lin[2], Frank Y. Chen[3], Quan Yuan[1], [1]Zhejiang University, Hangzhou, China; [2]The University of Hong Kong, Hong Kong, China; [3]City University of Hong Kong, Tat Chee Avenue, Hong Kong. Contact: yulohuang@zju.edu.cn

We study a data-driven joint inventory and financial hedging problem in a risk-averse newsvendor setting for a new product. Historical data on similar products and financial markets are available for the firm. We consider the impact of product features and return rates of financial assets on product demand and explore the use of financial derivatives to hedge against profit risk. A data-driven approximation procedure based on historical data is proposed, which is consistent and asymptotically optimal. Experiments indicate that financial hedging always benefits the firm when integrated with inventory hedging as long as the firm exhibits sufficient risk aversion, which contradicts the theoretical problem. We also find that financial hedging may regularize the data-driven model, but it may also mitigate the positive impact of risk-averse constraint regularization.

4 Sourcing Under Supply Uncertainty: Impact of Tariff and Shipping Cost

Yulan Amanda Wang[1], Guang Xiao[2], Jingwen Xu[3], Lei Chen[4], [1]The Hong Kong Polytechnic University, Hung Hom, Hong Kong; [2]Hong Kong Polytechnic University, Hung Hom, Hong Kong; [3]The Hong Kong Polytechnic University, Hong Kong, Hong Kong; [4]Jinan University, Guangzhou, China

In this study, we consider a three-tier decentralized global supply chain that consists of a buyer, a reliable supplier located outside a free trade area, an unreliable supplier situated within a free trade area, and a logistics service provider (LSP) that transports products from suppliers to the buyer. We consider different combinations of trade agreements and tariff calculation schemes: First, based on who shall bear the tariff and shipping cost, the buyer and supplier can undertake one of the following three trade agreements: Ex Works (EXW), Delivered at Place (DAP), or Delivered Duty Paid (DDP). Second, depending on the basis of dutiable value on which the tariff is calculated, two tariff calculation schemes, i.e., Free on Board (FOB) and Cost Insurance Freight (CIF), are considered. We characterize each member's preference for the aforementioned tariff agreements.

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SB27

CC-North 131C

Socially Sustainable Service Operations

Community Committee Choice Session

Session Chair: Qiuping Yu, Georgetown University/ Georgia Tech, Washington, DC

Session Chair: Xiaoxuan Hou, University of Washington, Seattle, WA

1 The Impact of Scheduling Quality on Worker Turnovers: Evidence from a national Restaurant Chain in the U.S.

Qiuping Yu[1], Haonan Zhang[2], [1]Georgetown University, Washington, DC, DC, [2]University of Washington-Seattle, Seattle, WA, Contact: qiuping.yu@georgetown.edu
Just-in-time scheduling in service industries offer unique advantages for restaurant and retail stores to match labor supply to customer demand. However, this scheduling practice can lead to insufficient, inconsistent, and unpredictable schedules for employees. Such irresponsible schedules could lead to employees' voluntary turnover. We empirically examine the causal effect of irresponsible scheduling on part-time employees' voluntary turnover decision under a restaurant setting. We conclude that perceiving insufficient working hours and earnings, volatile and unpredictable schedules significantly contribute to turnover.

2 Leapfrogging for Last-Mile Delivery in Health Care: Drone Delivery for Blood Products in Rwanda

Harriet Jeon[1], Claudio Lucarelli[1], Jean Baptiste Mazarati[2], Donatien Ngabo[3], Hummy Song[1], [1]The Wharton School, University of Pennsylvania, Philadelphia, PA, [2]University of Global Health Equity, Kigali, Rwanda; [3]Ministry of Health, Rwanda, Kigali, Rwanda. Contact: hummy@wharton.upenn.edu
The access to and quality of health care, especially in hard-to-reach areas, are challenges for many countries. Traditional solutions improve geographic connectivity through incremental and costly infrastructure investments. Radical technological innovations may allow leapfrogging to directly improve access to quality medical care. Using data from Rwandan public hospitals, we examine whether adopting drone delivery technology improves operational and health outcomes. We find that adopting drone delivery leads to a substantial reduction in on-hand inventory, wastage, and inpatient mortality for patients with post-partum hemorrhage (PPH). Additional analyses suggest that the drone delivery system exhibits a leapfrogging effect.

3 The Effect of Fair Workweek Laws on Worker Schedules and Store Performance

Caleb Kwon, Ananth Raman, Harvard Business School, Boston, MA
Fair Workweek laws aim to help workers by entitling them to additional compensation from their employers when their schedules are unilaterally adjusted on short notice. Despite having been implemented in seven jurisdictions, little is known about their impact on worker schedules and employment. In this paper, we use a difference-in-differences strategy surrounding the enactment of Chicago's Fair Workweek Ordinance to study its effects on scheduling and employment-related outcomes. Consistent with the objectives of Chicago's Fair Workweek law, we estimate a significant increase in the amount of notice provided to employees for their shifts. Importantly, this increase in advance notice is not accompanied by commonly expressed concerns about Fair Workweek laws, such as job loss, hiring reductions, or decreased scheduled hours or shifts for employees.

4 Too Good to Go: Combating Food Waste with Surprise Clearance

Luyi Yang[1], Man Yu[2], [1]University of California, Berkeley, Berkeley, CA, [2]Hong Kong University of Science and Technology, Hong Kong, Hong Kong
We study a novel clearance mechanism of perishable goods to reduce food waste and increase store profit.

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SB28

CC-North 132A

Platforms and Multichannel Operations: Incentive of Decision Makers

Community Committee Choice Session

Session Chair: Jaelynn Oh, University of Utah, Salt Lake City, UT

1 Food Ordering and Delivery: How Platforms and Restaurants Should Split the Pie

Jaelynn Oh[1], Chloe Kim Glaeser[2], Xuanming Su[3], [1]The University of Utah, Salt Lake City, UT, [2]University of North Carolina at Chapel Hill Kenan-Flagler Business School, Chapel Hill, NC, [3]University of Pennsylvania, Philadelphia, PA, Contact: jaelynn.oh@eccles.utah.edu
Food ordering and delivery platforms generate online demand for restaurants and deliver food to customers. In return, restaurants pay the platform a commission, typically a percentage of the order amount. We study the commission contract between the food delivery platforms and restaurants. We find inefficiencies in the food commission contract which is widely used in the practice and propose a new contract which can eliminate the inefficiencies.

2 Favorable Risk Selection in Medicare Advantage: The Effect of Allowing Non-Medical Services

Woonam Hwang[1], Jonas Oddur Jonasson[2], Heikki Peura[3], [1]University of Utah, Salt Lake City, UT, [2]MIT Sloan School of Management, Somerville, MA, [3]Imperial College

Business School, London, United Kingdom. Contact: woonam.hwang@eccles.utah.edu
Social determinants of health (SDOH)---such as health-related knowledge and behaviors---account for a significant part of health outcomes. The provision of non-medical services that affect SDOH, however, traditionally falls outside the purview of healthcare providers, resulting in little integration with healthcare delivery. The US CHRONIC Care Act seeks to ameliorate this situation, allowing Medicare Advantage (MA) insurers to offer an expanded range of non-medical supplementary services, with the goal that this integration will improve health outcomes. We develop a game-theoretical model to study the impact of this policy change on decisions and outcomes for beneficiaries and MA insurers.

3 Managing User-Generated Content Platforms
Ruize Ma[1], Yunke Mai[2], Bin Hu[3], [1]Dalian University of Technology, Dalian, China; [2]University of Kentucky, Lexington, KY, [3]University of Texas at Dallas, Dallas, TX, Contact: rzma@mail.dlut.edu.cn
The popularity of user-generated content (UGC) platforms enable professional creators to earn a living by sharing the platform's advertising revenue. UGC platforms need to effectively manage the growth of both creator and user bases and its own profitability with its dynamic promotion, advertising and revenue sharing decisions. We comprehensively analyze a UGC platform and characterize its optimal operating policies and show that the platform's advertising and revenue sharing strategies differ in early, intermediate and late stages. We also analyze alternative monetization models such as sponsored contents and tipping.

4 Offline Returns for Online Retailers via Partnership
Soo-Haeng Cho[1], Leela Aarthy Nageswaran[2], Elina Hwang[3], [1]Carnegie Mellon University, Pittsburgh, PA, [2]University of Washington, Seattle, WA, [3]University of Washington-Foster School of Business, Seattle, WA
Online shoppers often prefer to return items to stores than to mail them back. We study the newly emerging business practice where an online retailer and a store retailer partner to offer customers a store return option. Our results show that store and online retailers who offer differentiated products have incentives to partner, as in the case of the return partnership between Everlane and Cost Plus World Market. Interestingly, return partnerships may also feature retailers who offer similar products as in the case of Amazon-Kohl's. In this case, online customers' migration to store returns ensures a store retailer's incentive to partner while the incentive of an online retailer is also assured when store visits are not too convenient.

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SB29

CC-North 132B

Innovations in Retail Operations

Community Committee Choice Session

Session Chair: Soraya (Nadia) Fatehi, The University of Texas at Dallas, Richardson, TX

1 Estimating the High-Dimensional Correlation Structure in Transportation Demand for Robust Service Network Design
Joline Uichanco[1], Amitabh Sinha[2], [1]University of Michigan, Ross School of Business, Ann Arbor, MI, [2]Amazon, Seattle, WA, Contact: jolineu@umich.edu
Amazon operates its own freight transportation network (i.e., fleet of trailers, consolidation terminals) in order to ship packages from fulfillment centers to customer locations. To incorporate flexibility, models for network design must explicitly consider uncertainty in the transportation demands, a high-dimensional random vector. However, estimating the high-dimensional correlation structure with limited data is extremely challenging. In this talk, we propose using Principal Component Regression (PCR) to estimate transportation demands as a linear function of lower-dimensional primitive factors. We then propose a factor-based uncertainty set for transportation demands that can be used in robust network design models. We conduct computational experiments to demonstrate the value of using our approach in service network design.

2 Reducing Food Waste Through Early Adoption of Supply Transparency Technology
N. Bora Keskin, Chenghuai Li, Jing-Sheng (Jeannette) Song, Duke University, Durham, NC, Contact: chenghuai.li@duke.edu
Motivated by the rapid development of digital technologies that allow fresh-produce retailers to track the conditions of their supplies in real-time, this paper studies whether an early adopter advantage exists in a competitive retail market and the impact of mergers. Considering a duopoly facing freshness-dependent demand, we show that an early adopter can achieve greater profit growth due to the spillover-capture effect when the retail margin is low and/or the market-expansion effect when consumer utility is boosted by the technology adoption. Under certain conditions, early adoption can also lead to a greater reduction in food waste or a greater increase in consumer surplus. Furthermore,

sometimes the monopoly can have a higher level of adoption than duopoly in the presence of uncertainty-transmission motive, leading to increased demand fill rate or less food waste.

3 Expanding into On-Demand Markets with "Airbnb of Warehousing"
Soraya (Nadia) Fatehi, Anyan Qi, The University of Texas at Dallas, Richardson, TX, Contact: Soraya.Fatehi@UTDallas.edu
Despite the potential benefit of capturing more demand, few firms offer on-demand fulfillment services due to operational challenges. One emerging solution to address these challenges is the "Airbnb of Warehousing (AW)." The AW allows a firm to flexibly tap into excess capacities of independent warehouse providers closer to its on-demand markets, which enables the on-demand fulfillment services without long-term commitments or high upfront costs. We investigate how a firm should utilize the AW to expand into its on-demand markets. We study the firm's problem under scenarios where the firm has access to the AW option, and the firm (i) knows the demand parameters of its on-demand markets or (ii) has no or limited knowledge about its on-demand markets. Our proposed policies help retailers expand into their untouched on-demand markets efficiently and flexibly via the AW.

4 Like Attracts Like: Optimal Assortment on a Platform
Hakjin Chung[1], Myeonghun Lee[1], Hyun-Soo Ahn[2], [1]Korea Advanced Institute of Science and Technology, Seoul, Korea, Republic of; [2]University of Michigan, Ann Arbor, MI, Contact: hakjin.chung@kaist.ac.kr
Online marketplace platforms have become a major pillar of the retail industry, providing consumers with convenient access to many products and providing sellers with the ability to reach a vast customer base. However, high commission fees and intense competition drive some sellers off their respective platforms. We study the platform's problem of determining the assortment and fee policies when sellers can decide whether to join or not based on self-interests. We find that the optimal assortment is strikingly homogeneous, including all sellers who are similar in traffic and product attractiveness and filling the rest of the assortment by selecting a few sellers below the band. Compared to a uniform fee, an individualized fee results in a wider range of sellers, as the platform can incentivize some high-traffic sellers to stay while squeezing more revenue from a few others.

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SB30

CC-North 132C
Business and Climate Change
Community Committee Choice Session
Session Chair: Christian Blanco, Ohio State University, Columbus, OH

1 Science-Based Targets: Empirical Analysis of Carbon Reduction Commitments by Global Firms
Donghyun Choi[1], Abhinav Shubham[2], Manpreet Singh Hora[1], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, Contact: manpreet.hora@scheller.gatech.edu
A growing number of firms are joining Science-Based Target (SBT) initiatives and are pledging to set carbon reduction or net-zero targets. We identify the antecedents of setting SBTs. Merging the historical SBTs with firm-level financial and environmental performance data, our findings unravel insights on antecedents and consequences.

2 Optimal Hour-Ahead Commitment and Storage Decisions of Wind Power Producers
Emre Nadar[1], Ece Cigdem Karakoyun[2], Harun Avci[3], Woonghee Tim Huh[4], Ayse Selin Kocaman[2], [1]Bilkent University, Ankara, Turkey; [2]Bilkent University, Ankara, Turkey; [3]Northwestern University, Evanston, IL, [4]University of British Columbia, Vancouver, BC, Canada. Contact: emre.nadar@bilkent.edu.tr
We study the energy commitment, generation and storage problem for a wind farm paired with a battery. We model this problem as a Markov decision process and characterize the optimal policy structure. We implement our structural results into a heuristic solution method that yields near-optimal solutions within a few minutes.

3 Quality Costs of Fuel Efficiency Improvements in the Automobile Industry
Donggyu Jeon[1], George Ball[1], Gil Souza[2], [1]Operations and Decision Technologies, Kelley School of Business, Indiana University, Bloomington, IN, [2]University of Tennessee Knoxville, Knoxville, TN, Contact: djeon93@indiana.edu
In this study, we empirically examine the impact of firms' efforts to improve the environmental performance of a vehicle (measured as MPG) on product quality (measured as the number of quality complaints reported) in the automotive industry. We provide operational and strategic managerial implications of improving sustainability on product quality.

4 Does Less Information Result in More? The Role of Information About Circular Economy Strategies in Take-Back Programs for Clothing

Erin Mckie[1], Anna Saez de Tejada Cuenca[2], Vishal Agrawal[3], [1]The Ohio State University, Columbus, OH, [2]IESE Business School, Barcelona, Spain; [3]Georgetown University, Washington, Contact: asaezdetejada@iese.edu

Retailers are increasingly sponsoring take-back initiatives to facilitate the recycling and reuse of secondhand clothing. To stimulate the return of goods, retailers share information about disposal-related circular economy strategies and offer consumers a small incentive in exchange for used clothing items. The effects of different approaches are unknown yet are postulated to have significant implications on retailers' ability to collect used clothing items. Through three online and laboratory experiments involving over 3,500 subjects, we test how consumers' likelihood to return their used garments is affected as the degree of information transparency and reward level is manipulated. Our results suggest that significant gains can be achieved by offering modest rewards and strategic disclosures of circular economy business model information.

Sunday, October 15, 10:45 AM - 12:00 PM

SB31

CC-North 221A

Statistical Methods for Operations

Contributed Session

Session Chair: Lan Gao, University of Tennessee Knoxville, Knoxville, TN

1 Robust Statistical Methods for Adversarial Attack Mitigation in Federated Learning

Mohammad Mahdi Ahmadi, The University of Arizona, Tucson, AZ

This study investigates the application of robust statistical methods to address the impact of adversarial attacks in machine learning models. Specifically, we explore the effectiveness of these methods in federated learning settings. By comparing the results to centralized machine learning, both in the absence and presence of adversarial attacks, we aim to assess the robustness and reliability of the proposed techniques. Our findings shed light on the potential of robust statistical methods to mitigate the adverse effects of adversarial attacks in federated learning.

2 Transformer-Based Unsupervised Anomaly Detection with Multivariate Time Series

Soomin Lee[1], Juheon Kwak[2], Wonkeun Jo[1], Sungsu Lim[1], Dongil Kim[2], [1]Chungnam National University, Yuseong-gu, Daejeon, Korea, Republic of; [2]Ewha Womans University, Seodaemun-gu, Seoul, Korea, Republic of. Contact: sxxmin.lee@g.cnu.ac.kr

Anomaly detection is one of the most important tasks in various industries. For multivariate time series (MTS), anomaly detection methods have been proposed by considering characteristics such as frequency and trend. We propose a novel transformer-based unsupervised anomaly detection model for MTS. The proposed method considers both time and frequency domains. The proposed model for anomaly detection includes independent modules to decompose the signal and extract information in the time and frequency domains. The experiments employing four benchmarks resulted that our method outperformed several benchmark methods, which was promising enough to warrant further study on various domains.

3 Data-Driven Quickest Change Detection Using Wasserstein Uncertainty Sets

Liyan Xie, The Chinese University of Hong Kong, Shenzhen, Shenzhen, China. Contact: xieliyan@cuhk.edu.cn

We study online change detection problems under known pre-change distribution, while only information about the post-change distribution is through a set of samples. This post-change data is used in a data-driven minimax robust framework, where an uncertainty set for the post-change distribution is constructed using the Wasserstein distance. The robust change detection problem is studied in an asymptotic setting where the mean time to false alarm goes to infinity. It is shown that the density corresponding to the least favorable post-change distribution is an exponentially tilted version of the pre-change density and can be calculated efficiently. A Cumulative Sum (CuSum) test based on the least favorable distribution is proposed and proved asymptotically optimal. The results are extended to the case where the post-change distribution contains multiple scenarios.

4 Distance Correlation Can Enhance Understanding of Recurrent Neural Networks for Time Series Forecasting

Christopher Salazar, University of Washington, Seattle, WA, Contact: salezara@uw.edu

Our current understanding of how recurrent neural networks (RNN) learn time series forecasting is limited. We adapt a statistical dependency measure, called distance correlation, to investigate the non-linear relationships of

RNN activation layers with the variables of interest such as prediction time horizon and lag characteristics. We conduct a series of experiments that show RNNs learn auto-regressive time series well but struggle with data exhibiting heteroscedasticity. We also generate heatmaps to show a visual representation of RNN activation layers at various time epochs and for different network architectures. We believe our approach can be useful to characterize the effectiveness of other neural networks in the future.

5 Thompson Sampling with Discrete Support

Lan Gao[1], Xueru Zhang[2], Wei Zheng[3], [1]University of Tennessee Knoxville, Knoxville, TN, [2]Purdue University, West Lafayette, IN, [3]The University of Tennessee Knoxville, Knoxville, TN, Contact: lgao13@utk.edu

Thompson sampling is a popular algorithm for multi-armed bandit problems, but its Bayesian posterior update can be computationally expensive for complex reward distributions. Recently, prior discretization has been proposed to address this issue. In this paper, we propose a new prior discretization method that guarantees the same regret rate without requiring the unrealistic assumption that the true parameter is within the discrete prior support. Moreover, we introduce a modified posterior update approach that further improves the performance of discrete prior Thompson sampling. We prove that the accumulated regret is bounded by O(log(T)) with high probability. In addition, we conduct numerical experiments to validate our theoretical analysis and demonstrate the performance of our proposed algorithm.

Sunday, October 15, 10:45 AM - 12:00 PM

SB32

CC-North 221B

Conic Optimization and Approximation Algorithms

Community Committee Choice Session

Session Chair: Daniel De Roux Uribe, Carnegie Mellon, PA

1 Approximation Algorithms for Stochastic Orienteering Problems

David Aleman, University of Waterloo, Waterloo, ON, Canada

An instance of knapsack stochastic orienteering (SKO) consists of a complete rooted metric graph. Each node is associated with a job with correlated random processing time and reward. These random variables are independent across different vertices. We are given two budgets B and W. A solution to SKO without cancellations consists of a rooted path of total length at most B that visits a sequence of vertices in a possibly adaptive fashion. When a vertex is visited its corresponding job is executed non-preemtively. The reward of a completed job is collected if the sum of completion times of vertices processed so far is at most W. The goal is to maximize the total expected reward. In SKO with cancellations we are can cancel a job at any given timestep without collecting its reward. We provide LP based approximation algorithms for these problems. This is a joint work with Chaitanya Swamy.

2 Burer-monteiro Method For Low-rank Sum-of-square Certification

Shixuan Zhang[1], Greg Blekherman[2], Mauricio Fernando Velasco[3], Rainer Sinn[4], [1]Texas A&M University, College Station, TX, [2]Georgia Institute of Technology, Atlanta, GA, [3]Universidad de los Andes, Bogota, Colombia; [4]Leipzig University, Leipzig, Germany. Contact: shixuan.zhang@tamu.edu

To certify a sum of k squares on a real projective variety, one can minimize the distance of the sum of squares of k linear forms from it in the space of quadrics. This is known as the Burer-Monteiro method in semidefinite optimization. When k is smaller than the dimension of linear forms, the certification problem can be applied in low-rank semidefinite relaxation of polynomial optimization. We discuss the existence of spurious local minima in this nonconvex optimization problem with some characterization based on the properties of the underlying real projective variety. We also propose efficient algorithms to avoid such spurious local minima.

3 Second Order Cone Approximations for a Graph Latency Problem

Daniel de Roux, Carnegie Mellon University, Pittsburgh, PA, Contact: dderoux@andrew.cmu.edu

We consider an information dissemination problem in an undirected graph where sources inform correspoding sinks and constantly updates their information. The goal is to keep every sink in the graph as freshly informed as possible of their correspoding source. We work under a synchronous information spreading model in which any node can communicate with at most one neighbor at each time, thus forming a matching over which information is transmitted at each step. We introduce a problem in minimizing the maximum latency of sources and sinks. We give an algorithm to solve the problem on trees and then we propose a second order cone program to approximate the solution of the problem in general graphs. We prove that a solution of

this program can approximate the original problem within polylog factors. Finally, we show that the solution obtained is both locally and globaly periodic.

4 A Linearization Proposal for the Redundancy Allocation Problem

Isis Lins, Lavínia Araújo, Caio Maior, Márcio Moura, Universidade Federal de Pernambuco, Recife, Brazil. Contact: lavinia.mendes@ufpe.br

The Redundancy Allocation Problem (RAP) is a common NP-hard nonlinear problem in Reliability Engineering. The aim is to increase reliability while adhering to budget and quantity limits for subsystem components. (Meta-)heuristics commonly address it, while exact linear methods still need to be explored. This study proposes an approximate linear formulation of RAP for series-parallel configuration, for which the failure of a single subsystem leads to system failure. The proposed formulation minimizes the failure probability of the least reliable subsystem and the product of subsystems' probabilities as a proxy to maximizing system reliability. In addition to applying exact linear programming, this formulation also allows using quantum optimization algorithms that require quadratic, binary, and unconstrained problems.

5 Delving into the Heart and Soul of Matrix Optimization: A New Perspective to Spectrally Constrained Models

Casey Garner, University of Minnesota, Minneapolis, MN, Contact: garne214@umn.edu

At first glance, matrix optimization might appear equivalent to optimizing over simple column vectors in Euclidean space; however, when we consider constraining the spectrum of a matrix, we realize this perspective is woefully inadequate hiding much richness and veiling numerous challenges. In this talk, we shall discuss a novel framework for spectrally constrained matrix optimization which allows general constraints on the spectrum, moving well beyond traditional constraints such as positive semidefiniteness, and present new algorithms for handling highly non-convex matrix optimization problems.

Sunday, October 15, 10:45 AM - 12:00 PM

SB33

CC-North 221C

Novel Applications of Discrete Optimization

Community Committee Choice Session

Session Chair: Diego A. Moran, Universidad Adolfo Ibañez, Santiago, Chile

1 Risk-Averse Dynamic Antibiotic Time Machine Problem

Burak Kocuk, Deniz Tuncer, Sabanci University, Istanbul, Turkey. Contact: burak.kocuk@sabanciuniv.edu

Given a treatment length and a set of antibiotics, antibiotic time machine problem aims to maximize the probability of reversing the mutations that lead to antibiotic resistance. This problem can be modeled as a Markov Decision Process. Due to the seriousness of the issue, obtaining risk averse solutions would be a reasonable approach. We formulate a risk-averse MILP model for this problem with scenarios in which the risk is measured using conditional value-at-risk. We propose a risk-averse scenario decomposition algorithm, which partitions the scenario set into group subproblems. We construct lower and upper bounds based on the optimal values and solutions of the group subproblems. We enhance the standard algorithm with improved cuts by exploiting the special structure of the problem. We conduct computational experiments with real data and obtain promising results.

2 Optimal Unlabeled Set Partitioning with Application to Risk-Based Quarantine Policies

Jiayi Lin[1], Hrayer Aprahamian[1], Hadi El-Amine[2], [1]Texas A&M University, College Station, TX, [2]George Mason University, Fairfax, VA, Contact: jiayilin@tamu.edu

We consider the problem of partitioning a set of items into unlabeled subsets so as to optimize an additive objective. Under an arbitrary objective, this class of problems is known to be an NP-complete combinatorial problem. We study this problem under a broad family of objectives characterized by elementary symmetric polynomials, which are "building blocks'' to symmetric functions. By analyzing a continuous relaxation of the problem, we identify conditions for a more tractable network flow reformulation that can be solved in polynomial-time. We show that a number of results from the literature arise as special cases of our proposed framework, highlighting its generality. Our case study, which is an application of quarantining heterogeneous populations using real COVID-19 data, reveals significant benefits that underscore the importance of data-driven policies.

3 Uncovering Multiple Collective Tendencies in Preference Data: A Split Consensus Kemeny Aggregation Approach with Polyhedral Enhancements

Romena Yasmin, Adolfo Raphael Escobedo, Arizona State University, Tempe, AZ, Contact: ryasmin@asu.edu

The present work is focused on developing principled aggregation methods that challenge the assumption of a single underlying ground truth for preference data. The objective is to identify multiple latent subgroups with conflicting preferences present within a set of subjective evaluations. To achieve this objective, we employ the mixed integer programming formulation of the Split Consensus Kemeny Aggregation (SC-KA) model. In order to establish a heuristic algorithm, we explore the relationship between the SC-KA model and the K-means clustering algorithm. Additionally, we present a polyhedral approach to enhance the computation of the proposed heuristic. This approach exploits valid inequalities that can be generated from the correspondence between weak order polytopes and preference structures to refine the characterization of the solution space.

4 Optimization Methods for Experimental Design

Rodolfo Carvajal[1], Diego A. Moran[2], Burak Kocuk[3], Jacqueline Meza[4], [1]Universidad Adolfo Ibáñez, Viña del Mar, Chile; [2]Universidad Adolfo Ibañez, Santiago, Chile; [3]Sabanci University, Istanbul, Turkey; [4]Universidad Adolfo Ibáñez, Santiago, Chile

Given a number of observations, each of them having some attributes of interest (e.g. if the observations are people, the attributes could be: height, weight, age, etc.), a fundamental question in experimental design is to partition the observations into statistically equivalent groups. This is crucial, for instance, in clinical trials when studying the effectiveness of a new medical treatment for which the observations are separated into two groups: the treated group and the control group. In this talk, we review some optimization approaches to solve this problem and present novel conic mixed-integer programming models whose solutions outperform the ones obtained by the methods proposed in the literature.

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SB34

CC-North 222A

Influence and Design in Network Games

Community Committee Choice Session

Session Chair: Ceyhun Eksin, Texas A&M University, College Station, TX

1 Information Design for Unknown Quadratic Games

Ceyhun Eksin[1], Furkan Sezer[2], [1]Texas A&M University, College Station, TX, [2]Texas A&M University- College Station, Chicago, IL, Contact: eksinc@tamu.edu

The talk discusses the problem of designing information structures in incomplete information games when the designer does not know the game payoffs exactly. This is a common situation in many real-world settings, where the game payoffs are often uncertain due to various factors such as incomplete information, imperfect modeling, or unknown parameters. We propose a robust optimization approach to address this problem. Specifically, we consider information design for the setting when the unknown payoff parameters are adversarially chosen. We develop a tractable SDP formulation given quadratic payoffs, Gaussian signal distributions, and ellipsoid perturbations. Numerical experiments show that the designer would choose to hide information about the state to the players as its uncertainty about the players' payoffs increases.

2 Information Design in Channel Capacity and Delay Constrained Settings

Emrah Akyol, SUNY, Binghamton, NY

This work is concerned with the quantization setting where the encoder and the decoder have misaligned objectives. While the unconstrained variation of this problem has been well-studied under the theme of information design problems in Economics, it becomes more appealing with a constraint on the cardinality of the message space. We first motivate the problem via a toy example demonstrating the strategic quantization problem's intricacies, explicitly showing that the quantization resolution can change the nature of optimal encoding policy and the iterative optimization of the decoder and the encoder mappings may not converge to a local optimum solution. We develop a gradient-descent based solution and present numerical results that demonstrate strategic quantization features that differentiate it from its classical counterpart.

3 Information Design for Non-Bayesian Agents in Repeated Non-Atomic Games

Ketan Savla, University of Southern California, Los Angeles, CA

Consider the following repeated routing game. In every round, a state is i.i.d. sampled from a publicly known distribution, which influences latency functions. The planner makes private route recommendations to participating agents, constituting a fixed fraction, according to a publicly known signaling strategy. These agents choose to obey or not according to satisficing regret cumulative over all participating agents. The other agents adopt myopic best response to a calibrated forecast of the decisions of participating agents. We show that, for parallel networks, if the planner's strategy satisfies the obedience condition, then, almost surely, the link flows are asymptotically consistent with the induced Bayes correlated equilibrium.

4 Algorithmic Collective Action in Machine Learning

Eric Mazumdar, Caltech, Pasadena, CA

We initiate a principled study of algorithmic collective action on digital platforms that deploy machine learning algorithms. We propose a simple model of a collective interacting with a firm's learning algorithm in which the collective pools the data of participating individuals and instructs them how to modify their own data to achieve a collective goal. We investigate this model in several learning-theoretic settings. In each setting, we come up with strategies and characterize success as a function of the collective's size. We validate our results by conducting experiments on a skill classification task involving freelancer resumes and a classier trained on top of a BERT-like language model. Altogether, our results support the conclusion that algorithmic collectives of exceedingly small size can exert significant control over a platform's learning algorithm.

Sunday, October 15, 10:45 AM - 12:00 PM

SB35

CC-North 222B

Constrained Stochastic Optimization

Community Committee Choice Session

Session Chair: Xin Jiang, 1</sup

Session Chair: Qi Wang, Lehigh University, Bethlehem, PA

1 Stochastic Zeroth-Order Riemannian Derivative Estimation and Optimization

Shiqian Ma[1], Jiaxiang Li[2], Krishnakumar Balasubramanian[3], [1]Rice University, Houston, TX, [2]UC Davis, Davis, CA, [3]University of California, Davis, Davis, CA, Contact: sqma@rice.edu

In this talk, we consider stochastic zeroth-order optimization over Riemannian submanifolds. Our main contribution is to propose estimators of the Riemannian gradient and Hessian from noisy objective function evaluations, based on a Riemannian version of the Gaussian smoothing technique. The proposed estimators overcome the difficulty of the non-linearity of the manifold constraint and the issues that arise in using Euclidean Gaussian smoothing techniques when the function is defined only over the manifold. We use the proposed estimators to solve Riemannian optimization problems in different settings, and analyze the oracle complexity of our algorithms for obtaining appropriately defined epsilon-solutions. Our complexities are independent of the dimension of the ambient Euclidean space and depend only on the intrinsic dimension of the manifold.

2 Exact and Inexact Subsampled SQP Method for Equality Constrained Stochastic Optimization

Jiahao Shi[1], Albert Solomon Berahas[1], Raghu Bollapragada[2], [1]University of Michigan, Ann Arbor, MI, [2]The University of Texas at Austin, Austin, TX

In this paper, we propose a subsampled second order algorithms for solving equality constrained optimization problems in which the objective is defined by the expectation of a stochastic function and constraint functions are deterministic. We use line search methods in the algorithm and present the local and global convergence results. To fill the gap of the step size selection scheme in the analysis, we modify the algorithm with a new proposed line search condition. Finally, we develop an inexact algorithm to reduce computational cost.

3 On the Almost-Sure Convergence of the Iterates and Lagrange Multipliers in a Stochastic SQP Method

Frank E. Curtis, Xin Jiang, Qi Wang, Lehigh University, Bethlehem, PA, Contact: xjiang@lehigh.edu

Stochastic sequential quadratic optimization (SQP) methods for solving continuous optimization problems with nonlinear equality constraints have attracted attention recently. However, for a certain recently proposed class of such methods that is built upon the stochastic-gradient methodology from the unconstrained setting, convergence guarantees of the iterates and Lagrange multiplier estimates have been limited to convergence-in-expectation guarantees. This is in contrast to the unconstrained setting in which stronger almost-sure convergence results can be proved for stochastic-gradient-based methods. In this talk, we present new almost-sure convergence guarantees for the iterates and the Lagrange multipliers generated by a stochastic SQP algorithm.

4 A Stochastic-Gradient-Based Interior-Point Algorithm for Solving Smooth Bound-Constrained Optimization Problems

Frank E. Curtis[1], Vyacheslav Kungurtsev[2], Daniel Robinson[1], Qi Wang[1], [1]Lehigh University, Bethlehem, PA, [2]Czech Technical University in Prague, Prague, Czech Republic. Contact: qiw420@lehigh.edu

A stochastic-gradient-based interior-point algorithm for minimizing a continuously differentiable nonconvex objective function subject to bound constraints is presented, analyzed, and demonstrated. The algorithm is unique from other interior-point methods for solving smooth nonconvex optimization problems since the search directions are computed using stochastic gradient estimates. It is also unique in its use of inner neighborhoods of the feasible region--defined by a positive and vanishing neighborhood-parameter sequence--in which the iterates are forced to remain. With a careful balance between the barrier, step-size, and neighborhood sequences, the proposed algorithm converges in both deterministic and stochastic settings. The numerical experiments show that the algorithm can outperform a projected-(stochastic)-gradient method.

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SB36

CC-North 222C

Fleet Planning and Operation in the Era of Connected, Autonomous, Shared and Electric Vehicles

Community Committee Choice Session

Session Chair: Zhaocai Liu, National Renewable Energy Laboratory, Golden, CO
Session Chair: Xinwu Qian, University of Alabama, Tuscaloosa, AL

1 Battery Swapping and Management System Design for Electric Trucks Considering Battery Degradation

Yanling Deng[1], Zhibin Chen[1], Pengyu Yan[2], Renxin Zhong[3], [1]New York University Shanghai, Shanghai, China; [2]University of Electronic Science and Technology of China, Chengdu, China; [3]Sun Yat-sen University, Guangzhou, China

This study focuses on the optimal design of a Battery swapping station (BSS) system that exclusively serves an electric truck (ET) fleet offering dedicated-line transportation services. By explicitly incorporating the battery degradation effect, we develop a mathematical model to determine the optimal configuration of the BSS system to minimize the total system cost including the fixed investment cost and the battery lifecycle cost. A battery charging management strategy is then proposed to reduce the battery degradation cost. Numerical experiments show that the system design model can well capture the trade-off between the one-time battery purchase cost and the long-term battery degradation cost; and the battery charging management strategy significantly reduces the battery degradation cost, resulting in a more cost-efficient BSS system.

2 Equitable Deployment of Wireless Charging Lanes in Transportation Networks

Ziqi Song, University at Buffalo, The State University of New York, Buffalo, NY

Electric vehicles are increasingly being acknowledged as a key instrument in achieving sustainable transportation, with the potential to significantly diminish emissions and air pollution. To facilitate this shift towards EVs and overcome their current limitations, it is imperative for governments to invest in public charging infrastructure, thereby extending the travel range of EVs and alleviating concerns related to range anxiety. However, given budgetary constraints, the development of such public refueling stations must be both cost-effective and equitable. In light of this, we propose a future where EVs proliferate, and governmental agencies begin to incorporate wireless charging lanes within regional road networks. The objective is to maximize societal welfare while ensuring an equitable distribution of the benefits derived from these charging lanes.

3 GTFS-Data Based Electric Bus System Energy Consumption Estimation and Planning

Zhaocai Liu, National Renewable Energy Laboratory, Golden, CO, Contact: zhaocai.liu@nrel.gov

This presentation talks about our recent works on electric bus system energy consumption estimation and planning. We first developed a data-driven machine learning based modeling framework for electric bus energy consumption estimation. A machine learning model is trained using real-world bus operation data to predict electric bus energy consumption. We then developed a General Transit Feed Specification (GTFS) data based user-friendly workflow to help transit agencies adopt the machine learning energy consumption model in electric bus fleet planning and operation.

4 Modular Vehicles Can Reduce Greenhouse Gas Emissions for Departure Flight Baggage Transportation

Zhiwei Chen[1], Xiaopeng Li[2], Xiaowei Shi[3], Xiaobo Qu[4], [1]Drexel University, Philadelphia, PA, [2]University of Wisconsin, Madison, Madison, WI, [3]University of Michigan, Ann Arbor, Ann Arbor, MI, [4]Tsinghua University, Beijing, China

Modular vehicle (MV) is an emerging transportation technology that allows vehicles to adjust their capacity flexibly by assembling or disassembling identical detachable units. This innovative technology offers us a new perspective to decarbonize the aviation sector, as it holds promise for reducing GHG emissions in flight baggage transportation. To investigate this possibility, this study proposes an MV operation paradigm and a corresponding "greenest" MV scheduling problem that aims to minimize MV-relevant GHG emissions while transporting baggage from the terminal to the aircraft without delay. A series of case studies at the Tampa International Airport were conducted to evaluate the performance of the proposed MV operation and the construction-merging heuristic.

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SB37

CC-North 223

Modern Stochastic Optimization: Theory and Applications

Community Committee Choice Session

Session Chair: Karmel S. Shehadeh, Lehigh University, Bethlehem, PA

Session Chair: Man Yiu Tsang, Lehigh University, Bethlehem, PA

1 Sample-Based Online Generalized Assignment Problem with Unknown Poisson Arrivals

Zihao Li, Hao Wang, Zhenzhen Yan, Nanyang Technological University, Singapore, Singapore. Contact: hao_wang@ntu.edu.sg

We study an online Generalized Assignment Problem where we need to allocate online items to offline bins. Online items follow independent Poisson processes with unknown arrival rates. Each online item will either be packed into a bin which will deduct the bin's capacity by the item's demand and generate a reward, or be rejected upon its arrival. The reward and demand depend on the bin and item, and the demand and capacity are D-dimension vectors. Our goal is to maximize the total reward. We provide sample-based algorithms utilizing pre-existing offline data and sequentially revealed online data for a simplified online matching setting and the original setting. We present parametric competitive ratios and analyze the effect of offline data, planning horizon, and dimension. Finally, we demonstrate the effectiveness of our algorithms numerically.

2 Information Basis In Dynamic Robust Optimization

Ningji Wei[1], Peter Zhang[2], [1]Texas Tech University, Lubbock, TX, [2]Carnegie Mellon University, Pittsburgh, PA

Constant and affine policies are commonly used for approximating optimal policies in multistage robust optimization. The former is computationally efficient, while the latter often provides policies with desirable performance. In this work, we examine a natural transition between the two policy families and identify two types of sparsity associated with the concepts: information filters and information bases. Based on this, we develop an algorithm to construct a certain type of policies on-the-fly to obtain a near-optimal affine policy using a small-sized information basis. We prove that the performance of the policy obtained from this algorithm converges exponentially to the optimal affine policy. Then, we demonstrate its run-time efficiency via computational experiments.

3 A Branch-and-Cut Algorithm for Distributionally Robust Chance-Constrained Programs with a Finite Support

Hamed Rahimian, Soumya Pathy, Clemson University, Clemson, SC, Contact: hrahimi@clemson.edu

In this talk, we study a distributionally robust optimization approach to chance-constrained stochastic programs to hedge against uncertainty in the distributions of the random parameters. We assume that there are a finite number of scenarios to represent the uncertainty and model the distributional ambiguity with a polyhedral set. We propose a decomposition-based algorithm to solve the resulting problem, and showcase our results for ambiguity sets formed via moment-based constraints, total variation distance, and Wasserstein distance.

4 Robust Design of Critical Supply Chains

Hao Hao[1], Peter Zhang[1], Erica R. Fuchs[1], Ningji Wei[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Texas Tech University, Lubbock, TX, Contact: haohao@andrew.cmu.edu

The challenge of balancing resiliency and efficiency with limited resources in critical supply chains requires a principled approach. To this end, we propose a two-stage supply chain design model under uncertainty. Our model captures the trade-off between cost and robustness under worst-case supply and demand disruptions; as well as the multiple time scales of resiliency building and contingency planning. Specifically, the model optimizes for the risk-mitigating first-stage network design and resource allocation that maximize the total profit under both common uncertainty and extreme events. We deploy affinely adjustable robust optimization (AARO) formulations to our problem. We provide theoretical support for (near) optimality of this method and demonstrate its tractability through numerical studies on semiconductor and pharmaceutical supply chains.

Sunday, October 15, 10:45 AM - 12:00 PM

SB38

CC-North 224A

Optimization Society's Award Session I

Award Session

Session Chair: Oktay Gunluk, Cornell University, Ithaca, NY
Session Chair: Andy Sun, MIT, Cambridge, MA

1 **Award Presenter**
Renato D C Monteiro, ISyE Georgia Tech, Atlanta, GA

2 **Award Presenter**
Alper Atamturk, UC Berkeley, Berkeley, CA, Contact: atamturk@berkeley.edu

3 **Award Presenter**
Alberto Del Pia, University of Wisconsin–Madison, Madison, WI

Sunday, October 15, 10:45 AM - 12:00 PM

SB39

CC-North 224B

Continuous Labor Planning for Ultra-Fast Delivery at Amazon

Community Committee Choice Session

Session Chair: Martin Savelsbergh, ISyE Georgia Tech, Darlington, Australia

1 Continuous Labor Planning Overview
Roman Levkin, Thomas Fillebeen, Amazon, Seattle, WA
Given the volatility in labor supply and customer demand, Amazon supply chain businesses can benefit from a blended fixed and flexible under-the-roof labor workforce. Fixed associates, working a reoccurring shift pattern week-over-week, enable the business to lock a baseline capacity with a certain guarantee early. Flexible associates, picking up on-demand shifts each week, allow business to accommodate volatility. To facilitate blended workforce planning at scale, we introduced the Continuous Labor Planning (CLP) suite of decision support tools. CLP posts on-demand shifts from 3 weeks to 2 hours ahead of operations trading off improving forecast accuracy and decreasing associate acceptance probabilities. This enables scheduling to staff as close as possible to actual labor demand, which reduces costs.

2 Labor Plan Optimization for Under-the-Roof Operations at Amazon
Zeynep Sargut, Amazon, Bradenton, FL, Contact: zeyneps@amazon.com
An under-the-roof (UTR) associate at an Amazon Ultra-Fast delivery site can work on multiple processes such as inbound and outbound, where each process has its own tasks with corresponding deadlines. A labor plan translates the most recently task forecasts from different processes into a blueprint of how many associates are needed at each process at each time for a given operating period. To create an operationally feasible and cost-effective labor plan, an optimization model is proposed where the costly time-periods, available shifts, time-dependent productivity rates, priorities of processes, associate transfer times between processes, and target process buffers are considered. The optimal labor plan forms the basis for the creation of associate shifts and directly impacts labor planning cost.

3 Shift Creation and Modification for Under-the-Roof Operations at Amazon
Ramon Auad, Amazon, Atlanta, GA
Shift modifications and incremental postings are foundational to run a seamless and cost-effective under-the-roof operation at Amazon. We present an optimization-based modular system to create and modify associate shifts in response to variability in demand and supply. In case of higher-than-expected demand, the system fills gaps between the labor plan and existing associate shifts by recommending either the creation of incremental flexible shifts or the extension of existing ones. Conversely, when demand is lower than expected, it reduces existing shift hours by recommending voluntary time off opportunities. The system ensures that scheduled shifts are aligned with labor requirements, thereby minimizing costs and maximizing customer and associate experience.

4 Continuous Shift Release for Amazon's Ultra-Fast Delivery Business
Hadi Panahi[1], Thomas Fillebeen[2], Roman Levkin[2], [1]Amazon, St. louis, MO, [2]Amazon, Seattle, WA
Continuous labor planning (CLP) leverages incremental on-demand shift postings for flexible associates at multiple planning horizons prior to the operation day. Once shifts are posted, flexible associates can choose their preferred shifts.

The amount of required labor hours at a given planning horizon is determined by demand forecast accuracy and the likelihood of associates selecting shifts. Posting shifts early benefits from higher likelihood of shifts acceptance while posting late takes advantage of a more accurate demand forecast. Continuous Shift Release (CSR) is an optimization model which determines the shift release cadence by planning horizon while respecting business service level agreements.

5 Fulfillment Capacity Allocation for Ultra-Fast Delivery at Amazon

Saba Neyshabouri, Amazon

In ultra-fast delivery, customer promise windows that overlap share fulfillment capacity. In particular, high speed promise windows that overlap with the flexible ones compete for shared capacity. To make this capacity allocation decision, the capacity allocation engine (CAE) maximizes capacity utilization while maximizing delivery fee revenue. It has an offline component that sets order distribution targets and an online component that seeks to meet these targets. CAE can be extended to close the loop on the continuous labor planning by connecting the signals from labor supply, and managing the promise window availability to increase demand.

Sunday, October 15, 10:45 AM - 12:00 PM

SB40

CC-North 225A

Learning in Transportation Network Modeling: Session I

Community Committee Choice Session

Session Chair: Zhichen Liu, University of Michigan, ANN ARBOR, MI

1 Wardrop Equilibrium Can be Boundedly Rational: A New Behavioral Theory of Route Choice

Jiayang Li, Zhaoran Wang, Marco Nie, Northwestern University, Evanston, IL, Contact: JiayangLi2024@u.northwestern.edu

In transportation, it is widely believed that Wardrop equilibrium (WE) has a relatively weak behavioral underpinning. To strengthen this foundation, one must reckon with bounded rationality, which was typically accompanied by a modification of WE. Here we show that giving up perfect rationality need not force a departure from WE. On the contrary, WE can be reached in a routing game played by boundedly rational travelers. We achieve this result by developing a day-to-day model called cumulative logit (CULO), which assumes routes are valued based on the accumulative cost received in the past. We prove the convergence of CULO toward WE under mild conditions. Our theory thus upholds WE's role as a benchmark. It also resolves the theoretical challenge posed by Harsanyi's instability problem by explaining why equally good routes at WE are selected with different probabilities.

2 Modeling Multi-modal Curbside Usage In Dynamic Networks: A Computational Graph Approach

Jiachao Liu[1], Sean Z. Qian[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Carnegie Mellon University, Pittsburgh, PA, Contact: jiachaol@andrew.cmu.edu

The proliferation of emerging mobility technology prompts an explosive growth in demand for ride-hailing services and on-demand deliveries, transforming curb spaces into valuable but unprecedentedly oversaturated public infrastructure. It is critical to analyze the system-level impacts associated with multi-modal curb usage and to understand the interactions among curb users to facilitate optimal curb management. Our study proposes a curb-aware network modeling framework that encapsulates the route choice, competition, and interactive effect among various curb users and embeds the curb usage dynamics and associated network impact into the mesoscopic dynamic network loading model. Emerging curb usage data is used to calibrate the framework with other multi-source data via a computational graph approach. Two networks are used to test our proposed framework.

3 A Unified Framework for End-to-End Transportation Network Equilibrium Modeling

Zhichen Liu, University of Michigan, ANN ARBOR, MI

This study aims to develop a unified end-to-end framework for building transportation network equilibrium models from empirical data. The framework unifies the use of model-based and model-free approaches for representing supply/demand-side modeling components and directly learns them and the equilibrium state from data. Specifically, it uses computational graphs with learnable parameters to approximate unknown modeling components and embeds them in a variational inequality (VI) that enforces user equilibrium conditions. By minimizing the differences between the estimated and observed travel times, the parameters for supply/demand-side components are simultaneously estimated. Theoretically, the proposed framework can approximate target link times with infinitely small errors if the VI is well-posed.

4 Revitalizing Bottleneck Models: Integrating Calibratable Schedule Delay Disutility from a Queuing and Machine Learning Perspective

Mohammad Abbasi, Xuesong Zhou, Arizona State University, Tempe, AZ, Contact: mohammad_abbasi@asu.edu

This talk discusses the limitations of bottleneck models in transportation planning and proposes an approach to address these issues. It explores the use of polynomial fluid queues to improve the understanding of traffic dynamics at oversaturated bottlenecks. By integrating different modeling approaches, including macroscopic analytical formulations and mesoscopic queue vehicular fluid models, the speaker aims to capture the complex relationship between dynamic demand, supply, and congestion. The approach is demonstrated through case studies conducted in congested corridors of cities like New York, Los Angeles, and Phoenix, using real-world data. The talk emphasizes how traditional models can be enhanced with machine learning techniques to tackle modern transportation planning challenges such as eco-routing and eco-arrival control.

Sunday, October 15, 10:45 AM - 12:00 PM

SB41

CC-North 225B

Optimizing Service Facilities to Improve Freight Transportation Operations

Community Committee Choice Session

Session Chair: Adrian Hernandez, Northwestern University, Evanston, IL

1 Delivering Efficiency: Joint Optimization of Parcel Locker Location and Configuration Considering Vehicle Routing and Flexible Delivery Alternatives

Lissa Melis, Vikash V. Gayah, Andisheh Ranjbari, Penn State University, University Park, PA, Contact: lissa.melis@uantwerpen.be

To respond to the growing challenge of the last-mile delivery of goods, the use of parcel lockers has been widely proposed as an alternative to home deliveries. When a carrier wants to use company-owned parcel lockers, three decisions need to be made: the number of lockers provided, the location of the lockers and the internal configuration and capacity of the lockers. An optimization problem that combines these decisions with vehicle routing and alternative delivery strategies (home or locker delivery), has not yet been investigated in the literature. We will therefore introduce Parcel Locker Location-Configuration-Routing Problem with Flexible Delivery alternatives. As a solution method, we propose an adaptive large neighborhood search heuristic that considers both the carrier's and customer's perspective. We will conclude with some managerial recommendations.

2 Optimal Extreme Fast Charging Station Investment with Renewable Energy Generation and Storage

Ridvan Aksu, Mesut Yavuz, University of Alabama, Tuscaloosa, AL, Contact: myavuz@cba.ua.edu

Extreme Fast Charging (xFC) stations are key to widespread adoption of electric vehicles in commercial transportation due to the high energy demand of Medium and Heavy Duty (MD/HD) freight vehicles. Due to intense power requirement of xFC, power grids struggle to keep up with the demand. We analyze utilizing renewable energy generation and energy storage systems for a viable investment plan for such a station. Based on DCFC station design for an uncertain operation environment we optimize the station investment plan through the generation and storage capacities, as well as the energy storage policy.

3 Multi-Stage Stochastic Optimization of Intermodal Freight Transportation: A Case Study of the U.S. Southwest Supply Chain

Sarita Rattanakunuprakarn[1], Mingzhou Jin[2], [1]University of Tennessee, Knoxville, TN, [2]University of Tennessee, Knoxville, Knoxville, TN, Contact: srattan3@vols.utk.edu

Freight supply chains in the United States face significant and persistent challenges, including traffic congestion, extended drayage time, workforce shortages at ports, warehouses, and among truck drivers, as well as social and environmental concerns. We study an inbound supply chain problem within the U.S. Southwest region, employing mixed-integer stochastic programming to minimize transportation costs under demand uncertainty. The first-stage decision determines long-term strategies for optimal logistics centers equipped with intermodal facilities to improve accessibility to railroad systems. The sub-problem stages are formulated as network flow problems to determine transportation operations for a one-year period. This includes determining the optimal routing and the assignment of the number of goods to be loaded onto railcars and trucks.

4 Enhancing Infrastructure Network Resilience Under Uncertainty: A Network Completion Strategy

Mohamad Darayi, The Pennsylvania State University--

Great Valley, Malvern, PA, Contact: mud415@psu.edu

The functionality of infrastructure networks is threatened by disruptive events that can disable the networks' capacity. This research proposes a simulation-based optimization model to allocate budget under uncertainty to enhance network resilience via network hardening and/or network completion strategies. The proposed model is implemented in a stylized case study of Pennsylvania's freight transportation network.

5 Locating and Sizing Refueling Facilities to Support Freight Rail Decarbonization

Adrian Hernandez[1], Max Ng[2], Pablo Luis Durango-Cohen[2], Hani S. Mahmassani[2], [1]Northwestern University, Evanston, IL, [2]Northwestern University, Evanston, IL

The decarbonization of energy intensive transportation services with cyclic operations on expansive networks (e.g., freight rail, trucking, and intercity bus services) presents significant challenges. We present a flexible framework, consisting of two components, to address the problems of locating and sizing service facilities on existing networks. We extend nominal flow-based facility location models to account for repositioning rolling stock along cyclical trajectories to enable periodic service. For these, we present a formulation for point-to-point service and a formulation which considers intermediate O-D flow capture (i.e., chained trips). We also present a minimum cost network flow model to determine optimal energy sourcing strategies. We illustrate these formulations on an example corridor and a portion of the US rail network.

Sunday, October 15, 10:45 AM - 12:00 PM

SB42

CC-North 226A

Predictive and Constraint based Learning Techniques with Business Applications

Community Committee Choice Session

Session Chair: Neta Rabin, Tel-Aviv University, Tel-Aviv, Israel

Session Chair: Gonen Singer, Bar-Ilan University, Ramat Gan, Israel

1 A Hybrid Cost-Sensitive Machine Learning and Optimization Models for the Resource-Constrained Classification Problem

Gonen Singer[1], Lior Rabkin[1], Matan Marudi[1], Itay Margolin[2], [1]Bar-Ilan University, Ramat Gan, Israel; [2]Intuit, Tel-Aviv, Israel. Contact: gonen.singer@biu.ac.il

Resource-constrained classification tasks are common in real-world applications such as allocating tests for disease diagnosis and hiring decisions when filling a limited number of positions. We propose a comprehensive analytic framework for scenarios that, in addition to including multi-class classification problems with misclassification costs, also have constraints on the number of classified samples of classes due to resource limitations. To classify samples under the constraints, the framework uses a probability matrix generated by a trained cost-sensitive classifier as the input for an optimization model with a minimum cost objective and resource allocation constraints. To illustrate its effectiveness and applicability, the framework with a cost-sensitive neural network was applied in the context of a medical resources allocation case study.

2 Utilizing Machine Learning Methods for Improving the Readiness of the Fire and Rescue Authority

Neta Rabin[1], Gonen Singer[2], Yaniv Leucher[1], Elan Zamler[3], Michael Belinsky[3], [1]Tel-Aviv University, Tel-Aviv, Israel; [2]Bar-Ilan University, Ramat Gan, Israel; [3]Israel National Fire and Security Authority, Rishon Lezion, Israel

Fire fighting services employ historical and online datasets for prediction of fires, improving preparedness and risk analysis. In Israel, this field is still in its initial stages, and although the Fire Authority holds large amounts of data, a system that transforms this data into practical insights does not exist. In this work, we fuse internal datasets together with information from external sources in order to identify typical patters that increase the risk for fires and patterns that are associated with response to hazards. We focus on dimension reduction methods for pattern recognition and prediction methods, such as XGBoost and kernel based regression for forecasting future hazards per district.

3 Optimizing Flow Shop Scheduling with Shift Constraints: A Genetic Algorithm Approach

David Freud, Amir Elalouf, Bar-Ilan University, Ramat Gan, Israel

Our study introduces a new variation of the classic flow shop scheduling problem (FSSP) by imposing “shift constraints” where machines are only permitted to begin processing a job if they can complete it within a given and defined shift duration. We use a genetic algorithm that integrates an encoding scheme, selection and crossover operators, a mutation operator, and a fitness function. Our findings indicate that the genetic algorithm yields better results than the NEH algorithm, a commonly used benchmark across various instances.

4 Design for Explainability: A New XAI Method Based on Design of Experiments

Irad Ben-Gal, David Steinberg, Aviv Notovich, Tel-Aviv University, Tel Aviv, Israel. Contact: bengal@tauex.tau.ac.il

We propose a new Design for Explainability (DFX) methodology that for a given trained Machine Learning (ML) model; a feature training set; and a list of potential features interactions generates a Design of Experiments (DOE) plan to measure the importance or the effect of features, while estimating selected high-order features' interactions, with a lower computational cost than the SHAP.Experiments show that DFX and SHAP are equivalent in approximately 80% of the cases in identifying the top 10% of the most affecting features, while the DFX utilize on average 1.05% of the number experiments that are required by SHAP.

5 Spatio-Temporal Time-Series Forecasting Using an Iterative Kernel-Based Regression

Ben Hen[1], Neta Rabin[2], [1]Tel Aviv University, Israel; [2]Tel-Aviv University, Tel-Aviv, Israel

Spatio-temporal time-series forecasting is relevant in various domains like epidemiology or economics. Kernel-based regressions, which capture non-linear data-function relationships, provide simple and efficient forecasting models. In this work, we propose a kernel-based iterative regression model that utilizes multiscale kernels to fuse data from various spatial locations and improve the accuracy of time-series forecasting. The model resembles deep learning ideas but is easy to implement and effective for small datasets. Experimental results for forecasting solar energy, epidemiology infections, and fire event forecasts show that the proposed model outperforms existing techniques.

Sunday, October 15, 10:45 AM - 12:00 PM

SB43

CC-North 226B

AAS Best Student Presentation Competition II

Award Session

Session Chair: Gianmarco Andreana, [1</sup]

1 Flying High with Improved Data: How an Instructor Training Workshop Boosting Pilot Competency Assessment

Qingyin Ge, NUS IORA, Singapore, Singapore

Data informativeness is crucial for effective decision-making. In the context of pilot competency evaluation within an international airline, under a discrete grading scale from 1 to 5, we observed limited variation in grading, with grades being dominated by '3' (83%) and '1' or '5' rarely used (<0.1%). Instructor interviews revealed varied interpretations of the grading rubric, particularly the ambiguous '3'. The lack of specificity could lead to uniform yet potentially spurious grading patterns, adversely affecting trainee development and the integrity of the airline training system. Our research tackles a salient issue in pilot training: the tendency of instructors to default to a constant, neutral grade, thereby hindering the granularity and usefulness of feedback. More specifically, we ask: Can information sharing sessions for instructors trigger more varied and informative grading behavior? We hypothesize that this intervention raises informativeness of pilot competence assessments, thereby enhancing the grading efficacy. Our research combines Abadie's synthetic control method and the multi-period DiD approach to estimate the causal effect of information sharing workshops on instructors' grading patterns. The former method is applied for pre-treatment fit, the latter for treatment effect detection. Furthermore, our study serves as a pioneering exploration of evaluator behaviors and grading bias within the aviation sector.

2 The Terminal Airspace and Sequencing and Scheduling Problem (TASSP): An Optimization Approach

Wayne Ng, Singapore University of Technology and Design, Singapore, Singapore

The terminal airspace is crucial for aviation operations. It handles incoming and outgoing aircraft at airports. Efficient management of this airspace is essential for safety and reducing operational challenges. Proper sequencing and scheduling of aircraft are important to minimize delays, fuel consumption, and emissions. While runway sequencing and scheduling have received attention, optimizing aircraft sequencing in previous waypoints leading to the runways has been overlooked. Air Traffic Controllers (ATCs) need to intervene before aircraft reach the runway to ensure desired sequencing. This involves speed control, utilization of holding stacks, and vectoring techniques. In this research, we propose an integrated optimization approach that utilizes matheuristic algorithms to optimize runway aircraft sequencing and decisions in the terminal airspace, including aircraft speeds, utilization of holding stacks, and vectoring. We evaluate the algorithm using data from the congested terminal airspace of Changi Airport in Singapore. Our proposed algorithm employs an iterative process that combines a Linear Programming (LP) model with a Genetic

Algorithm, enabling the rapid generation of feasible solutions (within 1 second) and convergence to near-optimal solutions in approximately 10 minutes. To the best of our knowledge, this is the first algorithm that incorporates holding and vectoring decisions using optimization methods. When compared to commercial microsimulation models like Airtop, our proposed algorithm is capable of providing similar solutions within seconds. Furthermore, when left to optimize the runway sequence, the algorithm outperforms the ad-hoc routines from Airtop, resulting in significantly reduced delays. We address the Terminal Airspace Sequencing and Scheduling Problem (TASSP) as an optimization challenge. Our modeling approach represents the terminal airspace as a graph, with nodes representing intersections or holding stacks, and links denoting the aircraft paths. We optimize the continuous variable of time taken for each link, which encompasses aircraft speed or additional time resulting from vectoring. Nodes with holding patterns account for the time spent in holding. The objective is to minimize the overall flight time for aircraft traveling to and from the runway, while always adhering to the minimum separation standards (e.g. from ICAO).

3 Learning in the Airspace for Combinatorial Network Routing

Xiyitao Zhu, University of Illinois Urbana-Champaign, Champaign, IL

In aircraft trajectory planning, information about weather conditions in the airspace is critical, because planners utilize such information to decide what trajectory an aircraft could take to reduce its travel cost. However, in current practice, the information collection is spatially and temporally sparse. Specifically, aircraft usually herd onto traveling through well-used paths, so the updated weather information is limited to only a few sections of the airspace. In other words, other sections are mostly unsampled and potentially useful information about these less-traveled sections gets outdated quickly as weather changes dynamically over time. These information-related shortcomings leave great potential for improvement in aircraft trajectory planning and necessitate a better information collection process. In the best interest of the Federal Aviation Administration (FAA), one proposed way to address such shortcomings is to use en-route aircraft as sensors to sample the airspace and collect near-real-time information while traveling. That means, certain aircraft could be used to explore the less sampled airspace and collect information for other aircraft to exploit for future routing decisions to minimize the total travel costs in the aviation system. The exploration-exploitation trade-off is first addressed in the multi-armed bandit (MAB) framework. Existing works have analyzed different variants of MAB. Particularly in the airline routing setup, the uncertainty structure of wind conditions in the airspace by an Ornstein-Uhlenbeck process and proposes different algorithms with performance guarantees applied to airline networks with disjoint paths that do not share any common arcs in the corresponding graph. Yet, the airline routing network has a natural combinatorial structure. Our work tries to extend this scope by incorporating the combinatorial consideration and seek to design sampling strategies/algorithms that take advantage of the combinatorial structure of the problem. We also propose a new algorithm and we are working on upper bounding its regret. The results would not be limited to the airline network routing problems; they are also applicable to general bandit setups with spatial-temporal correlation and combinatorial structures, which haven't been studied before.

Sunday, October 15, 10:45 AM - 12:00 PM

SB44

CC-North 226C

Generative AI, Content Creation, and Platforms

Community Committee Choice Session

Session Chair: Hong Zhang, University of Texas at Dallas, Richardson, TX

1 Designing A Personalized Generative Framework Towards Better Content Creation Strategy

Hong Zhang[1], Hongchang Wang[2], Amit Mehra[1], Zhiqiang Eric Zheng[3], [1]University of Texas at Dallas, Richardson, TX, [2]University of Texas at Dallas, Allen, TX, [3]University of Texas-Dallas, Richardson, TX

While the emergence of generative AI tools boosts content production, it lacks the ability to align with market preferences in the sense that the content generated by AI may not necessarily be appreciated by humans as intended. Further, current generative AI falls short of customizing content creation based on creators' experiences. This paper develops a personalized generative framework to assist creators in adopting better creation strategies with improved content sales. Toward that end, we incorporate GPT3 with a reinforcement learning reward model to make AI aligned with content-sale objectives. This architecture is further augmented by higher rewards when the contents generated by GPT3 don't deviate too much from the creator reference model in order to realize content personalization. We subsequently evaluate the framework in a non-fungible token (NFT) market.

2 Generative AI, Human Creativity, and Art

Eric Zhou, Dokyun Lee, Boston University, Boston, MA, Contact: ebzhou@bu.edu

This research examines the impact of Generative Artificial Intelligence (AI) on human creativity and its implications for content production. With the advent of AI algorithms capable of generating music, digital artworks, code, and stories, the line between human and machine-generated creativity has become blurred. As generative AI continues to evolve, it's essential to understand its effects on creative production and the perception of creative artifacts. Using data from an online Art sharing platform, the study focuses on three research questions: the influence of generative AI on human creative production, its role in enabling more innovative content, and its impact on creative expression and artistic content.

3 What's in a Name? the Impact of Artist Names in Image Generator Prompts

Jason Bell, Oxford University, Oxford, United Kingdom. Contact: jason.bell@sbs.ox.ac.uk

Widely accessible Generative AI has the potential to accelerate creativity, but also raises questions about the economics of art, intellectual property, and control of data. Generative image models are typically trained on datasets which include work from artists who did not give consent. End users often use artist names to replicate particular styles, which has already led to lawsuits. We examine the effects of artist names in image prompts. We use both a vision transformer and a choice model estimated on conjoint data. We demonstrate a means of conservatively estimating the impact of artist names in image prompts on preferences and willingness-to-pay. More broadly we offer insights into data sourcing for generative AI.

4 Large Language Model In Creative Work: The Role Of Collaboration Modality And User Expertise

Zenan Chen[1], Jason Chan[2], [1]University of Minnesota-Twin Cities, Minneapolis, MN, [2]University of Minnesota, Minneapolis, MN, Contact: chen6029@umn.edu

Large Language Models (LLMs) are rapidly being adopted by businesses to assist users in a wide range of open-ended tasks, including ones that require creativity. We conducted an experiment where we task both expert and non-expert users to write an ad copy with and without the assistance of LLMs. We compare two ways of working with LLMs: (1) using LLMs as "ghostwriters," which assume the main role of content generation task and (2) using LLMs as "sounding boards," to provide feedback based on human-created content. Our results show that the two human-LLM collaboration modalities can have very different outcomes. Using LLMs as sounding boards yields an overall positive effect, by enhancing the quality of the resultant ad copies, especially for non-experts. However, using LLMs as ghostwriters did not provide significant benefits and is in fact detrimental to expert users.

Sunday, October 15, 10:45 AM - 12:00 PM

SB45

CC-North 227A

Machine Learning Meets Discrete Optimization

Community Committee Choice Session

Session Chair: Stefano Gualandi, Princeton
Session Chair: Thiago Serra, Bucknell University, Lewisburg, PA

1 The Bemi Stardust: A Structured Ensemble of Binarized Neural Networks

Stefano Gualandi[1], Ambrogio Bernardelli[1], Simone Milanesi[1], Hoong Chuin Lau[2], Neil Yorke-Smith[3], [1]University of Pavia, Pavia, Italy; [2]Singapore Management University, Singapore, Singapore; [3]Delft University of Technology, Delft, Netherlands

Binarized Neural Networks (BNNs) are receiving increasing attention due to their lightweight architecture and ability to run on low-power devices. The state-of-the-art for training classification BNNs restricted to small dataset is based on Mixed Integer Programming. This paper proposes the BeMi ensemble, a structured architecture based a single BNN for each possible pair of classes and applying a voting scheme to predict the final output. The training of a single BNN is achieved by a MIP model that optimizes a lexicographic multi-objective function. We computationally validate our model using the MNIST and Fashion-MNIST datasets. While previous approaches achieve an average accuracy of 51.1% on the MNIST dataset, our approach achieves an average accuracy of 61.7% when trained with 10 images per class and 76.4% when trained with 40 images per class.

2 Optimizing Objective Functions from Trained Relu Neural Networks

Georgia Perakis[1], Asterios Tsiourvas[2], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]MIT, Cambridge, MA, Contact: atsiour@mit.edu

In recent years, practitioners and academics have been increasingly incorporating machine learning models in data-driven optimization problems for decision-making. We introduce scalable algorithms that enable the integration of ReLU networks into data-driven optimization problems. Our algorithm takes advantage of the piecewise linear structure of ReLU neural networks and reduces the initial mixed-integer optimization problem (MIP) into several easy-to-solve linear optimization problems (LPs) through sampling. We demonstrate that the algorithm achieves a locally optimal solution from the first iteration, and we present a precise bound on the number of samples required for computing an optimal solution. We validate the performance of the proposed algorithms by conducting extensive numerical experiments with synthetic and real-world data.

3 Getting Away with More Network Pruning: From Sparsity to Geometry and Linear Regions

Junyang Cai[1], Khai-Nguyen Nguyen[1], Nishant Shrestha[2], Aidan Good[1], Ruisen Tu[1], Xin Yu[3], Shandian Zhe[3], Thiago Serra[1], [1]Bucknell University, Lewisburg, PA, [2]Bucknell University, Lewisburg, [3]University of Utah, Salt Lake City, UT, Contact: thiago.serra@bucknell.edu

One surprising trait of neural networks is the extent to which their connections can be pruned with little to no effect on accuracy. But when we cross a critical level of parameter sparsity, pruning any further leads to a sudden drop in accuracy. This drop plausibly reflects a loss in model complexity, which we aim to avoid. In this work, we explore how sparsity also affects the geometry of the linear regions defined by a neural network, and consequently reduces the expected maximum number of linear regions based on the architecture. We observe that pruning affects accuracy similarly to how sparsity affects the number of linear regions and our proposed bound for the maximum number. Conversely, we find out that selecting the sparsity across layers to maximize our bound very often improves accuracy in comparison to pruning as much with the same sparsity in all layers.

4 Fitting Hyperplanes to Minimize the Quantile Error in Noisy Data Sets

John W. Chinneck[1], Paul Brooks[2], [1]Carleton University, Ottawa, ON, Canada; [2]Virginia Commonwealth University, Richmond, VA, Contact: chinneck@sce.carleton.ca

Given a noisy set of data points (general fit) or a set of data points and an outcome variable (regression fit), contaminated with outliers, the goal is to fit a hyperplane that minimizes the maximum error for some quantile of the data points, often 50% of the points. This is a difficult problem in statistics. Mixed-Integer Optimization (MIO) algorithms provide an exact solution for small data sets but do not scale well. We develop (i) fast heuristic methods, and (ii) an improved MIO that is more scalable and effective than the existing MIO formulation, especially in combination with initialization heuristics. We examine the effect of halting the MIO early. Also, since it is sometimes assumed that a quantile-error minimizing fit is a good fit to the complete set of inliers in a data set, we examine whether this is true.

5 Mending Neural Networks with Logic: Case Studies in Language Technology

Vivek Srikumar, The University of Utah, Salt Lake City, UT

Large language models command the state-of-the-art across natural language processing. But such models can be opaque monoliths whose behavior is difficult to control except via explicit supervision.

In this talk, I will present a new paradigm for training machine learning models using discrete knowledge rather than simple data supervision. This framework allows us to guide models to satisfy specific properties that are expressed in logic. Specifically, I will show how we can systematically compile declarative constraints into regularizers that guides model training. I will present experiments which show that adding such declarative knowledge gives models are not only more accurate, but also more self-consistent in their predictions.

Sunday, October 15, 10:45 AM - 12:00 PM

SB46

CC-North 227B

Exploring Equity and Fairness in Public Services Administration

Community Committee Choice Session

Session Chair: Nathan Adeyemi, Northeastern University, Boston, MA

1 Disaggregating Power Outages From Disconnections: A Commonwealth Edison Case Study

Akua McLeod[1], Amritanshu Pandey[2], Destenie Nock[3], [1]Carnegie Mellon University, Pittsburgh, PA, [2]University of Vermont, Burlington, VT, [3]Carnegie Mellon University, Pittsburgh, PA, Contact: aamcleod@andrew.cmu.edu

Power outages negatively impact household resilience and cause energy insecurity. Standard metrics measure reliability across an electric utility service territory, but miss the details of how outages are experienced by different demographic groups. We develop a new model for disaggregating power outages from disconnections in residential electricity consumption AMI data, using logistic regression. We then evaluate how the duration and frequency of outages change across zip codes with different demographics within the Commonwealth Edison service territory.

Leveraging this analysis, we provide more granular metrics for electricity reliability, thus highlighting gaps in energy accessibility, and informing equitable investment in electric distribution infrastructure.

2 Amplified Access for All: A Simulation and Metaheuristic Guided Approach to Psychiatric Inpatient Bed Redistribution

Nathan Adeyemi[1], Kayse Lee Lee Maass[2], [1]Northeastern University, Boston, MA, [2]Northeastern University, Boston, MA, Contact: adeyemi.n@northeastern.edu

This work aims to improve patient access to care by reallocating inpatient mental health beds, reducing long wait times in the Emergency Department (ED) for individuals with mental health crises. A simulation was developed involving over 140 healthcare provider locations to model patient trajectories from ED care to inpatient treatment. The simulation considers patient characteristics and hospital resources to determine a patient's final treatment location. Output statistics were used in a multi-objective optimization model to allocate psychiatric treatment beds across the state. Findings indicate improvements in key access metrics including reductions in patient treatment delay, travel distance for externally transferred patients, and the total number of patients treated, promoting equitable and efficient access to inpatient mental healthcare.

3 Heterogeneous Impact Of LIHEAP On Non-economic Measures Of Energy Consumption

Jaih Hunter-Hill, Destenie S. Nock, Carnegie Mellon University, Pittsburgh, PA

Standard metrics of success of the Low-Income Home Energy Assistance Program (LIHEAP) primarily focus on household energy burden reduction--failing to capture how the program changes household energy consumption patterns. Understanding these patterns can shed light into non-economic effects of LIHEAP program participation within households. We employ a Diff-in-Diff framework to analyze the impact of LIHEAP on energy consumption behavior. Leveraging this analysis, we provide insights into behavior shifts for LIHEAP funding recipients and offer suggestions for how vulnerable households shift energy usage following a reduction of financial burden.

4 A Simulation-Based Approach to Improve Equitable Housing Coordination in New York City

Yaren Bilge Kaya, Kayse Lee Lee Maass, Northeastern University, Boston, MA

This study uses simulation modeling to improve access to temporary public housing resources for runaway and homeless youth (RHY), a highly vulnerable population susceptible to human trafficking. By simulating a set of crisis and emergency shelters in New York City funded by a single governmental organization with demographic eligibility criteria, stochastic RHY arrival, impatient youth behavior, and a coordinator that determines which server pool RHY is routed to, we evaluate different queue routing strategies. Our simulation results suggest that changing the routing process can decrease the average wait time by one day and reduce the proportion of RHY abandoning shelters by 13%, providing a more efficient, equitable, and interpretable means of coordinating access to housing resources for RHY.

Sunday, October 15, 10:45 AM - 12:00 PM

SB47

CC-North 227C

QSR Best Student Paper Competition

Award Session

Session Chair: Chen Zhang, Tsinghua University, Beijing, China

Session Chair: Hui Yang, Penn State

Sunday, October 15, 10:45 AM - 12:00 PM

SB48

CC-North 228A

Multi-process Modeling, Monitoring, and Control in Smart and Connected Systems

Community Committee Choice Session

Session Chair: Chao Wang, University of Iowa, Iowa City, IA

1 Integration of Feedback and Feedforward Control in Laser Powder Bed Fusion

Rongxuan Wang, Chaoran Dou, Benjamin Bevans, Alex Riensche, Prahalada Rao, Amirul Islam Saimon, Zhenyu James Kong, Virginia Tech, Blacksburg, VA, Contact: rxwang@vt.edu

Laser powder bed fusion can fabricate complex geometries, but ensuring a high tolerance is challenging. The primary cause of the shape error is the melt pool size fluctuation due to heat accumulation. However, it is challenging to implement power compensation precisely because quantifying the heat accumulation in both part and local scales is computationally expensive. This work addresses this issue by integrating feedforward and feedback control on real-time laser power adjustment. The part-scale heat accumulation is considered by the FEA model. A heuristic method was used to suggest the printing temperature of each layer. The within-layer heat accumulation is regulated by a high-speed feedback laser power controller. The framework has been demonstrated on an open-source machine, and a high-resolution 3D scanner verifies the result.

2 Tensor-based Feedback Control for Local Structured High-dimensional Streaming Data Under Limited Control Capability

Zihan Zhang, Kamran Paynabar, Jianjun Shi, ISyE Georgia Tech, Atlanta, GA

This study introduces a tensor-based feedback control model for structured high-dimensional (LSHD) streaming data, addressing limitations of conventional control models. Unlike traditional models that often overlook local correlation structures, our approach leverages kernel distributions to capture local response auto-correlations and incorporates the practical knowledge of control actions. We propose a dynamic control strategy that determines optimal control locations to boost efficiency under resource constraints. The model effectiveness is confirmed through simulations and case studies.

3 Online Active Learning with Transfer Learning

Zengchenghao Xia, Chao Wang, University of Iowa, Iowa City, IA, Contact: zengchenghao-xia@uiowa.edu

Active learning guides design and modeling with high sampling costs, but current methods suffer cold-start problems. We use transfer learning to solve the cold-start problem by leveraging knowledge from related, data-rich processes. Specifically, we construct a multi-output Gaussian process (MGP) to model inter-process relationship. The MGP features i) a special covariance structure that characterizes inter-process relationship, and ii) an iterative online Bayesian framework for reducing computational load in parameter estimation. The inter-relationship captured by this novel MGP is then fed into the active learning using integrated mean-squared error as the objective. We provide theoretical justifications that the objective is non-increasing as we get more data. Numerical and real case studies are implemented to show the superiority of the proposed method.

4 The Agglomerative Attribute Grouping (AAG): A Nonparametric Subspace Analysis Method for Anomaly Detection, Forecasting and Clustering

Irad Ben-Gal[1], Dario Bacher[2], Morris Amara[1], Erez Shmueli[1], [1]Tel Aviv University, Tel-Aviv, Israel; [2]Tel-Aviv University, Tel Aviv, Israel

The agglomerative attribute grouping (AAG) is a new subspace analysis approach that looks for subspaces of highly correlative attributes. Such correlations can be used to improve the identification of abnormal data samples. The proposed AAG algorithm relies on a generalized multi-attribute measure (derived from information theory measures over attributes' partitions) for evaluating the "information distance" among various subsets of attributes. Extensive evaluation over real-world data sets demonstrates that in the vast majority of cases, AAG outperforms both classical and state-of-the-art subspace analysis methods for anomaly detection, forecasting, and clustering.

Sunday, October 15, 10:45 AM - 12:00 PM

SB49

CC-North 228B

Knowledge Fusion for High-dimensional Data Modeling and Analysis

Community Committee Choice Session

Session Chair: Shancong Mou, Georgia Institute of Technology, Smyrna, GA

1 Knowledge-Driven Posterior Regularized Bayesian Neural Network with Aleatoric Uncertainty

Jiayu Huang, Yongming Liu, Hao Yan, Arizona State University, Tempe, AZ

Modelling uncertainties, epistemic and aleatoric uncertainty, is crucial for decision-making in various fields, as it allows us to quantify potential outcomes and risks. Epistemic uncertainty arises from a lack of knowledge or data and can be modelled using Bayesian Neural Networks (BNN). While aleatoric uncertainty, which is related to inherent randomness or variability, can provide more realistic uncertainty estimates that inform robust decision-making. Also, domain knowledge is commonly available in various fields and could improve the performance of BNNs. We propose to use posterior regularization and sampling methods to incorporate various types of knowledge constraints into BNN, considering aleatoric uncertainty. Our simulation and case studies demonstrate that the proposed model outperforms traditional BNNs without constraints.

2 Video Foreground Segmentation via Posterior Regularized Robust Bayesian Tensor Factorization

Shenghao Xia, Jian Liu, University of Arizona, Tucson, AZ,

Contact: shenghaoxia@arizona.edu

Video foreground segmentation is a critical step in detecting moving objects from the background in video processing. Tensor factorization has been used in foreground segmentation due to its mathematical convenience in processing complex high-dimensional data, such as color images and videos. However, traditional tensor factorization lacks the ability to incorporate domain knowledge on video properties and to explicitly consider the estimation uncertainty. In this research, a new Bayesian tensor factorization method is proposed to formulate the characteristics of the dynamic foreground as posterior regularization terms in an optimal estimation problem. A series of case studies have shown the performance improvement of the proposed model over benchmarks.

3 On the Statistical Power and Limit of Scientific Machine Learning

Yiping Lu, STANFORD, CA

I'll discuss the statistical limit of linear operator learning in this talk. We build the first min-max lower bound for this problem. The min-max rate has a particular structure where the more challenging parts of the input and output spaces determine the hardness of learning a linear operator. Our analysis also shows that an intuitive discretization of the infinite-dimensional operator could lead to a sub-optimal statistical learning rate. Then, I'll discuss how, by suitably trading-off bias and variance, we can construct an estimator with an optimal learning rate for learning a linear operator between infinite dimension spaces. We also illustrate how this theory can inspire a multilevel machine-learning algorithm of potential practical use.

4 Robust Learning for Unsupervised Fine-Grained Anomaly Detection

Shancong Mou, Georgia Institute of Technology, Atlanta, GA

Unsupervised Fine-grained anomaly detection is an important yet challenging problem, which has not been well addressed. Robust learning is able to achieve robust signal restoration under unknown corruptions. Therefore, it is a promising tool for achieving the fine-grained anomaly detection goal. However, current robust learning is mainly designed for image/functional curve data and relies on strong statistical assumptions of the signal component, which may limit its applications. In this talk, I will discuss the recent development of robust learning in addressing those limitations and its corresponding applications in unsupervised pixel-wise anomaly detection.

Sunday, October 15, 10:45 AM - 12:00 PM

SB51

CC-North 229B

Pathway to Decarbonization of the Energy Sector

Community Committee Choice Session

Session Chair: Omer Karaduman, Stanford University, Cambridge, MA

1 Flattening Energy Consumption Curve by Direct Load Control Contracts

Ali Fattahi[1], Saeed Ghodsi[2], Sriram Dasu[3], Reza Ahmadi[4], [1]Johns Hopkins University, Baltimore, MD, [2]University of California, Los Angeles, Los Angeles, CA, [3]University of Southern California, Los Angeles, CA, [4]University of California Los Angeles, Los Angeles, CA, Contact: rahmadi@anderson.ucla.edu

Flattening Energy-Consumption Curves
by Monthly Constrained
Direct Load Control Contracts Direct load control contracts (DLCCs) are a class of incentive-based demand-response programs that allow utilities to assign "calls" to customer groups to reduce their energy usage by a pre-specified amount for a given length of time. We develop a hierarchical approximation approach, which consists of an annual problem and monthly problems, to solve the DLCC implementation problem effectively and in a reasonable amount of time.A large utility firm in California implemented our model and informed us that the additional reduction in cost was approximately 4%. Our sensitivity analysis reports the impact of managerial concerns on some policies to enhance customer experience, and provides insights for improving the features of DLCC contracts.

2 Optimization for Highly Decarbonized Clean Power Systems

Thomas Lee, Xin Chen, Andy Sun, Massachusetts Institute of Technology, Cambridge, MA, Contact: t_lee@mit.edu

In order to achieve high decarbonization, the US power grid needs significantly more wind, solar, and storage resources. Challenges remain as to how such systems can emerge, and be operated with high economic efficiency and low risk. The appropriate computational models for planning such a clean power system should balance sufficient levels of spatial, temporal, and scenario resolution. A large scale nodal-resolution power system planning model is developed, in order to study the investment and operations of optimal high-renewable systems in different regions of the US.

3 Quantifying the Likelihood of Imbalances from Variable Renewable Energy Sources: A Risk Scoring Methodology for Energy Generators

Andres F. Ramirez, Alberto J. Lamadrid, Lehigh University, Bethlehem, PA, Contact: anr422@lehigh.edu

We present a framework that integrates information from the output of the Security Constrained Economic Dispatch (SCED) and Security Constraint Unit Commitment (SCUC) to calculate a risk score for stakeholders in Electricity Systems. Simulations were conducted to evaluate the variability and sensitivity of the risk-scoring methodology. The score is sensitive to changes in the optimization models and can effectively identify high-risk generators. The risk score provides a quantitative measure of the likelihood that a generator will cause imbalances in the grid due to variability and uncertainty. The proposed framework was tested using real-world data from the New York system (NYISO), and the results showed that it can effectively identify high-risk generators.

Sunday, October 15, 10:45 AM - 12:00 PM

SB52

CC-North 230

Optimization under Uncertainty Applications for Electric Power Systems

Community Committee Choice Session

Session Chair: Hanbin Yang, cuhksz, Shenzhen, China

1 A Risk-Averse Maintenance and Operations Scheduling Model with Flexible Generation Under Wind Energy Uncertainty

Natalie Randall, Beste Basciftci, University of Iowa, Iowa City, IA

We propose a risk-averse contextual predictive maintenance and operations scheduling problem with flexible generation under wind energy uncertainty. We formulate the problem as a two-stage risk-averse stochastic mixed-integer program. Gaussian Process Regression is used to predict wind energy and is leveraged into the stochastic program through a conditional expectation. We solve this computationally challenging problem using a risk-averse progressive hedging algorithm. Our results show the impact of adopting a risk-averse approach compared to a risk-neutral one, and highlight the value of integrating flexible generation and contextual information that leads to cost-effective plans with less failures. The solution algorithm provides speed-ups compared to GUROBI and finds optimal solutions in most instances.

2 Multi-Period Power System Risk Minimization Under Wildfire Disruptions

Hanbin Yang, The Chinese University of Hong Kong, Shenzhen, Shenzhen, China. Contact: hanbinyang@link.cuhk.edu.cn

Wildfire risk is increasing globally, posing a growing threat to power systems, with grid failures fueling the most destructive wildfires. In day-to-day operations, preemptive de-energization of equipment is an effective tool to mitigate the risk and damage of wildfires. However, such power outages have significant impacts on customers. This paper proposes a novel framework for planning preemptive de-energization of power systems to mitigate wildfire risk. We model wildfire disruptions as stochastic disruptions with random magnitude and timing and formulate a two-stage stochastic program. We develop a decomposition algorithm to generate adaptive shutoff plans before a disruption occurs. Our method reduces both wildfire damage costs and load-shedding losses over multiple periods, and our nominal plan is robust against the uncertainty model perturbation.

3 Uncertainty-Aware Power-Gas Infrastructure Planning Under Deep Decarbonization Scenarios

Rahman Khorramfar[1], Dharik Sanchan Mallapragada[2], Saurabh Amin[1], [1]MIT, Cambridge, MA, [2]MIT Energy Initiative, Massachusetts Institute of Technology, Cambridge, MA, Contact: khorram@mit.edu

We consider a joint electricity power and natural gas infrastructure planning problem and propose stochastic programming (SP) and distributionally robust optimization (DRO) formulations that consider interannual variations in both energy demand and renewable energy supply, and account for the operational constraints of the joint system. We develop a computational approach that exploits the spatial correlation between electric power and natural gas demands both within and across load zones, resulting in a mixed-integer programming (MILP) formulation. We compare the resulting uncertainty-aware designs with the certainty equivalent problem for realistic power-gas systems in the U.S. New England region and highlight the importance of systematic modeling of inter-annual variability in demand and renewable energy supply.

4 A Framework For Balancing Power Grid Resiliency And Efficiency With Bi-objective Stochastic Integer Optimization

Ramsey Rossmann[1], Mihai Anitescu[2], Julie Bessac[2],

Michael C. Ferris[1], Mitchell Krock[2], Jim R. Luedtke[1], Line Roald[1], [1]University of Wisconsin-Madison, Madison, WI, [2]Argonne National Laboratory, Argonne, IL, Contact: rossmann2@wisc.edu

Designing a power grid that is both efficient on average and resilient to extreme weather events is a critical challenge. Traditional stochastic programming approaches to this are highly sensitive to sampling error due to the presence of low probability events with very high impacts. Stochastic programming also fails to account for system goals changing under extreme conditions. For example, when the power grid faces extreme weather the goal shifts to minimizing load shed, with little concern for cost. We present a bi-objective modeling approach that addresses these issues and illustrate it in the context of capacity planning in the electric grid. By having an objective that explicitly focuses on load shed in extreme temperature scenarios, we achieve better solutions with smaller sample sizes. We also show the importance of spatial correlation in temperature samples.

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SB53

CC-North 231A

Game Theoretic Models of Energy Markets

Community Committee Choice Session

Session Chair: Joseph Edward Duggan, University of Dayton, Dayton, OH

Session Chair: Ramteen Sioshansi, Carnegie Mellon University, Pittsburgh, PA

1 Distributionally Robust Optimization for a Hybrid Power Plant Trading Electricity and Hydrogen

Andrea Gloppen Johnsen, Technical University of Denmark, Kongens Lyngby, Denmark

In this work we present a Distributionally Robust Optimization model for the optimal scheduling of a hybrid power plant comprised of a wind energy source and electrolyzer. The hybrid power plant can participate both in electricity and hydrogen markets, as well as ancillary service markets. However, it is also exposed to several sources of uncertainty, such as wind power production, market prices, and reserve activation. The proposed model is reformulated into a mixed-integer linear program to determine the optimal day-ahead power and reserve bids of the entire hybrid power plant. The model is applied to a case study in Denmark, part of the Synchronous grid of Continental Europe, and compared to both a deterministic and sample average approximation model.

2 Coordination of Operation of Shared Hydropower Reservoirs

Stein-Erik Fleten[1], Lennart Hagemann[2], Hossein Babazadeh[1], [1]Norwegian University of Science & Technology, Trondheim, Norway; [2]University of Duisburg-Essen, Essen, Germany. Contact: stein-erik.fleten@ntnu.no

Typical hydropower systems comprise several power plants along a river. These power plants often have different owners with distinct operating strategies, so there is a need for coordinating the release of production water from upstream reservoirs. We use optimization and complementarity models to analyze the case of an interesting coordination mechanism used in Sweden, where virtual individual reservoir levels and power swaps are elements that contribute to ensuring that the different owners can operate independently.

3 Strategic Sector Coupling? Market Power in Heat and Power Markets

Afzal Siddiqui[1], Sebastian Maier[2], [1]Stockholm University, Kista, Sweden; [2]University College London (UCL), London, United Kingdom. Contact: asiddiq@dsv.su.se

Decarbonisation of the power sector envisages vast uptake of variable renewable energy (VRE) technologies. Coupling between heat and power sectors via combined heat and power (CHP) plants could provide the flexibility needed to mitigate intermittent VRE output. However, firms with CHP plants could use the link between the two energy sectors to manipulate electricity prices. We use a bi-level model to investigate the incentives for such strategic behaviour. At the upper level, a firm with both heat-only and CHP plants determines its heat output and is constrained by power-market operations at the lower level. Such a strategic firm produces more (less) heat from its CHP (heat-only) plant vis-à-vis the social optimum in order to constrain its maximum power output. Thus, it uses its leverage to manufacture scarcity in the power market to boost the electricity price.

4 Underground Hydrogen Storage as a Tool for Enhancing Energy Security: An Economic Perspective for the German Case

Ange Blanchard, CentraleSupelec, Paris-Saclay University, Saclay, France. Contact: ange.blanchard@chaireeconomieduclimat.org

Hydrogen technology is essential for reducing emissions in sectors that are hard to decarbonize. In Germany, the demand for hydrogen is expected to double by 2035, and the majority of the supply will be imported. To address this issue, Underground Hydrogen Storage (UHS) is a potential solution that can lower production costs and enhance reliability. Our study assesses the value of UHS by analyzing its ability to leverage time arbitrage and its role in mitigating supply disruptions. We use a Stochastic Dual Dynamic Programming algorithm and a Markov Chain to account for the uncertainty surrounding renewable energy sources and potential supply shocks. By reducing the need for expensive hydrogen supply capacity, UHS facilities can serve as a hedge against supply risks, and political support in the form of subsidies or tenders is critical for UHS investment decisions.

Sunday, October 15, 10:45 AM - 12:00 PM

SB54

CC-North 231B

Sustainable Supply Chains and Recycling

Community Committee Choice Session

Session Chair: Majid Alipanah, University of Arizona, Tucson, AZ

1 Sustainable Supply Chain for Recycling of Lithium-Ion Batteries in the United States

Majid Alipanah, Sunday Usman, Apurba Saha, Hongyue Jin, University of Arizona, Tucson, AZ, Contact: majidalipanah@arizona.edu

Recycling spent lithium-ion batteries (LIBs) has attracted lots of attention recently, due to the increasing demand for critical materials contained in LIBs, putting high pressure on their geological reserves. This study evaluated the potential of bioleaching technology as a sustainable solution for recycling spent LIBs. A supply chain model has been developed to include required upstream processes with the objective of maximize economic feasibility of the technology. The model has been applied for the U.S. and optimal supply chain configuration was identified, considering the main affecting factors on the economic viability of the technology. The economic viability of the technology was identified to be highly sensitive to the black mass price. The study also examined the non-cooperative scenarios where each tier tries to maximize its own profit.

2 To Donate or Not to Donate: Optimal Policies for Supermarket In-Kind Donations to Food Banks

Shabnam Salehi, Irem Sengul Orgut, Emmett John Lodree, University of Alabama, Tuscaloosa, AL

Food banks are non-profit organizations that collect donations from donors and distribute them to food insecure households through a network of charitable agencies. The quality of in-kind perishable donations received by food banks is a key factor in their operations and food distribution process. However, retailers, one of the major in-kind donors to food banks, may prefer to donate perishables as late as possible in hopes of selling the products, despite receiving a tax credit for the donated food. This study adopts the perspective of the supermarket with the goal of maximizing profit. We develop a decision model that identifies the best time for donating perishables. We find that, even in terms of retailers' profit, it is not always optimal to wait until the last minute to donate.

3 A Novel Optimization Model with Python Package for Controlling Harmful Algal Blooms in Lake Okeechobee

Ashim Khanal[1], Vahid Mahmoodian[2], Hadi Charkhgard[1], [1]University of South Florida, Tampa, FL, [2]USF, Tampa, FL, Contact: ashimkhanal@usf.edu

Our research aims to mitigate nutrient contamination in Lake Okeechobee, a large freshwater lake in the US, and its watersheds. Excessive nutrient pollution from fertilizers and various effluents has led to the proliferation of harmful algal blooms. Addressing this issue involves approaches like implementing preventative measures such as Best Management Practices (BMPs) to regulate nutrient loading and employing curative measures like Water Treatment Technologies (WTTs) to remove nutrients. Our study takes a comprehensive approach, utilizing a mathematical optimization model to minimize nutrient contamination. We optimize the choice and placement of BMPs and WTTs while considering uncertainties. Numerical analysis shows the effectiveness of our model in reducing contamination. We also offer a user-friendly Python package, 'NutrientRedOpt', in pip library.

4 The Impacts of Sustainable Supply Chain Strategies and Environmental Performance on Competitive Advantages

Yao-Te Tsai[1], Chia-Hui Yu[2], [1]National Kaohsiung University of Science and Technology, Koahsiung, Taiwan; [2]National Taipei University of Business, Taipei, Taiwan. Contact: yaottsai@nkust.edu.tw

Governments and international organizations have developed initiatives and commitments to address environmental issues. The key responsibility of business to society is to find a balance between environmental, social, and economic performance, and more and more companies are willing to reduce environmental pollution in their supply chain processes and become environmentally friendly. This study aims to examine the relationships between sustainable supply chain strategies, environmental performance, and competitive advantages. In addition, this study investigates the moderating effect of institutional pressures on the correlation between green supply chain strategies and competitive advantage.

Sunday, October 15, 10:45 AM - 12:00 PM

SB55

CC-North 231C

Research on Innovative Platform Operations

Community Committee Choice Session

Session Chair: Ming Hu, University of Toronto, Minneapolis, MN

Session Chair: Zhoupeng (Jack) Zhang, Rotman School of Management, University of Toronto, Toronto, ON, Canada

1 Mobile App Push Strategies on Consumer Engagement

Jiaru Bai[1], Qiang Gao[2], Zhuping Liu[3], [1]Stony Brook University, Stony Brook, NY, [2]Baruch College, City University of New York, New York, NY, [3]Baruch College, New York, NY, Contact: jiarub@uci.edu

Building on consumer behavioral theories, we hypothesize that mobile app push strategies should be based on consumers' spatial and temporal information. Leveraging unique large-scale consumer data on companies' push promotions and customers' responses from a mobile coupon platform, we calibrate a hidden Markov model to test and verify our conjectures.

2 Temporal or Spatial Pooling Solves Wild Goose Chase

Mingliu Chen[1], Ming Hu[2], [1]Columbia University, New York, NY, [2]University of Toronto, Toronto, ON, Canada. Contact: mc5006@columbia.edu

Wild Goose Chase is a phenomenon that may greatly hinder efficiencies in the ride-hailing context. A driver may drive a significant time for a pick-up but end up with a short ride. We propose implementing either temporal or spatial pooling to improve operational efficiencies in such systems. Under temporal pooling, an available driver is not immediately dispatched upon a rider's arrival but until a certain number of riders cumulated in the system. Then the driver is dispatched to pick up the closest one. In spatial pooling, drivers only pick up riders at certain locations instead of chasing them around the city. We show that both pooling mechanisms may greatly improve operational efficiencies. Furthermore, there exists an optimal rider density in temporal pooling, and the efficiency of spatial pooling critically depends on riders' disutility of traveling on foot.

3 Freelancers or Employees? A Field Experiment with a Food Delivery Platform

Wee Kiat Lee[1], Yao Cui[1], Qi Li[2], [1]Cornell University, Ithaca, NY, [2]The Chinese University of Hong Kong, Shenzhen, Shenzhen, China. Contact: liqi@cuhk.edu.cn

The ongoing debate surrounding the regulation of gig platforms to classify service providers as employees rather than freelancers has generated significant industry discussions. However, the potential impact of such a transition on the operational efficiency of gig platforms is largely unknown. In this paper, we adopt an operational perspective to examine this issue. We collaborate with a food delivery platform and implement a field experiment in which orders are randomly routed to freelancers and employees. Using the experimental results, we compare the job performance between freelancers and employees, and derive insights into how a platform should adjust its operational policies when it changes the recruitment status of service providers.

4 Dissecting Fake News: The Role of Novelty and Polarization in Information Diffusion

Senthil Veeraraghavan[1], Kenneth Moon[1], Yijing Zhang[1], Jiding Zhang[2], [1]University of Pennsylvania, Philadelphia, PA, [2]New York University Shanghai, Shanghai, China. Contact: yijingz@wharton.upenn.edu

This study examines the social dynamics of news sharing and its implication for misinformation and media slant. We aim to uncover the underlying economic motives that drive individuals to share news content on social media platforms such as Facebook. Specifically, we propose a method using NLP to quantify news novelty, factoring in its relation to a historical 'news pool' and exposure of similar stories over time and then study the role of novelty and surprise in sharing, and the influence of social tribalism.

Sunday, October 15, 10:45 AM - 12:00 PM

SB56

CC-North 232A

Optimization for Social Good

Community Committee Choice Session

Session Chair: Jean Pauphilet, London Business School, London, United Kingdom

Session Co-Chair
Baizhi Song, London Business School, London, United Kingdom

1 Stability in Many-to-Many Matching of Refugees to Employment Opportunities via Integer Optimization

Marcela Vasconcellos, Andrew C. Trapp, Worcester Polytechnic Institute, Worcester, MA, Contact: msvasconcellos@wpi.edu

Millions of displaced persons are in vulnerable situations due to a lack of permanent solutions for their inclusion in host countries. We approach the challenge of finding formal employment for at-risk refugees by formulating a many-to-many matching problem using integer optimization. Stable matches are important for eliminating the envy that occurs when two players would prefer being matched to one another over their suggested match. We investigate the correctness and efficiency of existing and novel constraint inequalities that can serve to ensure stability in matching optimization models. We also explore their effect on the match quality in many-to-many scenarios. The proposed methods are tested on representative profiles of refugees and job opportunities.

2 Food Subsidies at the Base-of-the-Pyramid: Take-Up, Substitution Effects and Nutrition

Alp Sungu, Ali Aouad, Kamalini Ramdas, London Business School, London, United Kingdom. Contact: asungu@london.edu

We investigate the impact of consumer food subsidy programs on poor consumers' nutrient purchases and data-driven pathways to improve the efficacy of such programs. We conduct an experiment in an urban settlement in Mumbai, India. First, we open a subsidy store to mimic governments' food subsidy programs. Second, we equip local grocery stores with point of sale scanner devices and start a loyalty card program to track individuals' shopping baskets. By randomly assigning households to a subsidy program, we examine how government-like subsidies affect food shopping behaviour. Next, we exogenously vary the subsidized food. Based on estimates of the take-up rates, we uncover a tradeoff between the nutrient richness of different staples and their attractiveness to customers.

3 Optimizing the Path Towards Plastic-Free Oceans

Dick Den Hertog[1], Jean Pauphilet[2], Yannick Pham[3], Bruno Sainte-Rose[3], Baizhi Song[2], [1]University of Amsterdam, Amsterdam, Netherlands; [2]London Business School, London, United Kingdom; [3]The Ocean Cleanup, Rotterdam, Netherlands. Contact: bsong@london.edu

The rising plastic pollution in the oceans has considerable adverse effects on both ecosystems and economic activities. We partner with an NGO and build an optimization-based algorithm that optimizes the route of the plastic collection system to maximize its collection quantity under complex plastic dynamics. We model the problem as finding the longest path in a well-structured graph. The model can incorporate various operational constraints and be extended to larger decision spaces, such as joint planning of the route and the schedule of ship operations. One of the challenges is that plastic distribution is affected by the previous collection route. To solve this, we propose a search-and-bound type of method to efficiently search for the near-optimal solution. We validate our findings on historical ocean data and achieve more than 50% improvement over the current method.

4 Optimization of Ambulance Dispatch Decisions

Anton J. Kleywegt[1], Vincent Guigues[2], Victor Hugo Nascimento[3], [1]ISyE Georgia Tech, Atlanta, GA, [2]School of Applied Mathematics (EMAp), Fundação Getulio Vargas (FGV), Rio de Janeiro, Brazil; [3]Systems Engineering and Computer Science, UFRJ, Rio de Janeiro, Brazil. Contact: anton@isye.gatech.edu

Ambulance dispatch decisions affect response times to emergencies, quality of service provided by ambulances and crews, as well as distribution of ambulances in preparation for future emergencies. Ambulance dispatch decisions are made when an emergency call arrives and a decision is made which ambulance to dispatch, and when an ambulance completes a task and a decision is made where the ambulance should wait for the next dispatch. These decisions should take into account factors such as: (a) Ambulances and crews have different capabilities appropriate for different emergencies. (b) Different ambulances would provide different response times. (c) Available ambulances should provide good coverage for future emergencies. We propose a number of optimization models to support ambulance dispatch decisions, and compare their performance with methods from the literature.

Sunday, October 15, 10:45 AM - 12:00 PM

SB57

CC-North 232B
Digital Platform and OR/MS

Community Committee Choice Session

Session Chair: Yuqian Xu, UNC-Chapel Hill Kenan-Flagler Business School, Chapel Hill, NC

1 Supply Constraints and Housing Rental Market Equilibrium in the Sharing Economy: Evidence from the Airbnb Regulation

Guofang Huang, Jianing Li, Susan F. Lu, Qianli Xu, Purdue University, West Lafayette, IN

This paper analyzes the effects of a supply-constrained regulation on sharing platforms on the equilibrium of the housing rental market, including its quantity, price, and social welfare implications. Using the data from Airbnb, Zillow, and the United States Census Bureau, we examine how a supply-constrained regulation (specifically, the San Francisco's 2017 policy) on sharing platforms can balance the equilibrium of the housing rental market. Our analysis demonstrates that the supply-constrained regulation implemented in San Francisco is effective in reducing the supply of short-term sharing rentals and in reducing the equilibrium prices in the long-term rental market. Moreover, we find that the price effect is less pronounced in affordable housing segments compared to high-end housing segments.

2 Beyond The Average: Empirical Study Of Heterogeneity In Online Retail

Natalie Epstein[1], Santiago Gallino[2], Antonio Moreno[3], [1]Harvard Business School, Cambridge, MA, [2]University of Pennsylvania, Philadelphia, PA, [3]Harvard Business School, Boston, MA

The evolution from brick-and-mortar to online retail has increased service heterogeneity for consumers and cost-to-serve heterogeneity for retailers. In this paper, we show that service performance matters for customers' future purchasing behavior, that it can be a significant driver of operational costs, and the trade-offs between providing better service at higher costs.

3 Scaling Peer-to-Peer Marketplaces in Supply Constrained Markets Through Lease-to-Earn Contracts

Milind Sohoni[1], Neha Sharma[2], Achal Bassamboo[2], [1]Indian School of Business, Hyderabad, India; [2]Kellogg School of Management, Evanston, IL, Contact: mgsohoni@gmail.com

Peer-to-peer marketplaces find it hard to scale up in markets where there is low asset ownership, as in emerging markets, or markets with strict regulations such as New York City. To operate at a scale, many platforms in emerging markets finance assets through long-term leases and offer a share in revenue to users who rent out their assets, hence called lease-to-earn contracts. While such contracts have been effective in some markets, they have not met with success in some markets. In this paper, we find the optimal lease-to-earn contract and theoretically find the value of such contracts.

4 Evolution of Ride Services: From Ride Hailing to Autonomous Vehicles

Daehoon Noh[1], Tunay Tunca[2], Yi Xu[3], [1]University of California, San Diego, San Diego, CA, [2]Robert H. Smith School of Business, College Park, MD, [3]University of Maryland, College Park, MD, Contact: dnoh@ucsd.edu

In recent years ride service industry has been evolving rapidly driven by disruptive technologies such as mobile apps and autonomous vehicles (AVs). While decentralized Ride Hailing companies have gained significant market share in the past decade, vertically-integrated robotaxi services using emerging AVs are starting to enter the market. We model and analyze the competition between an AV-based ride service firm (AV) and a platform-based Ride Hailing firm (RH). We find that when customers are sufficiently patient, in competition, the RH firm predominantly gains the upper hand in the market even if it has a cost disadvantage. Surprisingly, entry of the AV firm into a market with an RH monopolist incumbent may reduce total vehicle supply. When customers are impatient, the entry of an inefficient AV firm may even lead to a decrease in social welfare.

Sunday, October 15, 10:45 AM - 12:00 PM

SB58

CC-North 232C

Machine Learning to Inform Business Decisions

Contributed Session

Session Chair: Marc Goessling, Afresh Technologies, Jersey City, NJ

1 Improving Restaurant Sales Forecasting Using Weather Forecasting Data

Shikhar Prasad Acharya[1], Biniv Maskay[2], [1]University of North Texas at Dallas, Dallas, TX, [2]Loras College, Dubuque, IA

Forecasting sales in any restaurant is crucial for inventory management and scheduling of employee hours. Most traditional methods almost exclusively rely on time series analysis and utilize factors such as month of year, day of week, and time of day to forecast sales. We analyzed daily sales of a fast-food restaurant in central Iowa for 3 years by using machine learning algorithms XGBoost and SHAP.

Our study shows that adding weather forecast data from NOAA such as average temperature and precipitation as independent factors significantly improves the accuracy of sales forecasting in a restaurant. This can result in cost reduction through better inventory planning and scheduling of employee hours in restaurants.

2 Intelligent Decision Support System for Steel Market Analytics

Pyam Oveys[1], Mahima Naznin[1], Thomas Willerth[1], Sharan Srinivas[2], James Noble[2], Anthony Ross[2], Kihyung Kim[3], [1]University of Missouri, Columbia, MO, [2]University of Missouri, Columbia, MO, [3]University of Missouri, COLUMBIA, MO, Contact: mngnd@mail.missouri.edu

The price of steel is set by multiple market factors as well as domestic and international events resulting in high price volatility. As such, understanding the trends in steel pricing is crucial for making profitable procurement decisions. Through correlation and covariance analysis we have identified several new critical economic predictors that impact the price of steel. This data is then used in an interactive decision support system utilizing a visualization dashboard as well as a predictive model. Numerical experiments indicate our model, a blend of time series analysis, linear regression, and machine learning, can predict the price of steel with a high degree of accuracy up to 12 weeks in advance.

3 Grocery Demand Forecasting in the Presence of Weekly Advertised Promotions

Marc Goessling, Afresh Technologies, San Francisco, CA, Contact: marc.goessling@afreshtechnologies.com

A core requirement for successful grocery store ordering policies are accurate demand forecasts. The forecasts have to be probabilistic in nature and they have to cover multiple possible target horizons of different lengths. We present a practical system for this task based on a deep neural network. An additional challenge for grocery demand forecasting are frequently occurring price discounts. These can correspond to planned weekly advertised promotions or ad-hoc temporary price reductions for liquidation reasons. One of our findings is that price elasticity can vary drastically based on the type of grocery item, meaning that the corresponding sales-price curves have different steepness. We discuss how we incorporated price sensitivity into our forecaster and how it impacted forecast accuracy.

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SB59

CC-West 101A

Behavioral Issues in Multiple Criteria Decision Making

Community Committee Choice Session

Session Chair: Jyrki Wallenius, Aalto University School of Business, Kirkkonummi, Finland

Session Chair: Kalyanmoy Deb, Michigan State University, East Lansing, MI

1 Multiple Objectives Cause Psychological Burden

Jyrki Wallenius[1], Matias Kivikangas[2], Julian Blank[3], Ville Harjunen[4], Pekka Malo[1], Eeva Vilkkumaa[1], Kalyanmoy Deb[5], Niklas Ravaja[6], [1]Aalto University School of Business, Espoo, Finland; [2]Aalto University School of Business, Espoo, Finland; [3]Michigan State University, East Lansing, MI, [4]Helsinki University, Espoo, Finland; [5]Michigan State University, Espoo, MI, [6]Helsinki University, Helsinki, Finland

We investigate a situation relevant for Multiple Criteria Decision Making (MCDM) as well as Evolutionary Multi-objective Optimization (EMO), where the decision-maker needs to make a series of choices between nondominated options characterized by multiple objectives (criteria, attributes, dimensions). We measure how different levels of difficulty — the number of decision-making dimensions (attributes, objectives) — influence the psychological burden in a laboratory study. We use psychophysiological, behavioral, and self-report methods to make potentially impacting conclusions.

2 Biases in Multiattribute Utility Analysis (MAUA)

Detlof von Winterfeldt, USC, Los Angeles, CA, Contact: detlof@aol.com

We discuss omission, weighting, and scaling biases in MAUA. We demonstrate how these biases, when uncorrected, can lead to serious distortions of the results of a MAUA.

3 Using Process Tracing to Study Consumer Multiattribute Choice

Ilkka Leppänen, Aalto University School of Business, Espoo, Finland. Contact: ilkka.j.leppanen@aalto.fi

We use a novel method of dynamic process tracing in a preference-based choice task among consumer products. The method is based on a motor response dynamics paradigm that is derived from evidence accumulation models where the decision process is represented as a process of noisy temporal integration of information. We demonstrate that this method can model not just the decision maker's preferences among different attributes, but also the internal components of processing related to attribute information. We also use this method to explore how internal processing is affected by display properties of the choice options.

4 Cognitive Operations: Models that Open the Black Box and Predict Our Decisions

Konstantinos Katsikopoulos, University of Southampton

Cognitive operations examines how people make decisions under risk and uncertainty in operational settings by opening the black box and specifying the cognitive processes that lead to human behavior. Drawing on economics, psychology and artificial intelligence, the book provides an innovative perspective on behavioral operations: It shows how to build optimization as well as heuristic models for describing human behavior and how to compare such models on various dimensions such as predictive power and transparency, and also discusses interventions for improving human behavior. This talk will be particularly valuable to academics and practitioners who seek to select a modeling approach that suits the operational decision at hand.

5 Empirical Studies to Compare Interactive Multiobjective Optimization Methods with Human Participants

Giovanni Misitano[1], Bekir Afsar[1], Johanna Silvennoinen[1], Ana Belén Ruiz[2], Francisco Ruiz[3], Kaisa Miettinen[4], [1]University of Jyväskylä, Jyväskylä, Finland; [2]University of Malaga, Malaga, Spain; [3]University of Malaga, Malaga, UT, Spain; [4]University of Jyvaskyla, Univ. of Jyvaskyla, Finland. Contact: giovanni.a.misitano@jyu.fi

Applying interactive multiobjective optimization (MOO) methods necessitates preference information from a decision maker (DM). Because of the active role of the DM, comparison of interactive methods must be planned carefully. Previous comparisons have been rare and irreproducible. We have developed a new, reproducible experimental design to compare interactive MOO methods with human participants. Utilizing a novel questionnaire, we measure the cognitive load experienced by DMs, their satisfaction with the solution process and the solution finally obtained. We also compare the methods' ability to reflect preferences and responsiveness to changes in the preferences. Our design enables a transparent comparison of interactive MOO methods.

Sunday, October 15, 10:45 AM - 12:00 PM

SB60

CC-West 101B

Growth of Student Researchers Through Executive Functions Lenses

Panel Session

Session Chair: Mihir Mehta, Penn State University, State College, PA

Session Chair: Nathan B. Gaw, Air Force Institute of Technology, Wright-Patterson AFB, OH

Session Chair: Katherine Adams, University of Wisconsin-Madison, Monona, WI

1 Growth of Student Researchers Through Executive Functions Lenses

Nathan B. Gaw, Air Force Institute of Technology, Wright-Patterson AFB, OH

Panel discussion on neurodivergence and DEI initiatives in this direction.

2 Panelist

Samantha De Palo, Jones-Gordon School, Phoenix, AZ

3 Panelist

Mihir Mehta, Penn State University, State College, PA

Sunday, October 15, 10:45 AM - 12:00 PM

SB61

CC-West 101C

Innovation, Regulation, and Humanitarian Logistics

Community Committee Choice Session

Session Chair: Wenqing Zhang, University of Minnesota Duluth, Duluth, MN

Session Chair: Muer Yang, University of St. Thomas, Minneapolis, MN

1 Exploring Benefits and Ethical Challenges in the Rise of Mhealth (Mobile Healthcare) Technology for the Common Good

Sameer Kumar[1], Panagiota Galetsi[2], Korina Katsaliaki[3], [1]University of St Thomas, Minneapolis, MN, [2]University of St Thomas, Thessaloniki, Greece; [3]International Hellenic University, Thessaloniki, Greece. Contact: skumar@stthomas.edu

This study reflects on proliferating ethical initiatives in healthcare industry while leveraging innovative digital technological infrastructures including use of mobile technology for health professionals. Using content analysis, smartphone apps for health professionals were classified based on type. Expanded CPM theory explain ethical

considerations of mHealth apps' selection based on existing privacy & trustworthiness features, giving emphasis to apps utilizing smart technologies. Future agenda include development of technologically advanced and responsible mHealth apps. Disease handbook/manual and differential diagnosis are most frequently appearing mHealth apps. Apps utilizing AI methods are still few with expectations for apps with more smart capabilities. Study offers multi-layered analysis of usefulness of health-diagnosis mobile apps.

2 Mitigating Probability Uncertainties in Prepositioning Relief Supplies a Scenario-Robust Approach

Muer Yang[1], Sameer Kumar[2], Xinfang Wang[3], Michael Fry[4], [1]University of St. Thomas, Minneapolis, MN, [2]University of St Thomas, Minneapolis, MN, [3]Georgia Southern University, Statesboro, GA, [4]University of Cincinnati, Cincinnati, OH, Contact: yangmuer@stthomas.edu

The high-level uncertainty inherent to humanitarian logistics requires resilient plans for prepositioning relief supplies. This paper seeks to accommodate both aleatoric and epistemic uncertainties related to humanitarian logistics decisions. The proposed two-stage stochastic models incorporate a f-divergence uncertainty region to improve their solutions' robustness against uncertainty in the estimated probability of scenarios. We conduct Monte Carlo simulation studies using a real-world case of hurricane preparedness in the Southeastern United States to demonstrate that our methods are effective in mitigating probability uncertainties, particularly when the estimation errors of the scenario probabilities are large.

3 New Tech and Carbon Tax

Wenqing Zhang, University of Minnesota Duluth, Duluth, MN

The adoption of green technologies by firms may provide benefits that do not exceed the costs of adoption many may seek alternate-green methods that can provide output that can achieve a satisfying level of strategic performance. We use a game-theoretic model to see how marketing sustainable practices through social media a!ect it.

4 How Does the Blockchain Affect the Online Channel Selection of Competitive Remanufacturing?

Wei Gu, Chen Wang, Shufen Dai, University of Science and Technology Beijing, Beijing, China

Under the dual effects of environmental protection and economic benefits, original equipment manufacturers (OEMs) have started product remanufacturing. OEMs are facing the online channel selection (agency, resale, dual channel) issue when considering the cannibalization effect of the remanufacturing product to the new product. This paper integrates the quality perception and green perception of the consumer into a Stackelberg model to study the impact of the blockchain application on online channel selection of the competitive products. The results indicate that whether blockchain technology can improve the total profitability of online channels depends on consumers' sensitivity to the blockchain. After adopting blockchain technology, OEMs are more inclined to sell competitive products online through a dual channel mode.

5 Overconfidence in Subscription-Based Services: An Experimental Study

Wei Gu, Jing Luo, University of Science and Technology Beijing, Beijing, China

This study investigates the impact of overconfidence on customers' preferences in a subscription-based service. Using bike sharing services as an example, we examine whether customers who overestimate their usage tend to choose a monthly subscription plan instead of pay-per-use. Additionally, we explore how the pricing strategy, specifically bundling the monthly membership with other products or services, affects customer behavior and exacerbates overconfidence. By conducting experiments, this study uncovers the factors that drive customers' payment decisions and highlights potential implications for businesses determining pricing strategies in subscription-based services.

Sunday, October 15, 10:45 AM - 12:00 PM

SB62

CC-West 102A

Political Redistricting

Community Committee Choice Session

Session Chair: Maral Shahmizad, Oklahoma State University, Stillwater, OK

1 Redistricting Compromise with Distance Metrics and Midpoints

Kiera W. Dobbs[1], Ian Griffith Ludden[2], Douglas M. King[3], Sheldon H. Jacobson[4], [1]University of Illinois at Urbana-Champaign, Champaign, IL, [2]University of Illinois Urbana-Champaign, Urbana, IL, [3]U of Illinois at Urbana-Champaign, Urbana, IL, [4]University of Illinois, Urbana, IL, Contact: kdobbs2@illinois.edu

We propose an optimization framework to facilitate compromise between two given district plans. Using the transfer distance metric on graph partitions, we formulate a mixed-integer linear program to determine a feasible (approximate) midpoint plan between two given plans. We also generalize this program to find any fractional point between the two given plans and present computational experiments.

2 Political Districting to Minimize County Splits

Maral Shahmizad, Austin Buchanan, Oklahoma State University, Stillwater, OK, Contact: maral.shahmizad@okstate.edu

When partitioning a state into political districts, a common criterion is that political subdivisions like counties should not be split across multiple districts. This criterion is encoded into most state constitutions and is sometimes enforced quite strictly by the courts. However, map drawers, courts, and the public typically do not know what amount of splitting is truly necessary. In this presentation, we provide answers for all congressional, state senate, and state house districts in the USA using 2020 census data. Our approach is based on integer programming. The associated codes and experimental results are publicly available on GitHub.

3 In Pursuit of Compact Majority-Minority Districts

Samuel Kroger[1], Hamidreza Validi[2], Tyler Perini[3], Illya V. Hicks[3], [1]Rice University, Houston, TX, [2]Texas Tech University, Lubbock, TX, [3]Rice University, Houston, TX, Contact: sak8@rice.edu

The Voting Rights Act, Section 2, enacts the creation of majority-minority districts to provide minority groups with the opportunity to elect representatives of their choice. The Voting Rights Act enumerates three conditions (“Gingles prongs”) which necessitate the creation of majority-minority districts. We proposes mixed integer programming (MIP) formulations and fixing procedures for identifying the number of majority-minority districts which can be made and producing compact majority-minority districting plans at county and tract levels. While compactness is usually considered as an objective in redistricting optimization formulations, we provide a framework for optimizers to capture it in constraints. This provides opportunities to pursue other crucial redistricting criteria (e.g., federal constitutional requirements) in the objective function.

4 Distrix and Fastmap: Addressing America’s Gerrymandering Problem with a Puzzle Book, Strategy Game, and Computer Algorithm

Matthew Petering, University of Wisconsin-Milwaukee, Milwaukee, WI, Contact: mattpete@uwm.edu

We describe three recent projects aimed at increasing the fairness of political districts in the USA. The Distrix Puzzle Book contains 90 brainteasers that challenge readers to draw election districts that are fair or rigged in favor of different parties. The award-winning Distrix game system introduces a new method for political redistricting in which political parties form election districts in a high-stakes game, one voting precinct at a time. The FastMap computer algorithm considers 15 redistricting criteria when creating maps of congressional, state legislative, and local election districts. It generated the most politically fair maps of Wisconsin’s legislative districts in 2020-2021 and the maps that best adhered to the Wisconsin Supreme Court’s “least change” ruling from Nov. 30, 2021. Our experiences with these projects are shared.

Sunday, October 15, 10:45 AM - 12:00 PM

SB63

CC-West 102B

Data, AI, and Business Processes

Community Committee Choice Session

Session Chair: Brian Han, Gies College of Business, UIUC, Los Angeles, CA

1 Value of Autonomous Last-Mile Delivery: Evidence from Alibaba

Brian Han[1], Meng Li[2], Yanan Zhang[3], Lixia Wu[4], [1]Gies College of Business, UIUC, Los Angeles, CA, [2]University of Houston, Houston, TX, [3]Shanghai Jiaotong University, Shanghai, China; [4]Cainiao Smart Logistics Network Ltd., Hangzhou, China

This paper provides the first empirical evidence on consumer responses based on Alibaba’s recent implementation of autonomous last-mile delivery on university campuses in China. The study leverages customer-level data from three universities over three years, employing a difference-in-differences approach combined with matching to estimate the impact of autonomous delivery adoption on order quantities. We find that compared with self-pickup, consumers order significantly more after adopting autonomous last-mile delivery. The number of orders increased by 24% in the first three months and 18% during following months. The efficiency and flexibility of autonomous vehicles reduce consumers’ travel costs, driving long-term usage and increased sales. However, the value of autonomous delivery diminishes when a fee is charged.

2 The Value of Operational Transparency: Empirical Evidence from a Food Delivery Platform

Zhanzhi Zheng[1], Yuqian Xu[2], Bradley R. Staats[3], [1]UNC Kenan-Flagler Business School, Chapel Hill, NC, [2]UNC-Chapel Hill Kenan-Flagler Business School, Chapel Hill, NC, [3]University of North Carolina at Chapel Hill, Chapel Hill, NC, Contact: zhanzhi_zheng@kenan-flagler.unc.edu

Operational transparency permits service providers to build trust with customers. In July 2021, Zhejiang province published a regulation that online restaurants show real-time food preparation processes online. Using a novel data-set of restaurants we use this policy change to investigate how operational transparency impacts restaurants' business performance.

3 Crowd-Starting a Shared (Shuttle) Service with Customer Suggestions

Long He[1], Tu Ni[2], [1]George Washington University, Washington, DC, [2]National University of Singapore, Singapore, Singapore. Contact: longhe@gwu.edu

We consider a platform that offers a shared shuttle service by gathering customer suggestions in a "crowd-starting" manner, which provides valuable information about customer needs. However, this also poses a challenge in balancing service coverage and quality to meet customer needs. To address this, we propose a service design optimization model to maximize expected customer adoption where we use a preference list model to understand how customers will respond to different service attributes and how their suggestions inform these responses. We further apply our model to a shared shuttle service case study and discuss practical considerations in the service design process.

4 Robotic-Assisted Surgery: Are Experts Learning from Interactions with Machines?

Thomas Ware, Arizona State University, Tempe, AZ

Robotic-assisted surgery is an emerging minimally-invasive surgical innovation to augment surgeons' capabilities in the operating room. To develop a better understanding of the role of human collaboration with robots in operative settings, we study whether robotic-assisted surgeries lead to improved overall effectiveness by reducing intraoperative risks during the procedure. We test our hypothesis using panel regression with patient-level surgery data in collaboration with the Veterans Health Administration. We observe significant reductions in intraoperative risks, in comparison to surgeries utilizing only manual techniques. We contribute to the research on robotic-assisted surgery and, more importantly, information systems literature by describing the benefits of machine-enabled augmentation.

Sunday, October 15, 10:45 AM - 12:00 PM

SB64

CC-West 102C

Social Media Analytics Best Student Paper Award

Award Session

Session Chair: Wenqi Shen, Virginia Tech, Blacksburg, VA

1 Chatbot in Disguise: How Non-Disclosing Agent Identity Spurs Strategic Behavior

Yu (Rain) Kan, Yifan Yu, Lin Jia, Yong Tan, University of Washington- Michael G. Foster School of Business, Seattle, WA

This study explores the impact of agent type (AI, ChatGPT, human, or undisclosed) on customers' strategic behavior and satisfaction in a two-round experiment. Findings indicate heightened strategic behavior and lower satisfaction in the non-disclosure group. This study uncovers dual pathways causing these effects and utilizes mediation analysis and policy tree methods, providing significant business insights.

2 Deep-Learning-Based Causal Inference for Large-Scale Combinatorial Experiments: Theory and Empirical Evidence

Zikun Ye[1], Zhiqi Zhang[2], Dennis J. Zhang[2], Heng Zhang[3], Renyu Zhang[4], [1]University of Washington, Seattle, WA, [2]Washington University in St. Louis, St. Louis, MO, [3]Arizona State University, Tempe, AZ, [4]The Chinese University of Hong Kong, Hong Kong, China

We develop a framework combining deep learning and double machine learning to estimate and infer the causal effect of any treatment combination of multiple treatments when observing only a small subset of treatment combinations. Our proposed framework exploits Neyman orthogonality and combines interpretable and flexible structural layers in deep learning. To empirically validate our method, we collaborated with a large-scale video-sharing platform and implemented our framework for three experiments involving three treatments where each combination of treatments is tested.

3 Are You Already Satisfied? The Heterogeneous Effect of Media User Generated Contents on Free and Paid Mobile Games: Evidence from YouTube Comments

Seungwook Jin, Keumseok Kang, KAIST, Daejeon, Korea, Democratic People's Republic of

This research examines how user-generated content (UGC) sentiment impacts mobile game sales using a dataset of 58,000 apps and YouTube comments. Findings show positive sentiment boosts paid-to-play game revenue, but decreases free-to-play revenue, indicating a substitutional effect. Sentiments affect various aspects of the revenue generation process, from downloads to long-term retention.

4 Intertemporal Spillovers in Consumer Experiences: Empirical Evidence and Service Design Implications

Abhishek Deshmane[1], Victor Martínez de Albéniz[2], Guillaume Roels[3], [1]Georgia Institute of Technology, Atlanta, GA, [2]IESE Business School, New York, NY, [3]INSEAD, Fontainebleau, France

Experiences are influenced by the impact of previous activities. Through a model that separates inherent quality from individual satisfaction, positive and negative spillovers are disentangled. Our findings suggest scheduling the best activity in the middle for maximum utility and saving a "wild card" activity to recover from bad outcomes.

Sunday, October 15, 10:45 AM - 12:00 PM

SB65

CC-West 103A

Innovative Operations

Community Committee Choice Session

Session Chair: Neda Mirzaeian, University of Texas at Dallas, Richardson, TX

1 The Impact of Exchangeable Sports Tickets on Customer Purchasing Behavior

Hayri Alper Arslan[1], Yao Cui[2], Ross Rotwein[3], Ovunc Yilmaz[4], [1]University of Texas at San Antonio, San Antonio, TX, [2]Cornell University, Ithaca, NY, [3]MountainStar Sports Group LLC, El Paso, TX, [4]University of Colorado Boulder, Boulder, CO

Using transactional data from a US professional sports company that owns a baseball and a soccer team, we investigate the impact of selling exchangeable tickets that provide fans flexibility to change the game they attend for a small additional fee. We find that the use of exchangeable tickets leads to significant changes in customers' purchase time and total spending.

2 Promoting Equity in Micro-Mobility Sharing Services

Sheng Liu[1], Long He[2], Wu Hao[3], [1]University of Toronto, Toronto, ON, Canada; [2]George Washington University, Washington, WA, [3]National University of Singapore, Singapore, Singapore

Public authorities subsidize and regulate micro-mobility sharing services to ensure mobility equity. However, the effects of such policies on equity, especially when service providers prioritize profits over fairness, are unclear. Our study focuses on two equity-related policies-subsidy policy and regulatory policy, and we analyze their impacts on service performance. Our study offers insights into the efficiency and effectiveness of different equity policies in micro-mobility sharing services.

3 Optimal Cardinal Contests

Goutham Takasi, University of Texas-Dallas, Richardson, TX, Contact: vgt170000@utdallas.edu

We study the optimal design of a crowd-sourcing contest in settings where the output is quantifiable - e.g., a data science challenge. This setting is in contrast to settings where the output can only be assessed qualitatively - e.g., designing a logo. The rapidly growing literature on the design of crowd-sourcing contests focuses on ordinal contests - these are contests where contestants' outputs are ranked by the organizer and awards are based on these ranks. Such contests are ideally suited for the latter setting (where output is qualitative). For our setting (quantitative output), it is possible to design cardinal contests where awards are based on the actual outputs and not on their ranking alone - thus, our space of contest designs includes ordinal contests but is much larger. We derive an easy-to-implement contest design for this setting and prove its optimality.

4 Modeling and Managing Curbside Ride-Hailing Drop-Offs

Neda Mirzaeian[1], Soo-Haeng Cho[2], Sean Z. Qian[2], [1]University of Texas at Dallas, Richardson, TX, [2]Carnegie Mellon University, Pittsburgh, PA, Contact: neda.mirzaeian@utdallas.edu

We investigate the effect of ride-hailing drop-offs on morning commuting patterns, characterizing a user equilibrium for commuters. We develop a continuous-time traffic model that incorporates parking fees and traffic congestion. In this model, commuters make decisions regarding departure times from their residences and transportation mode options, choosing between personal vehicles and ride-hailing services. Additionally, the ride-hailing company (RHC) determines the ride-hailing fares. Our results reveal that, in an unregulated market, the RHC can control the market to maximize its profit, causing substantial congestion and increased system cost. We demonstrate that by adjusting downtown parking fees and imposing drop-off tolls, we can significantly reduce both the system cost and congestion levels. We illustrate our results using data from Pittsburgh.

Sunday, October 15, 10:45 AM - 12:00 PM

SB66

CC-West 103B

Collaboration in Innovation

Community Committee Choice Session

Session Chair: Pascale Crama, Singapore Management University, Singapore, Singapore

1 Prototyping in New Product Development

Gaoyu Xie[1], Janne Kettunen[2], [1]George Washington University, Washington, DC, [2]The George Washington University, Washington, Contact: gaoyux@gwmail.gwu.edu

The study employs the binomial option pricing model to examine when it is optimal to develop a prototype under uncertainty in product development efforts. The analysis is conducted with decision-makers (DMs) who aim to maximize their mean-variance utility. The study shows that when the level of development uncertainty is low, prototyping is optimal as it helps to learn about market requirements, leading to product improvements. On the other hand, when development uncertainty is high, a prototype is useful as a screener, allowing DMs to selectively abandon unfavorable development outcomes. In contrast, under medium or extremely high levels of development uncertainty, the optimal decision is to abandon development. Overall, the study highlights the dual purpose of prototyping and its importance in dealing with development uncertainty.

2 Should We Renegotiate or Leave the Contract?

Sara Rezaee Vessal, France

The suppliers might sometimes develop a new product with inferior quality to the buyer's expectations. We model the possibility of conditional acceptance of such products by the buyer. Our goal is to track the effect of conditional acceptance on supplier incentives to exert product development efforts. We construct a non-cooperative sequential game with risk-neutral players and analyze their equilibrium strategies. We find that implementing the conditional acceptance policy indeed affects supplier incentives if the product is of relatively high value to the buyer. The effect direction depends on the cost of effort and project success probability.

3 R & D Consortia in Competitive Supply Chains

Gaoyan Lyu[1], Pascale Crama[2], Yi Xu[3], [1]Beijing Institute of Technology, Beijing, China; [2]Singapore Management University, Singapore, Singapore; [3]University of Maryland, College Park, MD, Contact: lgy@bit.edu.cn

R&D consortia, which coordinate R&D activities of their member firms, have been successful in many industries. We study a model with two competing supply chains each consisting of a manufacturer and a supplier. The manufacturers compete in the final product market, and can conduct R&D to reduce unit product costs of their final products. The R&D can be done in three different ways: by the two manufacturers independently, by them jointly in a horizontal R&D consortium, or by the supplier and the manufacturer jointly in each supply chain in two vertical R&D consortia. We find that as compared to independent R&D, both the horizontal consortium and the vertical consortia lead to higher R&D effort, wholesale prices, and output quantities in the supply chains. However, different supply chain parties' preferences over the two types of consortia are not necessarily consistent.

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SB67

CC-West 104A

Disaster Management: Industrial and Civil Engineering

Community Committee Choice Session

Session Chair: Hootan Kamran, University of Toronto, Toronto, ON, Canada

1 Distance-Based Critical Node Detection for Strategic Vaccination Policies

Faraz Khoshbakhtian[1], Hamidreza Validi[2], Mario Ventresca[3], Dionne Aleman[4], Randy Giffen[5], Proton Rahman[6], [1]University of Toronto, Toronto, ON, Canada; [2]Texas Tech University, Lubbock, TX, [3]Purdue University, Lafayette, IN, [4]University of Toronto, Toronto, ON, Canada; [5]IBM Canada, St. John's, NL, Canada; [6]Eastern Health, St. John's, NL, Canada. Contact: faraz.khoshbakhtian@mail.utoronto.ca

Effective vaccination policies are vital for controlling infectious diseases. We formulate the vaccination problem as the distance-based critical node detection problem (DCNDP) and present a novel approach for optimal vaccination under budget constraints. We introduce a lightweight integer programming model for 2-hop DCNDP and a divide-and-conquer pipeline for near-optimal solutions on large networks. Applied to a simulated contact network of a Canadian province (>500K nodes) during COVID, our method reduces 2-hop connectivity by 84% with 20% vaccine coverage. We further enhance our approach by integrating granular agent-based pandemic modeling and machine learning to derive effective vaccination policies. Our framework can be adapted to different regions and can be used as a decision-making tool to enhance public health outcomes.

2 Prominent Methodologies for Examining the Resilience of Infrastructure Systems

Nazanin Tajik, Misissipi State University

The research establishes the nexus of standard vulnerability measures and the 17 prevalent network topologies, aiming to draw the effectiveness of these measures on different network topologies against different disruption scenarios. The research conducted empirical analyses on the network topologies under the most common disruption patterns, including local, random, targeted, and cascading disruptions. With different network sizes, The resulting body of knowledge illustrates the triangular connection between network topology, disruption patterns, and vulnerability measures efficiency.

3 Concurrent Restoration of Coupled Infrastructures

Shabnam Rezapour, Namrata Saha, Mohammadhadi Amini, Florida International University, Miami, FL, Contact: nsaha003@fiu.edu

Timely restoration of critical infrastructures (CIs) is mandatory to increase the resilience of communities against disruptive events. Due to the resource scarcity after disasters, the restoration of all disrupted components cannot be triggered simultaneously in CIs. In this paper, we develop a novel modeling and solution approach that enables us to generate a cooperative restoration plan for coupled CIs under decentralized decision-making structure and different levels of uncertainty.

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SB68

CC-West 104B

Digital Society and Advanced Data Analytics: Innovations, Advancements, and Challenges

Community Committee Choice Session

Session Chair: Jiao Wu, Northern Illinois University, DeKalb, IL

Session Chair: Jiaxi Luo, Midwestern State University, Wichita Falls, TX

1 HOW TO MAKE VIDEOS MORE ATTRACTIVE? AN INVESTIGATION ON THE IMPACTS OF VIDEO FEATURES ON VIEWER ENGAGEMENT

Ying Wang[1], Jiao Wu[1], Jaeki Song[2], [1]Northern Illinois University, DeKalb, IL, [2]Texas Tech University, Lubbock, TX

This study investigates the factors contributing to active engagement for virtual influencer videos. By integrating the elaboration likelihood model and social identity theory, our proposed theoretical framework elaborates on the relationship between various features of influencer videos and engagement rates. Further, it demonstrates that video character types could moderate this relationship. We found that visual features such as brightness, colorfulness, and vividness have a more pronounced influence on engagement rates in animated character videos than in human-like character videos. In contrast, the content topics discussed in the videos exert a stronger influence on engagement rates in videos featuring human-like characters than in animated character videos.

2 Emotion and Ideology Factors on Persuasiveness of Online Petitions

Jiao Wu, Northern Illinois University, DeKalb, IL, Contact: jwu3@niu.edu

Victory Online petition helps the mass people to influence decisions and arouse broad attention. Different linguistic cues are found to influence the persuasiveness of the petition. In this work, we combine discrete emotional cues and political ideology cues. We developed an analytical model which illustrates the relationship between the discrete emotion cues and ideology cues with the success of the online petitions. The data were from Change. Org. Our results highlight the need to use objective data to reduce the drawbacks of survey methods. Also, the findings can be used to design and develop more efficient petitions.

3 Impact of Covid-19 on Consumer Sentiments in the Automotive Industry: A Text-Mining Approach

Jiaxi Luo, Midwestern State University, Wichita Falls, TX

The COVID-19 pandemic has significantly disrupted the automotive industry, especially due to semiconductor chip shortages. This situation raises two key questions: Has consumer sentiment during the automobile purchase process changed due to COVID-19? How do these sentiments influence their ratings of car dealerships? To tackle these queries, we employ a text-mining methodology coupled with an ordered probit regression analysis. Our findings reveal that post-COVID-19, the sentiment keyword "fast" positively impacts online dealership ratings. Conversely, "wait" negatively affects ratings. Interestingly, "willing" and "mess" have consistently negative effects on ratings, both pre and post-pandemic. This study offers a unique perspective on the evolving consumer sentiments in the automotive industry amid a global crisis.

4 Consistency Is Not Always Key: Text And Image Consistency Across Social Media Posts

Timothy Kaskela[1], Jaeki Song[2], [1]Oregon State University, Corvallis, OR, [2]Texas Tech University, Lubbock, TX

Social media platforms have provided an important lane of communication between corporations and consumers. There has been substantial research into engagement that occurs between corporations and consumers, but there are areas that need further examination. We build upon existing research on social media engagement and consistency to examine how two components of a social media post, text and complexity, can impact engagement through consistent messaging across consecutive posts for a single company. A pilot study is conducted in which 62,853 tweets and 19,997 images are collected from 8 different companies. We find that consistency of text leads to positive engagement, however consistency of image and the interaction between text consistency and image consistency have a negative effect on engagement. Planned further research and implications are then discussed.

Sunday, October 15, 10:45 AM - 12:00 PM

SB69

CC-West 105A

Market Design for Social Impact, Applications and New Insights

Community Committee Choice Session

Session Chair: Michael L. Hamilton, University of Pittsburgh, Pittsburgh, PA

1 Two-Sided Assortment Optimization with Simultaneous and Sequential Matches

Ignacio Rios[1], Alfredo Torrico[2], [1]The University of Texas at Dallas, Richardson, TX, [2]Cornell University, Ithaca, NY

We study the two-sided assortment problem recently introduced by [Rios et al., 2022]. A platform must choose an assortment of profiles for each user in each period. Users can either like/dislike as many profiles as they want, and a match occurs if two users see and like each other, potentially in different periods. The platform's goal is to maximize the expected number of matches generated. We show that the problem is NP-hard, even if we consider two periods and only one-directional sequential matches. Given this, we focus on the case with two periods and provide algorithms and performance guarantees for different variants of the problem. We use data from our industry partner (a dating app in the US) to numerically show that the loss for not considering simultaneous matches in the second period when making first-period decisions is negligible.

2 Project 412Connect: Bridging Students and Communities

Alex DiChristofano[1], Michael L. Hamilton[2], Sera Linardi[3], [1]Washington University in St. Louis, St. Louis, MO, [2]University of Pittsburgh, Pittsburgh, PA, [3]University of Pittsburgh, Pittsburgh, PA

In this work, we investigate some of the challenges Black-owned businesses face. Taking into account dynamics specific to the Pittsburgh region, we determine that university students represent an under-utilized market for these businesses. We investigate the root causes for this inefficiency and design and implement a platform, 412Connect, to increase support for Pittsburgh Black-owned businesses from students in the university community. The platform operates by coordinating interactions between student users and participating businesses. Our platform design choices are aided by two simple, novel models for badge design and equity-orientated recommendations that may be of independent interest.

3 Eliminating Waste in Cadaveric Organ Allocation

Peng Shi, Junxiong Yin, University of Southern California, Los Angeles, CA, Contact: junxiong.yin@marshall.usc.edu

Many reforms have been or are currently being implemented to address the cadaveric organ wastage problem. However, we show that waste will still be a problem as long as the allocation mechanism continues to prioritize patients by their waiting times, which incentivizes patients to reject organs of reasonable quality now to wait for better offers in the future. By analyzing a theoretical model, we show that the necessary and sufficient conditions to eliminating waste are to disincentivize waiting by allocating over-demanded organ types only to the patients who recently signed up for transplantation, and to give the patients who are not allocated their ideal organs an opportunity to take another offer. However, such a policy may be contentious as it no longer prioritizes patients by waiting times. Moreover, it may reduce the welfare of the patients who are the most willing to wait.

4 Hyperlocal Food Sharing: Household vs Commercial Food Donation Channel

Ekaterina Astashkina[1], Masha Shunko[2], Haonan Zhang[3], [1]Ross School of Business, University of Michigan, Ann Arbor, [2]University of Washington, Seattle, WA, [3]University of Washington-Seattle, Seattle, WA, Contact: hzhang96@uw.edu

We utilize the proprietary dataset from the world's largest food sharing platform, which facilitates donation of soon-to-expire excess food generated by (i) households and (ii) food businesses (supermarkets, grocery stores, bakeries, etc.) to the households in need. The platform aims to reduce household- & commercial- food waste and alleviate hunger. We both analytically and empirically examine the impact of the introduction of the second (commercial) channel as opposed to just the household channel onto the donation activities performed by households. We characterize the equilibrium outcomes of the platform before (after) adding the commercial channel and characterize the optimal level of commercial channel intervention that boosts the demand for household channel and matching rates.

Sunday, October 15, 10:45 AM - 12:00 PM

SB70

CC-West 105B

The Future of Federated Learning: Prospective Trends and Research Directions

Community Committee Choice Session

Session Chair: Brianna Mueller, University of Iowa, Iowa City, IA

1 New Federated Learning Algorithms for Deep Learning with Unbounded Smooth Landscape

Mingrui Liu, George Mason University, Fairfax, VA

The current analysis of federated optimization algorithms for training deep neural networks typically requires the landscape to be smooth. However, there is a class of deep neural networks which is inherently nonsmooth, with a potentially unbounded smoothness parameter. Examples include recurrent neural networks, long-short term memory networks, and transformers. It remains unclear how to design provably efficient federated optimization algorithms for training these neural networks.
In this talk, I will consider the federated deep learning setting in the presence of unbounded smoothness. I will introduce two new efficient algorithms for homogeneous and heterogeneous data respectively. The main result is that these algorithms provably enjoy linear speedup and require significantly fewer communication rounds.

2 Dynamic Ensemble Selection for Personalized Federated Learning: A Decentralized Approach Based on Peer-To-Peer Model Sharing and Adaptive Model Aggregation

Brianna Mueller, University of Iowa, Iowa City, IA

The heterogeneity of datasets in federated learning (FL) poses challenges in achieving robust model aggregation and generalization. To address such challenges, personalized FL methods have been proposed to tailor the learning process to each client's data distribution. In this context, we introduce a novel approach that leverages dynamic ensemble selection (DES), which not only offers personalized models for individual clients, but also delivers unique solutions for each test sample. Our proposed framework is based on peer-to-peer model sharing, where clients maintain a collection of models from all the participants in the network. The key to DES is adaptive model aggregation where the most competent classifiers are selected to predict the label of a specific test sample. This presentation will discuss the advantages of DES and share comparisons with existed methods.

3 On the Efficiency and Robustness of Federated Learning

Hongyi Wang, Carnegie Mellon University, Pittsburgh, PA, Contact: hongyiwa@andrew.cmu.edu

Federated learning (FL) offers a privacy-preserving collaborative learning solution, though it grapples with high communication costs and susceptibility to attacks. In this talk, Dr. Wang will initially present FedMA, which matches and averages hidden elements bearing similar signatures. FedMA surpasses widely-used FL algorithms, all while reducing communication overhead.
Subsequently, Dr. Wang will explore FL's robustness, emphasizing vulnerabilities to backdoor attacks and asserting that robustness to backdoors entails resilience to adversarial examples with guarantees. He will introduce edge-case backdoors, which trigger misclassifications on atypical inputs, potentially jeopardizing fairness across diverse ML tasks.

Sunday, October 15, 10:45 AM - 12:00 PM

SB71

CC-West 105C

AI Generated Content (AIGC)

Community Committee Choice Session

Session Chair: Ting Li, Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands

1 The Downfall of Q & A? How Large Language Modelers Affect Q & A: A Study on Stackexchange

Dominik Gutt, Martin Quinn, Erasmus University Rotterdam, Rotterdam, Netherlands. Contact: gutt@rsm.nl

Large Language Models (LLM) have attracted immense attention since the end of 2022. In this paper, we examine the effects of introducing the arguably most popular LLM, ChatGPT, on the user-generated content on Stackexchange. We find that subsequent to the introduction of ChatGPT, the number of questions posted to Stackexchange drastically decreased. This research contributes to the developing literature stream on the effects of generative artificial intelligence on platforms. Our findings also imply that LLMs may be drilling away their own foundation because they are partly trained on openly available data from Stackexchange.

2 Exploring the Impact of Suggestion Richness and Question Richness of Generative AI on User Creativity and Satisfaction

Hanwen Wang[1], Cheng Yi[1], Ting Li[2], [1]Tsinghua University, Beijing, China; [2]Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands. Contact: wanghw22@mails.tsinghua.edu.cn

This study focuses on the collaboration between generative AI and humans in a design context, where AI can offer suggestions and ask questions to humans. We explore how the richness of AI-generated suggestions and questions, measured by the number of viewpoints contained, affects user engagement and creativity through the design process, and finally influences users' satisfaction with the final design. We posit that while greater suggestion richness can increase users' engagement, it may restrain human creativity due to an overreliance on AI. Moreover, based on cognitive load theory, we expect that question richness may mitigate the restraining effect of suggestion richness on creativity. Our hypotheses are tested in an experiment with a 2x2 factorial design. The study makes theoretical contributions to human-AI collaboration and provides practical implications.

4 Community/Committee'S Choice Submission

Ting Li, Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands

Sunday, October 15, 10:45 AM - 12:00 PM

SB72

CC-West 106A

Machine Learning and Data Analytics for Agriculture Applications

Community Committee Choice Session

Session Chair: Shouyi Wang, University of Texas at Arlington, Arlington, TX

Session Chair: Hieu Trung Pham, University of Alabama in Huntsville, Huntsville, AL

1 A Biclustering Approach to Phenotype Prediction

Hieu Trung Pham, University of Alabama in Huntsville, Huntsville, AL

Phenotypic variation in plants is due to genetics (G), environment (E), and their interaction (GEI). GEI is critical in explaining why some genotypes perform well in different environments. In plant breeding, incomplete data is a challenge. We propose a new model of GEI effects that uses a two-way table of phenotype observations. Our analysis uses a biclustering algorithm that handles missing values, identifying homogeneous cells with no GxE interaction. We fit no-interaction models to predict phenotypes and draw insights into a cultivar's performance in unused test environments. Our method is validated on different plant species, showing superior performance.

2 Using Machine Learning to Identify the Initial Planting Date of Crops

Angela Avila, Jianzhong Su, University of Texas at Arlington, Arlington, TX

This study focuses on training a neural network to accurately predict the planting date of any given field by leveraging time series leaf area index (LAI) data. Specifically, we utilize LAI data collected in Bushland, TX over a span of 35 years as the basis for our model. Through a third-degree polynomial regression, the LAI time series growth of different crops is fitted, and the resulting coefficients are utilized to train a neural network, enabling estimation of the field's initial planting date. To enhance the effectiveness of the neural network training, our dataset is augmented by creating various third-degree polynomials that mimic the LAI growth patterns of crops. The preliminary data indicated the predictive Machine Learning Model can predict the planting dates of various crops.

3 Analyzing Data for Hyperspectral Images of Bacteria in Chickens

Ashley Alfred, Jianzhong Su, University of Texas-Arlington, Arlington, TX

This talk delves into the utilization of hyperspectral imaging technology for bacteria detection in chickens. We will discuss the adoption of innovative data analysis techniques to differentiate and classify bacterial strains in chicken tissue. The talk aims to highlight the potential of this non-invasive, rapid, and high-throughput tool in the poultry industry, emphasizing its role in enhancing food safety and quality. Our findings can pave the way for new approaches in pathogen identification, potentially revolutionizing the veterinary and food industry.

4 Using the K-Nearest Neighbor Algorithm to Predict Precipitation Based on Historical Data

Sean Guidry Stanteen, Jianzhong Su, University of Texas at Arlington, Arlington, TX, Contact: sean.guidrystanteen@mavs.uta.edu

This study explores the application of the K-Nearest Neighbor (KNN) algorithm for predicting precipitation patterns using historical data. The KNN algorithm is employed to analyze past weather data and identify similar patterns to forecast future precipitation events. The research aims to assess the effectiveness of the KNN approach in predicting precipitation, thereby providing valuable insights for meteorological forecasting, and improving our understanding of weather patterns. Results indicate promising potential for accurate and efficient precipitation prediction using the KNN algorithm.

Sunday, October 15, 10:45 AM - 12:00 PM

SB73

CC-West 106B

Economics of Platforms

Community Committee Choice Session

Session Chair: Garud Iyengar, 1</sup

Session Chair: Fahad Saleh, Wake Forest University, Winston-Salem, NC

1 Community/Committee'S Choice Submission

Yugang Yu, 1</sup

2 Fintech Expansion

Jing Huang, Texas A&M University, College Station, TX, Contact: jing.huang@tamu.edu

I study credit market outcomes with different competing lending technologies: A fintech lender that learns from data and is able to seize on-platform sales, and a banking sector that relies on physical collateral. Despite flexible information acquisition technology, the endogenous fintech learning is surprisingly coarse---only sets a single threshold to screen out low-quality borrowers. As the fintech lending technology improves, better enforcement harms, while better information technology benefits traditional banking sector profits. Big data technology enables the fintech to leverage data from its early-stage operations in unbanked markets to develop predictive models for expansion into new markets.

3 The Distributional Effects of "Fulfilled By Amazon" (FBA)

Garud Iyengar[1], Yuanzhe Ma[1], Thomas Rivera[2], Fahad Saleh[3], Jay Sethuraman[1], [1]Columbia University, New York, NY, [2]McGill University, Montreal, QC, Canada; [3]Wake Forest University, Winston-Salem, NC, Contact: ym2865@columbia.edu

We provide an economic model of an e-commerce retail platform (e.g., Amazon) that offers a fulfillment service (e.g., "Fulfilled By Amazon") to merchants that sell on its platform. We demonstrate that the introduction of such a service generates disparate impacts on the different platform participants. In particular, while such a service benefits low service quality merchants and consumers, it reduces welfare for high service quality merchants. We compare the economic implications of introducing the fulfillment service when it is optimally designed by the platform vs an independent logistics company. We show that the distributional welfare effects are more pronounced when the platform provides the fulfillment service thereby demonstrating the impact that dual ownership of the platform and fulfillment service has on participant welfare.

4 Advertising and Price Competition Under Consumer Data Privacy Choices

Kinshuk Jerath, Columbia Business School, New York, NY, Contact: kj2323@columbia.edu

Recent privacy regulations and firm policies endow consumers with the choice of whether to allow firms to use their personal data for marketing (and other) purposes. We consider a scenario with competing horizontally differentiated firms that advertise to heterogeneous consumers, through an ad platform. If a consumer opts in, she provides an imperfect signal of her type, based on which the ad platform can price ads, and the firms can target ads and prices. Consumers make privacy choices by considering their surplus utility from product consumption. Compared to a benchmark where all consumers are opted-in to data sharing, with privacy choices consumers' surpluses are weakly higher, the firms' profits are weakly lower, and the ad platform's profit is either lower or higher depending on the signal accuracy and extent of product differentiation.

Sunday, October 15, 10:45 AM - 12:00 PM

SB74

CC-West 106C

Economics and Computation II

Award Session

Session Chair: Jiashuo Jiang, Hong Kong University of Science and Technology, New York, NY

1 Signaling Competition in Two-Sided Markets

Omar Besbes[1], Yuri Fonseca[1], Ilan Lobel[2], Fanyin Zheng[1], [1]Columbia University, New York, NY, [2]New York University, New York, NY

Consider a platform facilitating decentralized many-to-many matches between two sides. A key attribute of supply is how competitive it will be for demand to obtain the supply after the match. Should the platform reveal competition levels to potential demand? We answer this question empirically in the context of a labor platform. We partnered with a services marketplace which sells non-exclusively labor market leads to service workers. We propose and estimate a structural model in which workers internalize expected competition levels. Our counterfactual analysis finds that signaling competition significantly improves outcomes for market participants and may lead to a win-win situation for both the platform and agents depending on certain market characteristics.

2 A Nonparametric Framework for Online Stochastic Matching with Correlated Arrivals

Ali Aouad[1], Will Ma[2], [1]London Business School, London, United Kingdom; [2]Columbia University, New York, NY

The design of online policies for stochastic matching and revenue management settings is usually bound by the Bayesian prior that the demand process is formed by a fixed-length sequence of queries with unknown types, each drawn independently. This assumption of serial independence implies that the demand of each type, i.e., the number of queries of a given type, has low variance and is approximately Poisson-distributed. Thus, matching policies are often based on ``fluid'' LPs that only use the expectations of these distributions.

This paper explores alternative stochastic models for online matching that allow for nonparametric, higher variance demand distributions. We propose two new models, \Indep and \Correl, that relax the serial independence assumption in different ways by combining a nonparametric distribution for the demand with standard assumptions on the arrival patterns -- adversarial or random-order. In our \Indep model, the demand for each type follows an arbitrary distribution, while being mutually independent across different types.

In our \Correl model, the total demand follows an arbitrary distribution, and conditional on the sequence length, the type of each query is drawn independently. In both settings, we show that the fluid LP relaxation based on only expected demands can be an arbitrarily bad benchmark for algorithm design. We develop tighter LP relaxations for the \Indep and \Correl models that leverage the exact distribution of the demand, leading to matching algorithms that achieve constant-factor performance guarantees under adversarial and random-order arrivals. More broadly, our paper provides a data-driven framework for expressing demand uncertainty (i.e., variance and correlations) in online stochastic matching models.

3 Centralized Versus Decentralized Pricing Controls For Dynamic Matching Platforms

Omer Saritac[1], Ali Aouad[1], Chiwei Yan[2], [1]London Business School, London, United Kingdom; [2]University of Washington Seattle, San Francisco, CA

Motivated by recent regulations and increased public scrutiny on platform control, we analyze how pricing centralization affects online service platforms using a fluid model of dynamic two-sided matching. We explore outcomes from a fully centralized pricing system, where the platform sets the price, to a fully decentralized one, where suppliers set prices. Our research uncovers the structure of stationary market equilibria and resulting social welfare under various degrees of centralization. We find that in 'impatient' markets, centralized platforms yield higher social welfare, while in more patient markets, decentralized pricing approaches first-best outcomes. Semi-centralized pricing rules, offering some flexibility to suppliers in setting their prices, recover near-optimal outcomes in most market conditions.

4 Tightness Without Counterexamples: A New Approach and New Results for Prophet Inequalities

Jiashuo Jiang[1], Will Ma[2], Jiawei Zhang[3], [1]Hong Kong University of Science and Technology, New York, NY, [2]Columbia University, New York, NY, [3]New York University, New York, NY

Prophet inequalities establish tight performance ratios between online and offline allocation algorithms. We formulate the worst-case instance construction as an optimization problem, directly finding the tight ratio without two separate bounds. Our analysis involves identifying the structure in a new "Type Coverage" dual problem, providing a unified framework that derives new prophet inequalities and recovers existing ones. Our paper shows that Chawla et al.'s "oblivious" method is best-possible among all static threshold algorithms, and confirms a separation between the convergence rates of static and adaptive algorithms. Our framework also allows us to numerically illustrate the tight guarantee under any number of starting units, with guarantees for k>1 exceeding the state-of-the-art.

5 Equitable Stable Matchings Under Modular Assessment

Kemal Yildiz[1,2], Ahmet Alkan[3], [1]Bilkent University, Ankara, Turkey; [2]Princeton University, Princeton, NJ, [3]Sabancı University, Istanbul, Turkey. Contact: kemalyild@gmail.com

We propose a framework for addressing issues of equity and social welfare in the stable matching model. We first establish an equivalence between an ordinal condition and modular optimization on the lattice of stable matchings. This equivalence charts out a domain where equity or welfare criteria separate over individuals and appear as weights in optimization. We call the ordinal condition convexity and the domain modular. Convexity requires stable "mixtures" of matchings in a solution to also be in the solution. We next propose a novel class of equitability criteria called equity undominance and characterize the modular stable matching rules that are equity undominated. Notably, the modular stable matching rules provide for clear testable implications and a wide range of specifications allowing efficient optimization.

Sunday, October 15, 10:45 AM - 12:00 PM

SB75

Session.Location:CC-West 208A

Modeling of Transportation Systems

Contributed Session

Session Chair: Elham Heydarigharaei, York University, Toronto, ON, Canada

1 Deep Learning and Machine Learning for Analyzing Risky Driving Behavior

Yihan Wang, Yanjing Wang, Ziru Wang, Clark University, Worcester, MA, Contact: jamieyihan@gmail.com

Aggressive driving behavior is the number one factor in road crashes, with 106,727 fatal crashes (55.7% of the total) involving one or more aggressive driving behaviors by drivers during a recent four-year period, according to the AAA Foundation for Traffic Safety. This paper aims to use deep learning and machine learning methods to analyze and understand risky driving behaviors. Our data comes from collecting accelerometer and gyroscope-based sensor information installed on cell phones. We train these models to effectively identify and classify risky behaviors such as aggressive driving, distracted driving, and speeding. The results of this study provide valuable insights into the factors that contribute to dangerous driving and allow us to develop proactive measures to enhance road safety and promote responsible driving habits.

2 Coins, Cards, or Apps: Impact of Payment Methods on Street Parking Occupancy and Wait Times

Sena Onen Oz[1], Mehmet Gumus[1], Wei Qi[2], [1]McGill University, Montreal, QC, Canada; [2]Tsinghua University, Beijing, China. Contact: sena.onenoz@mail.mcgill.ca

This study examines how different payment methods affect drivers' payment behavior, street parking occupancy and incurred wait. We develop an analytical model for the optimal payment amount and analyze payment patterns. The empirical findings indicate that drivers tend to pay less when they pay with cash or via mobile applications than with credit cards. To provide further guidance to municipalities, we simulate the street parking situation to verify the effects of each payment method and pricing on the parking occupancy and wait. The results show that using mobile payment apps leads to shorter waiting times and lower parking occupancy. Simulations also reveal the asymmetrical effects of price changes on occupancy and wait times. These findings highlight the potential benefits of mobile payments and price adjustments for improving street parking experiences.

3 Can Usage-Based Pricing Reduce Congestion?

Itai Ater[1], Adi Shany[1], Brad Ross[2], Eray Turkel[2], Shoshana Vasserman[2], [1]Tel Aviv University, Israel, Tel Aviv, Israel; [2]Stanford Graduate School of Business, Stanford, CA, Contact: eray.turkel.93@gmail.com

Municipalities around the world are increasingly adopting congestion pricing policies in order to curb road traffic. Despite the growing enthusiasm for congestion pricing by policymakers, there is limited rigorous evidence that such policies are effective at reducingthe number of cars on the road, and constituent concerns over inadvertent distributional consequences have slowed the adoption of these policies by years. We analyze a major field experiment testing the efficacyof congestion pricing fees in Israel. Our analysis of data shows that individuals cut their congestion-related driving in response to per-Km pricing. What kind of drivers change their behavior the most and what kinds of trips are reduced the most and what are the distributional implications? We will focus on heterogeneity in effects and implications on highway traffic density.

4 Emission-Based Signal Control Optimization on Arterials

Efthymia Kostopoulou, University of Massachusetts Amherst, Amherst, MA, Contact: ekostopoulou@umass.edu

The rapid increase of car ownership in recent decades has led to the increase of air pollutants in road networks, degrading the air quality and public health. Traffic signals are components of the urban networks able to be modified to promote efficiency and sustainability. This study develops real-time signal control system for a single intersection that is part of a signalized arterial, i.e., vehicles arrive in platoons. This system optimizes signal control timings by minimizing the emissions of auto and transit vehicles. The model can handle both oversaturated and undersaturated flow conditions, takings into account delays experienced from residual queues. The final mathematical model is a mixed integer linear model that is characterized by low computation times, sufficient to allow for real-time optimization and applicability in the real-world.

5 Traffic Assignment Under Crowd-Sensed Congestion Information

Elham Heydarigharaei[1], MohammadAmir Ahmadian Shahreza[1], Sina Bahrami[2], Mehdi Nourinejad[3], [1]York University, Toronto, ON, Canada; [2]University of Michigan, Ann Arbor, MI, [3]York University, Toronto, ON, Canada. Contact: eheydari@yorku.ca

Accurate travel time estimation is crucial for drivers when choosing between multiple route options. However, tools like Google Maps may neglect unexpected delays or driving conditions. Additionally, stationary sensors and cameras are not cost-effective alternatives. In contrast, crowdsensing provides accurate traffic information without requiring significant infrastructure investment. This study analyzes the trade-off between information accuracy and traffic congestion, considering the length of the prediction horizon. Our objective is to optimize crowdsensing systems and enhance decision-making for drivers seeking the shortest path.

Sunday, October 15, 10:45 AM - 12:00 PM

SB76

Session.Location:CC-West 208B

Optimization of Layout and Stocking

Contributed Session

Session Chair: Abhijit Gosavi, Missouri University of Science & Technology, Rolla, MO

1 Optimal Wave Design in Fulfillment Centers - the Key to Faster Speed

Sai Anjani Kumar K V N, Gowtham Bellala, Rishabh Bhat, Sarvesh Desai, Vikas Goel, Flipkart internet private limited, Bangalore, India

Fulfillment centers (FC) of an e-tailer typically assign approved orders to waves (defined by a wave end or cut-off time). Orders that miss the earliest network connection during the order promise end up waiting idle at an FC for a long duration. The percentage of such orders is referred to as spillage. Reducing spillage results in an improved delivery speed leading to increased platform conversion. In this work, we study the problem of optimal FC wave design that minimizes spillage considering hourly order patterns, network, capacity and other operational constraints. Reducing spillage for a large network by manual choice of wave cut-offs is challenging and leads to suboptimal decisions. We propose an integer optimization model to optimize the wave design. The proposed model was used at a large e-commerce company in India that resulted in a 35% reduction in overall spillage.

2 Solving the Unequal-Areas Layout Problem: A Meta-Heuristic Approach for Retaining Dimensions

Joshua Adu Afari[1], Abhijit Gosavi[2], Robert Marley[1], [1]Missouri University of Science & Technology, Rolla, MO, [2]Missouri University of Science & Technology, Rolla, MO, Contact: jay22@mst.edu

The so-called unequal-areas layout problem has been widely studied under the aspect-ratio assumption that allows the department's dimensions to be *distorted* as long as its area remains the same. Distortion of the width can lead to conditions in which machines in a department may not fit in the space designed. In this presentation, we present a meta-heuristic approach in which the dimensions are *not* distorted, along with numerical results. The new approach seeks to minimize the so-called dead space between departments, but, unlike the aspect-ration approach, does *not* ensure it becomes zero.

3 Kitting Optimization Models to Support Line Stocking and Hybrid Robotic Operations

Amirreza Talebi[1], Theodore T. Allen[2], [1]The ohio state university, Columbus, OH, [2]Ohio State University, Columbus, OH, Contact: talebi.14@osu.edu

We propose part delivery and kitting optimization models of trade-offs with realistic cost numbers to support possible transitions in material handling. Part feeding methods such as line stocking, operator-kit packing, and hybrid robot-operator kit packing are included. An application at a major automotive manufacturer is used to illustrate the benefits.

4 Multi-Swap Simulated Annealing Algorithm for Order Batching and Sequencing Problem in a Sequential Zone Picking System

Jeongwon Park[1,2], Soondo Hong[1], [1]Pusan National University, Busan, Korea, Republic of; [2]Arizona State University, Phoenix, AZ

This study proposes a heuristic algorithm to optimize the order batching and sequencing problem (OBSP) in a sequential zone picking system. The proposed algorithm solves the OBSP with multiple 2-opt local searches to balance the workload across zones. For each iteration, the algorithm evaluates the total maximum workload in each time window and significantly improves the order picking performance of large-size warehouse systems in a short time. Simulation experiments demonstrate that the proposed algorithm outperforms existing methods in terms of solution quality and efficiency, making it a promising approach for real-world warehouse applications.

5 Vertical Product Location Effect on Sales: A Field Experiment in Convenience Stores

Zahra Jalali[1], Maxime Cohen[2], Necati Ertekin[3], Mehmet Gumus[2], [1]McGill University, Montreal, QC, Canada; [2]McGill University, Montreal, QC, Canada; [3]University of Minnesota, Minneapolis, MN

Most retailers use the eye-level location to enhance demand. Yet, little is know about what happens to products at other shelves when a product is moved to the eye-level. We study how changing vertical locations of products in a shelving unit impacts product sales and overall sales, and whether this effect varies across products. We conducted a 20-week field experiment at 6 C-stores. Our results show that the eye-level generates an additional 13.8% and 8.5% more demand compared to the stoop-level and the stretch-level. Yet, this increase comes at an expense of demand loss at other shelves, leading to pure substitution among products. We also find that the vertical location effect varies across products. Incorporating this heterogeneity into planogram optimization can increase profit by 3% at the focal retailer, a significant 36.4% improvement over using homogeneous effects.

Sunday, October 15, 10:45 AM - 12:00 PM

SB77

Session.Location:CC-West Lecture Hall

Game Theory and Markov Systems

Contributed Session

Session Chair: Zhengqi Lin, Rutgers University, Jersey city, NJ

1 On Coin Flipping Games with Uncertainty in the Probability of Heads: Beyond Linear Kelly Betting Strategies

B. Ross Barmish[1], Anton V. Proskurnikov[2], [1]Robust Trading Solutions, LLC, Boxford, MA and University of Wisconsin, Madison, WI, [2]Politecnico di Torino, Torino, Italy. Contact: bob.barmish@gmail.com

In this paper we "robustify" Kelly's celebrated betting strategy for a game involving N flips of a biased coin with probability of heads p. Unlike the classical theory with p being perfectly known, we only assume that a subset P of [0,1] is specified for this probability. Whereas the classical Kelly strategy defines the size of all wagers to be the same fixed fraction of wealth along sample paths, our main result is that assurance of robustness with respect to P dictates use of a strategy which is nonlinear in nature yet can be computed efficiently. To our knowledge, nonlinear strategies have not been considered to date in the body of literature under consideration.

2 How the Mean Field Games Applied to Many Players Differential Games?

Kemal Gursoy, Rutgers University, Piscataway, NJ, Contact: kemalgursoy@netscape.net

The mean field game systems may be used to construct Nash equilibria for finitely many players differential games. In this work, a model will be introduced to support to find an approximate Nash equilibria for multiplayer games.

3 Transportation Distance Between Kernels and Approximate Dynamic Risk Evaluation in Markov Systems

Zhengqi Lin[1], Andrzej Ruszczynski[2], [1]Rutgers University, Newark, NJ, [2]Rutgers University, Piscataway, NJ

We introduce a distance between kernels based on the Wasserstein distances, study its properties, and propose a method for approximating solutions to forward-backward Markov systems. In addition, we establish the metric properties of the kernel distance and relate it to various modes of convergence in the space of kernels. We then propose a recursive approximation scheme for the forward system of a Markov system using the kernel distance and estimate the error of the risk evaluation by the errors of individual kernel approximations. We illustrate the results on stopping problems and well-known risk measures and we develop a particle-based numerical procedure with finite support sets. Finally, we apply the proposed approach to pricing an American basket option in a financial problem.

Sunday, October 15, 10:45 AM - 12:00 PM

SB78

Session.Location:CC-West 211A

Energy Storage and Electricity Pricing in Smart Grids

Contributed Session

Session Chair: Ashfaque Mohib, Wichita State University, Wichita, KS

1 Energy Storage as Learning-Agents in Electricity Markets

Ningkun Zheng, Bolun Xu, Columbia University, New York, NY, Contact: nz2343@columbia.edu

The strategic behavior of energy storage in energy markets is crucial for market power mitigation and new market model development. While prior research has attempted to model strategic energy storage behaviors, these efforts have often been constrained by high computational costs and assumptions of perfect market clearing knowledge among energy storage participants. This study seeks to overcome these challenges by integrating a wholesale energy market simulation with a model-based machine learning energy storage bidding algorithm. This novel approach offers a more realistic representation of energy storage strategic behaviors in real-world scenarios.

2 Elucidating the Capabilities and Limitations of Long-Duration Energy Storage Modeling Approaches

Sourabh Dalvi, National Renewable Energy Laboratory, Denver, CO, Contact: sourabh.dalvi@nrel.gov

Energy storage deployment enables integration of variable renewable energy (e.g., wind, solar) in power systems. However, existing models for long-duration storage lack accurate representation. This study discusses challenges, limitations, and proposes improvements. Enhanced long-duration storage dispatch modeling can increase operational value by 4.3%-13.8% and capacity credit by 14%-33.7%. This represents significant cost-saving opportunities for US Independent System Operators. Three dispatch methods were assessed, favoring end volume targets. Further research is needed for improved methods and inclusion of extreme climate events in power system planning and operation.

3 Designing Efficient and Equitable Retail Rate for Distributed Energy Resources

Madalsa Singh[1], Bruce Cain[2], Ines Azevedo[1], [1]Stanford University, Stanford, CA, [2]Stanford University, Stanford, CA, Contact: madalsa@stanford.edu

Rooftop solar and storage adoption with variable electricity retails that reflect marginal (energy) and fixed (network) costs of utility can play an important role in efficient and equitable decarbonization. Under net-energy metering, especially in states with high tariffs, adopters of solar and/or storage have been overcompensated for the surplus energy sold back. In this work, we test different retail rate formulations - two-part, tiered, and high peak-off peak time varying volumetric tariffs - under a net bill minimization decision making framework with flexible electrified load to understand adopter bill savings, utility net costs, and society's environmental surplus focused on distributional equity. Initial results indicate storage with solar provides benefits to both adopters and utility with time varying rates (for both volumetric and two-part tariffs)

4 Optimization Model for Grid Connected Photovoltaic and Battery Energy Storage System

Ashfaque A. Mohib[1], Mehmet Bayram Yildirim[2], Ehsan Salari[1], Al Tamimi[3], [1]Wichita State University, Wichita, KS, [2]Wichita State University, Wichita, KS, [3]Sunflower Electric Power Corporation, Wichita, KS, Contact: aamohib@shockers.wichita.edu

This paper proposes an optimization model for photovoltaic (PV) and battery energy storage systems (BESS) in a grid-connected electric network. The model considers the variability and uncertainty of solar energy generation resources and the available capacities for the battery storage systems to determine the best energy mix to meet the growing energy demands. A Mixed Integer Linear Programming (MILP) technique was used on experimental IEEE bus systems to determine the optimal solution for combining PV and BESS to reduce dependency on the electric grid system. Academic researchers and utility asset managers would benefit from the experimental results obtained from this research paper to gain better insights into achieving their sustainable energy growth requirements, given a limited budget over a planning horizon.

Sunday, October 15, 10:45 AM

- 12:00 PM

SB79

Session.Location:CC-West 211B

Doing Good with Good O.R. II

Award Session

Session Chair: Robert G. Randall, Princeton Consultants, Inc., Greenville, SC

Session Chair: Justin J. Boutilier, University of Wisconsin - Madison, Madison, WI

1 Community-engaged School District Design: A Stream-based Approach

Aysu Ozel, Northwestern University, Evanston, IL

Decades after Brown v. Board of Education, school districts are still struggling with equal access to education. To make decisions with equity at the core, community engagement in every aspect of district design is essential. In partnership with a school district, we revisit the district design problem with a focus on community co-design. We present a compact formulation incorporating multiple decisions simultaneously, providing an efficient way to have a community-centered process and discuss the critical role it played in a community initiative to address historic inequities.

2 Reducing Air Pollution Through Machine Learning

Leonard Boussioux[1], Cynthia Zeng[2], [1]UW Foster, MIT, Somerville, MA, [2]Massachusetts Institute of Technology, Somerville, MA

The work presents a data-driven approach to mitigate air pollution impact from industrial plants on nearby cities by linking operational decisions with weather conditions. Our method combines predictive machine learning models to forecast short-term wind conditions and prescriptive production level recommendations to minimize air pollution impact. We have successfully deployed our models at the OCP Safi site, the largest phosphate plant in Morocco. Our framework provides a pathway for sustainable industrial development by forgoing the trade-off between pollution and industrial activities.

3 Analytics for Societal Impact: Improving Access to Volunteers on Volunteer Match

Akshaya Suresh, Yale University, New Haven, CT

In collaboration with VolunteerMatch—the world's largest online platform for connecting volunteers with nonprofits—we designed and implemented a new recommendation algorithm called SmartSort that builds on ideas from online robust optimization while also incorporating unique aspects of nonprofit operations. Based on promising experimental results showing a statistically significant 8-9% increase in our metric for equity, VolunteerMatch has deployed SmartSort nationwide. We expect it to provide an additional 30,000 volunteer sign-ups annually to opportunities with limited access to volunteers.

4 Hartford HealthCare Improves Hospital Operations with Patient Outcome Predictions

Liangyuan Na[1], Kimberly Villalobos Carballo[2], [1]Massachusetts Institute of Technolgy, Cambridge, MA, [2]Massachusetts Institute of Technolgy-Operations Research Ctr, Cambridge, MA

In collaboration with Hartford HealthCare, we develop machine learning models predicting inpatient outcomes, i.e., 24hr/48hr discharge, ICU transfers, mortality and discharge dispositions (AUC 76%-93%). These predictions enable more discharges (10%-29%) and fewer 7/30-day readmissions (p-value <1e-3). We implement an automated pipeline displaying daily predictions with user-friendly software. Over 200 medical staff currently use our tool, resulting in a significant reduction in patient-average length of stay (0.67 days) and projected annual benefits of $55-$72 million for Hartford HealthCare.

Sunday, October 15, 10:45 AM - 12:00 PM

SB80

Session.Location:CC-West 212A

Undergraduate Operations Research Prize I

Award Session

Session Chair: Zhijie Sasha Dong, University of Houston, Houston, TX

1 Estimating and Visualizing Demand for Dockless Shared Micromobility Systems

Kyran Flynn, Brown University, Cambridge, MA

Shared micromobility, publicly available bikes and scooters, generate data governments can use to understand user demand and access in the city. However, the data can censor users' true starting locations and underestimate demand. This paper offers a novel and interpretable demand estimation model from trip data that models user arrivals as time and location dependent Poisson processes. We design an Expectation-Maximization algorithm to estimate the underlying parameters of this process along with efficient, publicly accessible visualization software to run the model and visualize its results.

2 Smoothed Analysis of Online Non-parametric Auctions

Naveeb Durvasula, University of California-Berkeley, Berkeley, CA

Online learning of revenue-optimal auctions is a fundamental problem in mechanism design without priors. Nevertheless, all existing positive results assume that the auctioneer optimizes over a parameterized auction class (e.g. pricings and auctions with reserves). This leaves behind a significant gap in our understanding of online-learnability of general non-parametric auction classes. We provide the first positive results for online learnability of a non-parametric auction class, for smooth adversaries (in the style of smoothed analysis in online learning) and the class of smooth auctions.

3 A Time-Discretized Mathematical Model and Heuristic for Breast Cancer Radiotherapy

Scholar Sun, University of Waterloo, Toronto, ON, Canada

Sliding window intensity-modulated radiation therapy is a cancer treatment method whereby a high-energy beam is modulated by a set of tungsten leaves that move unidirectionally across the beam field to irradiate cancerous tissue. We formulate a nonlinear mixed integer program to optimize the delivery of treatment wherein the optimal motion of the leaves is determined. Additionally, a heuristic that generates a high-quality feasible solution is proposed. We demonstrate that the solutions generated can be directly implemented in clinical treatment planning software to assist planners.

Sunday, October 15, 10:45 AM - 12:00 PM

SB81

Session.Location:CC-West 212B

Animating the Analytics

Community Committee Choice Session

Session Chair: Sourav Chatterjee, University of North Texas, Denton, TX

1 Everything Everywhere All at Once - Teaching Can-Dos with Concepts

Kelly Slaughter, TCU, Fort Worth, TX, Contact: kelly.slaughter@tcu.edu

How can students participate in experiential problem-solving without understanding the underlying concepts? How can students understand the underlying concepts without experiential opportunities? In this session I will share some examples of interweaving the "Can Do" with the Concept that creates a healthy confusion leading to student learning.

2 Beginning with the End in Mind when Integrating Predictive and Prescriptive Analytics

Matthew A. Lanham, Purdue University, Lafayette, IN

We demonstrate a new case example to help students learn how to bridge the gap when interfacing predictive analytics with prescriptive analytics. We advocate to teach students to think with the end in mind, one of Stephen Covey's seven habits for highly successful people, when designing and developing analytics solutions for decision-support. Our carpet manufacturing case example challenges the manufacturer to determine the optimal settings to achieve a retailer's specified stain resistance requirements. We demonstrate options in integrating the estimated predictive model via the baseline linear regression model into a formal optimization model, as well as considerations when the predictive model is non-parametric.

3 An Assessment Of Tools Used In Business Analytics Curricula And Applicability In Industry

Prakash Shrivastava, University of Texas at Dallas, Richardson, TX

This talk will summarize results of a survey about tools students learn in Business Analytics programs and tools they use in Industry. This talk would delineate opportunities for potential augmentation of program based on feedback from alumni and practicing business analysts.

4 Dealing with Imperfect Data

Stephen Robertson, Southern Methodist University, Dallas, TX

The dreaded words for a data analyst: "messy data." However, handling less than perfect data is an ever-present and inevitable challenge we must face. Imperfect data may come in a number of forms, including missing data, inaccurate data, duplicate data, unstructured data, inconsistent data, too much data, and more. An obvious goal is to clean such dirty datasets in a way that allows us to employ our standard statistical methodologies to produce reliable results and conclusions. In extreme cases where data cleansing options are limited, perhaps the best option is to develop a strategy that most effectively utilizes the good data while minimizing the impact of the imperfect data.

Such a strategy can take on different meanings in different situations, and we explore some of these strategies by considering examples of real data from various industries.

Sunday, October 15, 10:45 AM - 12:00 PM

SB82

Session.Location:CC-West 212C

Optimization for Portfolio Selection

Contributed Session

Session Chair: Sheung Chi Chow, Australian National University, Canberra, Australia

1 Optimal Currency Portfolio with Implied Return Distribution in the Mean-Variance Model

Norio Hibiki[1], Yuta Hibiki[2], Takuya Kiriu[3], [1]Keio University, Yokohama, Japan; [2]Asset Management One Co., Ltd., Tokyo, Japan; [3]Osaka University, Osaka, Japan. Contact: hibiki@ae.keio.ac.jp

We construct an optimal currency portfolio using the implied return distribution in the mean-variance approach and examine the performance through a backtest. We estimate the implied expected spot return, implied volatility, and implied correlation from currency option price data, and propose a method of constructing a fully forward-looking optimal currency portfolio without historical data. We implement the backtest from January 2006 to October 2020 on a currency portfolio comprising seven currencies and US-dollar interest rate, and examine the usefulness of the proposed method. We find that the proposed method yields a higher performance than the conventional method in previous studies that use historical data.

2 Portfolio Optimization with Weight Constraints Derived from a Nonlinear Function (NF) Reflecting Macroeconomic Variables

Jihye Yang, Seongmoon Kim, Yonsei University, Seoul, Korea, Republic of. Contact: jihyeyang89@gmail.com

We propose the macro augmented portfolio selection models with weight constraints derived from a nonlinear function (“NF”) reflecting Baltic Dry Index, Interest rate, Money supply, and Inflation rate that are estimated based on an exponentially weighted moving average (EWMA) method. We assess the performance of the models with NF compared to that of the models with weight constraints derived from a linear function (“LF”) in 12 different stock markets. The experimental results demonstrate the models with NF outperformed those with LF as well as general benchmarks. We show that the portfolio selection models can be improved by the constraints derived from NF reflecting the major macroeconomic variables of our interest.

3 Modified Mean-Variance Analysis, Portfolio Optimization and Prospect Theory

Sheung Chi Chow, Australian National University, Canberra, Australia. Contact: sheung.chow@anu.edu.au

We consider the use of mean-variance (MV) analysis and portfolio optimization for investors with different preferences under prospect theory. We explore the relationship between these concepts and prospect theory, incorporating prospect stochastic dominance (PSD) to make the results widely relevant. It demonstrates how partial moments align with PSD and can be used to eliminate PSD-inefficient investments. Using partial moments, we also formulate a rule akin to the MV rule to rank investments according to different value functions under prospect theory. This rule can pinpoint PSD-efficient segments on the MV frontier, helping to identify the subset of MV portfolio choices that are both MV and PSD-efficient. Additionally, partial moments enable us to devise a portfolio optimization method for building a portfolio that surpasses a target investment in a PSD sense.

Sunday, October 15, 10:45 AM - 12:00 PM

SB83

Session.Location:CC-West 213A

Stochastic Models on Pandemic Management

Contributed Session

Session Chair: Feifan Wang, Mayo Clinic, Rochester, MN

1 A Coupled Seir-Replicator Dynamics Model for Covid-19 Pandemic

Soham Das, Ceyhun Eksin, Texas A&M University, College Station, TX, Contact: soham.das@tamu.edu

In this work, we leverage a SEIR model coupled with replicator dynamics describing changes in population behaviors for forecasting the dynamics of the COVID-19 pandemic. We formulate forecasting of future epidemic states as a problem of estimating the game-theoretic incentive parameters that drive the dynamics of the coupled SEIR model. We find that given sample sequences of data on population infection states, hospitalization numbers, and standard approximations for disease parameters, one can derive a least-squares regression to estimate the incentive parameters. The estimates of these parameters are used to produce our forecasts, which we apply both to

synthetically generated data as well as actual hospitalization datasets from Texas and California. We find our forecasts obtain high performance in predicting hospitalizations in a 30 day horizon.

2 Modeling Preventive Behavior and Viral Characteristics on Disease Spread
Isabella Freitas[1], Pitu Mirchandani[2], [1]Arizona State University, Tempe, AZ, [2]Arizona State University, Tempe, AZ
An agent-based model was developed to simulate the spread of disease (e.g. COVID-19) through a population. The primary objectives for this model were to include two major factors and assess how these factors impact disease spread. These two major factors are preventative populations behaviors and viral characteristics. Preventative behaviors include social distancing, masking, and vaccination. Viral characteristics include aspects of the disease which may impact its spread such as viral load. The outcome of this research is a model that can be used to assess how making changes to population behaviors can impact disease dynamics.

3 Dynamic Human Activity Recognition and Its Application in Healthcare
Feifan Wang, Hojjat Salehinejad, Mayo Clinic, Rochester, MN, Contact: wangfeifan86@gmail.com
Human activity recognition (HAR) using machine learning is a novel approach for sensing and detection of human activities, especially in healthcare systems. However, limited attention has been paid to human activity dynamics. In this study, a framework of dynamic human activity recognition (DHAR) is proposed based on a partially observable Markov Decision Process (POMDP) model. It is motivated by the potential inaccuracy of current HAR models in real-world environments. Given a set of HAR models available, the proposed method dynamically selects an HAR model, according to the observed human activities, to better recognize the next human activity. The simulation experiment is conducted and shows better performance of the framework than a single HAR model. This approach has potential in applications in healthcare, such as fall detection.

Sunday, October 15, 10:45 AM - 12:00 PM

SB84

Session.Location:CC-West 213B
Health Care Resource Planning
Contributed Session
Session Chair: Silviya Valeva, Saint Joseph's University, Philadelphia, PA

1 Incorporating Sustainability in Cost-Effectiveness of Cancer Surveillance Programs
Gizem Nemutlu[1], Jagpreet Chhatwal[2], [1]Brandeis University, Waltham, MA, [2]Harvard Medical School, Mass General Hospital, Boston, MA, Contact: gnemutlu@brandeis.edu
Sustainability in healthcare is becoming a great concern as carbon emissions produced at healthcare facilities is significant. Cost-effectiveness analyses, commonly used in health outcomes research, do not take carbon footprint costs into account when identifying the most cost-effective intervention. MRI and CT as diagnostic tools are 33 and 17 times more costly than ultrasound per abdominal scan although, especially for low-risk groups, there may not be a significant difference in the health outcomes due to undergoing MRI/CT vs ultrasound. In this study, we consider the cost of carbon footprint in our cost-effectiveness analysis for liver cancer surveillance and summarize different surveillance protocols without sacrificing health outcomes.

2 Inventory Rationing During a Pandemic: Model and Applications
Benjamin Neve, Weber State University, Syracuse, UT, Contact: benjaminneve@weber.edu
The availability of real-time data showing dynamic regional healthcare needs skyrocketed during the pandemic, with several large organizations providing the data for free and in many forms. As such, better-informed inventory rationing decisions became possible at a higher level than ever before. During the COVID-19 pandemic, several instances of rationing occurred in the US healthcare system. We present a model that takes into account multiple rationing classes in a healthcare environment using simulation optimization, where parameters can be derived from near real-time, openly-available healthcare data. We also provide a simplified model that performs well in real-world settings and allows for applied customization under different governing policies.

3 ICU Networks Design with Step-Down Units
Silviya Valeva[1], Guodong Pang[2], Andrew J. Schaefer[2], [1]Saint Joseph's University, Philadelphia, PA, [2]Rice University, Houston, TX, Contact: svaleva@sju.edu
Intensive care units (ICU) care for some of the most critically ill patients within hospitals. Once ICU patients are stable enough, they can be moved to downstream units, making space for incoming critical patients. Types of downstream units vary based on staff training and level of care. While the most general type of downstream units are wards,

caring for stable patients before discharge, some hospitals utilize intermediate (or step-down) units that are able to care for semi-critical patients. We explore network design considerations based on utility-maximizing optimization models. We test and validate our proposed network topologies using large-scale multi-period simulation studies considering patient health evolution and transfer policies between various level of care units.

Sunday, October 15, 12:45 PM - 2:00 PM

SC01

CC-North 120A

Simulation Optimization in the New Era of AI

Tutorial Session

Session Chair: Hari Balasubramanian, University of Massachusetts, Amherst, Amherst, MA

1 Simulation Optimization in the New Era of AI

Yijie Peng[1], Chun-Hung Chen[2], Michael Fu[3], [1]Peking University, Beijing, China; [2]George Mason University, Centreville, VA, [3]University of Maryland, College Park, MD

We review simulation optimization methods and discuss how these methods underpin modern artificial intelligence (AI) techniques. In particular, we focus on three areas: stochastic gradient estimation, which plays a central role in training neural networks for deep learning and reinforcement learning; simulation sample allocation, which can be used as the node selection policy in Monte Carlo tree search; and variance reduction, which can accelerate training procedures in AI.

Sunday, October 15, 12:45 PM - 2:00 PM

SC04

CC-North 121A

Online Decision Making Algorithms

Community Committee Choice Session

Session Chair: Jinglong Zhao, Boston University, Boston, MA

Session Chair: Mika Sumida, University of Southern California, Los Angeles, CA

1 Randomized Robust Price Optimization

Xinyi Guan, Velibor Misic, UCLA Anderson School of Management, Los Angeles, CA, Contact: xinyi.guan.phd@anderson.ucla.edu

The robust multi-product pricing problem is to determine the prices of products to maximize the worst-case revenue taken over an uncertainty set of demand models. A tacit assumption is that the pricing decision is deterministic. We consider a randomized approach to robust multi-product pricing, where a decision maker specifies a distribution over potential price vectors to maximize its worst-case revenue. We analyze when a randomized price scheme performs as well as a deterministic price vector, and propose solution methods for obtaining an optimal randomization scheme over a discrete price set for the case where the demand model uncertainty set is convex or discrete, and show how these methods are applicable for common demand models. We numerically compare the randomized approach against the deterministic approach on a variety of synthetic and real problem instances.

2 Bidding in Multi-Unit Pay-as-Bid Auctions

Rigel Galgana[1], Negin Golrezaei[2], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Massachusetts Institute of Technology, Lexington, MA, Contact: galganarigel@gmail.com

We consider the problem of learning how to bid in repeated multi-unit pay-as-bid auctions, which are prevalent in treasury or procurement auctions. In these auctions, a large number of (identical) items are allocated to the highest bidders who pay the sum of their winning bids. The complexity of solving this challenging combinatorial optimization problem serves as a major obstacle to market entry, especially for smaller firms. To improve market efficiency, we design computationally efficient, low-regret online learning algorithms for both the full information and bandit feedback bid optimization problems. Numerical simulations suggest that the resulting equilibrium yields optimal welfare.

3 Adaptive Neyman Allocation

Jinglong Zhao, Boston University, Boston, MA

Neyman Allocation is an omnipresent concept in designing social experiments and clinical trials. In this work, I present how to conduct Neyman Allocation in an adaptive fashion.

4 Maximum Optimality Margin: A Unified Approach for Contextual Linear Programming and Inverse Linear Programming

Chunlin Sun[1], Shang Liu[2], Xiaocheng Li[2], [1]Stanford University, Stanford, CA, [2]Imperial College Business School, London, United Kingdom. Contact: chunlin@stanford.edu

We study the predict-then-optimize problem where the output of a machine learning prediction task is used as the input of some downstream optimization problem, say, the objective function of an LP. We develop a new approach to the problem called maximum optimality margin which designs the machine learning loss function by the optimality condition of the downstream optimization. The max-margin formulation enjoys both computational efficiency and good theoretical properties for the learning procedure, and our new approach only needs the observations of the optimal solution in the training data rather than the objective function. The method and its analysis not only shed light on the generic problem formulation of inverse and contextual LP, but also draw implications for problems of utility modeling, choice modeling, and revealed preference.

Sunday, October 15, 12:45 PM - 2:00 PM

SC05

CC-North 121B

Online Markets and Policy Design

Community Committee Choice Session

Session Chair: Zhen Lian, Cornell University, NEW YORK, NY
Session Chair: Faidra Monachou, Harvard University, Cambridge, MA

1 Fair Assortment Planning

Qinyi Chen[1], Negin Golrezaei[2], Fransisca Susan[1], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Massachusetts Institute of Technology, Lexington, MA, Contact: qinyic@mit.edu

Many online platforms prioritize featuring items with the highest popularity or revenue when making assortment planning decisions. This, however, can lead to undesirable outcomes for the rest of the items, making them leave the platform and hurting the platform's long-term goals. Motivated by that, we introduce and study a fair assortment planning problem, which requires any two items with similar quality/merits to be offered similar outcomes. We propose a framework to find near-optimal solutions to this problem, using the Ellipsoid method and an approximate separation oracle to its dual. We then develop two approximate separation oracles, which result in a polynomial-time 1/2-approx. algorithm and a PTAS for the original problem. We conclude with a case study on the MovieLens dataset, which shows the efficacy of our algorithms and sheds light on the price of fairness.

2 Online Fair Allocation of Perishable Resources

Chamsi Hssaine, University of Southern California, Marshall School of Business, Los Angeles, CA

We consider a practically motivated variant of the canonical online fair allocation problem: a decision-maker has a budget of *perishable* resources to allocate over a fixed number of rounds. Each round sees a random number of arrivals, and the decision-maker must commit to an allocation for these individuals before moving on to the next round. The goal is to construct a sequence of allocations that is *envy-free* and *efficient*. We design an algorithm which takes as input (i) a prediction of the perishing order, and (ii) a desired bound on envy. Given the remaining budget, the algorithm uses forecasts of future demand and perishing to adaptively choose one of two carefully constructed guardrail quantities. We show that our algorithm achieves the optimal envy-efficiency Pareto frontier. We demonstrate its strong numerical performance using data from a partnering food bank.

3 Community/Committee'S Choice Submission

Hongyao Ma, Columbia University, New York, NY

4 Information Design In Ride-hailing

Feifan Zhang, Duke University, Durham, NC

Conventional wisdom in ride-hailing suggests that disclosing trip details to drivers hurts the platform, as drivers become selective about trips ("cherry-picking"). Still, recent shifts in regulations and labor are nudging platforms towards more transparency for drivers. To understand its implications, we analyze a platform with two levers on drivers: the pay, and the transparency of this pay. The platform faces uncertain demand, characterized by multiple demand scenarios. We find that, surprisingly, revealing full information is optimal, providing that the pay is set properly in each scenario. However, if the platform cannot dynamically adjust the pay, then full information can backfire, worse than not sharing any information at all. Our results highlight the intricate relationship between the information policy and the driver pay in ride-hailing.

Sunday, October 15, 12:45 PM - 2:00 PM

SC06

CC-North 121C

Learning, Operations and Society

Community Committee Choice Session

Session Chair: Chonghuan Wang, Massachusetts Institute

of Technology, Cambridge, MA
Session Chair: Jinzhi Bu, The Hong Kong Polytechnic University, Hong Kong, Hong Kong

1 Offline Feature-Based Pricing Under Censored Demand: A Causal Inference Approach

Zhengling Qi[1], Jingwen Tang[2], Ethan Xingyuan Fang[3], Cong Shi[2], [1]The George Washington University, D.C., [2]University of Michigan, Ann Arbor, MI, [3]Duke University, Durham, NC, Contact: tjingwen@umich.edu

We study a feature-based pricing problem with demand censoring in an offline setting. A firm is endowed with a finite inventory and faces a random demand. With the demand function unknown, the firm has access to a dataset consisting of quadruplets of historical covariates, inventory, price, and potential censored sales quantity. Our objective is to find the optimal pricing rule to maximize the expected profit. Through the lens of causal inference, we propose a novel data-driven algorithm motivated by survival analysis and doubly robust estimation. We derive a finite sample regret bound to justify the proposed offline learning algorithm. Thorough numerical experiments demonstrate our proposed algorithm performs robustly well, demonstrating the value of factoring in demand censoring for feature-based pricing.

2 Transfer Learning, Cross Learning and Co-Learning Across Newsvendor Systems

Lei Li, Purdue University, West Lafayette, IN

Decision making with limited data is challenging. We demonstrate that transfer learning can improve decision performance in the focal system by leveraging a well-trained solution using the ample data in a related system. We further propose cross learning by adapting the parametric solution of Operational Data Analytics for non-parametric decision making. The resulting decision significantly improves the performance of the focal system over the transfer-learned solution and is shown to be asymptotically optimal. When there are multiple related systems with limited data, we derive a co-learning solution shown to be asymptotically optimal for each involved system, as well as the aggregate system, by pooling the data from different systems. Our results underscore the role of statistical and structural knowledge in designing efficient decisions with limited data.

3 Government Policies to Incentivize Citizen Preparedness for Supply Disruptions

Xiaoyan Zhao, Venus Lo, Stephen Shum, City University of Hong Kong, Kowloon Tong, Hong Kong. Contact: venus.hl.lo@cityu.edu.hk

The public can suffer from significant loss due to inadequate preparation ahead of supply disruptions due to emergencies. Governments can minimize the impact of disruptions by encouraging the public to store supply at home as part of emergency preparation. We study a government's problem of incentivizing emergency preparedness. The government can implement a citizens-based incentive via a discount or coupon to reduce their cost of holding spare supply. Alternatively, the government can implement a retailer-based incentive by subsidizing the retailer's capacity during regular times so that citizens can easily acquire spare supply in advance. These incentives are effective under different circumstances. We present an approximation algorithm to find a hybrid policy. By combining the incentives, the hybrid policy incurs much lower social loss than a single policy.

4 On Dynamic Pricing with Covariates

Hanzhao Wang[1], Kalyan Talluri[2], Xiaocheng Li[1], [1]Imperial College Business School, London, United Kingdom; [2]Imperial College Business School, London, VT, United Kingdom. Contact: h.wang19@imperial.ac.uk

We consider the dynamic pricing problem with covariates under a generalized linear demand model: a seller can dynamically adjust the price of a product over a horizon of T, where the demand of the product is jointly determined by the price and an observable covariate vector $x_t\in\mathbb{R}^d$ through an unknown generalized linear model. In this paper we show a Thompson Sampling pricing algorithm, which is simple and efficient, has an $\tilde{O}(d\sqrt{T})$ regret upper bound without assuming any statistical structure on the covariates x_t (which can even be arbitrarily chosen). Furthermore, we extend the algorithm into the setting with inventory constraint.

5 Simple Policies for Joint Pricing and Inventory Management

Adam Elmachtoub[1], Harsh Tarak Sheth[2], Yeqing Zhou[3], [1]Columbia University, New York, NY, [2]Columbia IEOR, New York, NY, [3]Eindhoven University of Technology, Eindhoven, Netherlands. Contact: y.zhou2@tue.nl

We study the fundamental joint pricing and inventory control problem, where the customers are price sensitive. In the continuous review infinite horizon setting, the optimal policy is known to be an (s, S, p) policy, and the optimal price changes for every inventory state. We consider policies with only a small number of prices offered and compare these policies to the optimal policy.

When customer valuations follow an MHR distribution, we provide policies with theoretical guarantees for revenue and costs. In the lost sales case, we show that there exists a single-price policy that achieves at least as much revenue as the optimal dynamic policy while incurring costs at most \sqrt{ln*eS**} times more. The cost ratio is improved to 1.225 when the valuation distribution is uniform. When backlogging is allowed, we show that a three-price policy can achieve similar guarantees.

Sunday, October 15, 12:45 PM - 2:00 PM

SC07

CC-North 122A

Pricing and Simple Mechanisms for Combinatorial Allocation Problems

Community Committee Choice Session

Session Chair: Andres Cristi, Universidad de Chile, Santiago, Chile

1 A Constant Factor Prophet Inequality for Online Combinatorial Auctions

Jose Correa[1], Andres Cristi[2], [1]Universidad de Chile, Santiago, Chile; [2]Universidad de Chile, Santiago, Chile. Contact: andres.cristi.e@gmail.com

In online combinatorial auctions, m indivisible items are to be allocated to n agents who arrive online. Agents have random valuations for the different subsets of items, and the goal is to allocate the items on the fly so as to maximize the total value of the assignment. For the case where valuations are subadditive, we prove the existence of an O(1)-competitive algorithm, resolving a central open problem in the area. Our result is based on a novel but elementary sampling idea, which we call the Mirror Lemma. This lemma is essentially concerned with understanding algorithms for which the sets of allocated and unallocated items distribute equally. The other main ingredient is a nonstandard application of Kakutani's fixed point theorem. We will give an overview of the techniques and discuss implications for pricing mechanisms.

2 Mnl-Bandit in Non-Stationary Environments

Ayoub Foussoul, Columbia University, New York, NY

In this paper, we study the MNL-Bandit problem in a non-stationary environment and present an algorithm with worst-case dynamic regret of $O(\min{\sqrt{NTL}, N^{\frac{1}{3}}(\Delta^k_{\infty})^{\frac{1}{3}} T^{\frac{2}{3}} + \sqrt{NT})$. Here N is the number of arms, L is the number of switches and Δ^k_{∞} is a variation measure of the unknown parameters. We also show that our algorithm is near-optimal (up to logarithmic factors). Our algorithm builds upon the epoch-based algorithm for stationary MNL-Bandit in Agrawal et al., 2016. However, non-stationarity poses several challenges and we introduce new techniques and ideas to address these. In particular, we give a tight characterization for the bias introduced in the estimators due to non stationarity and derive new concentration bounds.

3 An Empirical Analysis of Optimal Nonlinear Pricing

Soheil Ghili[1], Russ Yoon[2], [1]Yale University, New Haven, CT, [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: ykyoon@mit.edu

In "continuous choice" settings, consumers decide not only on whether to purchase a product, but also on how much to purchase. As a result, firms should optimize a full price schedule rather than a single price point. This paper provides a methodology to empirically estimate the optimal schedule under multi-dimensional consumer heterogeneity. We apply our method to novel data from an educational-services firm that contains purchase-size information not only for deals that materialized, but also for potential deals that eventually failed. We show that the optimal second-degree price discrimination (i.e., optimal nonlinear tariff) improves the firm's profit upon linear pricing by about 7.9%.

4 Component Pricing with a Bundle Size Discount

Zechao Li[1], Ningyuan Chen[2], Xiaobo Li[3], Chun Wang[4], [1]Tsinghua University, Beijing, China; [2]University of Toronto, Toronto, ON, Canada; [3]National University of Singapore, Singapore, Singapore; [4]Tsinghua University School of Economics and Management, Beijing, China

Firms selling multiple products usually adopt bundle pricing in their marketing strategy. We propose a simple and widely used bundling mechanism, referred to as component pricing with a bundle size discount (CPBSD), which sells bundles for the summed prices of the included products minus a discount based on the number of products purchased. Theoretically, we show that CPBSD attains the optimal profit asymptotically under mild conditions. Practically, we formulate a mixed-integer linear program to solve CPBSD and develop an approximation algorithm for efficiently solving it in large-scale problems. In numerical studies, we show that CPBSD outperforms other bundling mechanisms; especially for the high product heterogeneity, the high production costs, and the potential surplus provided by products that are negatively correlated with the product valuations.

5 On Online Contention Resolution Schemes For The Matching Polytope Of Graphs

MacRury Calum[1], Will Ma[1], Nathaniel Grammel[2], [1]Columbia University, New York, NY, [2]University of Maryland, Maryland, MD, Contact: cm4379@columbia.edu

Online Contention Resolution Schemes (OCRS's) represent a modern tool for selecting a subset of elements, subject to resource constraints, when the elements are presented to the algorithm sequentially. OCRS's have led to some of the best-known competitive ratio guarantees for online resource allocation problems, with the added benefit of treating different online decisions---accept/reject, probing, pricing---in a unified manner. We analyze OCRS's for resource constraints defined by graph matchings, a fundamental structure in combinatorial optimization. We improve the state of the art both in terms of algorithmic guarantees and impossibility results. Our algorithms directly improve the best-known competitive ratios for online accept/reject, probing, and pricing problems on graphs. Most notably, this includes the prophet matching problem with edge arrivals.

Sunday, October 15, 12:45 PM - 2:00 PM

SC08

CC-North 122B

APS Special Session: Queueing Models for Today's Compute Centers

Award Session

Session Chair: Andrew Daw, University of Southern California, Marshall School of Business, Los Angeles, CA
Session Chair: Christina Lee Yu, Cornell University, Ithaca, NY

1 Queueing Models for Today's Compute Centers

Mor Harchol-Balter, Carnegie Mellon University, Pittsburgh, PA

Almost all queueing models assume that a job runs on a single server. But this one-server-per-job model is not a good representation of today's compute jobs.
A typical data center job occupies multiple cores concurrently for some fixed time. Unfortunately, very little is known about the performance of such "multiserver job" queueing models. We present the first results on response time for multiserver job models.
Other compute jobs, like database queries and many machine learning jobs, are malleable. They can run on *any* number of cores, where the job's speed is a function of the number of cores allocated to it. We present the first results on optimal core allocation algorithms for such parallel speedup jobs.
All results presented are very recent and are a testament to how open both these settings are. If you are looking for open problems to work on, this is a good talk for you!

Sunday, October 15, 12:45 PM - 2:00 PM

SC09

CC-North 122C

Scaling Limits of Interacting Particle Systems

Community Committee Choice Session

Session Chair: Ruoyu Wu, Iowa State University, Ames, IA

1 Smoothness of Directed Chain Stochastic Differential Equations and Its Applications

Tomoyuki Ichiba, Ming Min, University of California Santa Barbara, Santa Barbara, CA

On a filtered probability space for the space of continuous functions, we shall consider a system of stochastic equations called directed chain stochastic differential equations for a pair of stochastic processes whose marginal distributions in the path space are identical and their joint distribution is uniquely determined by the system of equations with the distributional constraints. In this talk we discuss the smoothness of the solutions of the equations under some regular conditions and introduce its applications of such systems to the stochastic filtering problem and to the generative adversarial network problem in finance.

2 Longtime Behavior of Stochastic Waves on Metric Spaces and Their Genealogies

Wai-Tong (Louis) Fan[1], Yifan (Johnny) Yang[2], [1]Indiana University, Bloomington, IN, [2]Indiana University, Bloomington, IN, Contact: waifan@iu.edu

Stochastic reaction-diffusion equations are important models in mathematics and in applied sciences such as spatial population genetics and ecology. However, for many reaction terms and noises, the solution notion of these equations is still missing in dimension two or above, hindering the study of spatial effect on stochastic dynamics. In this talk, I will discuss a new approach, namely, to study these equations on general metric graphs and fractals. This enables us to assess in great detail the impact of spatial effect on the co-existence and the genealogies of interacting populations. We will focus on recent results on extinction/survival probability, quasi-stationary distribution, asymptotic speed and other long-time behaviors for stochastic reaction-diffusion equations of Fisher-KPP type.

3 Multi-Component Matching Queues in Heavy Traffic

Bowen Xie, Washington University in St. Louis, St. Louis, MO

We consider multi-component matching queue systems in heavy traffic consisting of K ≥ 2 distinct perishable components, which arrive randomly over time to their respective queues at high speed at the assemble-to-order station and wait until an instantaneous match or their patience runs out. For a sequence of such systems parameterized by n, when the arrival rates tend to infinity in concert as n ⍰ ∞, we obtain a heavy traffic limit of the appropriately scaled queue length vector characterized by a coupled stochastic integral equation with a scalar-valued non-linear term under mild assumptions. We demonstrate some crucial properties. Motivated by the cost structure of blood bank drives, we formulate an infinite-horizon discounted cost functional and show that the expected value of the cost for the nth system converges to that of the heavy traffic limit as n tends to infinity.

4 Weakly Interacting Jump Processes with Graphon Interactions

Ruoyu Wu, Iowa State University, Ames, IA

We consider systems of weakly interacting jump processes on heterogeneous random graphs and their large population limit. The interaction is of mean field type weighted by the underlying graphon. A law of large numbers result is established as the system size increases and the underlying graphons converge. The limit is given by a graphon particle system consisting of independent but heterogeneous nonlinear Markovian processes whose probability distributions are fully coupled. An application to individual-based epidemic models is discussed.

Sunday, October 15, 12:45 PM - 2:00 PM

SC10

CC-North 123

Ergodicity and Scaling Limits of Stochastic Networks

Community Committee Choice Session

Session Chair: Sayan Banerjee, 1</sup

1 Load Balancing in Parallel Queues and Rank-Based Diffusions

Sayan Banerjee[1], Amarjit Budhiraja[2], Ben Estevez[2], [1]UNC, Chapel Hill, Chapel Hill, NC, [2]UNC, Chapel Hill, Chapel Hill, NC, Contact: budhiraj@email.unc.edu

Consider a queuing system with K parallel queues in which the server for each queue processes jobs at rate n and the total arrival rate to the system is nK-v \sqrt{n} where v>0 and n is large. We study a family of rank-based routing policies in which O(\sqrt{n}) of the incoming jobsare routed to servers with probabilities depending on their ranked queue length and the remaining jobs are routed uniformly at random. Heavy traffic limit theorems, large time behavior and interchange of limits results are studied. Some comparisons with the classical join-the-shortest queue control policy are made.

2 Opinion Dynamics on Complex Networks: From Mean-Field Limits to Sparse Approximations

Mariana Olvera-Cravioto, UNC, Chapel Hill

In a world of polarized opinions on many cultural issues, we propose a model for the evolution of opinions on a large complex network. Our model is akin to the popular Friedkin-Johnsen model, with the added complexity of vertex-dependent media signals and confirmation bias, both of which help explain some of the most important factors leading to polarization. The analysis of the model is done on a directed random graph, capable of replicating highly inhomogeneous real-world networks with various degrees of assortativity and community structure. Our main results give the stationary distribution of opinions on the network, including explicitly computable formulas for the conditional means and variances for the various communities. Our results span the entire range of inhomogeneous random graphs, from sparse to dense.

3 A New Class of Bounds for Convergence of Markov Chains to Equilibrium

Yanlin Qu, Peter W. Glynn, Jose Blanchet, Stanford University, Stanford, CA

We introduce a unified framework to derive computable convergence bounds for Markov chains. Under this framework, bounds with various rates, ranging from polynomial to exponential, are derived from a single "contractive drift" (CD) condition. These bounds are computable, as all elements are explicitly defined in terms of one-step transition expectations. Various techniques are devised to verify CD for examples from queueing theory and stochastic optimization. For these examples, we obtain sharp bounds that scale correctly with respect to model parameters such as the traffic intensity in queueing models and the step size in optimization algorithms.

4 Distributed Rate Scaling in Large-Scale Service Systems

Debankur Mukherjee[1], Daan Rutten[1], Martin Zubeldia[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]University of Minnesota, Minneapolis, MN

We consider a large-scale parallel-server system, where each server independently adjusts its processing speed in a decentralized manner. The objective is to minimize the overall cost, which comprises the average cost of maintaining the servers' processing speeds and a non-decreasing function of the tasks' sojourn times. This problem is compounded by the lack of knowledge about task arrival rate and the absence of centralized control or communication among the servers. Drawing on stochastic approximation, we present a novel rate-scaling algorithm that ensures the convergence of all server processing speeds to the globally asymptotically optimum value as the system size increases. En route, we also analyze the performance of a fully heterogeneous parallel-server system, where each server has a distinct processing speed, which might be of independent interest.

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SC11

CC-North 124A

Frontiers in Adaptive Experimentation

Community Committee Choice Session

Session Chair: Hongseok Namkoong, Columbia University, New York, NY

Session Chair: Hannah Li, MIT, West Menlo Park, CA

1 Poisson Limits for Bernoulli Bandits

Wenjia Ba[1], Lin Fan[2], Peter W. Glynn[2], J. Michael Harrison[2], [1]Amazon, Menlo Park, CA, [2]Stanford University, Stanford, CA, Contact: linfan@stanford.edu

We introduce a new asymptotic regime for modeling bandit experiments with low success probability Bernoulli rewards. By considering success probabilities of $O(\gamma)$ in the limit of γ decreasing to zero, over time horizons of $O(1/\gamma)$, we show that the sample-path behavior of adaptive algorithms such as Thompson sampling can be approximated by solutions to stochastic ODE's driven by Poisson processes. Our results reveal insights about the regret behavior of such algorithms, as well as that of simple and tuning-free dynamic batch updating strategies.

2 Online RL For Digital Health Interventions: The Art Of Reward Design

Kelly W. Zhang, Columbia University, New York, NY, Contact: kelly.w.zhang@columbia.edu

Dental disease is one of the most prevalent chronic illnesses in the US. Advances in digital tech, like electric toothbrushes and smartphones, offer potential for promoting quality toothbrushing in real-time. We develop an online RL algorithm for learning when to send vs not send feedback/educational messages to patients via a mobile app to best promote quality toothbrushing. A key challenge is ensuring the RL algorithm is simple enough to learn in this data-sparse, real-world setting, while at the same time still manages to model delayed effects of sending messages (i.e., user burden). Via careful reward design we help the RL algorithm maximize high-quality brushing while accounting for user burden. Our RL algorithm is currently being pilot tested for a clinical trial that is planned to start in fall 2023.

3 Diffusion Models for Experimentation

Victor Araman, American University of Beirut, Beirut, Lebanon

We consider a decision maker who must choose an action in order to maximize a reward function that depends also on an unknown parameter. The decision maker can delay taking the action in order to experiment and gather additional information on the unknown parameter. We model the decision maker's problem using a Bayesian sequential experimentation framework and use dynamic programming and diffusion-asymptotic analysis to solve it. For that, we scale our problem in a way that both the average number of experiments that is conducted per unit of time is large and the informativeness of each individual experiment is low. Under such regime, we derive a diffusion approximation for the sequential experimentation problem, which provides a number of important insights about the nature of the problem and its solution.

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SC12

CC-North 124B

Green Products, Services and Market Mechanisms

Community Committee Choice Session

Session Chair: Metin Cakanyildirim, The University of Texas at Dallas, Richardson, TX

Session Chair: Lingling Shi, The University of Texas-Dallas, Richardson, TX

1 The Economical and Environmental Impacts of Reselling Returns

Xin Wang[1], Yulan Amanda Wang[2], Kanglin CHEN[3], [1]The Hong Kong University of Science and Technology, Kowloon, Hong Kong; [2]The Hong Kong Polytechnic University, Hung Hom, Hong Kong; [3]Southern University

of Science and Technology, Shenzhen, China
Many retailers resell returns with no quality problems as new to save costs as well as reduce carbon emission and other negative environmental impacts. However, customers might express concerns and incur valuation reduction when they receive returns resold as new. In this study, we examine the impact of reselling returns on the market and the environment. We show that when consumers have valuation reduction towards receiving returns, reselling returns can benefit the retailer, consumers, and the environment simultaneously. Interestingly, educating consumers to be more tolerant of receiving returns might result in higher carbon emission.

2 On the Environmental Impact of Load Shifting in the Day-Ahead Market

Clarisse Dupont[1], Yashar Ghiassi-Farrokhfal[2], Derek W. Bunn[3], Olga Kuryatnikova[4], [1]Erasmus university, Rotterdam, Netherlands; [2]Erasmus University, Rotterdam School of Management, Rotterdam, NY, Netherlands; [3]London Business School, London, United Kingdom; [4]Erasmus University, Rotterdam, Netherlands. Contact: dupont@rsm.nl

Storage and Demand Response can enhance renewable energy sources integration by managing imbalances through load shifting. However, these flexible assets may inadvertently increase the CO2 emissions of electricity procurement because of their inefficiencies and the shape of the marginal emission curve. We develop a model to understand the market conditions under which this phenomenon occurs in the day-ahead market. We then formulate three solutions - a capacity cap, a CO2 tax, and a transaction tax - to integrate load-shifting agents without increasing CO2 emissions. We further evaluate and confirm the validity of our analytical findings in more practical and diverse settings and through numerical studies, using data from the Dutch day-ahead market.

3 Data-Driven Operations for a Grid-Vehicle Integration System

Ziliang Jin[1], Jianqiang Cheng[2], Kai Pan[1], Zuo-Jun Max Shen[3], Yulan Wang[1], [1]The Hong Kong Polytechnic University, Kowloon, Hong Kong; [2]University of Arizona, Tucson, AZ, [3]University of California, Berkeley, CA, Contact: ziliang-lms.jin@connect.polyu.hk

We examine a grid-vehicle integration system that uses vehicle-to-grid (V2G) technology to connect the grid and the electrical vehicle (EV) sharing system. Our focus is on the operation of this integration system under uncertainties. We formulate this problem as a two-stage robust mixed-integer program. To improve the solving process, we propose three approaches that incorporate alternating direction method of multipliers (ADMM), machine learning (ML), and strong valid inequalities, respectively. Our approaches significantly outperform a commercial solver in both computational time and solution quality based on real data. Our findings suggest that in addition to enhancing the operation efficiency of the grid, V2G also promotes sustainability by reducing carbon emissions. However, the extent of this contribution varies under different power load patterns.

4 Pricing and Producing Green Products Under Subsidy Termination and Evolving Coopetition

Lingling Shi[1], Metin Cakanyildirim[2], Suresh P. Sethi[2], [1]The University of Texas-Dallas, Richardson, TX, [2]The University of Texas at Dallas, Richardson, TX, Contact: metin@utdallas.edu

Governments offer subsidies to consumers to reach green product adoption targets. Subsidies will terminate. Accounting for subsidy termination and interplay among subsidy, learning-by-doing and competition, we develop a two-period Stackelberg-Nash game between the government and manufacturers. We find that the government spends less subsidy expenditure with qualified-sales rule compared to all-sales rule. Each manufacturer adopts zero-inventory and skimming price strategies. Two manufacturers may learn individually or as a group. Interestingly, under group learning, a manufacturer's total equilibrium production quantity in two periods decreases in his rival's initial cost when the cooperation through group learning outperforms the competition between the manufacturers. Besides, group learning benefits the three parties only in specified cases.

Sunday, October 15, 12:45 PM - 2:00 PM

SC13

CC-North 125A

Intelligent Decision Making and its Applications

Community Committee Choice Session

Session Chair: Kuo-Ping Lin, 1</sup

1 Using Long Short-Term Memory for Waste Disposal Forecasting

Kuo-Ping Lin[1], Kuo-Chen Hung[2], [1]Tunghai University, Taichung City, Taiwan; [2]Hungkuang University, Taichung City, Taiwan. Contact: kplin@thu.edu.tw

This study attempts to apply Long Short-Term Memory (LSTM) to forecast the daily amount of recycling clinical and related waste generated. LSTM networks can capture dependencies in sequential data over long time lags. In this study, LSTM, support vector regression (SVR), generalized regression neural network (GRNN) and autoregressive integrated moving average (ARIMA) are examined to forecast the daily amount of recycling clinical and related waste generated. Empirical results indicate the LSTM model demonstrates better performance and robustness compared to the other approaches; The LSTM method can help experts in hospitals develop reasonable waste disposal projects, which can help the waste management system effectively achieve operational reliability and economy.

2 Community/Committee'S Choice Submission
I-Jan Wang, Taiwan

3 Application on Text Analytics for Supply Chain Resource Limits Assessment
Chih-Yuan Chu, Tunghai University, Taichung, Taiwan. Contact: cychu@thu.edu.tw
Designing resilient supply chains that can recover from the negative impacts of risk events is an important issue in product development. Accordingly, this study aims to utilize textual data from news articles and earnings call transcripts to assess the resource limits, one of the essential indicators of supply chain vulnerability. An integrated factor analysis (FA) and Analytical Network Process (ANP) method was proposed to model the company's supply chain resource limits index with potential importance weights. The results showed that the shortages of resources such as production capacity, energy, and manufacturing components are the most critical sub-factors. A company resource limits index (CRLI) and supply chain resource limits index (SCRLI) were developed to assist companies in evaluating the resource limits vulnerability.

4 Applying Robust Stochastic Optimization on Scheduling Problem in Electronic Manufacturing Services Industry
Kang-Ting Ma[1], Che-Wei Chou[2], Ren-Hong Luo[1], You-Qin Wang[1], [1]National Dong Hwa University, Hualien, Taiwan; [2]Feng Chia University, Taichung, Taiwan. Contact: cwchou@fcu.edu.tw
EMS excels in the manufacture and assembly of electronic products, handling a variety of components, including printed circuit board assembly (PCBa). PCBa comprises three main stages: Surface-Mount Technology (SMT), Dual in Package (DIP), and Assembly-Test-Packaging (ATP). While scheduling typically relies on due dates, the manual nature of SMT's post-process introduces uncertainty in process time. Therefore, this study aims to develop robust strategies for machine operation and overtime through a stochastic optimization mathematical model. To estimate the uncertainty of production time in post-process, we develop a simulation model to appraise the production time of varied products during the DIP and ATP process where full of variations in the manufacturing environment. This scheduler helps practitioners to meet the delivery schedule on time.

5 A Study on the Application of Data Envelopment Analysis to Evaluate the Innovation Performance of Taiwan's Fastener Industry
Sheng-Pin Wu, Tai-Yu Lin, National Cheng Kung University, Tainan, Taiwan
The fastener industry faces unprecedented challenges due to Covid-19 and competition from mainland China and Southeast Asian countries. This study evaluated the innovative performance of twelve listed companies. The R&D expense ratio, patent-grade distance, and net operating income were analyzed using data envelopment analysis. It has been found that R&D expenditures positively correlate with innovation performance and business turnover but not with patents. R&D expenditures in the fastener industry are driven by developing new products and processes. Adding new products and technologies will increase the company's overall benefits. The innovation energy accumulation and scale technical efficiency can also be improved in the fastener industry.

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SC14

CC-North 125B
Job Market Candidates - Responsible Operations
Community Committee Choice Session
Session Chair: Alp Sungu, London Business School, London, United Kingdom

1 Incentives And Conditions For Protecting Tropical Forests And Improving Smallholder Welfare
Xavier Warnes[1], Dan Andrei Iancu[1], Erica Plambeck[1], Joann de Zegher[2], [1]Stanford University, Stanford, CA, [2]MIT Sloan, Cambridge, MA, Contact: xwarnes@stanford.edu
Environmental science documents that agricultural production is a dominant driver of deforestation in developing countries. Complex land tenure systems coupled with low enforcement of conservation laws enable farmers to illegally convert tropical forests into productive land in search of a better income. We propose group incentives

conditional on protecting a specific forest area to prevent this deforestation while increasing farmer welfare. We model the deforestation decisions using a cooperative game in partition function form and show how these area-conditional incentives can leverage the existing social capital in agricultural communities. Finally, we demonstrate these incentives' effectiveness by using data from the Indonesian context.

2 Centralized Versus Decentralized Pricing Controls For Dynamic Matching Platforms

Omer Saritac[1], Ali Aouad[1], Chiwei Yan[2], [1]London Business School, London, United Kingdom; [2]University of Washington Seattle, San Francisco, CA, Contact: osaritac@london.edu

Motivated by recent regulations and increased public scrutiny on platform control, we analyze how pricing centralization affects online service platforms using a fluid model of dynamic two-sided matching. We explore outcomes from a fully centralized pricing system, where the platform sets the price, to a fully decentralized one, where suppliers set prices. Our research uncovers the structure of stationary market equilibria and resulting social welfare under various degrees of centralization. We find that in 'impatient' markets, centralized platforms yield higher social welfare, while in more patient markets, decentralized pricing approaches first-best outcomes. Semi-centralized pricing rules, offering some flexibility to suppliers in setting their prices, recover near-optimal outcomes in most market conditions.

3 Keep Water Flowing: The Hidden Crisis of Rural Water Management

Chengcheng Zhai[1], Rodney P. Parker[2], Kurt M. Bretthauer[2], Jorge Mejia[2], Alfonso J. Pedraza-Martinez[2], [1]Kelley School of Business, Bloomington, IN, [2]Indiana University, Bloomington, IN, Contact: zhaic@iu.edu

In rural areas of sub-Saharan Africa (SSA), people rely on handpumps for clean drinking water. Unfortunately, handpumps break down frequently due to lack of maintenance and repair. We collected mechanic visit and water point functionality data from three SSA countries. We develop a Markov decision process (MDP) that captures the main features of a maintenance program. The MDP determines the optimal schedule for NGO mechanics to visit water points, with the aim of minimizing water point downtime and the logistics costs. Our research challenges the notion held by many NGOs that preventive maintenance is costly and that monitoring and collecting functionality information is the key to improving water point functionality. We recommend NGOs invest in increasing water points reliability before investing in collecting more functionality information.

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SC15

CC-North 126A

Smart Bases

Community Committee Choice Session

Session Chair: Gregory S. Parnell, University of Arkansas, Fayetteville, AR

1 Smart Sensor Data Streams for Smart Bases

Natalie Myers, [1</sup]

The 2020 Army Installation Strategy establishes a vision for a future, modern Army that reduces costs and improves the environment, quality of life, security, and mission readiness by leveraging smart and connected technologies. Data-informed, smart installations will allow the Army to enable a data-rich, reconfigurable, and technology-enhanced information-age construct. To meet this end state, installations are looking for implementation guidance on how to leverage these technologies and generate the needed data. Researchers from the Army's Engineer Research and Development Center (ERDC) lead recent efforts to pilot smart city technologies to enable the identification and implementation strategies for Army installations. Join this session to learn about technologies being piloted at installations today and the data they are providing. These technologies include weather sensor to better inform everything from base closures to training schedules, as well as video surveillance to monitor remote fence lines or traffic congestion.

2 Leveraging Weather and Climate Intelligence Across Installation Platforms

Randy K. Buchanan, Engineer Research and Development Center, MS

Weather intelligence efforts support the modernization of installation decision-making processes by applying complex computational analytics and high-performance computing assets to inform decision makers for making real-time holistic weather-related decisions as well as supporting long-term climate resilience planning. Installations across the Department of Defense currently utilize weather and climate data but have a need for data at a rate and resolution not currently available. Multiple systems are trying to access and use much of the same data and information. Discovering, documenting, and leveraging these multiple systems is a formidable task, but can serve as a force multiplier to reduce duplication and increase impacts.

3 Weather Intelligence for Military Installation Decision Support - Lessons Learned

George E. Gallarno[1], Jaylen E. Hopson[1], Brendon Hoch[2], John P. Richards[1], Randy K. Buchanan[1], [1]US Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, MS, [2]US Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, MS, Contact: George.E.Gallarno@erdc.dren.mil

A plethora of authoritative weather observation and forecast-related data sources are readily available for analysis and modeling building. The sheer volume and variety of data sources complicates the task of acquiring and preparing relevant weather intelligence for military installation leadership in order to facilitate timely decisions in advance of extreme weather events. We overview lessons learned from data acquisition and implementation for two case study locations (Fort Carson, CO and Fort Moore, GA), illustrating a preliminary data pipeline (i.e., extraction, transformation, loading, and analysis) for extracting meaningful insights necessary for more consistent, transparent, and data-driven installation-level decisions.

4 Application of AI/ML on Local Climatological Data for Installation Forecasting Visibility

William A. Anderson[1], Brendon Hoch[2], Christina Rinaudo[1], John Richards[1], Randy Buchanan[1], George Gallarno[1], [1]Engineer Research and Development Center, Vicksburg, MS, [2]Engineer Research and Development Center, Hannover, NH, Contact: William.A.Anderson@erdc.dren.mil

Ground level visibility forecast data can be a valuable source of information for installation leaders who make decisions on airfield operations, unit training, and installation access that are impacted by visibility, which often is poorly forecast. This research examines the potential for machine learning algorithms to predict visibility using standard measured atmospheric data. Researchers applied a range of machine learning algorithms to collected historic local climatological data to examine the tenability of predicting forecast visibility. Considerations for over-fitting, multi-collinearity, and data sourcing were addressed to ensure the best model is selected. Case study results for Ft. Carson, CO and Ft. Moore, GA are discussed.

5 Preventing Heat Related Injuries in Military Trainings

Eric Specking[1], Gregory S. Parnell[2], Anthony Beger[1], William Anderson[3], Randy Buchanan[3], [1]University of Arkansas College of Engineering, Fayetteville, AR, [2]University of Arkansas, Fayetteville, AR, [3]Engineer Research and Development Center, Vicksburg, MS

Heat injuries cause major problems for the United States military with the Pentagon reporting a 68% increase in permanent damage or death caused by serious heat strokes. Fort Benning is home to one of the largest Army training posts and has the most heat related injuries in the military due to its climate. Training personnel currently use the WetBulb Globe Temperature Index and training details to assess risk. This presentation will 1) provide insights on how temperature impacts soldiers and current risk assessment methods, 2) describe our approach, which uses a data-driven weather-informed process, and 3) discuss future work of the project, which includes migrating our tool to the U.S. Army's Virtual Testbed for Installation Mission Effectiveness (VTIME) cloud environment.

Sunday, October 15, 12:45 PM - 2:00 PM

SC16

CC-North 126B

Optimization for Experimentation and Personalization in Managerial Settings

Community Committee Choice Session

Session Chair: Spyros Zoumpoulis, INSEAD, Fontainebleau, France

1 Adaptive Experimental Design for Personalized Treatment Policies

Molly Offer-Westort, University of Chicago

The goal of an multi-arm trial may be to learn which of several interventions is most effective, where the metric of success is simple regret. When candidate intervention sets vary across individuals, or when there is heterogeneity in which intervention is best, the objective may be to learn a personalized treatment policy. Adaptive designs can be used to learn policies with lower regret faster. We discuss design considerations, with application to a Facebook Messenger chatbot study targeting sources of COVID-19 vaccine hesitancy among 22,000 social media users in Kenya and Nigeria. After optimizing messaging using an adaptive experimental design, we compare an interactive concern-addressing chatbot to a chatbot that delivers a non-interactive public service announcement (PSA), as well as to a control, no information, condition.

2 Stochastic Optimization Forests

Nathan Kallus[1], Xiaojie Mao[2], [1]Cornell University, Long Island City, NY, [2]Tsinghua University, Beijing, China. Contact: maoxj@sem.tsinghua.edu.cn

We study contextual stochastic optimization problems, where we leverage rich auxiliary observations (e.g., product characteristics) to improve decision making with uncertain variables (e.g., demand). We show how to train forest decision policies for this problem by growing trees that choose splits to directly optimize the downstream decision quality, rather than split to improve prediction accuracy as in the standard random forest algorithm. We prove that our splitting criteria consistently approximate the true risk and that our method achieves asymptotic optimality. We extensively validate our method empirically, demonstrating the value of optimization-aware construction of forests and the success of our efficient approximations.

3 Optimal Experimentation for Learning Personalized Policies Across Locations

Stefanos Poulidis, Georgina Hall, Spyros Zoumpoulis, INSEAD, Fontainebleau, France. Contact: stefanos.poulidis@insead.edu

Firms wish to learn personalized policies for customers in heterogeneous yet related locations to maximize their monetary gains. To do this, they conduct experiments at each location to estimate the parameters of a customer response function. A key decision is which action to assign to each participant in the experiment, especially when a participant can only be assigned one action, or there are budget constraints. The existing experimentation methodology considers locations and experiments individually. In this work, we leverage the relationship between locations in the experimentation problem to learn more profitable policies by proposing novel estimators and a semidefinite programming approach.

4 A Perturbation-Based Approach to Optimistic-Pessimistic Duality in Robust Optimization

Louis L. Chen, Johannes Royset, Naval Postgraduate School, Monterey, CA, Contact: louischenusa@gmail.com

We revisit the duality between "Primal-Worst" and "Dual-Best" robust optimization formulations through the lens of a perturbation-based approach. In doing so, we find a more general and arguably simpler framework to develop this duality, expand on its prior results, highlight its connection to traditional duality, and show how it can derive a number of modern duality results not typically viewed as part of an optimistic-pessimistic framework. We also show applications in a variety of Operations and Management contexts and discuss the implications of this duality that occasionally pairs convex and non-convex programs.

Sunday, October 15, 12:45 PM - 2:00 PM

SC17

CC-North 127A

Data-driven Behavioral Service Operations

Community Committee Choice Session

Session Chair: Qiuping Yu, Georgetown University/Georgia Tech, Washington, DC

Session Chair: Masoud Kamalahmadi, University of Miami, Coral Gables, FL

1 Measuring Strategic Behavior by Gig Economy Workers: Multihoming and Repositioning

Gad Allon, Kenneth Moon, Daniel Chen, University of Pennsylvania, Philadelphia, PA, Contact: gadallon@wharton.upenn.edu

This study investigates the decision-making processes of gig economy workers, focusing on their choices regarding platform engagement and work locations. We analyze extensive worker activity data to explore how workers optimize their earnings and respond to incentives for platform switching and location changes. Our findings highlight the heterogeneity of worker preferences and reveal the costliness of multihoming compared to repositioning. Our findings suggest the significance of enabling free multihoming and efficient repositioning for improved earnings and service levels, providing valuable insights for platform operators and regulators.

2 Fairness in Policing and Crime Prevention with Causal Inference

Jonathan Zhou[1], Zheng Dong[1], Yao Xie[2], Qiuping Yu[3], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, [3]Georgetown University/Georgia Tech, Washington, DC, Contact: jyz@gatech.edu

We study how scheduling and dispatching policy impact police effectiveness and fairness using event-level police patrol and 911-call data from the Atlanta Police Department. Our findings suggest that two key factors—police availability and the design of patrolling divisions—contribute significantly to service quality disparities and differences in policing behavior across neighborhoods. Based on these results, we propose an optimization framework to mitigate disparities between zones and improve police service quality.

3 A Manager and an AI Walk into a Bar: Does ChatGPT Make Biased Decisions like We Do?

Yang Chen[1], Meena Andiappan[2], Tracy Jenkin[1], Anton Ovchinnikov[3], [1]Queen's University, Kingston, ON, Canada; [2]University of Toronto, Toronto, ON, Canada; [3]Smith School of Business, Queen's University, Kingston, ON,

Canada. Contact: tracy.jenkin@queensu.ca

Large language models such as ChatGPT have garnered global attention, promising to disrupt and revolutionize business operations. With increasing reliance on artificial intelligence (AI), there is an urgent need to understand whether there are systematic biases in AI decision-making given they are trained with human data and feedback, which themselves may be highly biased. This paper tests a broad range of behavioral biases commonly found in humans that are especially relevant to operations management. We found that while ChatGPT can be much less biased and more accurate than humans in problems with an explicit mathematical nature, it also exhibits many biases humans possess. Our research characterizes ChatGPT's behaviors in decision-making and showcases the need to consider potential AI behavioral biases when developing and employing AI for business operations

4 Racial and Gender Biases in Customer Satisfaction Surveys: Evidence from a Restaurant Chain

Masoud Kamalahmadi[1], Qiuping Yu[2], Yong-pin Zhou[3], [1]University of Miami, Coral Gables, FL, [2]Georgetown University, Washington, DC, [3]University of Washington, Seattle, WA, Contact: yongpin@uw.edu

Racial and gender inequalities are ubiquitous in the workplace. Whereas previous studies have primarily focused on employer discrimination, we study the role of customers, using 1,444,044 transactions and 257,656 customer satisfaction surveys from a full-service casual-dining restaurant chain in the US. We find that customer ratings of servers are biased against racial minority, and, interestingly, also against females despite their majority in this occupation. We further show that racial biases diminish as the uncertainty about the servers' ability decreases, while gender biases may even increase. These results suggest that statistical discrimination is the primary driver for racial biases, while status-based discrimination is likely the main driver for gender biases. Given these underlying mechanisms, we propose tailored strategies to mitigate the biases.

5 Impact of Empirical Research on Operations Management

Nalin Shani, Maria Ibanez, Kellogg School of Management, Evanston, IL

Empirical research has contributed significantly to the academic field of operations management(OM). There has also been a steady increase in empirical research being generated. Given this trend, an important question arises regarding how does empirical research shapes and drives the OM literature. We plan to investigate the impact empirical research had on recent publications in OM.

Sunday, October 15, 12:45 PM - 2:00 PM

SC18

CC-North 127B

Operations Research Approaches for Managing Chronic Diseases

Community Committee Choice Session

Session Chair: Karen T. Hicklin, University of Florida, Gainesville, FL

1 Improving Equity in Access Through Network Design: A Case Study of Specialist Cancer Care in Rwanda

Abel Sapirstein, Lauren N. Steimle, Georgia Tech ISyE, Atlanta, GA, Contact: asapirstein3@gatech.edu

Cancer is a growing cause of death in Rwanda and much of the developing world. Successful diagnosis and treatment of cancer requires orchestration of many specialists, often working together in a dedicated hospital. However, concentrating specialists in a small number of hospitals may further disadvantage populations currently without access to care. In this talk, we consider existing barriers to access and potential system improvements to increase access to specialist cancer care in Rwanda. We present a flexible modeling approach which is capable of weighing cost, demand for care, and provider availability while maximizing accessibility. We parameterize the model using publicly available data and propose solutions that align with the objectives of government and NGO partners.

2 Colorectal Cancer Tumor Proliferation Characteristics And Socioeconomic Status In The Southern Community Cohort Study

Zoe L. Walts[1,2], Thomas Lawler[2], Timothy Su[3], Qiuyin Cai[3], Mark Steinwandel[4], Wei Zheng[3], Shaneda Warren Andersen[1,2,3], [1]University of Wisconsin-Madison, Madison, WI, [2]University of Wisconsin Carbone Cancer Center, Madison, WI, [3]Vanderbilt University School of Medicine, Nashvillle, TN, [4]Vanderbilt Institute for Clinical and Translational Research, Rockville, MD, Contact: zwalts@wisc.edu

Black and low-income Americans experience increased colorectal cancer (CRC) mortality compared to White and high-income groups. Cox proportional hazards models were built to calculate hazard ratios (HR) and 95% confidence intervals (CI) of income, race, and factors related to socioeconomic status (CRC screening history, insurance status) with tumor expression of two proteins, ki-67 and p53, in incident CRCs. Ki-67 is a cell proliferation marker. P53 is a key cell cycle regulator. Income was positively associated with ki-67 (HR:1.48,CI:1.02-2.18). Lack of both insurance (HR:1.38,CI:0.88-2.16) and CRC screening (HR:1.43,CI:0.94-2.17) were marginally associated with ki-67. Lack of CRC screening was marginally associated with p53 (HR:1.56,CI:0.93-2.62). This evidence supports the hypothesis that socioeconomic resources may impact tumor development.

3 Maintaining Fairness in Chemotherapy Schedules Under Uncertainty

Batuhan Celik[1], Serhat Gul[2], Özlem Karsu[1], [1]Bilkent University, Ankara, Turkey; [2]TED University, Ankara, Turkey

Chemotherapy scheduling is hard to manage under uncertainty in infusion durations, and focusing on expected performance measure values may lead to undesired outcomes for some patients. This study aims to schedule daily patient appointments, considering a fair environment regarding patient waiting times. We maximize a fairness metric inspired by CVaR within a two-stage stochastic mixed-integer nonlinear programming model. We identify the optimal fairness level using a binary search algorithm. To solve stochastic feasibility problems at each iteration, we propose a novel reduce-and-augment algorithm. We use real data from an oncology hospital to compare our approach with multiple scenario reduction techniques from the literature.

Sunday, October 15, 12:45 PM - 2:00 PM

SC19

CC-North 127C

I Got Tenure, Now What?

Panel Session

1 I Got Tenure, Now What?

Anahita Khojandi, University of Tennessee, Knoxville, TN

Session Chair: Anahita Khojandi, University of Tennessee, Knoxville, TN

2 Panelist

Maria Esther Mayorga, North Carolina State University, Raleigh, NC

3 Panelist

Margaret L. Brandeau, Stanford University, Stanford, CA

4 Panelist

Mark Stephen Daskin, University of Michigan, Ann Arbor, MI

5 Panelist

Timothy Chan, University of Toronto, Toronto, ON, Canada

Sunday, October 15, 12:45 PM - 2:00 PM

SC20

CC-North 128A

Modeling and Controlling Epidemics

Community Committee Choice Session

Session Chair: Ujjal Kumar Mukherjee, University of Illinois, Urbana-Champaign, Champaign, IL

1 Hotspots for Emerging Epidemics: Multi-Task and Transfer Learning over Mobility Networks

Sebastian Souyris[1], Shuai Hao[2], Ujjal Kumar Mukherjee[3], Yuqian Xu[4], Sridhar Seshadri[5], Anton Ivanov[6], Mehmet Ahsen[6], [1]Rensselaer Polytechnic Institute, Troy, NY, [2]University of Illinois Urbana-Champaign, Champaign, IL, [3]University of Illinois, Urbana-Champaign, Champaign, IL, [4]UNC-Chapel Hill Kenan-Flagler Business School, Chapel Hill, NC, [5]University of Illinois, Champaign, IL, [6]University of Illinois at Urbana-Champaign, Champaign, IL, Contact: souyrs@rpi.edu

This paper introduces a data-driven framework to identify potential COVID-19 hotspots using advanced analytical methodologies, such as a long short-term memory (LSTM) model, multi-task learning, and transfer learning. The model considers mobility data and leverages historical influenza transmission data to improve predictions. We demonstrate that a hotspot-based lockdown policy can potentially reduce new infections by 21% compared to an infection-based policy and can perform similarly to a state-wide lockdown, but targeting fewer areas. In addition, including transfer learning from past data boosts hotspot prediction accuracy by 53.4%. This approach outperforms traditional epidemiological models and offers a practical tool for policymakers to make informed decisions on epidemic control.

2 When Machines Will Take Over? Algorithms for Human-Machine Collaborative Decision Making in Healthcare

Mehmet Ahsen[1], Mehmet U.S. Ayvaci[2], Radha Mookerjee[3], [1]University of Illinois at Urbana-Champaign, Champaign, IL, [2]The University of Texas at Dallas, Richardson, TX, [3]University of Texas- Dallas, Richardson, TX

We study a hospital's optimal acquisition of single or multiple predictive AI algorithms for redesigning work to allocate tasks between humans and machines. We analytically characterize whether and when human-machine collaboration strategy is desirable against the machine-alone strategy or human-alone strategy. We use data from a recent crowdsourced deep-learning mammography challenge to demonstrate the value of the optimal use of AI in radiology. Our findings can inform efforts in reimagining work in the age of AI.

Sunday, October 15, 12:45 PM - 2:00 PM

SC21

CC-North 128B

Health Care, Modeling and Optimization

Community Committee Choice Session

Session Chair: Min Kyung Lee, Purdue University, West Lafayette, IN

1 Admission and Patient Transfer Decisions in a Hospital Network via Reinforcement Learning

Jorge R. Vera, Matías De Geyter, Pontificia Universidad Católica de Chile, Santiago, Chile. Contact: jvera@ing.puc.cl

Decision making in healthcare is a complex problem due to uncertainty and dynamic. One very important problem is related to decisions on patient admissions. In a healthcare network composed of various hospitals, it should be convenient to consider the combined capacity of the whole system. Hence, besides admissions to a hospital, the transfer of patients to others is also a possibility. These decisions depend not only on patient medical condition but also on current capacity of the various areas of the hospitals. In this work, we have formulated the problem as a Markov Decision Process, and we address it using a Reinforcement Learning approach where the expected future cost is estimated using a Neural Network combined with simulation, based on the Double Deep Q Networks methodology. We show promising results in various test problems.

2 Using a Vaccine Scheduling Recommendation App to Make an Informed Immunization Schedule Decision in China

Dawei Wang[1], Rui Bian[2], Sujian Situ[2], Yongyu Su[2], Joel Sokol[3], Pinar Keskinocak[3], Paul Griffin[4], Yao-Hsuan Chen[5], [1]Merck & Co., Inc., Rahway, NJ, [2]MSD China Holding Co., Ltd., Shanghai, China; [3]ISyE Georgia Tech, Atlanta, GA, [4]The Pennsylvania State University, University Park, PA, [5]MSD (UK) Limited, London, United Kingdom. Contact: dawei.wang@merck.com

Fear of pediatric vaccines being co-administrated and the desire to catch up with delayed vaccines according to national immunization schedule due to ongoing COVID-19 pandemic are posing a real challenge to both healthcare providers and caregivers in China. In this study, we adapted a previously published vaccine scheduling model from the US to account for specific requirements and restrictions in the Chinese pediatric vaccination environment. The model has been further adapted as an online App tool to solve the aforementioned challenges in real time and in a user-friendly manner.

3 Modeling Multistate Health Transitions with Hawkes Processes

Jiwon Jung, Kiseop Lee, Mengyi Xu, Purdue University, West Lafayette, IN, Contact: jung320@purdue.edu

We present a multistate health transition model with a Hawkes process. Despite the popularity of Markovian assumptions, our observational findings suggest that the elderly who have experienced functional disability have a higher chance of functional disability and mortality. To account for the impact of past events and their duration, we incorporate a Hawkes process to estimate the intensity of age and gender-specific transitions: functional disability, recovery, and mortality. The estimation results suggest that functional disability and mortality intensities significantly increase on the onset of the disability and decay as the duration since the latest transition gets longer.

4 A Holistic Exploration of Transgender and Nonbinary Experiences Through a Causal Lens

Min Kyung Lee[1], Yuehwern Yih[2], [1]Purdue University, West Lafayette, IN, [2]Purdue University, West Lafayette, IN, Contact: lee1239@purdue.edu

Transgender and gender nonbinary (TNB) individuals experience significant health disparities, including limited healthcare access, delays in seeking care, and poorer psychological and general health outcomes. This study employs a causal lens to assess psychological health and healthcare utilization among TNB individuals using data from the Behavioral Risk Factor Surveillance System and the

U.S. Transgender Survey. Through the application of causal analysis techniques, such as propensity score matching and joint mixed-effects models with g-computation, we aim to uncover the underlying causal factors contributing to these disparities. This research seeks to inform targeted interventions and policies to address the unique healthcare needs of TNB individuals, ultimately promoting health equity and improving overall health outcomes in this population.

5 Controlling Covid-19 Positivity Rates in Schools

Zeynep Ertem[1], Anseh Danesharasteh[2], [1]State University of New York- Binghamton, Vestal, NY, [2]Binghamton University, Binghamton, NY

To make in-person learning easier, CDC recommended several mitigation strategies. Following these recommendations, the state of Massachusetts, implemented various COVID-19 prevention measures to ensure a safe re-opening and in-person environmentincluding Surveillance testing, test to stay testing, and on-site symptomatic testing. On the other hand, vaccination has been recommended as one of the most effective ways to reducetransmission for different age groups in schools. In this study, we conducted an interrupted time series (ITS) Regression to evaluate students' COVID-19 positivity rate using various preventive policies such as vaccines and masking policy, considering the testing programsas the treatment event.

Sunday, October 15, 12:45 PM - 2:00 PM

SC22

CC-North 129A

Interpretability in Machine Learning for Healthcare

Community Committee Choice Session

Session Chair: Jeremy Watts, University of Tennessee, Knoxville, TN

Session Chair: Anahita Khojandi, University of Tennessee, Knoxville, TN

1 MRI Prediction of Breast Cancer-Related Lymphedema

Jeremy Watts, University of Tennessee, Knoxville, TN, Contact: gkm819@vols.utk.edu

Breast cancer-related lymphedema occurs in up to 20% of women treated for breast cancer. Lymphedema is a chronic condition with no known cure, which can dramatically reduce patients' quality of life. While risk factors associated with the development of lymphedema have been shown, predictive algorithms have had limited success in identifying these patients. In this study, we examine the role of pre-operative MRI alongside demographic and clinical data in the prediction of breast cancer-related lymphedema. To this end, we leverage machine learning algorithms to identify anatomical variations in patients' MRIs associated with risk. The clinical explainability of pre-operative MRI was considered to aid physicians in identifying patients with a greater risk.

2 Interpretable Policies and the Price of Interpretability in Hypertension Treatment Planning

Wesley J. Marrero[1], Gian Garcia[2], Lauren N. Steimle[3], Jeremy Sussman[4], [1]Thayer School of Engineering at Dartmouth, Hanover, NH, [2]Georgia Institute of Technology, Atlanta, GA, [3]Georgia Tech ISyE, Atlanta, GA, [4]University of Michigan, Ann Arbor, MI, Contact: wesley.marrero@dartmouth.edu

Markov Decision Process (MDP) models are commonly used tools for optimizing sequential decisions under uncertainty in medical decision making. If the parameters of an MDP satisfy certain assumptions, the optimal policy is guaranteed to be monotone. Unfortunately, these assumptions are not always satisfied. In this research, we define the price of interpretability (PI), which measures the gap between the optimal and an interpretable policy. We assess the PI for the best-performing monotone policy (BMP) and the novel class-ordered monotone policy (CMP), which preserves interpretability along user-defined state and action classes. Within the context of hypertension treatment, we demonstrate that the CMP can be computed faster and achieves greater total quality-adjusted life years across a population of 66.5 million people in the US, compared to the BMP.

3 An Optimization Approach For Effective And Equitable Allocation Of Substance Use Treatment Centers

Matthew Baucum[1], Matt Harris[2], Lawrence Kessler[2], Guanyi Lu[3], [1]Florida State University College of Business, Tallahassee, FL, [2]University of Tennessee, Knoxville, TN, [3]Florida State University, Tallahassee, FL

Substance use disorder (SUD) is a pressing health concern in the U.S., and connecting communities with accessible SUD treatment is a growing public health imperative. In this paper, we develop a predict-then-optimize framework for allocating limited SUD treatment resources within U.S. states. We first use instrumental variable regression to estimate the effect of SUD treatment centers on county-level substance-related death rates. We then formulate a quadratic optimization problem that allocates treatment centers while balancing effectiveness (i.e., reducing the greatest number of substance-related deaths), equity (allocating centers to counties with the highest death rates), and equality (allocating centers based on population). We analyze our recommended treatment center allocation strategies to provide actionable insights for policymakers.

4 Headache Classification and Automatic Biomarker Extraction from Structural MRIs Using Deep Learning

Md Mahfuzur Rahman Siddiquee[1], Jay Shah[1], Catherine Chong[2], Simona Nikolova[2], Gina Dumkrieger[2], Baoxin Li[1], Teresa Wu[1], Todd Schwedt[2], [1]Arizona State University, Tempe, AZ, [2]Mayo Clinic, Phoenix, AZ

We present a deep learning-based classification pipeline to distinguish brain MRIs of individuals with migraine, acute post-traumatic headache (APTH), and persistent post-traumatic headache (PPTH) from healthy controls (HC). It includes data preprocessing, binary classification of HC vs. headache type using a 3D ResNet-18, and biomarker extraction from the trained 3D ResNet-18. We got 75%, 75%, and 91.7% classification accuracies for migraine, APTH, and PPTH, respectively. The most significant biomarkers identified by the classifier for migraine were caudate, caudal anterior cingulate, superior frontal, thalamus, and ventral diencephalon; for APTH, lateral occipital, cuneus, lingual, pericalcarine, and superior parietal; finally, for PPTH, cerebellum, middle temporal, inferior temporal, inferior parietal, and superior parietal.

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SC23

CC-North 129B

Analytics of OM

Community Committee Choice Session

Session Chair: Georgia Perakis, Massachusetts Institute of Technology, Cambridge, MA

1 Robust Methods For Hierarchical Time Series Forecasting In Operations

Pin-Yu Chen[1], Alkiviadis Mertzios[2], Georgia Perakis[3], Wei Sun[4], Asterios Tsiourvas[2], Yada Zhu[5], [1]IBM Thomas J. Watson Research Center, New York, NY, [2]MIT, Cambridge, MA, [3]Massachusetts Institute of Technology, Cambridge, MA, [4]IBM T. J. Watson Research Center, Yorktown Heights, NY, [5]IBM, Yorktown Heights, NY, Contact: mertzios@mit.edu

In this work, we develop novel methods for Hierarchical Time Series forecasting. A key goal is model robustness so that node failures in the hierarchy do not particularly affect the results. Our is general enough to be extended to most optimization based approaches so that it is robust to node failures. We develop an optimization based method where we derive a formulation which produces robust solutions that are reconciled in sample. We test our method against real-world datasets ranging from transportation to demand prediction. We demonstrate improvement over existing, non-robust approaches.

2 Document Classification with Reference Information: Model and Insights

Evan Yao[1], Josh Wilde[1], Retsef Levi[2], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]MIT, Cambridge, MA, Contact: evanyao@mit.edu

We present a methodology for automatically classifying documents into pre-specified classes without the need for excessive manually labeling. An expert is called upon to curate reference information, external documents which describe the desired classes, after which a nearest-neighbor search is used to assign each document an initial label, and then that label is updated in an iterative fashion. Our methodology achieves nearly the same accuracy as training a supervised classifier after labeling all the documents manually. To explain our strong behavior, we create a model for how the documents and reference information are jointly drawn with one being a corrupted version of the other. The model is used to explain why our methodology works well, while theoretical and empirical studies help support our insights.

3 Counterfactual-Driven Prescriptive Tree

Wei Sun, Shivaram Subramanian, Youssef Drissi, Zhengliang Xue, Markus Ettl, IBM Research, Yorktown Heights, NY, Contact: sunw@us.ibm.com

In this talk, we present a framework to learn interpretable optimal policy from observational data. The proposed framework consists of a causal teacher model which produces counterfactual outcomes corresponding to different treatment actions, and a prescriptive student model which distills a set of optimized policies in the form of a tree. We show the resulting prescriptive tree can be learned greedily for swift deployment. As the greedy heuristic is unable to incorporate constraints that are often critical for enterprise applications, we introduce a scalable mixed-integer program that solves the constrained policy prescription problem via column generation. We will highlight the results from an online test that shows a 7% increase in revenue over the legacy pricing benchmark, where we applied this solution to a large US airline in premium seat upsell.

4 Towards Improving the Interpretability of Deep Learning

Dimitris Bertsimas, Zhen Lin, Rama Ramakrishnan, Massachusetts Institute of Technology, Cambridge, MA, Contact: zhen2019@mit.edu

We develop low depth (up to depth 8) classification trees with hyperplanes to closely approximate neural networks. In this way, we contribute in increasing the interpretability of neural networks. To facilitate the stronger performance of the trees, we develop an optimization-based adaptive learning method to generate additional data for training the trees. We also propose variants of our method based on randomization and the combination of optimization and randomization. This method improves the performance of the trees in approximating the neural networks, and in real-world classification tasks. We show this optimization method performs better than randomization. We report computational results on 59 real-world classification datasets, with different sizes of neural networks with accuracy 95% relative to the neural network.

5 Predictive Analytics for Auto Insurance Industry Under Market Shocks

William Zhang[1], Saurabh Amin[1], Georgia Perakis[2], Aron Brenner[1], [1]MIT, Cambridge, MA, [2]Massachusetts Institute of Technology, Cambridge, MA

A key challenge faced by the insurance industry is the prediction of replacement cost of an asset under highly non-stationary conditions (e.g., market fluctuations and supply chain shocks). We develop a modeling approach for automobile replacement costs that accounts for a lack of historical data on replacement costs by leveraging historical data from key economic indicators. This approach involves nesting smaller models, each involving feature subsets with temporal dependencies to generate accurate and explainable predictions. Our main contribution is a new model selection procedure based on varying feature importance and confidence intervals. Our results show that this approach achieves better performance for various evaluation metrics in comparison to classical methods such as random forests and ensemble models.

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SC24

CC-North 130

Digital Supply Chains

Community Committee Choice Session

Session Chair: Behnam Malmir, Virginia Tech, Charlottesville, VA

1 Information or No Information Sharing in Closed-Loop Supply Chains

Maryam Esmaeili[1], Aram Bahrini[2,3], Robert Riggs[3], [1]Alzahra University, Tehran, Iran, Islamic Republic of; [2]University of Illinois Urbana-Champaign, Champaign, IL, [3]University of Virginia, Charlottesville, VA, Contact: bahrini@illinois.edu

In this paper, we investigate the impact of information sharing on the performance of a two-level closed-loop supply chain consisting of one manufacturer and one retailer, such that the manufacturer is a leader and the retailer is a follower. In the forward supply chain, the manufacturer sells products through the retailer, and in the reverse supply chain, the manufacturer collects the used products. Manufacturers and retailers have private information about demand despite uncertainty. We obtain the Stackelberg equilibrium for retail price, wholesale price, and the collecting rate of the used products. We compare their profits under information and no information-sharing scenarios. Results show that information sharing in the closed-loop supply chain under a leader-and-follower scenario only sometimes increases the profits of the manufacturer and the retailer.

2 Adopting Blockchain Technology for Real-Time Agri-Food Supply Chain Visibility Improvement

Ali Ala[1], Behnam Malmir[2], Hamed Baziyad[3], [1]Shanghai Jiao Tong University, Shanghai, China; [2]Virginia Tech, Charlottesville, VA, [3]Tarbiat Modares, Tehran, Iran, Islamic Republic of

The article explores the impact of blockchain technology on the agri-food supply chain. The study identifies eight fundamental indicators in the food industry based on blockchain technology and uses the fuzzy DEMATEL method to determine structural and cause-and-effect relationships between these indicators. The findings indicate that traceability and fraud prevention are the most effective indicators, while the intelligent contract index is the most effective. The study suggests that blockchain can be an effective solution for achieving transparency and reliable tracking in the food industry.

3 Pricing and Returns in the Era of Big Tech: Implications of Information Asymmetry Reversal

Kiarash M. Hassani, Murray Lei, Anton Ovchinnikov, Queen’s University, Kingston, ON, Canada. Contact: 18kmh4@queensu.ca

We present a model to optimize the sales and return policy of a monopolistic seller under three information scenarios and examine the resultant profit and consumer surplus. The results of the base model show that when returns are not allowed, the firm collects twice as much profit when it has equal information compared with the standard information asymmetry. When returns are allowed, full information is always better than equal information, and equal information is always better than no information for the firm. Likewise, when the firm is fully informed, it is always profitable to allow returns. When returns are not free for consumers, we end up with various pricing policies based on the magnitude of return hassle costs and other variables. These policies and their effects on the firm and consumers differ depending on the firm's information level.

4 Cost Based - AI Platform for Inventory Replenishment of Retail Pet Products

Shiyang Huang[1], Selen Onel[2], Erdem Eskigun[3], [1]Chewy Inc., Plantation, FL, [2]Chewy, Plantation, FL, [3]Chewy, Mill Creek, WA

The retail industry is constantly seeking ways to optimize its operations and reduce suboptimal buying decisions and associated costs. Several strategies for retail order cost minimization are proposed in the literature but these strategies need to be personalized based on the specific retail requirements. At Chewy, we studied shortcomings of multiple such systems and developed a superior cost optimization platform-based service for buying decisions that combines powerful mathematical concepts, linear programming, dynamic programming, and machine learning models.

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SC25

CC-North 131A

Healthcare Operations Management: Theory and Practice

Community Committee Choice Session

Session Chair: Ozden Engin Cakici, American University, Washington

1 Expanding Healthcare Services in Underserved Rural Areas

Rodney P. Parker[1], Kurt M. Bretthauer[1], Jonathan Eugene Helm[1], Masoud Kamalahmadi[2], Gregory Katzman[3], [1]Indiana University, Bloomington, IN, [2]University of Miami, Coral Gables, FL, [3]Richard L. Roudebush VA Medical Center, Indianapolis, IN, Contact: rodp@indiana.edu

We explore the effect of expanding healthcare services in underserved rural areas of the U.S. on their residents' access to care and utilization of healthcare services. Using data from a large healthcare system, we show that opening healthcare clinics improves access to care and affects demand in the entire network.

2 Payment Models for Coordinating Care Between Hospitals and Post-Acute Care Providers

Kenan Arifoglu[1], Tolga Tezcan[2], Hang Ren[3], [1]UCL School of Management, University College London, London, United Kingdom; [2]Rice University, Houston, TX, [3]George Mason University, Fairfax, VA

The traditional payment models (e.g., diagnosis-related-group (DRG) or outcome-based) primarily designed for conditions whose episode of care only involves a single provider. However, several conditions require care by more than one provider (e.g., hip/knee replacement) and traditional payment models do not provide sufficient incentives to coordinate care for such conditions.. Motivated by the Comprehensive Care for Joint Replacement (CJR) payment model recently introduced by the Center for Medicare and Medicaid Services (CMS), we propose simple payment models that provide care coordination between different providers, and improve cost efficiency and care quality in a collaborative way.

3 Using Information Technology to Improve Access to Medical Care

Opher Baron[1], Fanying Chen[2], Abraham Seidmann[3], [1]University of Toronto, Toronto, ON, Canada; [2]Boston University, Boston, MA, [3]Boston University, NEWTON, MA, MA, Contact: fanying@bu.edu

Our research on patient care delivery is inspired by an extensive field project with a large HMO to address the labor shortage and capacity limit, thus improving access to care (i.e., reducing waiting times) and revenue. We study how the combination of AI and a novel waiting line control mechanism can potentially support the effective introduction of a secondary care channel. We analyze the new system performance in overall capacity, service quality, and the cost of care delivery. Our initial theoretical, numerical, and empirical results show that this combined mechanism improves care delivery at a relatively low cost.

4 Telehealth in Acute Care: Pay Parity and Patient Access

Ozden Engin Cakici[1], Alex Mills[2], [1]American University, Washington, DC, [2]Baruch College, City University of New

York, New York, NY

Telehealth pay-parity policy requires payers to reimburse healthcare providers equally for telehealth and office visits. Using a three-stage game, we study the impact of telehealth reimbursement on provider's operational decisions, where patients choose between telehealth and office. We find that pay parity can decrease patient access and discuss its implications.

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SC26

CC-North 131B

Operations, Risk, and Commodities

Community Committee Choice Session

Session Chair: Danko Turcic, University of California, Riverside, 900 University Ave., CA

Session Chair: Panos Kouvelis, Washington University in St. Louis

1 All-Weather Hedging, Reshoring Decision Making, and Integrated Risk Management

Andrea Roncoroni[1], Gianna Figà-Talamanca[2], Paolo Guiotto[3], [1]ESSEC Business School, Cergy-Pontoise, France; [2]University of Perugia, Perugia, Italy; [3]University of Padova, Padova, Italy. Contact: roncoroni@essec.edu

Corporate exposure may change after severe market shocks, e.g., a pandemic, a geopolitical turmoil, or any extreme event. This change entails model risk, which in turn may undermine the effectiveness of IRM policies and drain liquidity to make suitable adjustments. We propose a novel hedge selection criterion: the hedge should be "All-Weather" in that it performs uniformly well across the selected dimension of model risk. We focus is on supply chain reliability as such a dimension. Concepts and heuristics are developed for a stylized newsvendor featuring an unreliable supplier. We show that the optimal combined forward hedge is All-Weather, while optimal single forward hedges are not. In a model of capacity reshoring, we show that All-Weather hedging yields a valuable time delay effect.

2 Revisiting Least Squares Monte Carlo for Option Exercise Using Meta Learning

Selvaprabu Nadarajah[1], Parshan Pakiman[2], Naushara Saldin[1], [1]University of Illinois at Chicago, Chicago, IL, [2]University of Illinois-Chicago, Chicago, IL, Contact: nsaldi2@uic.edu

Least squares Monte Carlo (LSM) is popular for exercising financial and real options. Recent sophisticated methods requiring heavy computation outperform LSM, also showing LSM's sensitivity to parameter choices. We present meta-learning LSM, which iteratively learns parameters by leveraging policy and bound information, while retaining LSM's simplicity.

3 Optimal Trading Policy for a Commodity in the Presence of Inventory Conversion Flexibility

Amar Sapra[1], Sridhar Seshadri[2], [1]Indian Instiitue of Management-Bangalore, Bangalore, India; [2]University of Illinois, Champaign, IL, Contact: sseshadr_98@yahoo.com

We examine the optimal blending and storage policy in the face of stochastic prices for a trading firm that seeks to take advantage of arbitrage opportunities through blending of commodities. Towards this end, we formulate a two-period model for a firm that trades in three grades of a commodity such that two of the grades can be blended to obtain the third grade. We find that the bid-ask spread plays a significant role in the structure of the optimal blending and storage policy: when the bid-ask spread is equal to zero, the optimal policy has a simple form; otherwise, the simple form breaks down. We also develop insights into the interplay between storage and blending capacities and the structure of the optimal policy.

4 Empirically Grounded Analytics For Commodity Markets

Ye Liu[1], Panos Kouvelis[2], Danko Turcic[3], [1]Olin Business School, Washington University in St. Louis, St. Louis, MO, [2]Olin Business School, Washington University in St. Louis, St. Louis, MO, [3]A. Gary Anderson Graduate School of Management, University of California, Riverside, Riverside, CA, Contact: ye.liu@wustl.edu

We study a data-driven model of a hog farm. Based on the prevailing market prices and inventory availability, a risk-averse farmer must periodically decide what hogs to sell and what hedges to implement while having to fulfill a contract with a meatpacker. Our optimal policy is derived through machine learning.

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CC-North 131C

Behavioral Queueing

Community Committee Choice Session

Session Chair: Dongyuan Zhan, University College London, London, United Kingdom
Session Chair: Rouba Ibrahim, University College London, London, United Kingdom

1 On Customer (Dis)honesty in Unobservable Queues: The Role of Lying Aversion

Arturo Estrada Rodriguez, School of Management University College London, London, United Kingdom. Contact: arturo.rodriguez.18@ucl.ac.uk

We construct a queueing-game-theoretic model where customers make strategic claims to reduce their waiting time, and the Manager decides on the static scheduling policy based on those claims to minimize the expected delay cost. We develop a lying aversion model where customers incur both delay and lying costs. We run controlled experiments to validate our modelling assumptions regarding customer misreporting. We then study the equilibrium that arises in our game and find that under certain conditions, the optimal policy is to use an *honour system* where service priority is given according to customer claims. We also find that it may be optimal to *incentivize more honesty* by means of an *upgrading policy* where some customers who claim to not deserve priority are upgraded to the priority queue. We find that the upgrading policy deviates from the celebrated cμ rule.

2 Rationally Inattentive Queueing with Customer Retrials

Caner Canyakmaz[1], Tamer Boyaci[2], [1]Ozyegin University, Istanbul, Turkey; [2]ESMT Berlin GmbH, Berlin, Germany. Contact: caner.canyakmaz@ozyegin.edu.tr

We investigate a strategic queueing model where customers do not directly observe the queue size but are able to acquire costly information about it. Customers are rationally inattentive and optimally trade off the benefits of better information against the costs associated with it while also considering the joining behavior of other customers. We assume that customers either choose to join the queue, balk, or retry at a cost hoping for a shorter queue in the future. We set up a game-theoretic framework and show that a unique symmetric equilibrium exists. We also show the existence of a unique threshold for the retrial cost that determines whether customers balk or retry, and that this threshold decreases in customers' information cost.

3 Order Ahead for Pickup: Promise or Peril?

Ke Sun[1], Yunan Liu[2], Luyi Yang[3], [1]Beijing University of Chemical Technology, Beijing, China; [2]North Carolina State University, Raleigh, NC, [3]University of California, Berkeley, Berkeley, CA

We study the innovative mobile-order-ahead technology that has been increasingly adopted by quick-service restaurants (e.g., Starbucks). With mobile ordering, customers can order ahead remotely in a mobile application on their phones and pick up their orders at the restaurant. Our paper highlights the unintended consequences of ordering ahead and provides practical design guidance for improving its performance.

4 Dynamic Scheduling of a Multiclass Queue in the Halfin-Whitt Regime: A Computational Approach for High-Dimensional Problems

Ebru Kasikaralar[1], Baris Ata[2], Michael Harrison[3], [1]University of Chicago, Chicago, IL, [2]University of Chicago, Chicago, IL, [3]Stanford University, Palo Alto, CA, Contact: ebrukasikaralar@chicagobooth.edu

We consider a finite-horizon Markovian queueing model of a telephone call center, where multiclass calls are served by a single pool of agents. Calls can end through service or abandonment. Each call class is characterized by its distinct arrival rate process, service rate, abandonment rate, and abandonment penalty. We focus on solving this MDP with high-dimensional state vectors, which poses challenges for conventional dynamic programming methods. To address this, we adopt the Halfin-Whitt heavy traffic regime and describe the approximating diffusion control problem. The resulting HJB equation from the limiting diffusion control problem characterizes the optimal policy. Inspired by Han et al. (2018), we introduce a novel computation approach using deep neural networks to solve the associated high-dimensional HJB equation and approximate the optimal policies.

5 The Impact of Procedural and Distributive Justice on Patient Flow in Hospitals

Galit Bracha Yom-Tov[1], Matias Kohn[1], Anat Rafaeli[2], [1]Technion - Israel Institute of Technology, Haifa, Israel; [2]Technion - Israel Institute of Technolog, Haifa, Israel. Contact: galit.yomtov@yahoo.com

We investigate the impact of procedural and distributive justice in routing patients between ED and inpatient wards on patient LOS. Using diff-in-diff analysis we show a large reduction in hospitalization LOS (14.7%) and in ED LOS (17%) when fair routing is used. We investigate the mechanisms that drive this reduction.

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CC-North 132A

Innovative Supply Chain Operations

Community Committee Choice Session

Session Chair: Tunay Tunca, Robert H. Smith School of Business, College Park, MD

1 Cybersecurity Investment Spillover: Implications for the Supply Chain

Duy Duc Dao, Hooman Hidaji, University of Calgary, Calgary, AB, Canada

As cybersecurity threats become more prevalent and IT supply chains more intertwined, both providers and firms need to invest in cybersecurity to secure their supply chains. Moreover, the downstream demand externality that firms exert on one another (competition or complementarity) moderate the interaction of provider and firm investments. We find that provider investment incentivizes firm investment only if the provider investment has a large positive spillover on firm investment, and that downstream competition negatively moderates the impact of provider investment on firm investment. Interestingly, in the case of substitutable (complementary) provider-firm investment spillover, increased provider investment benefits firm profit only if downstream externality is positive (negative).

2 The Effectiveness of Supplier Buy Back Finance: Evidence from Chinese Automobile Industry

Tunay Tunca[1], Daehoon Noh[2], Bin Yang[3], Weiming Zhu[4], [1]Robert H. Smith School of Business, College Park, MD, [2]University of California, San Diego, San Diego, CA, [3]China Development Bank, Beijing, China; [4]HKU Business School, Hong Kong, China. Contact: ttunca@umd.edu

Facing budget-constrained buyers, a novel approach for large suppliers is adopting buy-back financing schemes to relieve their downstream partners and reduce channel costs. Using game theoretical analysis and structural estimation of data from Chinese automobile industry, we analyze the efficiency of such financing schemes, and explore their impact on operational decisions and contract design. We find that such contract agreements can improve channel efficiency significantly over traditional financing methods.

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CC-North 132B

New Models and Algorithms for Resource Allocation Problems

Community Committee Choice Session

Session Chair: Murray Lei, Queen's University, Kingston, ON, Canada

1 Maximum Optimality Margin: A Unified Approach for Contextual Linear Programming and Inverse Linear Programming

Shang Liu[1], Chunlin Sun[2], Xiaocheng Li[1], [1]Imperial College Business School, London, United Kingdom; [2]Stanford University, Stanford, CA, Contact: s.liu21@imperial.ac.uk

In this paper, we study the predict-then-optimize problem where the output of a prediction task is used as the input of some downstream optimization problem, say, the objective coefficient vector of a linear program. The existing approaches largely suffer from either (i) optimization intractability and statistical inefficiency or (ii) requiring strong condition(s). We develop a new principle called maximum optimality margin which designs the loss function by the optimality condition of the downstream optimization. Our formulation enjoys both computational and statistical efficiency. More importantly, our new approach only needs the observations of the optimal solution rather than the objective function, which makes it a new and natural approach to the inverse linear programming. We also demonstrate its performance using numerical experiments.

2 Assortment and Inventory Planning Under Stockout-Based Substitution: The Many-Products Regime

Jingwei Zhang, The Chinese University of Hong Kong, Shenzhen, Shenzhen, China. Contact: zhangjingwei@cuhk.edu.cn

We study the joint assortment and inventory planning problem with stockout-based substitution. In this problem, we pick the number of units to stock for the products at the beginning of the selling horizon. Each arriving customer makes a choice among the set of products with remaining on-hand inventories. Our goal is to pick the stocking quantities to maximize the total expected revenue from the sales net of the stocking cost. Using a fluid approximation for the problem, we give solutions with performance guarantees that significantly improve earlier results. The optimality gap that we give under the multinomial logit model is the first one that does not depend on the number of products. We can guarantee that the stocking quantities generated by our rounding scheme perform well when both the demand volume and number of products are large.

3 Asymptotic Optimality of Open-Loop Policies in Lost-Sales Inventory Models with Stochastic Lead Times

Xingyu Bai, University of Illinois at Urbana-Champaign, Urbana, IL, Contact: xingyub3@illinois.edu

Inventory models with lost sales and large lead times are notoriously difficult to manage. Recently, it has been proven that in the lost-sales inventory model with divisible products, as the lead time grows large, a simple constant-order policy is asymptotically optimal. In this work, we consider the lost-sales inventory model in which the lead time is not only large but also random. Under the assumption that placed orders cannot cross in time, we establish the asymptotic optimality of constant-order policies as the lead time increases for the model with divisible products. For the model with indivisible products, we propose a bracket policy and prove that the bracket policy is asymptotically optimal. Our results on divisible products also hold for the models with order crossover and random supply functions. Finally, we provide a numerical study to derive further insights.

4 Incentivizing Resource Pooling

Chen Chen[1], Yilun Chen[2], Pengyu Qian[3], [1]New York University Shanghai, Shanghai, China; [2]CUHK Shenzhen, Shenzhen, China; [3]Purdue University, West Lafayette, IN, Contact: cc8029@nyu.edu

We study a decentralized multi-server system, where each server is associated with an M/M/1 queue and aims to minimize its time-average job holding and processing costs. Servers have limited information on the other servers. The objective is to design a mechanism that incentives resource pooling among servers. We design a simple token-based system to achieve this. A server can earn tokens by offering help and spend tokens to request help from other servers, in its self-interest. We analyze the system by employing an approximation methodology that combines the mean-field equilibrium with a fluid approximation. Leveraging this, we design key elements of the mechanism and present our main result: the proposed mechanism incentivizes *complete* resource pooling, and the resulting system performance achieves that under centralized control when the number of servers is large.

5 Costly Data Sampling in the Newsvendor Problem

Lennart Baardman, Hyun-Soo Ahn, Zijin Zhang, University of Michigan, Ann Arbor, MI, Contact: baardman@umich.edu

Deciding on production quantities of new products has to be done well before selling starts. When demand distributions are known, production quantities can be decided by solving a newsvendor problem. In practice, the demand distribution of a new product is unknown, and there is no historical data to estimate the distribution from. However, data can often be acquired at a cost, for example through surveys or test markets. We consider the problem of determining the optimal sample size such that our profit, accounting for data acquisition cost, is maximized. Theoretically, we show the optimal sample size is difficult to characterize, but can be bounded, and we provide policies that compute near-optimal sample sizes. Computationally, we show that our policies result in near-optimal profits for the newsvendor.

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CC-North 132C

Socially and Environmentally Responsible Operations

Community Committee Choice Session

Session Chair: Ali Kaan Tuna, Duke University, Durham, NC

1 When To Trust Your Suppliers While Training Them For Sustainability Under Asymmetric Information?

Özge Tüncel[1], **Tarkan Tan[2], Tim Kraft[3], [1]Maastricht University, Eindhoven, Netherlands; [2]University of Zurich, Zurich, -, Switzerland; [3]NC State - Poole College of Management, Raleigh, NC, Contact: o.tuncel@maastrichtuniversity.nl**

More and more companies are training their suppliers to enhance the sustainability impact created in their value chains. In the paper, we model the buyer's training decisions for suppliers with different initial sustainability capabilities. The buyer's training effort, and the supplier's initial capability and sustainability effort together create the sustainability impact. While both parties benefit from the sustainability impact, the supplier gains additional utility from the training effort. However, the buyer does not know the initial capability of the supplier. He can choose to fully trust the supplier or offer an imperfect prediction tool to his supply chain sustainability managers. Our findings offer insights into the supplier's preference to over or under-report, and the impact of using the prediction tool on the buyer.

2 Delivery Terms for Voluntary Carbon Offsets

Vishal Agrawal[1], Gokce Esenduran[2], Safak Yucel[1], [1]Georgetown University, Washington, [2]Purdue University, West Lafayette, IN, Contact: gesendur@purdue.edu

A carbon offset represents one unit of reduction in greenhouse gas emissions that can be used to compensate for emissions that occur elsewhere. Companies purchase voluntary carbon offsets under two delivery terms. The first is prompt delivery, where a seller first undertakes the investment, then yield uncertainty realizes, based on which the seller determines the price for carbon offsets as a recourse action. The second is forward delivery, where a buyer orders a certain quantity of offsets before the seller invests. Therefore, there is quantity risk due to yield uncertainty as the seller may generate fewer offsets than the buyer's order. Motivated by the importance of choosing the right delivery term for buyers, in this paper, we ask a fundamentally important question: Which delivery term should a buyer prefer, and which one leads to a higher environmental benefit?

3 Supply Chain Disruptions and Labor Violations: An Empirical Investigation

Li Ding[1], Basak Kalkanci[2], [1]Georgia Tech, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, Contact: lding60@gatech.edu

In this study, we aim to determine if major supply chain disruptions contribute to increased labor violation incidents and examine how the impact (if any) varies across industries as well as over time. By leveraging the exogenous shocks on production demand and labor supply and performing a staggered difference-in-difference analysis, our study aims to provide valuable insights into the causal relationship between supply chain disruptions and labor incidents.

4 Is Fast Fashion Really Killing the Planet? a Comparison to Traditional Apparel Supply Chains

Aditya Balaram[1], Mark Ferguson[2], Olga Perdikaki[2], [1]Loyola Marymount University, Los Angeles, CA, [2]University of South Carolina, Columbia, SC, Contact: aditya.balaram@grad.moore.sc.edu

Apparel retailers have typically followed either the traditional (long lead times and more durable products) or the fast-fashion approach (shorter lead times and less durable products). We compare these two approaches in terms of environmental impact, focusing on the effects of leftover inventory, product durability, and markdown pricing. We also examine how policy makers can reduce the environmental impacts of the two approaches, and provide guidance on which life-cycle phases sustainability efforts should be focused on.

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CC-North 221A

Financial Risk Analysis

Contributed Session

Session Chair: Yan WANG, University of Hong Kong, Hong Kong, China

1 Market Ambiguity Attitude and the Risk-Return Tradeoff

Mark Schneider[1], Soroush Ghazi[1], Jack Strauss[2], [1]University of Alabama, Tuscaloosa, AL, [2]University of Denver, Denver, CO, Contact: maschneider4@cba.ua.edu

The risk-return tradeoff for the aggregate stock market predicts that periods of high market volatility are followed by periods with higher average market excess returns. Despite being viewed as a fundamental law of finance, the risk-return tradeoff has been difficult to identify in the data, with some studies finding no relation or even a negative relation between market volatility and future excess returns. Motivated by a representative agent asset pricing model in the presence of Knightian uncertainty, we obtain the theoretical prediction that market ambiguity attitude moderates the risk-return tradeoff. We introduce a methodology for measuring market ambiguity attitude and test its relevance for explaining the risk-return tradeoff in in-sample and out-of-sample tests. We find support for the theoretical predictions.

2 The Impact of Macroeconomic Announcements on Risk, Preference, and Risk Premium

Takuya Kiriu[1], Norio Hibiki[2], [1]Osaka University, Toyonaka, Japan; [2]Keio University, Yokohama, Japan. Contact: kiriu@econ.osaka-u.ac.jp

This study examines the impact of macroeconomic announcements on the risk premium and its sources under time-varying preference. We propose a novel method to decompose risk premium changes into the risk and preference components, which are estimated from option prices immediately before and after the announcement using the Recovery Theorem. The results of the empirical analysis for the United States stock market indicate that (1) the negative (positive) macroeconomic announcement surprise increases (decreases) the risk premium; (2) the risk component mainly drives the increase (decrease) in the risk premium; and (3) the preference component has limited influence on the risk premium.

3 Investment Timing, Upper Reflecting Barrier, and Debt-Equity Financing

Takashi Shibata[1], Michi Nishihara[2], [1]Tokyo Metropolitan

University, Hachioji, Japan; [2]Osaka University, Toyonaka-Shi, Japan

This study considers how an upper reflecting barrier affects the interaction between financing and investment decisions. Here, a magnitude of upper reflecting barrier can be regarded as the degree of intense market competition. We show that fierce competition (a decrease in upper reflecting barrier) reduces the amount of debt issuance and delays investment, which decreases the credit spreads and leverage.

4 Estimating Var and Cvar Sensitivity when Sample Path is Discontinuous

Xianyu Kuang[1], Guangwu Liu[1], Dan Zhu[2], [1]City University of Hong Kong, Hong Kong, Hong Kong; [2]Monash University, Melbourne, Australia. Contact: dwyanekuang1996@gmail.com

Estimating the sensitivities of risk measures, such as the Value-at-Risk and the Conditional Value-at-Risk, is essential in many optimization applications, from hedging in financial markets to allocation of resources in large supply chains. As the underlying models become more complicated due to market innovations, the existing literature that often relies on a relatively simple structure breaks down. In this paper, we fill the gap by allowing the loss itself to exhibit discontinuities in the parameters of interest. Examples of this type include exotic options that possess look-back features and stochastic activity networks. We derive the closed-form expressions of the associated derivatives and present an estimation algorithm that is efficient and easy to implement. The numerical results show that our method is robust in performance across a range of examples.

5 Out-of-Sample Performance-Based Estimation of Expected Returns for Portfolio Selection

Yan Wang, Peng-Chu Chen, The University of Hong Kong, Hong Kong, China. Contact: yanw@connect.hku.hk

This paper provides a framework for obtaining estimates of expected asset returns for portfolio selection. The framework relies on a linear model based on the estimates of out-of-sample portfolio returns, where the expected asset returns are the coefficients to be estimated. The model is fitted by Bayesian regression to a synthetic data set generated from a set of historical asset returns over a limited time horizon. The estimator is computed using a Gibbs sampler; although the set of historical asset returns is finite, it is consistent and asymptotically efficient as the size of the synthetic data set grows to infinity. An empirical study shows that under appropriate conditions, with or without norm constraints, mean-variance portfolios constructed using this estimator produce better out-of-sample mean returns and Sharpe ratios than benchmark portfolios.

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CC-North 221B

Machine Learning for Optimization

Community Committee Choice Session

Session Chair: Bo Lin, University of Toronto, ON, Canada

1 Neur2SP: Neural Two-Stage Stochastic Programming

Justin Dumouchelle, Rahul Patel, Elias B. Khalil, Merve Bodur, University of Toronto, Toronto, ON, Canada. Contact: justin.dumouchelle@mail.utoronto.ca

Stochastic programming (SP) is a powerful modeling framework for decision-making under uncertainty. This work tackles two-stage stochastic programs (2SPs), the most widely used class of SP models. Solving 2SPs requires optimizing over a computationally intractable expected value function. A mixed-integer linear or nonlinear program in the second stage further aggravates the intractability, even when specialized algorithms that exploit problem structure are employed. Finding high-quality (first-stage) solutions - without leveraging problem structure - can be crucial in such settings. We develop Neur2SP, a method that approximates the expected value function via a neural network to obtain a surrogate model. Our extensive experiments on four benchmark 2SP problem classes with different structures demonstrate the efficiency and solution quality of Neur2SP.

2 Fast Continuous and Integer L-Shaped Heuristics Through Supervised Learning

Eric Larsen[1], Emma Frejinger[1], Bernard Gendron[2], Andrea Lodi[3], [1]Université de Montreal, Montreal, QC, Canada; [2]Universite de Montreal (DIRO), Montreal, QC, Canada; [3]Cornell Tech, New York, NY

We propose a methodology to speed up the solution process of mixed-integer linear two-stage stochastic programs targeted towards problems where the second stage is highly demanding. Our core idea is to gain large reductions in online solution time while incurring small reductions in first-stage solution accuracy by substituting the exact second-stage solutions with fast, yet accurate supervised machine learning predictions. The proposed method can solve hard benchmark instances, on average, in 9-20% of the time it takes the state-of-the-art exact method. Average optimality gaps are in most cases less than 0.1%.

3 A Machine Learning Approach to Solving Large Bilevel and Stochastic Programs: Application to Cycling Network Design

Bo Lin, Timothy Chan, Shoshanna Saxe, University of Toronto, Toronto, ON, Canada. Contact: imbo.lin@mail.utoronto.ca

We present a machine learning-based approach to solving bilevel programs that involve a large number of followers. We propose an optimization model that considers a sampled set of followers and exploits a machine learning model to estimate the objective values of unsampled followers. We embed machine learning model training into the optimization problem, which allows us to use general follower features that can not be represented using leader decisions. We prove bounds on the optimality gap of the generated leader decision as measured by the original objective function. We demonstrate the performance of our approach using synthetic instances of a cycling network design problem. Finally, we perform a real-world case study on cycling infrastructure planning, where we apply our approach to solve a network design problem with over one million followers.

4 Predict-Then-Calibrate: A New Perspective of Robust Contextual LP

Chunlin Sun[1], Linyu Liu[2], Xiaocheng Li[3], [1]Stanford University, Stanford, CA, [2]Tsinghua University, Beijing, China; [3]Imperial College Business School, London, United Kingdom. Contact: ly-liu19@mails.tsinghua.edu.cn

Contextual optimization, also known as predict-then-optimize or prescriptive analytics, addresses optimization problems involving covariates or context. Here, we focus on a risk-sensitive variant and propose a generic algorithm design paradigm called predict-then-calibrate. Our approach involves initially developing a prediction model, independent of downstream risk or robustness considerations, and then employing calibration techniques to quantify prediction uncertainty. By disentangling the prediction model from calibration/uncertainty quantification, we unleash the full potential of off-the-shelf machine learning methods while providing risk and robustness guarantees. Additionally, this paradigm yields new generalization bounds for the contextual LP problem and sheds light on the existing results of DRO in the contextual LP setting.

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CC-North 221C

Topics in Integer Programming and Combinatorial Optimization

Community Committee Choice Session

Session Chair: Joseph Paat, University of British Columbia, Sauder School of Business, Vancouver, BC, Canada

1 On Generating Function Method to Parametric Mixed-Integer Optimization

Luze Xu, Matthias Koeppe, University of California, Davis, Davis, CA

We study the problem of maximizing polynomial functions of fixed degree over the mixed-integer points of a polytope of fixed dimension. Our approach is based on the generating function method inspired by Barvinok's algorithm and the fully polynomial-time approximation scheme (FPTAS) by De Loera, Hemmecke, K{"o}ppe, and Weismantel for optimization in fixed dimension. Building on previous research on intermediate sums on polyhedra, we establish a connection between two ways of computing the generating function over mixed-integer points via Gale transformation. Additionally, we implement the computation of these types of generating functions in SageMath. With the generating function, we develop an approximation algorithm for the parametric optimization problem, which arises in bilevel mixed-integer programming.

2 Towards a Characterization of Maximal Quadratic-Free Sets

Joseph Paat, University of British Columbia, Sauder School of Business, Vancouver, BC, Canada

S-free sets are known to have a variety of applications, perhaps most notably in the generation of intersection cuts. When it comes to generating cuts using S-free sets, inclusion-wise maximal sets generate stronger cuts. In this talk we consider maximal S-free sets when S is defined by a quadratic inequality. We demonstrate that maximal quadratic-free sets can be generated using a map from an n-sphere to an m-sphere. Conversely, any such map that is also non-expansive defines a maximal S-free polyhedron. Underlying our work is a characterization of (not necessarily quadratic) maximal S-free sets, which allows us to also generate non-polyhedra maximal quadratic-free sets. This is joint work with Gonzalo Munoz and Felipe Serrano.

3 How Branch-and-Bound Compares to Sherali-Adams for 0-1 Integer Programs

Yatharth Dubey, Carnegie Mellon University

In this talk, we compare two systematic techniques to build strong extended formulations for 0-1 integer programs: specifically, the Sherali-Adams hierarchy, and Branch-and-

Bound. We exhibit simple instances for which Branch-and-Bound constructs a compact perfect formulation while Sherali-Adams requires an exponential number of variables and constraints, and vice versa. Finally, we discuss necessary and sufficient conditions for Branch-and-Bound to outperform Sherali-Adams in the context of polytopes described by no-good constraints. We hope that several parts of the proof are general enough to expand this analysis to more inclusive families of polytopes.

4 Unifying Strongly Polynomial Algorithms for Several Subclasses of Linear Programs

Bento Natura, Georgia Institute of Technology

The existence of a strongly polynomial algorithm for linear programs (LP) is one of the most important open problems in theoretical computer science and beyond. The last decades have seen tremendous progress for special subclasses of LP (e.g., minimum cost flow, multi-commodity flow, and discounted Markov decision processes) whose proofs of strong polynomiality rely on very different ideas, algorithms and techniques. Together with Allamigeon, Dadush, Loho, and Végh (FOCS 2022) we devised an interior point method that runs in strongly polynomial time whenever a certain notion called straight line complexity is polynomially bounded. Taking this algorithm as a blackbox, we show how strong polynomiality for many of the subclasses of LP can be recovered.

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Roundoff-Error Free Linear Algebra

Community Committee Choice Session

Session Chair: Erick Moreno-Centeno, Texas A&M University

Session Chair: Christopher Lourenco, US Naval Academy, Annapolis, MD

1 Overview of Roundoff-Error-Free Methods for Solving Linear Systems

Christopher Lourenco[1], Erick Moreno-Centeno[2], [1]US Naval Academy, Annapolis, MD, [2]Texas A&M University, College Station, TX, Contact: lourenco@usna.edu

Exactly solving linear systems is a fundamental problem in mathematics, operations research, and computer science. In this talk, we present the roundoff-error-free framework for solving linear systems. Specifically, this framework comprises dense LU, Cholesky, and QR factorizations as well as sparse LU and Cholesky factorizations. Moreover, each of these algorithms utilize exclusively integer-arithmetic and, in the sparse case, solve the system Ax=b in time proportional to arithmetic work---to date the only exact algorithms with this property. We conclude by describing two associated software packages which were shown to outperform competitor exact rational and exact iterative approaches. This software can be accessed either in C or via easy to use MATLAB and Python interfaces.

2 Round-Off Error Free QR Factorization via Integer-Preserving Gram-Schmidt

Lorena Mejia Domenzain, Texas A&M University, College Station, TX

QR factorization (A=QR) is widely used in math, computer science, and engineering to solve least squares problems. A critical property in QR is that Q's columns are pair-wise orthonormal. However, in some problems, round-off errors incurred when factorizing A can lead to a loss in orthogonality and, thus, incorrect solutions. Round-off Error Free (REF) QR factorization (A=QDR) was developed to address this issue; therein, Q's columns are pair-wise orthogonal, R is a right-triangular matrix, and D is a diagonal matrix; importantly, Q and R are integral matrices. This talk presents an Integer-preserving Gram-Schmidt orthogonalization process (IPGS) and an efficient IPGS-REF QR algorithm; both guarantee the critical orthogonality property using integer arithmetic.

3 An Early Termination Criteria for Dixon's Method

Kelsey Kitzmiller, Texas A&M University, College Station, TX

Dixon's p-adic lifting algorithm uses modular arithmetic to find exact solutions to systems of linear equations. Although this method is state-of-the-art for solving dense systems exactly, it often performs significantly more iterations than necessary to compute the solution. In order to avoid some of these unnecessary computations, a new early termination criteria is presented which is based on Cabay's criteria for congruence technique algorithms. This stopping procedure is predicated on a new version of rational reconstruction which partially reconstructs the modular image found at each p-adic lifting iteration. The complete algorithm maintains the same worst-case complexity as Dixon's original method but is more efficient in practice, as it performs only a small number of iterations beyond those which are necessary to compute the solution.

4 Efficient Exact Linear Program Solving

Ram V. Krishnamoorthy[1], Christopher Lourenco[2], [1]US Naval Academy, Annapolis, MD, [2]US Naval Academy, Annapolis, MD, Contact: m243456@usna.edu

Top-commercial Linear Program solvers generally perform well for the vast majority of instances, but over 20 years of literature have shown that they suffer from inaccuracies in 3-5% of problems due to improper floating-point (fixed-precision) calculations. When exactness or higher precision is needed, exact LP solvers exist; the forefront of which is SoPlex, an open-source algorithm that validates the optimality of LPs by using exact rational factorizations to solve key linear systems. These rational factorizations are the bottleneck of SoPlex, in the worst case occupying over 90% of the run time, and significantly slowing the exact solver. This project aims to address these drawbacks thereby improving our ability to efficiently solve LPs exactly.

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Efficient Algorithms for Large-scale Nonsmooth Optimization Problems in Data Science

Community Committee Choice Session

Session Chair: Guojun Zhang, The Hong Kong Polytechnic University, Hong Kong, China

2 A Feasible Method for Solving an SDP Relaxation of the Quadratic Knapsack Problem

Tianyun Tang, National University of Singapore, Singapore, Singapore

In this talk, we consider solving the low-rank SDP of the quadratic knapsack problem whose feasible region is an algebraic variety. We analyze the local geometric properties of singular points on this algebraic variety. With the geometric properties, we prove that under an appropriate rank condition, any second order stationary point of the non-convex problem is also a global optimal solution without any regularity assumption. This rank condition is much weaker than the classical rank condition if the coefficient matrix has certain special structures. We design a feasible method that can escape from non-optimal non-regular points. Numerical experiments are conducted to verify the high efficiency and robustness of our algorithm for solving large-scale quadratic knapsack problems with up to one million items. Joint work with Prof. Kim-Chuan Toh.

2 An Efficient HPR Algorithm for the Wasserstein Barycenter Problem with $0({\rm Dim(P)}/\varepsilon)$ Computational Complexity

Guojun Zhang, Yancheng Yuan, Defeng Sun, The Hong Kong Polytechnic University, Hong Kong, Hong Kong. Contact: guojun.zhang@connect.polyu.hk

In this paper, we propose and analyze an efficient Halpern-Peaceman-Rachford (HPR) algorithm for solving the Wasserstein barycenter problem (WBP) with fixed supports. While the Peaceman-Rachford (PR) splitting method itself may not be convergent for solving the WBP, the HPR algorithm can achieve an $O(1/\varepsilon)$ non-ergodic iteration complexity with respect to the Karush-Kuhn-Tucker (KKT) residual. More interestingly, we propose an efficient procedure with linear time computational complexity to solve the linear systems involved in the subproblems of the HPR algorithm. As a consequence, the HPR algorithm enjoys an $O({\rm Dim(P)}/\varepsilon)$ non-ergodic computational complexity in terms of flops for obtaining an ε-optimal solution measured by the KKT residual for the WBP, where ${\rm Dim(P)}$ is the dimension of the variable of the WBP.

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Computing and Optimization in Electric Grid Applications

Community Committee Choice Session

Session Chair: Xiangyu Zhang, National Renewable Energy Laboratory

Session Chair: Mengmeng Cai, 1</sup

1 Economic, Reliable and Secure Low-Carbon Electricity System Modeling

Xin Fang, Mississippi State University, MISSISSIPPI STATE, MS, Contact: xfang@ece.msstate.edu

In this seminar, an electricity market clearing model with renewable uncertainty and a cyber-physical dynamic simulation (CPDS) model capturing the uncertainty of the two-layer communication latency and power dynamics of DERs will be presented. The current LMP concept is extended to price renewable uncertainty explicitly. The benefits of variable resources providing AGC services are simulated comprehensively. The AGC model with communication delay is designed to validate DERs' frequency regulation services. The economics, reliability, and security regarding renewable and DER integration can be simulated in the proposed framework.

2 Delivery-Risk-Aware Flexibility Reserve Scheduling for Aggregated Distributed Energy Resources

Mengmeng Cai[1], Michael Blonsky[1], Elina Spyrou[2], [1]National Renewable Energy Laboratory, Golden, CO, [2]Imperial College London, Golden, CO, Contact: mengmeng.cai@nrel.gov

Distributed energy resources (DERs) offer valuable operational flexibility when aggregated. Innovative market products have emerged recently to harness and monetize the value of these flexible assets for variability management. However, DERs are subjected to delivery risk, i.e., the risk of not being able to deliver the flexibility in real-time at the amount committed in day-ahead, due to uncertainties in end-use behaviors and market operating conditions. This prevents DERs from effectively participating in the market. To address this issue, we propose a risk-aware flexibility reserve scheduling model leveraging two-stage stochastic optimization. This model assists DER aggregators in estimating a portfolio envelope within which the DERs can be freely dispatched to meet end-use needs and adapt to system operation realizations in real-time.

3 Grid-edge Modeling and Optimization to support Decarbonization and Resilience

Anamika Dubey, Washington State University, Pullman, WA

With rapid decarbonization goals and ambitious urban electrification targets, the electric power grid is undergoing unprecedented changes. The proliferation of distributed energy resources and flexible loads is pushing the control and operational requirements of the grid to the edge, thus significantly increasing the scale and complexity of grid operations. These grid-edge resources also hold the potential to support grid resilience in the aftermath of extreme weather events, which are impacting grid more often and with higher severity. Effective use of grid-edge resources to support decarbonization goals and resilience necessitates advances in modeling, analysis, and optimization of emerging electric power networks. In this talk, we will focus on the challenges and solutions to integrating grid-edge into grid operations. Along with traditional physics-based approaches, we will emphasize the need for scientific machine learning techniques to address the emerging computational challenges.

4 Differentiable Programming for Modeling and Control of Energy Systems

Jan Drgona, Pacific Northwest National Laboratory, Richland, WA, Contact: jan.drgona@pnnl.gov

This talk presents differentiable programming (DP) for domain-aware learning of differentiable models for dynamical systems. We introduce differentiable predictive control as a data-driven model-based policy optimization method that systematically integrates the principles of classical model predictive control with differentiable programming. We also show how to use recent developments in control barrier functions and neural Lyapunov functions to obtain online performance guarantees for neural control policies. We demonstrate the performance of these new DP-based methods in a range of simulation case studies, including modeling of networked dynamical systems, building control, and dynamic economic dispatch, including real-time deployment in an embedded device, serving as a proof of concept for control as a service setup.

Sunday, October 15, 12:45 PM - 2:00 PM

SC37

CC-North 223

Optimization under Uncertainty with Applications in Power Systems

Community Committee Choice Session

Session Chair: Yiling Zhang, University of Minnesota, Minneapolis, MN

1 New Formulations and Pricing Mechanisms for Stochastic Electricity Market Clearing Problem

Harsha Gangammanavar, Saumya Sakitha Sashrika Ariyarathne, Southern Methodist University, Dallas, TX, Contact: harsha@smu.edu

In this talk, we present new formulations of the stochastic electricity market clearing problem based on the principles of stochastic programming, precisely the notion of nonanticipativity. We design new pricing mechanisms by developing suitable dual optimization problems for these models. Our analysis illustrates the ability of these new pricing mechanisms to provide long-run revenue adequacy for the system operators and cost recovery and price distortion under every scenario for all market participants. We demonstrate these benefits through numerical experiments conducted on well-known test systems.

2 Bilevel Optimization Model for Distribution Network with Uncertain Renewables and Flexible Loads Under Wasserstein Metrics

Can Yin[1], Yiling Zhang[2], Jin Dong[3], [1]University of Minnesota, Twin Cities, Minneapolis, MN, [2]University

of Minnesota, Twin Cities, Minneapolis, MN, [3]Oak Ridge National Laboratory, Oak Ridge, TN, Contact: yin00412@umn.edu

Abstract: This work considers a distribution network pricing with uncertain renewables and flexible loads. We formulate a stochastic bilevel program to procure minimum-cost energy and decide optimal pricing for prosumers in the upper-level problem given the uncertainty in renewable energy productions. The lower-level problem optimally schedules the prosumers' flexible load (i.e., HVACs) according to the pricing decisions of the upper-level problem. Assuming the distribution of uncertainty is not known perfectly, the problem is solved using distributionally robust optimization under Wasserstein metrics. The problem is reformulated as a mixed-integer linear program. We conduct preliminary computational experiments on the IEEE 33-bus systems.

3 A Robust Bilevel Uncertainty-Set Maximization Approach for Optimizing Power Grid Flexibility with Integer 2nd-Stage Decisions

William Yang, University of Washington, Seattle, WA, Contact: wtyang15@uw.edu

We have seen a worldwide increase in renewable energy penetration necessary for reducing the global carbon footprint. However, the integration of renewable energy in the electricity sector has introduced significant uncertainty, hindering the power grid's ability to reliably balance energy supply and demand and increasing the risk of costly renewable energy curtailment or blackouts. We present a robust 2-stage uncertainty-set optimization method that helps grid flexibility by maximizing the net load deviation the system can tolerate. To solve this problem, we use a novel Primal Generation Algorithm based on column-and-constraint-generation (CCG). We test it on a virtual power plant case study to demonstrate its ability to improve grid flexibility with greater renewable energy penetration and show that our algorithm is more efficient than standard CCG algorithms.

4 Power Grid Resilience Optimization Using Decision-Dependent Uncertainty

Samuel O. Affar[1], Hugh Medal[2], Yang Chen[3], Guodong Liu[3], [1]University of Tennessee, Knoxville, Knoxville, TN, [2]University of Tennessee, Knoxville, TN, [3]Oak Ridge National Laboratory, Oak Ridge, TN, Contact: saffar@vols.utk.edu

Extreme weather events can cause unplanned disruptions in power distribution systems, highlighting the need for resilience-oriented action. This ongoing study proposes a two-stage stochastic mixed-integer program with decision-based uncertainty to determine how to optimally protect power distribution systems against such disruptions. In the first stage, a set of lines are hardened. A random set of destroyed lines is then realized. The probability for each element is dependent on the hardening decisions made in the first stage, i.e., decision-dependent uncertainty. In the second stage, network reconfiguration and DERs (Distributed Energy Resources) utilization decisions are made. The model seeks to minimize the expected cost of load shedding. To find a computationally fast way to solve the model, the study explores a decision-independent reformulation.

Sunday, October 15, 12:45 PM - 2:00 PM

SC38

CC-North 224A

Optimization Society's Award Session II

Award Session

Session Chair: Oktay Gunluk, Cornell University, Ithaca, NY
Session Chair: Andy Sun, MIT, Cambridge, MA

1 **Award Presenter**

Stefan Wild, Argonne National Laboratory, Lemont, IL

2 Maximal Quadratic-free Sets

Gonzalo Muñoz, Universidad de O'Higgins, Rancagua, Chile

The intersection cut paradigm is a powerful framework that facilitates the generation of valid linear inequalities, or cutting planes, for a potentially complex set S. The key ingredients in this construction are a simplicial conic relaxation of S and an S-free set: a convex zone whose interior does not intersect S. Ideally, such S-free set would be maximal inclusion-wise, as it would generate a deeper cutting plane. However, maximality can be a challenging goal in general. In this work, we show how to construct maximal S-free sets when S is defined by a general quadratic inequality. Our maximal S-free sets are such that efficient separation of a vertex in LP-based approaches to quadratically constrained problems is guaranteed.

3 **Award Presenter**

Jongeneel Wouter, Wouter Jongeneel, Lausanne, Switzerland

Sunday, October 15, 12:45 PM - 2:00 PM

SC39

CC-North 224B

Risk Management

Contributed Session

Session Chair: Agathe Sadeghi, Stevens Institute of Technology, Hoboken, NJ

1 Labor Momentum Stock Selection Strategies Through Supply Chain Network

Rei Yamamoto[1], Akifumi Isogai[2], [1]Keio University, Yokohama, Japan; [2]Mitsubishi UFJ Trust Investment Technology Institute Co., Ltd., Tokyo, Japan. Contact: rei.yamamoto@ae.keio.ac.jp

This study focuses on the propagation of job postings through the supply chain structure between firms and proposes an investment strategy that uses this information. Specifically, we find that an increasing number of job openings in customer firms affects the performance and stock price of supplier firms. The empirical analysis in the U.S. stock market confirms that the proposed strategy has a high stock selection effect in the manufacturing industry, where inter-firm ties are strong.

2 Modern Pandemic Crises and Default Risk: A Worldwide Evidence

KungCheng Ho, Fuzhou University of International Studies and Trade, fuzhou, China. Contact: kcho731101@163.com

This paper examines the relationship between modern health pandemic crises and financial stability. Specifically, it collects data on 250,223 firms in 43 countries (or regions) during five modern pandemic crises, SARS (2003), H1N1 (2009), MERS (2012), Ebola (2014), and Zika (2016), and finds that pandemic crises significantly increase the default risk of enterprises. Further analysis shows that formal and informal institutions acted as a "cushion" against the pandemic crisis. This paper addresses the hitherto inadequacy of COVID-related data. In addition, this paper argues that governments should build sound state institutions to withstand macroeconomic shocks and highlights the heterogeneity of default risk for enterprises operating in countries with different institutions.

3 Statistical Validation of Centrality in Financial Networks

Agathe Sadeghi, Zachary Feinstein, Stevens Institute of Technology, Hoboken, NJ, Contact: asadeghi@stevens.edu

Network analysis often relies on estimated networks which may deviate from the true interlinkages, impacting the accuracy of centrality measure. We introduce a statistical validation method for the centrality measure, leveraging a regression model to construct the underlying network and a centrality measure reflecting contagion risk. Our proposed methodology enables researchers to derive the distribution of the centrality measure, construct confidence intervals and conduct statistical tests to assess the validity of centrality values. We employ simulations to compare theoretical and empirical distributions with the true centrality. Our results demonstrate that the estimated centralities consistently fall within the 95% confidence interval. We apply our methodology to financial data which results in identifying statistically significant central nodes.

Sunday, October 15, 12:45 PM - 2:00 PM

SC40

CC-North 225A

The Impact of Uncertainty on Transportation Systems

Community Committee Choice Session

Session Chair: Handong Yao, 1</sup
Session Chair: Xiaopeng Li, 1</sup
Session Chair: Yiheng Feng, Purdue University, West Lafayette, IN
Session Chair: Qianwen Li, University of South Florida, Tampa

1 How to Understand, Accommodate, and Overcome Uncertainties in Traffic Control?

Brian Park, University of Virginia, Charlottesville, VA, Contact: bp6v@virginia.edu

In this talk, I will discuss challenges in traffic control due to uncertainties and what can be done to accommodate and possibly overcome such uncertainties. An example of traffic signal control is used to demonstrate the impact of uncertainties that negate some control variables and robust control to accommodate uncertainties. The challenges involved in a microscopic traffic simulation model calibration/validation due to uncertainties will also be discussed. I will also discuss challenges in connected automated vehicles again due to uncertainties and how to deal with them.

2 Learning Naturalistic Driving Environment with Statistical Realism

Xintao Yan, Zhengxia Zou, Shuo Feng, Haojie Zhu, Haowei Sun, Henry Liu, University of Michigan - Ann Arbor, Ann Arbor, MI, Contact: xintaoy@umich.edu

For simulation to be an effective tool for the training and testing of autonomous vehicles, the simulator must produce realistic safety-critical scenarios with distribution-level accuracy. However, due to the high dimensionality of real-world environments and the rarity of long-tail safety-critical events, how to achieve statistical realism in simulation is a longstanding problem. In this study, we develop NeuralNDE, a deep learning-based framework to model naturalistic driving environments. The results show that NeuralNDE can achieve both accurate safety-critical driving statistics (e.g., crash rate/type/severity and near-misses, etc.) and normal driving statistics. To the best of our knowledge, this is the first time that a simulator can reproduce the real-world driving environment with statistical realism, particularly for safety-critical events.

Sunday, October 15, 12:45 PM - 2:00 PM

SC41

CC-North 225B

70 Years of Urban Network Modeling: Past, Present, and Future

Community Committee Choice Session

Session Chair: Yanfeng Ouyang, U of Illinois at Urbana-Champaign, Urbana, IL
Session Chair: Qi Luo, Clemson University, Clemson, SC
Session Chair: Lili Du, University of Florida, Gainesville, FL
Session Chair: Samitha Samaranayake, Cornell University, Ithaca, NY

1 A Brief History of Urban Travel Forecasting

Marco Nie, Northwestern University, Evanston, IL

In this talk I will briefly review the history of urban travel forecasting, from the founding of the field in the 1950s to the present day. I will begin with the development of the "traditional" methods and how they had shaped the practice of transportation planning. Then, I turn to the scholarly efforts and achievements that had made the field a thriving multidisciplinary scientific enterprise. I also address the shortcomings of the existing methodologies that have drawn sharp criticisms in the past. The talk ends with my speculations about the future of the field.

2 Perspectives on Future Urban Network Modeling - Opportunities and Research Needs

Elise Miller-Hooks, George Mason University, Fairfax, VA

This talk will discuss the future of urban transportation network modeling opportunities and research needs, recognizing recent and coming advances in computing technologies, capabilities and methodologies. It will further imagine changing societal transportation needs and expectations. A key aim will be to spark creation of ideas for in-depth discussion with audience participation.

3 Special Session Informs TSL Urban Transportation SIG and TRB AEP-40

Qi Luo, Clemson University, Clemson, SC

This special session is co-hosted by INFORMS TSL Urban Transportation SIG and TRB AEP-40 Transportation Network Modeling Committee. Our goal is to attract a broader audience at INFORMS to recognize the recent advances in network modeling and spark an in-depth discussion of vital research topics in the coming decade.

Sunday, October 15, 12:45 PM - 2:00 PM

SC42

CC-North 226A

OR/AI: Integrating Operations Research with Artificial Intelligence

Panel Session

Session Chair: Cathy Honghui Xia, 1</sup
Session Chair: Ahmed Abbasi, University of Notre Dame, Notre Dame, IN

1 OR/AI: Integrating Operations Research with Artificial Intelligence

Ahmed Abbasi, University of Notre Dame, Notre Dame, IN

This panel session entitled "OR/AI: Integrating Operations Research with Artificial Intelligence" will feature panelists conducting research at the intersection of operations research (OR) and artificial intelligence (AI). The panel will discuss research and funding opportunities at the intersection of OR and AI.

2 Panelist

Ramayya Krishnan, Carnegie Mellon University, Pittsburgh, PA

3 Panelist

Bistra Dilkina, USC, Los Angeles, CA

4 Panelist

Nan Zhang, University of Florida, Gainesville, FL

5 **Panelist**

Cole Smith, Syracuse University, Syracuse, NY

6 Panelist
Tinglong Dai, Johns Hopkins University, Baltimore, MD

Sunday, October 15, 12:45 PM - 2:00 PM

SC43

CC-North 226B
Methods for Process Operations
Contributed Session
Session Chair: Yulin An, State College, PA

1 Prediction of Spring Steel Wire Rod Hardness Based on Wire Rod Rolling Process Data: A Case Study
Sungjun Hur, SEOKKYU PYO, Sungkyunkwan university, gyeonggi-do, Korea, Republic of. Contact: sjhur22@g.skku.edu
This paper presents a study on predicting the hardness of wire rod produced in Hyundai, a major steel production company in Korea. We install a line scanner in Hyundai's wire rod rolling process to collect a large amount of operational data. We then derive critical factors by analyzing the collected data with XGboost and Shapley additive explanations. In addition, we conduct experiments for exploring the effects of the critical factors on the hardness under various rolling process conditions. The hardness prediction model is built by the experimental data and validated by consultant with Hyundai's rolling process engineers. Future research directions on predicting the hardness are discussed in conclusion.

2 Functional Response from a Mixture Experiment: Design Choice and Analysis
Mona Khoddam, Arizona State University, Tempe, AZ, Contact: mkhoddam@asu.edu
This presentation discusses the problem of designing and analyzing mixture experiments when the response is functional, i.e., a series of data points collected over a continuum. Single viscosity values at fixed shear rates may fail to capture the differences in rheological properties among different chemical formulations. The presentation compares space-filling designs and I-optimal designs with respect to measures of predictive performance, and demonstrates the advantages of using self-validated ensemble modeling for simultaneous estimation and validation of predictive models in small-sample experiments with mixtures.

3 Degradation Modeling and Prediction Based on Monotonic Multi-Output Gaussian Process
Jinwen Sun, Congfang Huang, Shiyu Zhou, Dharmaraj Veeramani, University of Wisconsin-Madison, Madison, WI, Contact: jsun279@wisc.edu
This work presents a novel approach for degradation modeling and prediction using monotonic multi-output Gaussian process (MOGP). The monotonicity information is imposed by adding virtual observations and an approximate Bayesian inference method is employed to fit the model. The proposed method accommodates the monotonicity constraint of degradation processes, ensuring realistic and reliable modeling and prediction. Experimental results on simulation studies and the real-world dataset demonstrate the superior performance of the proposed approach compared to existing techniques.

4 Demonstration of an Intrinsic Geometrical Approach for 3-D Statistical Process Control from Real Scanned Discrete Manufactured Parts
Yulin An[1], Enrique Del Castillo[2], [1]Penn State University---University Park, State College, PA, [2]Pennsylvania State University, University Park, PA, Contact: yba5115@psu.edu
Statistical process control (SPC) has witnessed increased sophistication in metrology accompanied by increased size and complexity in the datasets related to production and manufacturing processes. Recently, spectral statistical approaches for 3-D SPC have been proposed, based on the estimation of the Laplace-Beltrami (LB) operator and its spectrum which provides a unique part feature description that carries considerable geometrical and topological information. In this talk, we present a practical demonstration of the methods based on sequences of real laser scans that generate meshes to which our methods are then applied.

Sunday, October 15, 12:45 PM - 2:00 PM

SC44

CC-North 226C
How the Integration of AI and Blockchain is Changing the World
Community Committee Choice Session
Session Chair: Jinwook Lee, Drexel University, Philadelphia, PA

1 Uber Freight Like-Wise: How the Intersection of 3PLs and Blockchain Can Help Disrupted Logistics Network

Lanqing Du[1], Jinwook Lee[2], [1]DREXEL UNIVERSITY, Philadelphia, PA, [2]Drexel University, Philadelphia, PA, Contact: ld695@drexel.edu

Third-party logistics services (3PLs) have historically been crucial to the commercial transportation sector. Looking ahead, technology enablers (blockchain) and the gig economy all contribute to reinventing the industry. On-demand 3PL services, compared to long-term contracts, became paramount for both carriers and shippers. In this paper, we study related decision-making problems on a disrupted logistics network, where nodes represent different 3PLs with their own disruption levels, and edges denote a shipping volume between a pair of nodes. To assess the added benefit from the development of information, infrastructure, and resource resilience, we additionally take into account the effect of blockchain-enabled transparent information communication integrating 3PL services in the activity-based model.

2 Bias and Unfairness in Automated Recruitment Tools

Qiao Lu[1], Lanqing Du[2], Jinwook Lee[3], [1]University of Pennsylvania, Philadelphia, PA, [2]DREXEL UNIVERSITY, Philadelphia, PA, [3]Drexel University, Philadelphia, PA, Contact: qiaolu@upenn.edu

Automated recruitment tools were invented in the early 1990s. They were designed to automate the process of organizing job applications. These tools were advanced by AI technologies in the 2000s, which could analyze and select candidate profiles based on a wide range of criteria, including experiences, skills, and education. Many companies utilized them to accelerate the hiring process and save costs. However, in recent years, bias and unfairness were perceived in the use of AI-powered recruitment tools, such as prejudicial treatment of different groups of people on the basis of gender or race. In this research, our goal is to determine bias and unfairness related to automated recruitment tools, investigate potential solutions, and identify research gaps.

3 Artificial Intelligence to Reduce Radiation-Induced Cardiotoxicity in Lung Cancer Radiotherapy: A Novel Functional Radiomics Using Cardiac Fdg-Pet/Ct

Wookjin Choi, Adam Dicker, Yevgeniy Vinogradskiy, Thomas Jefferson University, Philadelphia, PA, Contact: wookjin.choi@jefferson.edu

Traditionally, radiation-induced cardiotoxicity has been studied using cardiac radiation doses rather than functional imaging. We developed artificial intelligence (AI) models based on novel cardiac delta radiomics using pre- and post-treatment FDG-PET/CT scans to predict overall survival in lung cancer patients undergoing radiotherapy. We identified four clinically relevant delta radiomics features with the AI prediction models. The best model achieved an AUC of 0.91 on the training set and 0.87 on the test set. We are a pioneering group in AI for functional cardiac imaging. If validated, this approach will enable to use standard PET/CT scans as functional cardiac imaging with good predictive AUC for OS, as well as provide automated methods to provide functional cardiac information for clinical outcome prediction AI in lung cancer patients.

4 Community/Committee'S Choice Submission

Sung-Cheol Kim, Psychogenics, NJ

Temporal data points of animal movements provide valuable insights into an agent's health status. We propose a machine-learning approach to classify applied drugs based on animal behavior data collected through sensors. Our model, Gated Transformer Networks (GTN), employs Transformer networks with Attention architectures to analyze both temporal and channel features. GTN captures channel data's relative weight and signal variations' importance within time windows, enhancing classification performance. Experimental results demonstrate GTN's superiority in drug classification tasks. Our findings highlight GTN's potential as an efficient and reliable tool for classifying drugs based on their effects on animal behavior. This research contributes to drug discovery by optimizing therapeutic interventions using animal behavior data.

5 Web 3.0 and Smart Contracts: A Paradigm Shift for Supply Chain Coordination

Jinwook Lee[1], Lanqing Du[2], [1]Drexel University, Philadelphia, PA, [2]DREXEL UNIVERSITY, Philadelphia, PA, Contact: jl3539@drexel.edu

Some practical limitations and constraints of the Web 2.0-based supply chain network are the following: diverse regulatory policies; poor intricate network; ERP and a single point failure (centralized system); robustness; a lag in data integration; no transparency; no direct communication system among related participants. In the Web 3.0 based-supply chain network, powered by blockchain and artificial intelligence, many of the above-mentioned problems can be solved using appropriate algorithms that can be embedded in the system through (1) smart contracts; and (2) decentralized network systems. Looking at the supply chain as a p2p network on a graph, we use nodes and edges to

represent peers and related transaction flows and values. Business applications of NFTs, smart contracts, supply chain monitoring, and outlier detection are presented.

Sunday, October 15, 12:45 PM - 2:00 PM

SC45

CC-North 227A

Learning for Optimization: Performance and Robustness

Community Committee Choice Session

Session Chair: Bartolomeo Stellato, Princeton University, Princeton, NJ

1 Learning for Robust Optimization

Irina Wang[1], Cole Becker[1], Bart Paul Gerard Van Parys[2], Bartolomeo Stellato[1], [1]Princeton University, Princeton, NJ, [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: iywang@princeton.edu

We propose a data-driven method to automatically learn the uncertainty sets in robust optimization. Our training procedure reshapes the uncertainty sets by minimizing the expected performance across a family of problems while guaranteeing constraint satisfaction. We develop a stochastic augmented Lagrangian method that relies on differentiating the solutions of the robust optimization problems with respect to the parameters of the uncertainty set. We show sublinear convergence to stationary points under mild assumptions, and finite-sample probabilistic guarantees of constraint satisfaction using empirical process theory. Our approach can learn a variety of uncertainty sets while preserving tractability. Numerical experiments show that our method outperforms traditional RO approaches. We implement our method in the open-source package LROPT.

2 End-to-End Learning to Warm-Start Fixed Point Optimizers

Rajiv Sambharya[1], Vinit Ranjan[1], Georgina Hall[2], Brandon Amos[3], Bartolomeo Stellato[1], [1]Princeton University, Princeton, NJ, [2]INSEAD, Fontainebleau, France; [3]Meta, NYC, NY, Contact: rajivs@princeton.edu

We introduce a machine learning framework to warm-start fixed-point algorithms for parametric convex optimization. Our architecture consists of a neural network mapping problem parameters to warm-starts, followed by a predefined number of fixed-point iterations, with the loss function defined as the final fixed-point residual. In this way, the neural network predicts warm-starts with the end-to-end goal of minimizing the downstream loss. We provide PAC-Bayes generalization bounds on unseen data for common classes of fixed-point operators, including contractive and averaged operators. We apply our framework to popular algorithms including ADMM and Douglas-Rachford splitting to solve problems in control, statistics, and energy. Our approach significantly reduces the number of iterations required to solve these problems through learned warm-starts.

3 Data-Driven Performance Certification of First Order Methods for Parametric Quadratic Optimization

Vinit Ranjan, Rajiv Sambharya, Bartolomeo Stellato, Princeton University, Princeton, NJ, Contact: vranjan@princeton.edu

We introduce a framework to certify finite step convergence of first-order methods for parametric convex quadratic optimization. We formulate the certification problem as a maximization problem with performance metrics in the objective and algorithm iterations in the constraints. Our modular framework encodes, through quadratic constraints, a wide range of proximal algorithms and sets for initial iterates and problem parameters. We derive tractable convex relaxations using semidefinite programming and solve them via a custom operator splitting technique that scales to high dimensions. We demonstrate finite-sample probabilistic guarantees of the computed worst-case behavior using Wasserstein distributionally robust optimization. Numerical examples show that our method significantly reduces the conservatism of classical worst-case convergence bounds.

4 A Differentiable Architecture for Mixed-Integer Optimization

Gabriele Dragotto, Bartolomeo Stellato, Princeton University, Princeton, NJ, Contact: bstellato@princeton.edu

We consider the problem of optimizing a sequence of mixed-integer linear optimization problems (MIPs) with varying parameters. By combining recent advances in cutting plane generation and differentiation through convex optimization problems, we construct a new differentiable architecture to predict the optimal cutting planes from the key parameters of each instance. During the offline phase, our method maximizes the cutting planes' efficiency by evaluating the derivative of the solution of the continuous relaxations with respect to the cut-generating parameters. We show on preliminary computational results that, once trained, our architecture computes solutions with low infeasibility and suboptimality with fast and predictable execution times.

Sunday, October 15, 12:45

PM - 2:00 PM

SC46

CC-North 227B

Human Trafficking

Community Committee Choice Session

Session Chair: Baris Tezcan, Northeastern University, Brookline, MA

1 Breaking the Chains: An Innovative Network Interdiction Approach to Combat Labor Trafficking in Agricultural Supply Chains

Arezoo Jafari, Priscila de Azevedo Drummond, Shawn Bhimani, Amy Farrell, Kayse Lee Lee Maass, Northeastern University, Boston, MA, Contact: jafari.a@northeastern.edu

The agriculture industries in the United States significantly contribute to the nation's economy, providing support for over 40 million jobs. Farm workers, a critical workforce in these industries, are particularly vulnerable to labor trafficking and exploitation due to their immigration status and limited government resources for inspection. This study aims to develop a network interdiction model to aid law enforcement agencies in making well-informed decisions to combat labor trafficking networks more effectively. The proposed stochastic network interdiction model seeks to evaluate the potential benefits of inter-agency collaboration in enhancing their ability to dismantle trafficking operations. By doing so, the study aims to provide insights and strategies to protect farm workers better and maintain the integrity of the food and agriculture industries.

2 Using Analytics to Combat Sex Trafficking

Nickolas K. Freeman, Burcu B. Keskin, Greg Bott, University of Alabama, Tuscaloosa, AL, Contact: nkfreeman@cba.ua.edu

Sex trafficking refers to the use of force, fraud, or coercion for the purposes ofsexual exploitation. Several news and technical reports document links between commercial sex ads and sex trafficking. Our team leads an initiative named STANDD (Sex Trafficking Analytics for Network Detectionand Disruption) for The University of Alabama's Institute of Data and Analytics. Under this initiative, we manage an analytical pipeline that leverages techniques from the areas of network science and machine learning to transform ad data into products used by law enforcement and non-profit partners in counter-trafficking efforts. This presentation will focus on our ongoing efforts as well as emerging areas of research in this space.

3 Integration of Behavioral and Decision Science Methods to Design and Evaluate Interventions for Labor Trafficking and Exploitation

Matt Kammer-Kerwick, UT Austin, Austin, TX

This presentation describes a process we developed in a recent paper that integrates behavioral and decision science methods to design and evaluate interventions. We developed this process by extending a framework used to study partially observable systems with uncertain outcomes wherein there are multiple participating parties with competing goals. The extended framework that we proposed builds from artefactual data collection, thematic analysis, and descriptive analysis, toward predictive modeling and agent-based modeling. We apply our extended framework to an exploratory case study that examines the potential of worker centers as a venue for deploying interventions to address labor exploitation and human trafficking. We will also discuss ongoing research to integrate reinforcement learning to optimize model-based policy design.

4 Disrupting Human Trafficking Recruitment Using Community-Based Resource Allocation Models

Baris Tezcan[1], Kayse Lee Lee Maass[1], Thomas Sharkey[2], Yongjia Song[2], Lauren Martin[3], Kelle Barrick[4], Amy Farrell[1], [1]Northeastern University, Boston, MA, [2]Clemson University, Clemson, SC, [3]University of Minnesota, Minneapolis, MN, [4]RTI International, Research Triangle Park, NC, Contact: tezcan.b@northeastern.edu

A person's risk of being trafficked is greatly influenced by their (lack of) access to community support structures. We model a trafficker's process of recruiting sex trafficking victims using a network where states represent a potential victim's fluctuating likelihood of being trafficked, various trafficking recruitment strategies, and chances of being re-trafficked after leaving their trafficker. Potential victims transition from one state to another probabilistically. We aim to allocate resources throughout this network in a way that changes the state transition probabilities with the objective of minimizing the exploitation a victim experiences. We design and validate the states with a human trafficking survivor advisory board and generate data using inverse optimization that utilizes stakeholder interviews and relevant data from the literature.

Sunday, October 15, 12:45 PM - 2:00 PM

SC47

CC-North 227C

Recent Advancements in Process Monitoring of Complex Data

Community Committee Choice Session

Session Chair: Xiulin Xie, University of Florida, Gainesville, FL

1 Optimizing Control Chart Parameters: A Simultaneous Perturbations Stochastic Approximation Approach

Daniele Zago[1], Giovanna Capizzi[1], Peihua Qiu[2], [1]University of Padua, Padova, Italy; [2]University of Florida - Department of Biostatistics, Gainesville, FL, Contact: dzago@ufl.edu

Selecting control chart design parameters is a critical aspect of statistical process control. The typical approach minimizes the average run length when detecting a specific out-of-control scenario, while maintaining the in-control average run length fixed to a specific value. However, the control charts that are typically employed admit no explicit solutions, thus requiring a costly optimization routine. Furthermore, optimizing a multidimensional set of parameters is often computationally challenging when using traditional approaches. To address this problem, we propose an efficient two-step algorithm based on stochastic approximations. Our approach is applicable to univariate and multivariate control chart parameters, and simulated results indicate that our method is computationally more efficient that traditional approaches.

2 An Adaptive Cusum Chart for Drift Detection

Fan Yi, University of Florida, Gainesville, FL

In practice, sequential processes often have gradual changes in their process distributions over time. This is related to the drift detection problem in statistical process control. Most existing methods for drift detection are designed based on the assumption that the related drift is linear or have another specific pattern. In reality, however, such specified patterns may not be valid. We suggest an adaptive CUSUM chart to handle the drift detection problem with a flexible drift pattern. The new method integrates the general framework to construct a CUSUM chart based on the generalized likelihood ratio statistic and estimation of a shift size by the exponentially weighted least square regression procedure. Simulation and real example studies show that the proposed method is effective in various cases considered.

3 Profile Monitoring via Eigenvector Perturbation

Takayuki Iguchi, Air Force Institute of Technology, OH

Control charts monitor quality characteristics of a process over time to quickly detect undesirable behavior. There is a growing need for more flexible control charts (e.g., profile monitoring) to handle increasingly complex processes. A practitioner can experience alarm fatigue if the sampling rate is high (say, once a millisecond) and the control chart is set to an average in-control run length (ARL_0) of 370 as is typical in the literature. As alarm fatigue may result in detrimental effects to product quality, we seek to reduce the false alarm rate. Unfortunately, doing so usually increases the average out-of-control run length (ARL_1). Motivated by recent work on eigenvector perturbation theory, we develop two computationally fast nonparametric control charts which outperform their competition by achieving both an ARL_1 close to or equal to 1 and an ARL_0 on the order of 10^6.

4 Profile Monitoring of Random Functions with Gaussian Process Basis Expansions

Jonathan R. Stewart[1], Eric Chicken[1], Andrés Felipe Barrientos[1], Takayuki Iguchi[2], [1]Florida State University, Tallahassee, FL, [2]Air Force Institute of Technology, Wright-Patterson Air Force Base, OH

We consider online profile monitoring of random functions that admit basis expansions with Gaussian coefficients for out-of-control state detection. Our problem features two sources of variation: additive error and random fluctuations through random coefficients in the basis representation of functions. We study two-phase monitoring problems where the first stage learns the in-control process and the second stage leverages the learned process for out-of-control state detection. We outline learning and monitoring methods that exploit the Gaussianity of the basis coefficients to develop scalable and effective monitoring methods that makes weak functional assumptions. We demonstrate the potential of our method through simulation studies that highlight some of the nuances that emerge in profile monitoring of random functions.

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SC48

CC-North 228A

Recent Advances in Cyber-Physical Security - Part I

Community Committee Choice Session

Session Chair: Dan Li, Clemson University, Clemson, SC

Session Chair: Akash Tiwari, Texas A&M University, College Station, TX

1 An Integrated Cyber-physical Risk Assessment Framework for Worst-case Attacks in Industrial Control Systems

Navid Aftabi[1], Dan Li[2], Thomas Sharkey[2], [1]Clemson University, Clemson, SC, [2]Clemson University, Clemson, SC, Contact: naftabi@g.clemson.edu

Industrial Control Systems (ICSs) are critical infrastructures vulnerable to cyberattacks causing physical damage. This paper proposes an optimization-based cyber-risk assessment framework integrating cyber and physical systems in ICSs. The framework identifies high-risk cyberattacks by maximizing physical impact, quickly accessing cyber system components with limited vulnerabilities, evading physical system detection, and adhering to cyber and physical constraints. This framework provides a tool for generating the worst-case attack strategies to evaluate existing detection schemes. Numerical and case studies verify its effectiveness, showing that a worst-case strategic attacker can significantly accelerate physical system failure time while remaining undetected compared to a random attacker.

2 Advancing the Security of Cyber-Physical Manufacturing Systems: Challenges and Opportunities

Mohammed Shafae, Md Habibor Rahman, University of Arizona, Tucson, AZ, Contact: shafae1@arizona.edu

The threat of cyberattacks on smart manufacturing systems has been rapidly growing, with the potential for a multitude of different attack types, ranging from industrial espionage to system sabotage, causing physical equipment damage, operational downtime, and compromised product quality and reliability. Due to the cyber-physical nature of manufacturing systems, among several other unique aspects, traditional cyber-only security solutions are insufficient to defend manufacturing systems against the rampantly growing cyberattack threat. This talk discusses the importance of dedicated research and the development of additional cyber-physical defense measures designed for manufacturing. A critical review of current research efforts in this domain will also be presented, as will the opportunities for the future of this emerging research area.

3 Privacy-Preserving Data Sharing Strategy for Process-Defect Modeling in Metal-Based Additive Manufacturing

Wenmeng Tian[1], Mahathir Bappy[1], Durant Fullington[2], [1]Mississippi State University, Mississippi State, MS, [2]Mississippi State University, Starkville, MS, Contact: tian@ise.msstate.edu

Cyber-enabled manufacturing and cloud-enabled data sharing can equip small-to-medium manufacturers (SMMs) with the unique strengths of advanced metal-based additive manufacturing (AM) technologies. However, the AM process data often contains sensitive design information that is unfortunately vulnerable to design leakage when shared on the cloud platform. In this talk, we first discuss the design information disclosure in metal-based AM process data. Subsequently, a new adaptive AM printing path de-identification method is introduced. The proposed method generates synthetic melt pool images by removing the information of printing path trajectory while retaining the quality attributes for process-defect modeling. The synthetic melt pool images will be shared on the cloud to enable secured collaborative modeling among numerous AM users.

4 Spectral Dynamic Watermarking Cybersecurity Defense for Manufacturing Machine Tool Controllers

Akash Tiwari[1], Satish Bukkapatnam[2], [1]Texas A&M University, College Station, TX, [2]Texas A&M University, College Station, TX, Contact: akash.tiwari@tamu.edu

Sensing devices within manufacturing machine tool controllers are vulnerable against several cyberattacks. These attacks can be detected by the technique of dynamic watermarking (DWM) by introducing secret signals imposed onto the control signals. The DWM technique is known to cause unfavourable disturbance to precision manufacturing processes. The technique of Spectral DWM (S-DWM) is presented which introduces secret signals in the frequency domain to minimize design disturbance. We present experiment case studies to show that the S-DWM, in comparison to DWM detects attacks with ~5% deterioration in ARL and 95% improvement in path deviation.

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CC-North 228B

Data Analytics and Quality Control with Industrial Big Data

Community Committee Choice Session

Session Chair: Kaibo Wang, Tsinghua University, Beijing, China

1 Change Point Detection Of Multimode Processes Considering Both Mode Transitions And Parameter Changes

Jun Xu[1], Jie Zhou[2], Xiaofang Huang[2], Kaibo Wang[1], [1]Tsinghua University, Beijing, China; [2]Goldwind Science&Technology Co.,Ltd., Beijing, China. Contact: xu-j19@mails.tsinghua.edu.cn

Multimode processes refer to processes that work in multiple operating modes. Motivated by the torque control process of a wind turbine, we determine that there exist two types of changes in multimode processes: (1) mode transitions and (2) parameter changes. We propose a novel modeling framework for the offline change point detection problem of multimode processes considering both types of changes. We characterize each mode with a parametric cost function and formulate the problem as an optimization model. With certain assumptions, the asymptotic property ensures the accuracy of the model solution. To solve the model, we propose an iterative algorithm and develop a multimode-pruned exact linear time (multi-PELT) method for initialization. The simulation study and the real case study demonstrate the effectiveness of our method against alternative methods.

2 Multi-Node System Modeling and Monitoring with Extended Directed Graphical Models

Dengyu Li, Kaibo Wang, Tsinghua University, Beijing, China. Contact: lidy20@mails.tsinghua.edu.cn

Complex manufacturing systems usually contain a large number of variables with complicated relationships that cannot be expressed by simple functional relationships, thus increasing the difficulty of modeling and monitoring these systems. The directed graphical model (DGM) has been used for describing the relationship among variables. However, the DGM fails to consider the structural information among them that usually exists. To address this problem, an extended directed graphical model (EDGM) is proposed. Taking prior engineering knowledge into consideration, the EDGM uses groups of variables as nodes in the graph model and can effectively represent the relationship within and between nodes and provide promising monitoring performance. Numerical experiments and a real world case study are performed to verify the effectiveness of the proposed methods.

3 Two Approaches to Monitoring Multivariate Poisson Counts: Simple and Accurate

Jian Li, Xi'an Jiaotong University, Xi'an, China. Contact: jianli@xjtu.edu.cn

We consider the monitoring of multivariate correlated count data and adopt the Multivariate Poisson (MP) distribution with a two-way covariance structure for modeling MP counts, which has marginal Poisson distributions in each dimension and allows for pairwise correlations. Based on this, we develop two control charts to simultaneously monitor the mean vector and covariance matrix of MP counts. The first chart enjoys a simple charting statistic and is computationally fast, whereas the second one is accurate and provides a gold standard for monitoring MP counts. We also give recommendations on choice between them. Numerical simulations have demonstrated the advantages of the proposed two charts, and in non-Poisson cases we also test their robustness against underdispersion and overdispersion that are encountered often in count data.

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CC-North 229A

Solar Power

Community Committee Choice Session

Session Chair: Alexandra M. Newman, Colorado School of Mines, Golden, CO

1 Evaluating Different CSP Optimization Models

Kathleen Tomon, Colorado School of Mines, Golden, CO

The market for hybrid concentrating solar power (CSP) is increasing due to the growing demand of green energy. We explore four different hybrid CSP modeling approaches ranging from classical optimization to black-box heuristics. We use case studies with different energy markets to assess the advantages and disadvantages of these modeling approaches to provide recommendations for modeling hybrid systems.

2 Assessing The Cost, Environmental, And Equity Trade-offs Of Energy Transition Pathways In The U.S.

Teagan Goforth[1], Destenie S. Nock[1], Maxwell Brown[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]National Renewable Energy Laboratory / Colorado School of Mines, Golden, CO, Contact: tgoforth@andrew.cmu.edu

Many countries have committed to decarbonizing their energy system, but there is uncertainty with how to achieve a sustainable and just transition. This analysis investigates how the trade-offs of decarbonization outcomes are distributed across vulnerable groups. To assess this, we tie a US-wide capacity expansion planning model to a multi-criteria decision analysis to investigate the trade-offs of cost, environmental, and equity metrics across different electricity

futures. To evaluate equity, we investigate regional and community level distribution of health and economic impacts across different vulnerable groups and evaluate these across metrics like the Gini coefficient. We find that the Base case has short-term benefits in terms of cost and emissions, but by 2050, has solely cost benefits, with higher emissions than other scenarios.

3 Technoeconomic Comparison Between Concentrated Solar Power and Photovoltaic Power as Extended-Duration Peaking Resources
Xander Bard, The Ohio State University, Columbus, OH
We explore the ability of a concentrating solar power (CSP) plant with thermal energy storage (TES) to provide varying peaking capacity. The hourly operation of the CSP plant is simulated and optimized to determine its potential to provide energy during a variable peak-load window, ranging from 1 to 24 hours, for each day of the year. Then, we compare the ability of a photovoltaic (PV) system with lithium-ion battery energy storage to the behavior of the optimized CSP plant.

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Policy-enabling models for Renewable Energy, CCS and Decarbonization technologies

Community Committee Choice Session

Session Chair: Olivier Massol, IFP School, Rueil-Malmaison, France
Session Chair: Emma Jagu Schippers, CentraleSupélec, France

1 Carbon Removal Beyond Borders: How to Share the Gains from Inter-Regional Cooperation
Solene Chiquier[1,2], Emma Jagu[3,4], Niall Mac Dowell[5], Olivier Massol[6,4], [1]MIT Joint Program on the Science and Policy of Global Change, Cambridge, MA, [2]MIT Energy Initiative, Cambridge, MA, [3]IFP Energies nouvelles, Rueil-Malmaison, France; [4]CentraleSupelec, Gif-sur-Yvette, France; [5]Imperial College London, London, United Kingdom; [6]IFP School, Ruel-Malmaison, France. Contact: chiquier@mit.edu
International cooperation could greatly reduce the cost of deploying carbon dioxide removal (CDR) to levels compatible with the Paris Agreement. We examine whether and how multilateral agreements can be successfully implemented for deploying inter-regionally CDR. After evaluating coalitional gains resulting from such international cooperation when deploying inter-regional CDR pathways, we apply cooperative game theory to assess how these gains can be shared in a fair and mutually accepted manner, *i.e.,* key criteria to ensure successful inter-regional cooperation. Bridging the gap between cost-optimization problem and cooperative game theory, we provide recommendations to policymakers on fair gain-sharing principles that ensure the successful materialization of multilateral agreements, and thus the deployment of CDR at the Paris Agreement's levels.

2 Building More and Regretting Less: Oversizing Co_2And H_2Pipeline Systems Under Uncertainty
Adrien Nicolle[1], Olivier Massol[2], [1]Climate Economics Chair, Paris, France; [2]IFP School, Rueil-Malmaison, France. Contact: olivier.massol@ifpen.fr
Both Carbon Capture and Storage (CCS) and hydrogen systems require the installation of costly pipeline infrastructures transporting CO_2 or H_2. We first develop analytical models of the technology of these pipeline systems . That analysis shows that these technologies can be represented using Cobb-Douglas production functions. We then examine the least-costly deployment of an infrastructure serving unknown future demand patterns to clarify the optimal degree of oversizing that must be installed. As these anticipations may fail to materialize, we compare several possible deployment scenarios using a minimax regret perspective. Our findings provide insights on the microeconomics of these new infrastructures and show that building them ahead of proven demand is always a regret-minimizing strategy.

3 On the Design of Carbon Capture and Storage Policy Under Different Market Structures
Joseph Edward Duggan, University of Dayton, Dayton, OH, Contact: jduggan1@udayton.edu
Carbon Capture and Storage (CCS) is increasingly being recognized as having a role in decarbonizing the power sector. We examine a stylized model of carbon capture and storage under different forms of imperfect competition to examine the effects of both subsidies to incentivize CCS as well as emissions taxes to examine how these policy instruments impact market performance and social welfare. We explore the implications of private information on firms' costs of undertaking CCS on designing subsidy policy and the potential and limits of CCS in mitigating a variety of market failures.

4 Carbon Removal Beyond Borders: How to Share the Gains from Inter-Regional Cooperation
Emma Jagu Schippers[1], Solène Chiquier[2], Olivier Massol[3],

[1]CentraleSupélec, Gif-sur-Yvette, France; [2]MIT, Cambridge, MA, [3]IFP School, Rueil-Malmaison, France. Contact: emma.jagu@centralesupelec.fr

International cooperation could greatly reduce the cost of deploying Carbon Dioxide Removal (CDR) to levels compatible with the Paris Agreement. This paper examines the conditions for a multilateral agreement on interregional CDR deployment between four regions - the United States, the European Union, Brazil, and China. Using the Modelling and Optimization of Negative Emissions Technologies (MONET) framework and cooperative game theory, we provide a unique perspective towards deploying CDR cost-effectively to levels compatible with the Paris Agreement objectives, showing that multilateral agreements in accordance with Article 6.2 could enable international cooperation. Our approach clarifies guiding principles on fair gain-sharing to ensure such agreements can materialize.

5 Designing Retirement Strategies for Coal-Fired Power Plants to Address Air Quality and Health Considerations

Carla Campos[1], Emily Pakhtigian[2], Wei Peng[1], Joel Landry[3], Hannah Wiseman[4], [1]The Pennsylvania State University, State College, PA, [2]The Pennsylvania State University, State College, PA, [3]The Pennsylvania State University, State College, PA, [4]The Pennsylvania State University, State College, PA, Contact: carlacampos.sm@gmail.com

By considering six coal plant retirement strategies for Pennsylvania that vary by targets and priorities, we find the spatial distribution of the air quality impacts depends on which units are shut down and where. In addition, Pennsylvania's coal retirement decisions also influence the power generation and associated air quality impacts in the rest of the PJM region.

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GO Competition Construction

Community Committee Choice Session

Session Chair: Richard Paul O'Neill, ARPA-E, Silver Spring, MD

1 Go Competition Challenge 3 - Features and Impacts of Model Formulation

Jesse Holtzer, PNNL, WA

The Grid Optimization (GO) Competition Challenge 3 is a problem of AC security constrained unit commitment (SCUC). In this presentation we will describe some of the special features of the model formulation of this problem and touch on some of the impacts of these features on solutions and solver algorithms. For example, we will explore the impact of AC modeling on unit commitment. SCUC is widely used in the context of DA electric power system scheduling and markets, as well as in shorter term look ahead and longer term planning applications. In these applications, a DC power flow and balance model is typically used. For this competition, we used an AC model to enable voltage and reactive power to be influential in determining the optimal generation schedule. We will examine the impacts of this and other model features on solutions and solution techniques.

2 New Developments to Synthetic Grids

Farnaz Safdarian, Texas A&M University, College Station, TX, Contact: fsafdarian@tamu.edu

The synthetic grids are created to avoid disclosing any confidential information and facilitate research on realistic power grid data. These grids are consistently improved to be more realistic and more importantly more reliable and resilient. The improvements include updates to generator parameters, load offer curves, and grids to accommodate different loading and weather conditions. We also have been working on better ways to visualize the operation of electric grids.

3 The Grid Optimization Competition Challenge 3 Benchmark Algorithm

Robert Parker, Carleton Coffrin, Los Alamos National Laboratory, Los Alamos, NM

We have implemented a benchmark solver for the Grid Optimization Competition Challenge 3 optimization problem in order to test the solution platform and evaluation tools, to validate datasets, and to provide a known solution approach against which to compare competition submissions. This talk describes the decomposition approach taken by the benchmark algorithm and presents the performance of different configurations of the algorithm on datasets from the competition.

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CC-North 231A

Solving Emerging Power System Optimization and Control Problems

Community Committee Choice Session

Session Chair: Feng Qiu, Argonne National Laboratory, Lemont, IL

1 Optimal Public Safety Power Shutoff Program with N-1 Contingency Constraints

Feng Qiu, Argonne National Laboratory, Lemont, IL

To mitigate wildfire risk caused by power delivery facilities, utility companies have a standard practice, which is to shut off certain power delivery facilities in risky areas temporarily (called Public Safety Power Shutoff program or PSPS). Due to challenges of determining wildfire risks more precisely, PSPS is often carried out in more areas and for longer time than needed, resulting in excess power outages and significant interruptions to power supply. This work will explore a more optimized PSPS by reducing the load shedding and power outages. At the same time, we consider the fundamental N-1 security constraints in the PSPS model. We propose an optimization model and efficient solution algorithms to address the computational complexity.

2 Development of Optimal Offering Strategy of Virtual Power Plants: An SDDP Approach

Bai Cui, Iowa State University, Ames, IA, Contact: baicui@iastate.edu

Virtual power plants (VPPs) are becoming viable players in the wholesale electricity market. Due to various distributed energy resource components, VPP generation cost is affected by the real-time market price realization. To incentivize their market participation, VPPs should be able to make profit-maximizing power offerings based on price forecasts. This paper proposes a multistage stochastic optimization model to design VPPs' optimal power offering considering the price uncertainty in the day-ahead market. Our proposed model includes a virtual stage to determine the profit-maximization power offering and descendent stages to optimize DERs' cost-minimizing dispatch. We propose a zeroth-order gradient descent solution algorithm to solve the mutlistage stochastic optimization model. The algorithm internalizes a stochastic dual dynamic programming algorithm to optimize the DERs' dispatch and provide gradient information by numerical estimation. We iteratively update the power offering using the gradient estimation. Simulation results using test systems show good performance for large-scale multistage stochastic optimization problems.

3 Real-time Optimization for Wind-to-H_2 Driven Critical Infrastructures

Qifeng Li, University of Central Florida, Orlando, FL

This talk presents a real-time optimal operation model for the wind-to-hydrogen-driven low-carbon critical infrastructure (W2H-LCCI), where the energy consumption of CIs mainly comes from wind power, which can significantly reduce the carbon emission from CIs. The resulting optimization problem is a large-scale mixed-integer convex program (MICP). In order to solve the large-scale MICP problem in real-time, a fast solution method based on active constraint and integer variable prediction (ACIVP) is introduced. The ACIVP method predicts the binary variables and the active constraints based on the historical data of optimal solutions. As a result, only a small-scale continuous convex optimization problem needs to be solved online. To increase the accuracy of the ACIVP method, a method of feature space expansion is employed.

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CC-North 231B

Optimization and Deep Learning

Community Committee Choice Session

Session Chair: Kimberly Villalobos Carballo, Massachusetts Institute of Technology, Cambridge, MA

1 Robust Upper Bounds for Adversarial Training

Kimberly Villalobos Carballo, Massachusetts Institute of Technology, Cambridge, MA, Contact: kimvc@mit.edu

Many adversarial training methods for deep learning leverage upper bounds of the adversarial loss to provide security guarantees against adversarial attacks. Yet, these methods rely on convex relaxations to propagate bounds for intermediate layers, which affect the tightness of the bound at the output layer. We introduce a new approach to adversarial training by minimizing an upper bound of the adversarial loss that is based on a holistic expansion of the network instead of separate bounds for each layer. This bound is facilitated by state-of-the-art tools from Robust Optimization; it has closed-form and can be effectively trained using backpropagation. Across a variety of data sets we demonstrate that our approach is substantially more robust than state-of-the-art methods for larger perturbations, and it matches their performance for small perturbations.

2 Prescriptive Neural Networks with an Interpretability Option

Lisa Everest, Vasiliki Stoumpou, Massachusetts Institute of Technology, Cambridge, MA, Contact: leverest@mit.edu

We present a novel method that trains neural networks for prescriptive problems. Given a dataset with covariate features, treatments prescribed for each observation, and the corresponding outcome, we aim to prescribe the treatment that optimizes the outcome for a given observation. Our method involves three steps: 1) performing a counterfactual estimation step, 2) training a prescriptive neural network (PNN) with an appropriate prescriptive objective, and 3) training a corresponding classification tree that ensures interpretability without compromising performance. We apply this methodology to both structured and unstructured data and demonstrate that PNNs are tractable, flexible, and strongly-performing prescriptive models that can handle complex data structures.

3 Interpretable NLP For Identifying Risk Factors Of Intimate Partner Violence In Clinical Notes

Matthew Peroni, Jiayi Gu, MIT, Cambridge, MA, Contact: jgu321@mit.edu

With the rise of language models, there is increasing interest in using natural language data in modeling tasks in healthcare. However, previous works use black-box encoder models to generate feature representations which cause any modeling to lose all interpretability. In this work, we develop new modeling approaches that use encoder language models in a way that preserves some interpretability and allows us to identify critical passages in text for a given prediction task. We apply this to our work of identifying victims of Intimate Partner Violence (IPV) in clinical settings that utilizes tabular EHR and clinical notes. This methodology allows us to identify segments of text that represent potentially risk factors of IPV.

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SC55

CC-North 231C

Problems in Railway Operations

Contributed Session

Session Chair: Rahman Torba, SNCF & Mines Saint-Etienne, Paris, France

1 Optimization of Possession Times in Railway Networks: A Heuristic Approach

Yannick Burmeister, Dr. Arturo Crespo, Prof. Dr. Andreas Oetting, Technical University of Darmstadt, Darmstadt, Germany. Contact: burmeister@verkehr.tu-darmstadt.de

While possession times (due to railway construction and maintenance works) usually render portions of the railway infrastructure temporary unavailable, they are necessary to upkeep the its long-term serviceability. Therefore, possession times and the construction processes themselves must be planned and executed in such a way that railway operations are impaired as little as possible. Using graph theory and heuristic methods this contribution proposes a new approach for optimizing the planning of railway construction processes and possession times. The resulting approach enables a better capacity consumption in the railway network by allowing a smarter planning of possession times and a faster realization of railway construction works.

2 Improving Freight Train Throughput in the Indian Railway Network: A Structural Analysis

Himanshu Arha[1], Milind Sohoni[1], Kashish Arora[1], Raja Gopalakrishnan[2], [1]Indian School of Business, Hyderabad, India; [2]Indian Railways, New Delhi, India

In this paper, we study how to reduce congestion on the Indian Railway network. Specifically, we model a section controller's hold decision for a freight train at a railway station and estimate it using high-frequency train flow data. Using our estimates, we design policies to reduce congestion on the network.

3 Planning Services on Metro Rail Operations

Narayan Rangaraj, Indian Institute of Technology Bombay, Mumbai, India. Contact: narayan.rangaraj@iitb.ac.in

In countries like India, planning and operating metro rail services in urban areas is a challenging task, as it is often a supply constrained environment. Resources such as system headway (track capacity), rolling stock and crew could all be constraining factors, especially for handling peak period demands. We propose an integrated system for maximizing the benefit to commuters from the deployment of available resources using tools from optimization and simulation. A particularly useful framework is that of Periodic Event System Scheduling (PESP). We discuss application experience and possibilities, using the PESP framework and others. The decisions considered include line planning, vehicle scheduling and crew planning. The performance measures used are (i) waiting and travel time for customers, and (ii) vehicle and crew utilization.

4 Robust Scheduling in Sncf Railway Maintenance Centers

Rahman Torba[1,2], Stéphane Dauzère-Pérès[1], Claude Yugma[1], Cédric Gallais[2], Juliette Pouzet[2], [1]Ecole des Mines de Saint-Etienne, Gardanne, France; [2]SNCF, Saint-Denis, France. Contact: r.torba@emse.fr

This work addresses a multi-skill resource-constrained multi-project scheduling problem which originates from SNCF heavy maintenance factories. To solve large instances a new memetic algorithm combining a genetic algorithm with a simulated annealing procedure is implemented. Computational experiments conducted on real instances validate the efficiency of the algorithm. However, most of processing times are uncertain and additional tasks, with a known probability to be executed or not, can be encountered. Therefore, we will discuss on how to integrate these uncertainties in the decision process to generate robust schedules. The objective is to maximize the probability of meeting customer deadlines.

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CC-North 232A

Computing Techniques in Defense Settings

Community Committee Choice Session

Session Chair: Rob Mark Curry, United States Naval Academy, Annapolis, MD

1 Optimizing Cooperative Interdependent Attack Graphs to Compromise Cyberinfrastructures

Robert Mark Curry, United States Naval Academy, Annapolis, MD

As infrastructures in our society become increasingly interdependent, the possibility of attacks utilizing these interdependencies also increases. In this work, we consider attacks from multiple attackers working cooperatively to reach their goals. We model this problem under the assumption that more than one exploit may have to be used by an attacker to reach their objective. We provide a mixed-integer program (MIP) for this attacker model, and we provide a bounding algorithm that iteratively improves a series of upper and lower bounds to determine an. optimal solution. Furthermore, we provide preliminary analysis showing the computational effectiveness of our algorithm.

2 Optimal Basing of Aircraft for the Operational Support Airlift Program

Anna Svirsko, Will Traves, Gary Lazzaro, United States Naval Academy, Annapolis, MD, Contact: svirsko@usna.edu

The Operational Support Airlift (OSA) Program maintains a set of commercial aircraft owned and operated by the federal government to augment combat aircraft during war by moving military personnel and cargo or conducting intelligence runs. We study the usage of OSA aircraft during peacetime when OSA aircraft are used to transport Department of Defense personnel and cargo. From FY16 - FY19, the OSA program was able to fulfill over 85% of all transport requests in the continental United States. However, some bases consistently experience a high percentage of unsupported requests. This study considers alternate basing locations of aircraft within the OSA program to improve peacetime mission support.

3 Analyzing Daily Sorties at Nas Kingsville Utilizing Alternative Refueling Methods

Joseph Carl Foraker, Aimpoint Digital, Atlanta, GA, Contact: jcforaker@gmail.com

Training Air Wing TWO (TRAWING 2) is responsible for intermediate and advanced phases of Undergraduate Jet Pilot Training, and provides the U.S. Navy and Marine Corps with newly winged aviators. Our objective is to improve operations at TRAWING 2 using sortie output and aircraft refuel waiting time as measures of performance. We create a discrete-event simulation to model daily jet flow and operations at TRAWING 2. We compare current operations with alternative refueling strategies that incorporate hot pit refueling to minimize the time jets spend on the ground between consecutive sorties. We consider different factors and run a variety of experiments to determine the impact of fueling strategies on resource utilization in an effort to generate more sorties. We analyze the results of these experiments and determine which strategies lead to the largest number of sorties.

4 Marine Corps Prior Service Recruiting Optimization

Gary Lazzaro, United States Naval Academy, Annapolis, MD, Contact: lazzaro@usna.edu

We optimize the recruiting of prior service Marines into the Selected Marine Corps Reserve. Marine Corps Recruiting Command (MCRC) divides the US into six districts with 88 prior service recruiters (PSR) split between 20 offices to solicit prior service Marines. We solve two distinct problems. First, should the district boundary lines be changed to reflect current prior service recruiting challenges? Second, should locations of PSRs be changed in order to better contact prior service Marines? K-Means Clustering enables us to redraw the Marine Corps recruiting district lines to equitably distribute the recruit population. Our linear program optimizes the relocation of the PSRs to reserve center locations nationwide to minimize total distance traveled by recruiters.

5 Maximizing Occupied Nodes in Dynamic Network Flow Problems Using Time Indexed Graphs

Tanner Nixon, Robert Mark Curry, United States Naval Academy, Annapolis, MD

In this work, we seek to determine a schedule of network flows to be sent over a sequence of discrete time periods in order to maximize the total value of all occupied nodes. A node is deemed *occupied* when some minimum level of flow exists at a node from one time period to the next. We solve this problem three ways implementing a time-indexed graph, a time-expanded graph, and a heuristic algorithm which separates the network flow schedule into a sequence of sub-schedules. Utilizing a randomly generated data set, we show how heuristic algorithm consistently solves the problem faster than the MIP while producing high-quality near-optimal solutions. The heuristic algorithm should be used in time-sensitive applications when the MIP takes a considerable amount of time.

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CC-North 232B

Human-AI Interaction

Community Committee Choice Session

Session Chair: Yuqian Xu, UNC-Chapel Hill Kenan-Flagler Business School, Chapel Hill, NC

1 Finding a Needle in a Haystack: Identifying Valuable Information to Improve Human-AI Collaboration

Kris Johnson Ferreira[1], Jordan D. Tong[2], Shirley Huang[1], [1]Harvard Business School, Boston, MA, [2]University of Wisconsin Madison, Madison, WI, Contact: kferreira@hbs.edu

A key reason for allowing decision-makers to override AI predictions is because they might have access to private information that is unobserved by the AI algorithm - yet valuable in making predictions - for which they can use to improve upon the AI. Unfortunately, though, identifying valuable private information is often easier said than done, in part because it can be quite difficult for decision-makers to distinguish whether private information is valuable; such a distinction is left to their intuition and experience, which may be shrouded by noise. We propose a new method to identify decision-makers who use valuable private information. Via a series of controlled online experiments, we evaluate the effectiveness of our method compared to two natural benchmarks and uncover insights as to why our method outperforms both.

2 Causal Inference with Unstructured Data as Control Variables

Xu Sikun[1], Zhenling Jiang[2], Dennis Zhang[3], [1]Washington University in St Louis, ST LOUIS, MO, [2]University of Pennsylvania, Philadelphia, PA, [3]Washington University in St Louis, ST LOUIS, MO, Contact: sikun@wustl.edu

As unstructured data (e.g., images or videos) become increasingly available, they have become important confounders in empirical causal inference models. To control for unstructured data, many studies follow an embed-then-estimate framework. Researchers train a representation learning model to generate lower-dimensional embeddings of the unstructured data as inputs to causal inference models. We argue that such a framework can lead to biased causal estimates due to the training objective of the embedding model. We propose a confounding embedding method that effectively extracts low-dimensional embeddings from unstructured data as confounders. We demonstrate the effectiveness of the proposed method in obtaining accurate causal effect estimates using several examples, including a lab experiment with Visual-ChatGPT-generated synthetic images as stimuli.

3 Does Digital Mental Healthcare Service Access Affect Care Outcomes? Evidence from a Natural Experiment

Jiayuan Tian[1], Liangfei Qiu[2], Guohou Shan[3], [1]University of Florida, Gainesville, FL, [2]University of Florida Warrington College of Business Administration, Gainesville, FL, [3]Temple University, Philadelphia, PA

Mental illnesses like depression and anxiety are prevalent. To address them, mental healthcare services provided by digital platforms have been adopted recently. However, it is unknown whether and how the mental healthcare service access over digital platforms may affect the care outcomes. Building on the theoretical mechanisms of accessibility, our study leverages a natural experiment of the launch of mental healthcare digital platforms to investigate the impact of the digital access of mental healthcare services in terms of the mentally unhealthy days and the number of smokers at U.S. county level. Furthermore, we explore how disadvantage groups and the internet penetration moderate the main impact to unpack mechanisms.

4 Identity Disclosure and Anthropomorphism in Voice Chatbot Design: A Field Experiment

Yuqian Xu, UNC-Chapel Hill Kenan-Flagler Business School, Chapel Hill, NC
Fueled by the widespread adoption of algorithms and artificial intelligence (AI), the use of chatbots has become increasingly popular in various business contexts. In this paper, we study how to effectively and appropriately use voice chatbots via leveraging two design features (i.e., identity disclosure and anthropomorphism) and evaluate their impact on the firm operational performance.

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SC58

CC-North 232C
Applications on Greenhouse Gas Emission Reduction
Contributed Session
Session Chair: Elif Haktanir Aktas, Bahcesehir University, Istanbul, Turkey

1 Impacts of Building Sector GHG-Limiting Ordinances on Long-Term Investment Decisions Considering Policy Uncertainty
Stephanie Wilcox[1], Ozge Kaplan[2], Ben Field Hobbs[1], [1]Johns Hopkins University, Baltimore, MD, [2]U.S. Environmental Protection Agency, Durham, NC
Several cities in the U.S. have enacted GHG-limiting ordinances to reduce on-site building sector emissions. However, analyses of the ordinances' long-term impacts on natural gas and power system infrastructure investment are missing from the literature. In this study, we extend the U.S. EPA's City-Based Optimization Model for Energy Technology to model long-term minimum cost energy and building sector investment decisions of NYC's GHG-limiting ordinance. Our results show that the cost-optimal investment decisions depend significantly on the inclusion of necessary system upgrades such as natural gas main replacements and future costs of "clean" natural gas substitutes.

2 Renewable Energy Pathways to Carbon Neutrality in China
Zhenhua Zhang[1], Ziheng Zhu[2], Jessica A. Gordon[3], Xi Lu[4], Da Zhang[2], Michael R. Davidson[5], [1]University of California, San Diego, La Jolla, CA, [2]Tsinghua University, Beijing, China; [3]University of California, Berkeley, Berkeley, CA, [4]Tsinghua University, Beijing, China; [5]University of California, San Diego, La Jolla, CA, Contact: zhenhua@ucsd.edu
China has announced ambitious climate policy goals of reaching peak carbon emissions by 2030 and carbon neutrality by 2060. This process requires a large increase in low-carbon renewable energy and complementary infrastructure. While these long-term objectives are clear, the deployment structure, pace, and distributional impacts are uncertain. To address this gap, we developed a power system planning and operation model with a high spatial and temporal resolution for deploying renewables, storage systems, and transmission lines. We adapted this model to evolving power system conditions and input assumptions by sequentially linking the outputs of each decade to simulate technology vintaging mechanisms. The combined model outputs across periods identify feasible and efficient pathways for renewable deployment from 2020 to 2060.

3 Pathways to Carbon Neutrality in California's Heavy-Duty Transportation Sector
Eleanor M. Hennessy, Madalsa Singh, Ines Azevedo, Stanford University, Stanford, CA, Contact: emh@stanford.edu
California has a goal of reaching net zero greenhouse gas (GHG) emissions by 2045. Nearly 8% of the state's GHG emissions come from the heavy-duty transportation sector. We assess decarbonization strategies using two policy options: zero-emission vehicle (ZEV) sales mandates and accelerated retirement programs. We build a detailed, bottom-up fleet turnover model paired with an emissions and air quality model to track the evolution of the vehicle fleet and associated cumulative health and climate impacts of each policy. We track health impacts by race and income. We use second-hand vehicle prices to estimate the cost of retirements and identify the most cost-effective policies. We find ZEV sales mandates are insufficient to reach California's climate targets, and accelerated retirement policies targeting heavy-heavy duty vehicles are most cost-effective.

4 Incentive-Based Travel Behavior Change Mechanism to Mitigate System Level Carbon Emissions
Viswa Sri Rupa Anne[1], Srinivas Peeta[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA, Contact: vanne3@gatech.edu
In recent years, incentives are being proposed to change travel behavior to reduce system-level congestion. The transportation sector is one of the largest contributors of greenhouse gases in the United States, and behavior change strategies have the potential to reduce these emissions. This study proposes an incentive mechanism that nudges users

to carbon-efficient routes to reduce system-level carbon emissions. It uses a bi-level optimization framework to generate time-varying dynamic incentives.

5 Integration of Agricultural Fields with Hydrogen Valleys: A Decision Support Model for a Circular Economy
Elif Haktanir, Bahcesehir University, Istanbul, Turkey. Contact: elif.haktaniraktas@eng.bau.edu.tr
The decarbonization of the global economy is a pressing challenge in the 21st century, requiring substantial reductions in greenhouse gas emissions. The European Union (EU) has set an ambitious target to become the first climate-neutral economy by 2050, with Hydrogen Valleys playing a significant role in achieving this goal. Hydrogen Valleys contribute to the decarbonization of the EU's economy by promoting the production of green hydrogen and facilitating its utilization in various applications. Despite the significant potential for integrating agricultural fields with Hydrogen Valleys to foster a circular economy, this area remains largely unexplored in the existing literature. This paper aims to develop a decision support model that facilitates the integration of agricultural fields with Hydrogen Valleys.

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SC59

CC-West 101A

Judith Liebman

Community Committee Choice Session

Session Chair: James J. Cochran, The University of Alabama, Tuscaloosa, AL

Sunday, October 15, 12:45 PM - 2:00 PM

SC60

CC-West 101B

Mental Health Awareness through Pedagogy

Panel Session

Session Chair: Mihir Mehta, Penn State University, State College, PA
Session Chair: Sofía Pérez-Guzmán, Georgia Institute of Technology, Atlanta, GA

1 Mental Health Awareness through Pedagogy
Sofía Pérez-Guzmán, Georgia Institute of Technology, Atlanta, GA
Deciding to start a Ph.D. is not an easy task. Yet, many of us decide to trust our abilities and knowledge to take that step and enroll in the program of interest. While everyone's path is unique, for the most part, life as a Ph.D. student is challenging and requires hard work, sacrifice, and perseverance. It makes one wonder why to pursue this path? How to overcome the challenges faced during these years? Is it worth the sacrifice? This panel is intended to cover all these questions about life as a Ph.D. student, hearing opinions from current and former Ph.D. students.

2 Panelist
Mihir Mehta, Penn State University, State College, PA

3 Panelist
Joshua Fairchild, Creighton University, Omaha, NE

4 Panelist
Nichole Barta, Gonzaga University, Spokane, WA

Sunday, October 15, 12:45 PM - 2:00 PM

SC61

CC-West 101C

Empirical PSOR II

Community Committee Choice Session

Session Chair: Anqi Wu, Florida International University, Miami, FL
Session Chair: Chengyue Huang, University of Iowa, Iowa City, IA

1 Prioritizing Electric Utility Companies for Smart Meter Adoption: Empirical Evidence from the United States
Yue Gao, Jin Fang, Jing Zhang, Clark University, Worcester, MA, Contact: jinfang@clarku.edu
The reliability of a power distribution system is a critical indicator of its ability to supply uninterrupted electric power to customers. The installation of smart meters has been identified as a means of enhancing reliability by reducing power outages and restoration time. Smart meters are an essential component that aids in balancing energy supply and demand, promoting efficient energy use, raising awareness about energy savings among consumers, and improving the reliability of electricity supply. This study

employs a simultaneous equations model and network analysis to prioritize electric utility companies in the United States. Our research findings underscore the significance of smart meter adoption and provide valuable insights for policymakers and electric utility companies.

2 Politicizing Policy Response? Ramifications and Remedies

Chengyue Huang[1], Min Zhang[1], Natasha Foutz[2], Weiguo (Patrick) Fan[1], Rui Chen[3], [1]University of Iowa, Iowa City, IA, [2]University of Virginia, Charlottesville, VA, [3]Iowa State University, Ames, IA

Policy politicization is increasingly prevalent, undermining policy efficacy and public trust. This study proposes a computational framework to conceptualize, quantify, and uncover potential mechanisms of policy politicization. We evaluate the framework through two studies: one on general COVID-19 mask policy and another on firms requiring masks for entry. Our analyses of over 2.6 million tweets show that politicization decreases the reach of pro-policy tweets and increases the exposure of anti-policy tweets. The potential mechanisms may involve diverting audience attention and influencing their attitudes. Remedies include promoting messages from public health authorities to reduce politicized responses. Our research contributes insights into policy politicization, public opinion, and effective communication strategies in polarized environments.

3 Supply Network Complexity, Regulatory Risk and Firms' Engagement in Influencing Climate Change Policies

Zhenzhen Yan[1], Sriram Narayanan[2], Tobias Schoenherr[3], [1]Idaho State University, Pocatello, ID, [2]Michigan State University, East Lansing, MI, [3]Michigan State University, East Lansing, MI, Contact: zhenzhenyan@isu.edu

To enhance organizational legitimacy and competitive advantages, many firms have strived to go beyond policy compliance and engage in influencing climate change policies (EICCP). This research focuses on the antecedents of EICCP by examining the effects of risk and network factors on EICCP. Specifically, we examine whether firms' EICCP under regulatory risks is contingent upon the features of their supply network. This study contributes to the climate change and public policy literature. Our endeavor also responds to the call for more policy-related studies in our field from a supply chain perspective.

4 Consolidation Effect on Data Breaches in Hospitals

Nan Clement, University of Texas at Dallas, Richardson, TX, Contact: nclement@utdallas.edu

I study whether and how hospital mergers increase data breach probability. Using a stacked difference-in-differences estimation strategy, I show that in the two-year window after hospital consolidation, incidents of data breaches more than double as compared to the pre-treated groups. The effect is robust to changes in the two-year time window, sample size, or how standard errors are clustered. The signaling effect and the incompatibility effect of mergers cause more hacking activities such as phishing and ransomware attacks. Conversely, the complementary effect of organizational capital reduces such an increase. The truncated regression for the past five years shows that the situation is getting worse because of soaring cases of hacking activities, even though the efforts to address misconduct breaches were effective.

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CC-West 102A

Sustainability and Equity

Community Committee Choice Session

Session Chair: Abhinav Shubham, Georgia Institute of Technology, Atlanta, GA

1 Sequential Bias And Initial Disparity In Online Grading Systems

Jiaxin Pei[1], Zhihan (Helen) Wang[2], Jun Li[2], [1]School of Information, University of Michigan, Ann Arbor, MI, [2]Ross School of Business, University of Michigan, Ann Arbor, MI, Contact: helwang@umich.edu

Surname initial-ordered grading is the default configuration in the four largest online learning management systems (Canvas, Blackboard, Moodle, Brightspace), which covers over 90% of the US and Canadian markets. Through analyzing over 30 million grading records from a large public university, we found a significant and sizable sequential grading bias where assignments graded later receive worse grading outcomes, as well as more negative and less polite comments. Moreover, the system design converts such behavioral bias into a surname initial bias - Students with alphabetically lower-ranked surname initials constantly receive worse grading outcomes due to lower ranking in the grading queue. Our study calls for operational and organizational improvements from system designers and education institutions to foster a more equal online grading environment.

2 Impact of Female Inspector Presence on FDA Inspection Outcomes

Shirin Shahsavand[1], George Ball[2], Kevin Mayo[1], Kaitlin Wowak[3], [1]Washington State University, Pullman, WA, [2]Operations and Decision Technologies, Kelley School of Business, Indiana University, Bloomington, IN, [3]University of Notre Dame, Notre Dame, IN

The impact of gender on decision-making and outcomes in operations is a growing area of concern in academic literature and practical settings. Prior research indicates that differences in gender are highly salient in regulatory environments. We examine this phenomenon among inspectors examining FDA-regulated drugs and medical devices. We examine 20 years of inspections, exploring the relationship between the inspector's gender and the inspection outcome. We find that the presence of a female inspector is associated with the most severe outcome. Our study provides insights to academics and regulators regarding how the presence of female inspectors may influence inspection outcomes that impact customer health and safety.

3 Playing Fair? Environmental Impacts and Practices of Facilities in Minority Communities

Abhinav Shubham, Ravi Subramanian, Georgia Institute of Technology, Atlanta, GA, Contact: ashubham3@gatech.edu

Drawing on comprehensive US EPA and Census data, we examine the association between presence of substantial racial minority populations in host communities and facility-level environmental impacts and impact-reduction strategies. Our findings offer evidence for firms and policy makers to consider fairness and equity in managing and regulating environmental risks.

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SC63

CC-West 102B

Digital Economy and Digital Governance

Community Committee Choice Session

Session Chair: Cong Cao, Zhejiang University of Technology, Hangzhou, China

1 The Challenges and Opportunities Brought by Digital Economy Partnership Agreement Rules to Digital Governance

Cong Cao, Zhejiang University of Technology, Hangzhou, China. Contact: congcao@zjut.edu.cn

In recent years, scholars have discussed the promotion and impact of globalization of digital trade on the optimal allocation of digital resources, and further pointed out that China needs to adapt to the trend of globalization of digital governance, promote a high level of openness, enhance cross-border autonomy, especially actively join high-level digital trade agreements, and effectively expand international cooperation on digital governance in China. on the one hand, seek a balance between security and development, freedom and order, and gradually integrate the demands of all parties into the global digital economy development planning and digital governance framework. on the other hand, strengthen the exchange and cooperation of all parties in government, projects and talents, and contribute Chinese wisdom and Chinese solutions to global digital governance.

2 Community/Committee'S Choice Submission

Yangyan Shi, 1</sup

3 Do You like Talking to an Omnipotent Human-Like Robot? the Effect of Highanthropomorphism in Intelligent Virtual Assistants on Consumer Confirmation

Sihan Cheng, Zhejiang University, Hang Zhou, China. Contact: 202005710302@zjut.edu.cn

This study presents an investigation of the perceptual and expectation transfer mechanisms of consumers when interacting with intelligent virtual assistants (IVAs). A mixed-method design is used to identify four perception variables and propose a theoretical model using the ECM model. The model explores the relationship between IVA design, perceptual factors, expectation confirmation, and consumer attitude toward IVAs to promote sustainable usage. Using a quantitative survey, the study collects valid data and analyzes the results using PLS-SEM. The findings indicate that IVAs can enhance consumer perception and increase perceived usefulness while promoting sustainable usage. This study offers insights that can contribute to expanding theory and driving the development of the IVA industry.

4 Living Together for the Future: Exploring the Willingness of Functional Restricted Groups to use New Public Infrastructure Under the Integration of Virtual and Real Worlds

Zhenyang Shen, Zhejiang University of Technology, Hangzhou, China. Contact: 202101260120@zjut.edu.cn

The development of the digital age has created a new field where physical space and virtual space intersect, but the adoption of new technologies in this field poses challenges to the lives of functionally restricted groups. To explore the factors that affect the willingness of functionally restricted groups to use new public infrastructure in this context, we constructed a research model based on UTAUT theory, and the research results effectively identified the impact of factors from three perspectives: individual, social, and technological. This study groundbreaking focuses on the issue of inclusivity in the field of virtual and real integration, which helps to guide building a society for the common development of all humanity.

5 Exploring the Changes in Audience Satisfaction when Watching Sports Events on Live Streaming Platforms

Jinyang Zhou, Zhejiang University of Technology, Hangzhou, China. Contact: 202105710327@zjut.edu.cn

Recently, with the development of live broadcast platforms such as self-media, sports event broadcasting has also shifted from traditional TV broadcasting to live broadcast platform, this paper believes that in the scene of watching games in the live broadcast room, some nature characteristics and behavioral characteristics of sports fans have certain typicality, and according to the theory of social service landscape, a research model with perceived value as an intermediate variable is established to study the impact of interactive behavior and similarity between audiences in this service landscape on the perceived value and satisfaction of other users.

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SC64

CC-West 102C

Persuasion in Social Networks

Community Committee Choice Session

Session Chair: Tauhid Zaman, Yale University, New Haven, CT

1 Shaping Opinions In Social Networks With Shadow Banning

Yen-Shao Chen, Tauhid Zaman, Yale University, New Haven, CT, Contact: yen-shao.chen@yale.edu

Social networks are global platforms for shaping public opinions. Concerns about harmful content led to content moderation policies like shadow banning that restricts content visibility. Although shadow banning can be strategically utilized to mitigate the impact of harmful content, it also raises the risk of arbitrary opinion manipulation. In this talk, we formulate shadow banning as a linear program to find a scalable shadow banning policy for large-scale networks. Our findings demonstrate the significant potential of shadow banning as a powerful technique for precise opinion manipulation. However, we caution that its application should be exercised with care, especially when seeking to combat the effects of dangerous content. This research sheds light on the importance of responsible and transparent content moderation practices on social media platforms.

2 Measuring the Persuasive Power of ChatGPT

Weining Fang, Tauhid Zaman, Yale University, New Haven, CT, Contact: weining.fang@yale.edu

This study investigates the persuasive power of machine-generated content, specifically the ability of ChatGPT to influence human attitudes. 2,000 US adults aged 18 and above were recruited from Prolific and randomly assigned to an intervention group (n=1,000) and control group (n=1,000). Participants initially completed a survey on sports, education, or entertainment attitudes. They then read a paragraph, unaware it was generated by ChatGPT. The intervention group received a topic-relevant paragraph, while the control group read an unrelated paragraph on nature or history. The participants were then asked to answer the same survey questions to assess any change in attitudes. This before-and-after design measures the impact of AI-generated contents on perspectives, offering insights for marketing, education, and policy-making.

3 Pro-Russia Twitter Bots in the Ukrainian War

Tauhid Zaman, Yale University, New Haven, CT

This study investigates Twitter bots supporting pro-Russia narratives during the Ukrainian war. Analysis reveals sustained bot creation over a decade. Prior to the invasion, bots tweeted in Russian, but shifted to English later. Many bots exhibit multilingual capabilities, using over 40 languages. Notably, the bots amplify renowned Western anti-war voices. These findings offer essential insights into the strategies employed by pro-Russia bots, their influence on discourse, and implications for information warfare in future conflicts.

4 Detecting Twitter Bots using ChatGPT Embeddings

Michael Rossetti, Georgetown University, Washington, DC

Established methods for detecting automated social media accounts known as “bots” can be complex and computationally expensive. We simplify the process by leveraging text embeddings from commercially available large language models. We obtain embeddings from the OpenAI API representing tweets posted by a sample of 7,500 Twitter users discussing the first impeachment of US President Donald Trump. We are able to achieve high classification accuracy by training simple models (Logistic Regression, Random Forest, and XGBoost) directly on these embeddings to predict various labels including bot status, political sentiment, and language toxicity. Our work demonstrates a simple and cost effective way of detecting bots, and shows the breadth of applications for these embeddings in performing a variety of social network classification tasks.

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CC-West 103A

Digital Platforms and Innovation

Community Committee Choice Session

Session Chair: Sidika Candogan, 1</sup

1 Data Sharing and Market Protection

Linsheng Zhuang[1], Jussi Keppo[2], Zhi Chen[2], [1]National University of Singapore, Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore. Contact: linsheng.z@u.nus.edu

The success of many AI-powered applications (such as the automated driving systems) hinges on their access to big data. However, for privacy reasons, countries around the globe have been stepping up measures and even regulations to prevent data from being shared beyond their borders. As a result, multinational firms cannot tap into data collected in different markets to improve their applications. In this paper, we analyze the effect of market protection on AI innovation for multinational firms which compete in different markets.

2 Assortment Display, Price Competition and Fairness in Online Marketplaces

Hanwei Li, City University of Hong Kong, Hong Kong, Hong Kong

Online platforms have been expanding the seller base to widentheir product assortment to match the heterogeneous preferences ofconsumers. Nevertheless, the increasing number of sellers has intensifiedcompetition and resulted in sellers setting lower product prices. Thus, it is unclear whether displaying all sellers tothe entire customer base maximizes platform revenue. Motivated byplatforms such as Airbnb and eBay, we consider a game-theoretical setup inwhich each seller on the platform provides a single-unit product to aheterogeneous customer base and competes with other sellers on price. Weinvestigate sellers' optimal pricing decisions and the platform's optimalassortment display policy, characterized by the number of partitions andthe sellers and traffic assigned to each partition. We find that the platformshould display the entire assortment to all customers when demand issufficiently high. Moreover, we propose a tabulation algorithm and amixed-integer programming formulation to solve for the optimal decisionsof sellers and the platform. Moreover, we incorporate fairness constraints tobalance platform revenue and the fairness of both parties on the platform.We also present a case study to gauge the impact of the partitioneddisplay policy in the context of Airbnb. Finally, we extend the case inwhich each seller supplies a distinct product with an inventory size of one byconsidering scenarios in which each product has more than one unit.

3 Practical Lessons from Innovation with Digital Platforms

Joel Wooten, University of South Carolina, Columbia, SC

Digital platforms have served as an engine for innovation and disruption. To appreciate both the impact of these applications and the unanswered questions that are relevant for researchers, we will look at some lessons and insight from papers, recent startups, and the changing world of online tools.

4 External Innovation Mechanisms: A Modeling-Based Comparative Analysis

Sangjic Lee, Kohei Nishiyama, Nariaki Nishino, The University of Tokyo, Bunkyo-ku, Tokyo, Japan. Contact: sangjiclee@tmi.u-tokyo.ac.jp

As various mechanisms for implementing external innovation emerge and become available for companies, it is necessary to explore the problem of selecting the optimal combination of activities in according to the business environment. To this end, we (1) develop a framework for comparing the mechanisms, (2) formulate the decision-making structure of stakeholders for each mechanism using game theory, and (3) analyze the compatibility of the mechanisms with various levels of environmental factors through theoretical and experimental analysis. Implications for the selection of external innovation method are derived by comparatively interpreting the results with the business cases.

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CC-West 103B

Mechanisms Impacting Collaboration, Product Development, and Entrepreneurship

Community Committee Choice Session

Session Chair: Cheryl Gaimon, Georgia Institute of Technology, Atlanta, GA

1 Hierarchical Influence Structures and Collaborative Success in Online Communities: Explaining Peer Production Performance in the R/Place Event

Shizhen Chen, Tian Chan, Anandhi S. Bharadwaj, Emory University, Atlanta, GA, Contact: shizhen.chen@emory.edu

Online communities (OCs), e.g. Reddit or Wikipedia, are open collectives of individuals whose members are often anonymous and communicate in an environment constrained by technological mediation. In this paper, we empirically investigate the collaborative mechanisms of OCs in Reddit's r/place 2022 event. The event requires individuals to collaborate to produce an image pixel by pixel for an OC, it also put OCs in competition with each other. We show that hierarchical influence structure in an OC outperforms only when competition intensity is low. However, flat influence structure outperforms when competition intensity is high. We theorize and find empirical evidence that flat influence structures are better at engaging lurkers under high competition intensity.

2 Consumer Privacy and Personalized Recommendation on Online Platforms

Farzad Fathi, Yi Xu, Bo Zhou, University of Maryland, College Park, MD

This study explores the trade-off between consumer privacy and personalized recommendations on online platforms. A model is developed, characterizing consumers' willingness to pay and product tastes, with privacy levels impacting platform decisions. Results indicate that as privacy increases, platform profits decrease, but consumer utility follows a non-monotonic pattern. The research suggests that preserving privacy may not be the optimal policy.

3 How Entrepreneur Incentives Impact Product Development at Lean Startups

K. Sudhir[1], Steve Yoo[2], [1]Yale School of Management, New Haven, CT, [2]UCL School of Management, London, United Kingdom. Contact: o.yoo@ucl.ac.uk

The lean startup method (LSM) has gained wide acceptance among entrepreneurs and investors as an experimentation based, data-driven approach to product development and learning about product-market fit. But in practice, an entrepreneur's product development choices are motivated not only by learning about product-market fit, but also by the incentive to obtain downstream investor funding and favorable funding terms. We introduce a game theoretic model of product development using LSM that accounts for the entrepreneur's incentives to gain insight on how the incentives endogenously distort the lean startup product experimentation process. Our analysis clarifies that in practice, LSM's efficacy in launching successful innovations is nuanced, and not unambiguous for entrepreneurs, investors and the overall innovation economy.

4 Hybrid Entrepreneurship: An Operational Analysis

Zeya Wang[1], Morvarid Rahmani[2], Karthik Ramachandran[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, Contact: zeya.wang@scheller.gatech.edu

We investigate the debate between fully committed entrepreneurship and a hybrid approach in which the entrepreneur retains a stable "day job". A model-based investigation of the trade-offs reveals conditions under which the hybrid approach is optimal, and when it is optimal to make a full commitment. We also study how the entrepreneur's abilities and location may affect their strategy.

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CC-West 104A

Data Mining Best Paper Competition

Award Session

Session Chair: Nathan B. Gaw, Air Force Institute of Technology, Wright-Patterson AFB, OH
Session Chair: Young Woong Park, Iowa State University, Ames, IA
Session Chair: Andi Wang, Arizona State University, Mesa, AZ

Sunday, October 15, 12:45 PM - 2:00 PM

SC68

CC-West 104B

Deep Learning Based Data Mining on Unstructured Electronic Health Records

Community Committee Choice Session

Session Chair: Zhuqi Miao, [1]</sup

1 Automated Identification of Atrial Fibrillation from Single-Lead Ecgs Using Multi-Branching Resnet

Jianxin Xie[1], Bing Yao[2], [1]University of Tennessee, Knoxville, TN, [2]The University of Tennessee Knoxville, Knoxville, TN, Contact: jxinxie@gmail.com

Atrial fibrillation (AF) is the most common cardiac arrhythmia, which is clinically identified with irregular and rapid heartbeat rhythm. AF puts a patient at risk of forming blood clots, which can eventually lead to heart failure, stroke, or even sudden death. An advanced analytical model is crucial for interpreting ECG signals and aiding AF diagnostics. We propose a deep-learning method for automated AF identification from single-lead ECGs. We use the continuous wavelet transform to extract time-frequency features, develop a CNN structure incorporating ResNet for effective training, and multi-branching architectures to address imbalanced data. We evaluate the methodology using two real-world ECG databases, and results show superior performance compared to traditional models.

2 Leveraging Active-Supervised Learning and In-Context Learning to Identify Mobility Functioning Information in Clinical Text

Thanh Thieu, Tuan-Dung Le, Moffitt Cancer Center and Research Institute, Tampa, FL, Contact: thanh.thieu@moffitt.org

Limitation in physical function, or frailty, is an important component of geriatric assessment. It disqualifies elderly cancer patient from clinical trials or systemic therapies such as chemotherapy. It contributes to eligibility of U.S. social security programs and benefits. Mobility function is a self-contained, observable domain of physical function that has shared roles in both clinical and socioeconomic applications. Using the National NLP Clinical Challenges (n2c2) research dataset, we implement pool-based query-by-committee active supervised learning BERT models for mobility-related entity recognition. We additionally compare against few-shot learning on large-language models including T5 family, UL2, and ChatGPT. We present models accuracies and empirical lessons.

3 Natural Language Processing Models for Identifying Review of Systems Information from Clinical Notes

Hieu T. Nghiem[1], Zhuqi Miao[2], Thanh Thieu[3], Zheng Han[1], Johnson Thomas[1], [1]Oklahoma State University, Stillwater, OK, [2]SUNY-New Paltz, New Paltz, NY, [3]Moffitt Cancer Center, Tampa, FL, Contact: hieu.nghiem@okstate.edu

A Review of Systems (ROS) is a standard checklist in a clinical note that includes questions regarding all the major organ systems. It is an important tool for doctors to gather information about patient symptoms and overall health. However, extracting and analyzing ROS information from free-text clinical notes is a time-consuming task that can add to the documentation burden for doctors. To tackle the challenge, we developed a transformer-based NLP model. The model utilizes Clinical-Assertion-Negation BERT to recognize ROS-related symptoms and identify their associated negations, enabling the model to determine the presence or absence of symptoms. Once the symptoms are identified, the model maps them to the appropriate organ systems. By utilizing the model, the ROS information extraction process can be automated, resulting in improved efficiency and accuracy.

4 Recognizing Patient History from Clinical Notes Using Natural Language Processing

Tuan-Dung Le[1], Suhao Chen[2], Thieu Thanh[3], Zhuqi Miao[4], [1]University of South Florida, Tempa, FL, [2]South Dakota School of Mines and Technology, Rapid City, SD, [3]Moffitt Cancer Center and Research Institute, Tampa, FL, [4]SUNY-New Paltz, New Paltz, NY, Contact: miaoz@newpaltz.edu

History of Present Illness (HPI) and Past, Family and Social History (PFSH) are two crucial sections of a clinical note, providing valuable information that assists physicians in diagnosing and developing treatment plans. Moreover, they enable effective communication and continuity of care among healthcare professionals involved in the patient's care. However, extracting and analyzing patient history data documented in free-text clinical notes constitute a significant burden to healthcare professionals. To address this challenge, this study developed a transformer-based named entity recognition model, which can identify detailed HPI and PFSH elements from clinical notes. We evaluated the model's performance by comparing its accuracy with that of other methods. Additionally, we conducted error analyses to reveal the factors impacting the model's accuracy.

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CC-West 105A

Economic Models for Market Interactions and Decisions

Community Committee Choice Session

Session Chair: Peter Zhang, Carnegie Mellon University,

Pittsburgh, PA

1 Distributionally Robust Principal-Agent Problems and Optimality of Contract Menus

Peter Zhang, Carnegie Mellon University, Pittsburgh, PA

We propose a distributionally robust principal-agent formulation and a theoretical framework to quantify a contract menu's optimality gap. By our framework, the optimality gap of a contract menu is broken down into an adjustability gap and an information rent. Our results shed light on the existence of more positive results in the literature in terms of a simple menu's optimality in a worst-case setting rather than in a Bayesian setting. We show that this high-level observation relates to two basic technical facts: the sum of quasi-concave functions is not quasi-concave in general; the maximization operator and the expectation operator do not commute in general.

2 Evidence, Access, and Progress: A Mechanism Design Approach to Accelerated Drug Approval

Giuseppe Lopomo, David Ridley, Peng Sun, Chenxi Xu, Duke University, Durham, NC, Contact: chenxi.xu@duke.edu

Under the controversial accelerated approval program, the US Food and Drug Administration (FDA) gives conditional approval to drugs with a lower standard of evidence. After approval, the drug maker must conduct an additional trial to stay on the market. FDA advisors have resigned over approvals of drugs with insufficient evidence of effectiveness under the accelerated program. The rationale for the program is that it gives patients earlier access to drugs. We show another benefit of using mechanism design tools. The accelerated program promotes investment in drug trials for diseases that manufacturers might otherwise have neglected. Furthermore, we show that the relationship between evidence and the scope of the drug label should be nonlinear.

3 On the Convergence of No-Regret Learners to the Approximate Bayes-Nash Equilibrium in Single-Object Auctions

Mete Ş. Ahunbay[1], Martin Bichler[2], [1]Technical University of Munich, Garching, Germany; [2]Technical University of Munich, Garching B. München, Germany

Recent advances in equilibrium learning find approximate Bayes-Nash equilibrium in discretized versions of a wide variety of auction games. This is surprising, because equilibrium learning often cycles and can exhibit formally chaotic behavior in general finite games. However, it is known that no-regret learners converge to a coarse correlated equilibrium (CCE). Thus, to study convergence to Bayes-Nash equilibrium in single-item auctions, we analyze the Bayesian CCE polytope of first-price, second-price, and all-pay auctions, as well as Tullock contests. We show that the set of Bayesian CCE is close to the unique BNE of these games if the c.d.f. of the prior is concave. In particular, for refinements of discretizations parametrized by n, the maximum Wasserstein distance of any Bayesian CCE to the BNE is O(1/n). This suggests that an important class of games is learnable.

4 Comparing Centralized and Decentralized Matching in Labor Markets

Srinivasa Kartikeya Puranam[1], Michael Katehkais[2], [1]Rutgers University, Camden, NJ, [2]Rutgers University, Newark, NJ, Contact: karti@camden.rutgers.edu

Two mechanisms for matching which are dubbed centralized and decentralized mechanisms are compared. The payoff to the Labor Market Intermediary (LMI) which facilitates the matching in both mechanisms is studied. A discussion of when each of the two mechanisms are optimal is provided. Numerical simulations and their results are also presented.

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SC70

CC-West 105B

Infectious Disease Management and Control Policy

Community Committee Choice Session

Session Chair: Eyyub Yunus Kibis, Montclair State University, Montclair, NJ
Session Chair: Ozlem Cosgun, Montclair State University, Wayne, NJ

1 Hospital Utilizations During Covid 19 Pandemic: An Efficiency Problem

Eyyub Yunus Kibis[1], Musa Caglar[2], Ali Dag[3], Serhat Simsek[4], [1]Montclair State University, Montclair, NJ, [2]Tulane University, New Orleans, LA, [3]Creighton University, Gretna, NE, [4]Montclair State University, Wayne, NJ, Contact: kibise@montclair.edu

In this study, we develop a compartmental dynamic MIP model to investigate the transmission of the COVID-19 pandemic within a community. We propose policies that will help state governments to control the pandemic and reduce patient density at overcrowded hospitals. Our model predictions closely fit the real outbreak data and suggest

that the deployment of makeshift hospitals as post-treatment facilities will result in the most efficient use of resources to control the pandemic.

2 Modelling Hospital Bed and Ventilator Capacity Under Non-Pharmaceutical Interventions During Covid-19

Ozlem Cosgun[1], Eyyub Yunus Kibis[2], [1]Montclair State University, Wayne, NJ, [2]Montclair State University, Montclair, NJ

During the COVID-19 outbreak, all countries faced a critical shortage of beds and ventilators that caused a dramatic increase in mortality rates. In this study, we propose a capacity planning model that includes the optimal hospital bed and ventilator capacity expansion decisions under non-pharmaceutical interventions to minimize the number of deaths in New York City during COVID-19. An epidemic disease compartmental model (S4IRD) is proposed to project COVID-19 infections over time, and a MIP optimization model is developed to decide on the optimal bed and ventilator expansion amounts that minimize the number of deaths over time.

3 At What Prevalence of Resistance Should Empiric Antibiotic Treatment for Gonorrhea Change? a Cost-Effectiveness Analysis

Xuecheng Yin[1], Reza Yaesoubi[2], [1]Yale University, New Haven, CT, [2]Yale School of Public Health, New Haven, CT

Common diagnostic tests for gonorrhea do not provide information about the susceptibility of infection to antibiotics. Guidelines recommend changing antibiotics used for empiric therapy once resistance prevalence exceeds 5%. However, the basis for this threshold is not clear. We developed a model of gonorrhea transmission to project gonorrhea-associated costs and loss in quality-adjust life-years (QALYs) under different switch thresholds among men who have sex with men in the US. Using cost-effectiveness analysis, we identify hypothetical switch thresholds for varying values of willingness-to-pay per QALY and showed the health and economic burden of gonorrhea and the effective lifespan of antibiotics depends on the selected threshold

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SC71

CC-West 105C

Computation Research in Social Study

Community Committee Choice Session

Session Chair: Yicheng Song, University of Minnesota, Minneapolis, MN

Session Chair: Teng Ye, 1</sup

1 Understanding How Competing Products of Different Quality Tiers Affect Consumer Purchase and Return Decisions and the Implications to E-Commerce Platform Growth

Jisu Cao[1], Sha Yang[2], Chunmian Ge[3], [1]Arizona State University, Tempe, AZ, [2]University of Southern California, Los Angeles, CA, [3]South China University of Technology, Guangzhou, China. Contact: caojisu0319@gmail.com

We study the spillover effects of competing products of different quality tiers on consumer purchases and returns. Although third-party sellers bring revenue to e-commerce platforms, low-tier products may create a negative spillover on purchases and returns for existing ones, thus hurting overall profits. To understand this tradeoff, we developed and estimated a general-equilibrium model of consumers' purchase and return choice and sellers' entry decisions on their products using data from a leading e-commerce platform. We find that one unit increase in low-tier products is related to a .20% increase in return rate. Using counterfactual simulations, we derived important policy implications on consumer purchase and return rate, competition, and profits for platforms under two growth strategies: promoting high-tier entries vs. deterring low-tier entries.

2 Does "meaningful Use Attestation" Improve The Efficiency Of Emergency Department Care

Jingyan Dai, Liangfei Qiu, University of Florida Warrington College of Business Administration, Gainesville, FL, Contact: Jingyan.Dai@warrington.ufl.edu

The Centers for Medicare and Medicaid Services introduced the "Meaningful Use" program in 2009, which offers financial incentives to eligible healthcare providers who use Electronic Health Records (EHRs) in a meaningful way to enhance patient care. In our research, we investigated the effects of EHR utilization, as indicated by the "Meaningful Use Attestation" status of hospitals, on the efficiency of their emergency department care. To conduct our empirical analysis, we employed a staggered difference-in-differences approach using a hospital-level dataset spanning from 2011 to 2017. Additionally, we examined the moderating effects of the "Meaningful Use Attestation" on emergency department efficiency.

3 30 Million Canvas Records Reveal Widespread Sequential Bias and System-induced Surname Initial Disparity in Grading

Jiaxin Pei[1], Zhihan (Helen) Wang[2], Jun Li[2], [1]School of

Information, University of Michigan, Ann Arbor, MI, [2]Ross School of Business, University of Michigan, Ann Arbor, MI
Through analyzing 30 million Canvas grading records from a large public university, we found a robust and sizable sequential grading bias that assignments graded later tend to 1)receive lower scores 2)be ranked lower in the class and 3)receive comments that are more negative and less polite. Such a bias directly leads to negative outcomes that students graded later 1)are more likely to submit regrade requests and 2) receive lower final course grades. We further show that the grading system design converts the individual-level grading bias into a systematic bias against students with alphabetically lower-ranked surname initials, who constantly receive worse grading outcomes due to lower ranking in the grading queue. Such disparity is significant in a wide range of subjects and is more evident for complex grading tasks with higher workloads and longer average grading time.

4 Cleansing Public Discourse: Are Subreddit Bans Effective?

Xiaoxuan Xu, Feng Mai, Jingyi Sun, Stevens Institute of Technology, Hoboken, NJ, Contact: xxu62@stevens.edu

Shutting down online communities for content policy breaches is a draconian and controversial moderation strategy. This research examines the impact of subreddit bans on the toxicity and bias present in related communities' discussions. Our study shows that these bans can effectively lower explicit toxicity in other subreddits, underscoring the deterrent effect of these stern measures in shaping public discourse. However, we observe that levels of implicit bias appear to rise over time following such bans. This highlights the intricate challenges of mitigating subtler forms of bias in online settings.

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SC72

CC-West 106A

Advanced Deep Learning and Modeling Approaches for Time Series and Complex Network Analysis

Community Committee Choice Session

Session Chair: Shouyi Wang, University of Texas at Arlington, Arlington, TX

1 Learning from the Interactions within Complex Networks

Shuo Wang, University of Texas at Arlington, Arlington, TX

Complex networks are prevalent in our society - from nature to engineering infrastructures. Hence, revealing the underlying interactions, especially their dynamic structure, is the key to understanding the nature of targeted complex networks. Here, we adopt dynamic modeling to infer the dynamic interactions of a complex network from massive time-variant data. Several applications will be shown to demonstrate the applicability of this work.

2 A Multi-Modal Deep Fusion Framework of EEG and MEG for Brain Source Imaging

Meng Jiao, Feng Liu, Stevens Institute of Technology, Hoboken, NJ

This paper introduces a Multi-Modal Deep Fusion (MMDF) framework for solving the Electrophysiological Source Imaging (ESI) inverse problem, termed as MMDF-ESI. The framework combines Electroencephalography (EEG) and Magnetoencephalography (MEG) measurements using a specialized deep learning approach. The experiments show that MMDF-ESI provides superior localization accuracy and stability over single modality methods, particularly for larger activation areas and under low signal-to-noise ratio conditions, while enabling more concentrated reconstruction of the brain sources.

3 Prediction of Cannabis Addictive Patients with Graph Neural Networks

Shihao Yang, Feng Liu, Stevens Institute of Technology, Hoboken, NJ

This study explores the use of Graph Neural Networks (GNN) and its variants to enhance brain imaging classification in diverse populations, with data drawn from public neuroimaging databases. Focusing on the functional Magnetic Resonance Imaging (fMRI) data of cannabis addicts versus a healthy control group, we achieved an approximate accuracy rate of 80% in distinguishing the groups, with addicts showing significant functional connectivity alterations. These results underscore AI's potential in brain imaging and public health strategies.

4 An U-Net Based Deep Learning Approach to Predict Voxel Level Treatment Response for Lung Cancer Using 3D PET/CT Imaging Data

Shouyi Wang, Jie Han, University of Texas at Arlington, Arlington, TX

This study proposes a novel approach for predicting voxel-level treatment response in lung cancer patients using 3D PET/CT imaging data. The method is based on the U-Net deep learning architecture, which effectively leverages the spatial information present in the images. By analyzing the PET/CT scans, the model predicts the response of individual voxels to treatment. This approach holds promise for personalized treatment planning and assessment, potentially improving outcomes for lung cancer patients through more targeted therapies.

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SC73

CC-West 106B

Information and Market Microstructure

Community Committee Choice Session

Session Chair: Ruixun Zhang, Peking University, Beijing, China

1 Personalized Pricing, Network Effects, and Corporate Social Responsibility

Yan Xiong[1], Liyan Yang[2], [1]Hong Kong University of Science and Technology, Hong Kong, Hong Kong; [2]University of Toronto, Toronto, ON, Canada. Contact: liyan.yang@rotman.utoronto.ca

We propose a theory of corporate social responsibility by linking it to the firm's product markets. The firm's product exhibits network effects in the sense that the product's value to each consumer increases with the number of consumers. Moreover, with the technology development, the firm can adopt personalized pricing for each consumer. We show that such a firm could use social responsibility as a commitment device for low product prices, which helps overcome the coordination problem among consumers. In this way, the firm's profit function increases, supporting the notion of ``doing well by doing good.''

2 Principal Trading Arrangements: Optimality Under Temporary and Permanent Price Impact

Markus Baldauf[1], Christoph Frei[2], Joshua Mollner[3], [1]University of British Columbia, Sauder School of Business, Vancouver, BC, Canada; [2]University of Alberta, Edmonton, AB, Canada; [3]Northwestern University, Kellogg MEDS, Evanston, IL, Contact: cfrei@ualberta.ca

We study the optimal execution problem in a principal-agent setting. A client (for example, a pension fund, endowment, or other institution) contracts to purchase a large position from a dealer at a future point in time. In the interim, the dealer acquires the position from the market, choosing how to divide his trading across time. Price impact may have temporary and permanent components. There is hidden action in that the client cannot directly dictate the dealer's trades. Rather, she chooses a contract with the goal of minimizing her expected payment, given the price process and an understanding of the dealer's incentives. Many contracts used in practice prescribe a payment equal to some weighted average of the market prices within the execution window. We explicitly characterize the optimal such weights: they are symmetric and generally U-shaped over time.

3 A Spectral Analysis of High-Frequency Information Content

Agostino Capponi[1], Lintong Wu[2], Ruixun Zhang[2], [1]Columbia University, New York, NY, [2]Peking University, Beijing, China. Contact: wltsms@pku.edu.cn

We develop a framework to decompose information content into frequency-specific components and estimate its periodicity using the vector autoregressive model of Hasbrouck (1991) and the spectral framework of Wu, Zhang, and Dai (2022). We find that high-frequency periodicities in information content widely exist, particularly at 10-minute and 5-minute frequencies. We observed a strong correlation between information content periodicity and volumes as well as liquidity measures such as the spread. This supports the informational explanation for the spectral patterns in volumes (Wu, Zhang, and Dai, 2022), and the informational perspective of bid-ask spreads which is charged by market makers to mitigate adverse selection costs (Glosten and Milgrom, 1985).Long-short portfolios constructed based on a periodicity factor yield monthly Fama-French alphas of up to 1%.

4 Who Benefits from Securities Exchange Innovation?

Konstantin Sokolov[1], Andriy Shkilko[2], Eduard Yelagin[1], [1]University of Memphis, Memphis, TN, [2]Wilfrid Laurier University, Waterloo, ON, Canada

Securities markets continuously innovate to keep pace with technology. It isoften debated if such innovation is beneficial, and which market participants capture the benefits. We contribute to this debate by examining liquidity effects of a wide range of proprietary products and services introduced by trading venues in the United States. Exchange innovation is generally associated with liquidity improvements for those investors, who trade in small quantities. The effect is opposite for institutional investors; their trading costs increase, and their market participation declines. Democratizing access to innovation helps mitigate the above-mentioned adverse effects.

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SC74

CC-West 106C

Economics and Computation III

Award Session

Session Chair: Shuting Shen, Cambridge, MA

1 Multi-Item Order Fulfillment Revisited: LP Formulation and Prophet Inequality

Ayoub Amil[1], Ali Makhdoumi[2], Yehua Wei[3], [1]Duke University - Fuqua School of Business, Durham, NC, [2]Duke University, [3]Duke University, Durham, NC

In this work, we revisit the multi-item order fulfillment model introduced by Jasin and Sinha (2015). Specifically, we study a dynamic setting in which an e-commerce platform (or online retailer) with multiple warehouses and finite inventory is faced with the problem of fulfilling orders that may contain multiple items. The platform's goal is to minimize the expected cost incurred from the fulfillment process, subject to warehouses' inventory constraints. Unlike the classical literature on multi-item fulfillment, we propose an alternative offline formulation of the problem. In particular, in our model, the platform sequentially selects methods to fulfill the arriving orders. A method consists of a set of facilities that will determine which warehouses the items will ship from and, more importantly, whether multi-item orders will be split. Under this formulation, we design a class of dynamic policies that combine ideas from randomized fulfillment, prophet inequalities and subgradient methods for the general multi-item fulfillment model. Specifically, by establishing connections between the fulfillment and prophet inequality literature, we prove that our algorithm is both asymptotically optimal and has strong approximation guarantees in non-asymptotic settings. Our result shows that there is a simple and near-optimal procedure for solving multi-item fulfillment problems once the online retailer has enough inventory, independently of other problem parameters. To the best of our knowledge, this is the first result of this type in the context of multi-item order fulfillment. In addition, and of independent interest, our analysis also leads to new asymptotically optimal bounds for network revenue management problems.

2 Order-Optimal Correlated Rounding for Fulfilling Multi-Item E-Commerce Orders

Will Ma, Columbia University, New York, NY

We study the dynamic fulfillment problem in e-commerce, in which incoming (multi-item) customer orders must be immediately dispatched to (a combination of) fulfillment centers that have the required inventory.A prevailing approach to this problem, pioneered by Jasin and Sinha in 2015, has been to write a "deterministic" linear program that dictates, for each item in an incoming multi-item order from a particular region, how frequently it should be dispatched to each fulfillment center (FC). However, dispatching items in a way that satisfies these frequency constraints, without splitting the order across too many FCs, is challenging. Jasin and Sinha in 2015 identified this as a correlated rounding problem and proposed an intricate rounding scheme that they proved was suboptimal by a factor of at most ≈q/4 on a q-item order. This paper provides, to our knowledge, the first substantially improved scheme for this correlated rounding problem, which is suboptimal by a factor of at most 1+ln(q). We provide another scheme for sparse networks, which is suboptimal by a factor of at most d if each item is stored in at most d FCs. We show both of these guarantees to be tight in terms of the dependence on q or d. Our schemes are simple and fast, based on an intuitive idea; items wait for FCs to "open" at random times but observe them on "dilated" time scales. This also implies a new randomized rounding method for the classical Set Cover problem, which could be of general interest.We numerically test our new rounding schemes under the same realistic setups as Jasin and Sinha and find that they improve runtimes, shorten code, and robustly improve performance. Our code is made publicly available online.

3 Regret Minimization with Noisy Observations

Mohammad Mahdian[1], Jieming Mao[1], Kangning Wang[2], [1]Google Research, New York, NY, [2]Stanford University, Stanford, CA

In a typical optimization problem, the task is to pick one of a number of options with the lowest cost or the highest value. In practice, these cost/value quantities often come through processes such as measurement or machine learning, which are noisy, with quantifiable noise distributions. We study such scenarios using a regret minimization model.

In our model, the task is to pick the highest one out of n values. The values are unknown and chosen by an adversary, but can be observed through noisy channels, where additive noises are stochastically drawn from known distributions. The goal is to minimize the regret of our selection, defined as the expected difference between the highest and the selected value on the worst-case choices of values. We propose an algorithm that gives a constant-approximation to the optimal regret for any n.

4 Inference on the Optimal Assortment in the Multinomial Logit Model

Shuting Shen[1], Xi Chen[2], Ethan Xingyuan Fang[3], Junwei Lu[4], [1]Cambridge, MA, [2]New York University, [3]Duke University, Durham, NC, [4]</sup

Assortment optimization has received active explorations in the past few decades due to its practical importance. Despite the extensive literature dealing with optimization algorithms and latent score estimation, uncertainty quantification for the optimal assortment still needs to be explored and is of great practical significance. Instead of estimating and recovering the complete optimal offer set, decision-makers may be interested in testing whether a given property holds for the optimal assortment, such as whether they should include several products of interest in the optimal set, or how many categories of products the optimal set should include. This paper proposes a novel inferential framework for testing such properties. We consider the widely adopted multinomial logit (MNL) model, where we assume that each customer will purchase an item within the offered products with a probability proportional to the underlying preference score associated with the product. We reduce inferring a general optimal assortment property to quantifying the uncertainty associated with the sign change point detection of the marginal revenue gaps. We show the asymptotic normality of the marginal revenue gap estimator, and construct a maximum statistic via the gap estimators to detect the sign change point. By approximating the distribution of the maximum statistic with multiplier bootstrap techniques, we propose a valid testing procedure. We also conduct numerical experiments to assess the performance of our method.

5 Information Design of a Delegated Search

Yangge Xiao[1], Zhenyu Hu[1], Shouqiang Wang[2], [1]National University of Singapore, Singapore, Singapore; [2]The University of Texas at Dallas, DALLAS, TX

A principal delegates a sequential search to an agent, who bears the search cost and controls when to terminate searching. Upon termination, the search payoff is split between the principal and agent. However, only the principal can evaluate each search outcome. The principal designs an information policy to strategically disclose private outcomes over time to the agent. We show the optimal policy is fully prescribed by a sequence of deterministic *acceptance standards.* The agent is recommended and voluntarily willing to continue the search if and only if the current termination payoff fails to meet that period's standard. When the search results are not recallable, the acceptance standards are informative and determined *recursively* across different periods as the optimal stopping thresholds that the principal would employ should she conduct each search by herself at a *shadow cost*. When the search results are recallable, the optimal policy provides no information and the agent keeps searching up to a *cutoff period*, after which the acceptance standard in each subsequent period is determined *independently* of other periods by equating the agent's search cost with his marginal return from an additional search in that period.

Sunday, October 15, 12:45 PM - 2:00 PM

SC75

Session.Location:CC-West 208A

Drone based Operations and Delivery Systems

Contributed Session

Session Chair: Bahar Viniche, York University, Toronto, ON, Canada

1 Unmanned Aerial Vehicle Routing and Search Planning in a Disaster Area Considering Uncertainty and Equity

Nastaran Oladzadabbasabady[1], Rajan Batta[2], Miguel Lejeune[3], [1]University at Buffalo (SUNY), Buffalo, NY, [2]University at Buffalo (SUNY), Buffalo, NY, [3]George Washington University, Washington, D.C., DC

This work presents an approach to improve routing and searching decisions for a fleet of Unmanned Aerial Vehicles (UAVs) that are in charge of finding victims in a post-incident area. The proposed approach involves two mathematical optimization models: a deterministic model, and a stochastic programming model to address uncertain characteristics of practical humanitarian operations that affect the route and search planning. Due to limited search resources, search operations have great potential for inequities to occur, meaning in some areas, search is conducted with considerably less resources than other areas. In order to ensure equitable assignment of UAVs, innovative equity metrics are integrated into both models. The resulting models enable efficient and equitable decision-making for UAV route and search planning.

2 A Simulation-Heuristic Method for Drone Delivery in Rural Areas

xudong wang[1], Xueping Li[2], [1]The University of Tennessee, Knoxville, knoxville, TN, [2]University of Tennessee, Knoxville, Knoxville, TN, Contact: xwang97@vols.utk.edu

Under the current Covid-19 pandemic, drones greatly improve logistics, especially in rural areas, where inefficient road networks and long distances between customers reduce the delivery capacity of conventional ground vehicles. Besides, charging stations can improve the service range by drones' limited flight range. In this study, we utilize simulation to optimize the drone delivery system design to minimize the cost of the delivery system. As facility siting is usually difficult to optimize, we propose a novel simulation-heuristic framework to find near-optimal solutions. In addition, we conduct a case study using real-world data collected from Knox County, Tennessee, which showed our approach saves 15% on total costs over the benchmark.

3 Tactical Fleet Planning in Drone-Enabled Deliveries

Bahar D Viniche[1], Opher Baron[2], Oded Berman[2], Mehdi Nourinejad[1], [1]York University, Toronto, ON, Canada; [2]University of Toronto, Toronto, ON, Canada. Contact: bahardv@yorku.ca

Last-mile delivery is a time-sensitive and costly leg of the supply chain, requiring innovative delivery methods to recipients. Drones bring substantial value to this sector by avoiding congested road networks and travelling aerial trajectories at higher speeds. We present models of drone-assisted routing strategies in last-mile delivery using parametric design. At the strategic level, adding drones to the fleet requires characterizing the benefits of reducing delivery times. The study bridges the gap of incorporating routing-based operational level constraints, including drone flight range, multi-launching, and coordinating drone trajectories with truck paths. The analysis shows three outcomes, in which the performance of the delivery operations is limited by the capacity of the trucks, the range of drones, or the timing coordination of the trucks and drones.

Sunday, October 15, 12:45 PM - 2:00 PM

SC76

Session.Location:CC-West 208B

Optimization for Freight Transportation

Contributed Session

Session Chair: Christian Truden, University of Klagenfurt - Department of Operations, Energy, and Environmental Management, Klagenfurt, Austria

1 Dynamic Berth Allocation Policies in the Deep-Sea Terminals

Behman Orkun Tunay, Erasmus University, Rotterdam, Netherlands. Contact: tunay@rsm.nl

The Port of Rotterdam is a critical gateway for Western European industries in global trade. However, its substantial emissions contribution requires active decarbonization efforts to meet EU targets. Inland waterways play an important role for the modal shift towards a sustainable European transport network but the competition between the deep-sea vessels and the barges for the limited capacity challenges the terminals for their berth allocation policies. This research focuses on evaluating prioritization policies the deep-sea vessels and barges for berth allocation in deep-sea terminals, considering long-term performance and key performance indicators (KPIs) such as berth utilization, vessel throughput, waiting times, barge congestion, and modal split, using queuing networks.

2 An Exact Optimization Approach for Ship Schedule Recovery in Liner Shipping Networks Under Conflicting Objectives

Zeinab Elmi, Bokang Li, Maxim A. Dulebenets, Florida A&M University-Florida State University, Tallahassee, FL, Contact: elmi.zeinab@gmail.com

A variety of unexpected events can disrupt liner shipping schedules. Different ship schedule recovery options can be adopted in response to disruptive events. This study proposes a novel multi-objective model for ship schedule recovery that aims not only to minimize the total late ship arrivals at ports but also to minimize the total profit loss due to disruptive events that may occur at sea and/or at ports. An exact optimization algorithm is presented to obtain optimal Pareto Fronts. The computational experiments conducted for a real-life transit route demonstrate that the proposed exact optimization algorithm is able to generate Pareto Fronts in a timely manner and provide interesting insights.

3 The Relevance of an Enhanced Assessment of Follow-Up Conflicts in the Heuristic-Based Adjustment of Railway Schedules in Real-Time

Arturo Crespo Materna, Cedric Steinbach, Shanqing Chai, Hendrik Speh, Andreas Oetting, Technische Universität Darmstadt, Darmstadt, Germany. Contact: crespo@verkehr.tu-darmstadt.de

The execution of the planned railway operations requires schedule adjustments due to stochastic events. Due to their flexibility and efficiency, heuristic Conflict Detection Conflict Resolution (CDCR) approaches are arguably the most relevant methods to constitute decision-support tools for conducting the schedule adjustment. In CDCR approaches, conflicts are synchronously solved by generating a set of conflict resolution alternatives (CRAs). Only the most optimal CRA is later implemented to resolve the conflict. Therefore, each of the generated CRAs needs to be assessed not only based on their direct impact on the operations but also taking into account the conflicts they may induce on other trains (i.e.

follow-up conflicts). Thus, an assessment function with "look-ahead" capabilities becomes central for ensuring the quality of the adjustment process.

4 The Service Network Design Problem with Fleet and Emissions Management

Christian Truden, University of Klagenfurt - Department of Operations, Energy, and Environmental Management, Klagenfurt, Austria

While hydrogen fuel cell and battery-electric vehicles present opportunities to reduce emissions, effectively integrating their use into operations given range limitations, recharging (refueling) times, and sparse infrastructure requires careful planning. A recognition that the emissions associated with energy production can vary from one region to another is critical. This is also true with respect to the price of both energy and diesel fuel. In this work, we consider fleet management decisions regarding how many vehicles of each type (diesel, battery-electric, hydrogen) a carrier should acquire as well as in what regions they should operate. The impact of these fleet-level decisions on customer service is captured by explicitly modeling the routing of shipments and vehicles while recognizing the consumption of limited onboard resources.

Sunday, October 15, 12:45 PM - 2:00 PM

SC77

Session.Location:CC-West Lecture Hall

Theory and Application in Queueing Systems

Contributed Session

Session Chair: Akhil Singla, Northwestern University, Evanston, IL

1 On the Output Dynamics of the Discrete-Time M/G/1-Queue

Christoph Jacobi, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany. Contact: jacobi@kit.edu

The departure process of the M/G/1-queue is a point process. However, decomposition methods often assume departure streams to be renewal, which causes approximation errors when analyzing downstream queues. We investigate the auto-correlation of the departure process to find situations where the renewal assumption is not justified. We model the M/G/1-queue as a discrete-time Markov chain and compute the joint probability distribution of two departure instances that are ￼ > 0 instances apart. Numerical results show the effect of auto-correlation on the renewal assumption in decomposition methods.

2 Conic Integer Reformulations for Bandwidth Packing Problem with Queuing Delays

Masoud Amel Monirian[1], ONUR KUZGUNKAYA[2], Navneet Vidyarthi[2], [1]Concordia University, Montreal, QC, Canada; [2]Concordia University, Montreal, QC, Canada

We study the Bandwidth Packing Problem with Queuing Delay Cost (BPP-QDC) that arises in telecommunication networks. The decision in BPP-QDC is to choose the calls to accept and assign them on a single path to maximize the revenue on a network with limited link bandwidth. The resulting nonlinear problem has been solved in literature by exact methods of finite linearization and cutting plane algorithm up to a network size of 50 nodes. We present several equivalent reformulations of BPP-QDC as a mixed-integer second-order cone programming model. We further strengthen the proposed reformulations with McCormick and polymatroid cuts. Our results show that the best-proposed reformulation is capable of solving 191 out of 243 instances to optimality for networks with 80 nodes. The proposed polymatroid and McCormick cuts reduce the computation time by 11% and 22%, respectively.

3 A Markovian Continuous Approximation Modeling Forperformance Evaluation Ofbatch Processing on a Single Machine

Mohsen Nikfar, Alexander Vinel, Auburn University, Auburn, AL

This work proposes a modeling approach for performance evaluation of batch processing with sequence-dependent setup times on a single machine. We consider Poisson arrivals of jobs and a maximum for batch size and queue length. A typical existing approach is to assume a known distribution for the processing time of the batch. In contrast, we employ a continuous approximation, which allows us to characterize the full distribution for batch processing time (which is a solution to an instance of random TSP). The resulting model is a semi-Markov process, and we are able to derive expression for its limiting distribution and corresponding performance measures. The model is validated against a Monte-Carlo. We will also present some illustrative case studies.

4 Assessment of Performance of the Production Floor Based on the Impact of the Raw Materials Queue

Shahriar Tanvir Alam[1], Fahima Akter Azrin[2], Abu Saleh Md. Nakib Uddin[2], Moddassir Khan Nayeem[3], [1]University of Southern California, Los Angeles, CA, [2]Military

Institute of Science and Technology, Mirpur, Bangladesh; [3]University of Texas at San Antonio, Texas, TX, Contact: alams@usc.edu
This paper formulates the single server queuing models and provides a performance evaluation. The performance for "*Single Server Finite Queue Length Infinite Queue Population Model*" is most desirable where the raw materials have to wait for less time in the queue (approximately 55.65%) and reduces the queue length by approximately 57.68%. Based on the findings of the queue performance, an ARENA-based simulation has been illustrated to visualize the productivity of the production floor considering the impact of the raw materials queue. The simulation result shows that the implementation of the finding from the assessment of the queue performance increases the output by 2.4 times compared to the present condition.

5 Optimal Control Of Join Decision In Fork-Join Queues

Akhil Singla, Seyed Iravani, Northwestern University, Evanston, IL, Contact: akhilsingla@u.northwestern.edu
In fork-join (FJ) queues, each incoming job is copied to all its parallel servers. The join decision to predict and remove the job from the system is decided by a join server using all or some of the parallel server evaluations. FJ can capture the trade-off of speed and accuracy commonly arises in knowledge-based service systems like fact-checking for social media platforms, hospital diagnosis operations, legal systems. We study the optimal control of join decision in FJ queues. We show that the optimal dynamic join decision policy follows a double score threshold structure and a step-wise threshold structure in system queue sizes. We also propose an intuitive Line Heuristic (LH) that uses a simpler queueing model and performs within 2% optimality gap. To control the complex dynamics of FJ queues, we simply suggest decision makers to control the number of jobs in the system.

Sunday, October 15, 12:45 PM - 2:00 PM

SC78

Session.Location:CC-West 211A

Energy Systems Planning

Contributed Session

Session Chair: Ling Zhang, University of Washington, Seattle, WA

1 Valuation of a Sequential Compound Option Considering Generation and Transmission Expansions

Gazi Nazia Nur, K Jo Min, Iowa State University, Ames, IA
This study addresses an electric power decision-maker who has to decide on generation expansion in the short run and transmission expansion in the long run. To aid the decision-maker, we model an electrical expansion problem using a sequential compound option which includes a generation addition option followed by a transmission line addition option. Electricity demand is uncertain, and we assume it follows geometric Brownian motion. When demand increases, it creates a necessity for additional generation capacity. The network often needs a new transmission line to circulate this additional electricity. Thus, the demand and existing elements in the network influence later expansion decisions. We calculate the option value based on the benefit of the added components, and the benefit is determined from the reduction in locational marginal price after the supplements.

2 Using Real Option to Evaluate a Cap and Floor Compensation Model for a DC Connection Between ERCOT and the Western Grid

LUIZ BRANDAO[1,2], James S. Dyer[3], [1]PUC-Rio, Rio de Janeiro, Brazil; [2]University of Texas at Austin, Austin, TX, TX, [3]University of Texas-Austin, Austin, TX, Contact: brandao@iag.puc-rio.br
We will describe the use of real option pricing concepts to value a proposed transmission line linking the electric power grids in ERCOT (Texas) and the Western Interconnection (California and the West Coast). This study will examine novel pathways for the financing of transmission assets, including a cap and floor cost recovery system such as those used for inter-grid facilities in Europe and for major infrastructure projects in other countries. These cap and floor compensation models have characteristics similar to call options and put options on uncertain stock prices, and their value can be estimated in much the same way.

3 Abnormal Detection Using Two-Stage Method in Combined Power Plant

Yunhee Kim[1], Suk Joo Bae[2], [1]Hanyang University, Seoul, Korea, Republic of; [2]Hanyang University, Seoul, Korea, Republic of. Contact: yuuun@psm.hanyang.ac.kr
The paper presents a two-stage model for detecting abnormal events in complex systems using time series clustering and the Mahalanobis distance. Stage one involves clustering sensors with similar patterns using a DTW-based time-series clustering algorithm. A health indicator is then computed for each cluster using PCA and the Mahalanobis

distance. In stage two, the Mahalanobis distance calculates an abnormal score for each data point, and points exceeding a predefined threshold are flagged as abnormal. The method was evaluated using real-world power plant data, showing superior accuracy and efficiency compared to existing techniques. This approach has the potential to reduce computational resources needed for abnormal event detection, making it promising for real-world applications.

4 An Efficient Learning-Based Solver for Two-Stage DC Optimal Power Flow with Feasibility Guarantees

Ling Zhang, Daniel Tabas, Baosen Zhang, University of Washington, Seattle, WA, Contact: lzhang18@uw.edu

Two-stage stochastic DC optimal power flow (OPF) problems are computationally challenging to solve due to the large number of scenarios needed to accurately represent the uncertainties. We propose a learning method to solve two-stage problems efficiently and optimally. A technique called the gauge map is incorporated into the learning architecture design to guarantee the learned solutions' feasibility to the network constraints. That is said, the second-stage decisions are approximated by feed-forward functions that only output feasible solutions. Simulation results on standard IEEE systems show that, compared to iterative solvers and the widely used affine policy, our proposed method not only learns good-quality solutions but also accelerates the computation by orders of magnitude.

Sunday, October 15, 12:45 PM - 2:00 PM

SC79

Session.Location:CC-West 211B

George Nicholson Student Paper Competition I

Award Session

Session Chair: Anton Braverman, Northwestern University, Evanston, IL

Session Chair: He Wang, Georgia Tech, Atlanta, GA

1 Distributionally Robust Linear Quadratic Control

Bahar Taskesen, EPFL, Lausanne, Switzerland

We consider a generalization of the classic Linear-Quadratic-Gaussian (LQG) control problem, where the noise distributions are unknown and belong to Wasserstein ambiguity sets. The objective is to minimize a worst-case cost across all distributions in the ambiguity set. We prove that a control policy that is linear in the observations is optimal for this problem. We also propose an efficient Frank-Wolfe algorithm that efficiently identifies the least-favorable distributions within the Wasserstein ambiguity sets and then computes the controller's optimal policy using Kalman filter estimation.

2 Large Deviations and Metastability Analysis for Heavy-Tailed Dynamical Systems

Xingyu Wang, Northwestern University, Evanston, IL

We propose a framework integrating large deviations and metastability analysis of heavy-tailed dynamical systems. Applying it to heavy-tailed stochastic difference/differential equations, we provide sample path large deviations and first exit time analysis, offering the heavy-tailed counterparts of the classical Freidlin-Wentzell and Eyring-Kramers theories. Moreover, our results systematically characterize the intricate phase transitions in first exit times and an intriguing global behavior under truncated heavy-tailed dynamics that sheds light on the generalization mystery in deep learning.

3 Dynamic Resource Allocation: Spectrum of Achievable Performances and Algorithmic Design Principles

Akshit Kumar, Columbia Business School, New York, NY

This work explores the impact of distributional assumptions on algorithmic performance in dynamic resource allocation problems. We identify a novel fundamental driver of regret character showing that polynomial regret is unavoidable. We introduce the Conservativeness with respect to Gaps (CwG) principle and propose the Repeatedly Act using Multiple Simulations (RAMS) algorithm, achieving near-optimal performance. Our findings are in sharp contrast to existing guarantees and provide insights into the fundamental drivers of algorithmic performance in resource allocation.

Sunday, October 15, 12:45 PM - 2:00 PM

SC80

Session.Location:CC-West 212A

Undergraduate Operations Research Prize II

Award Session

Session Chair: Zhijie Sasha Dong, University of Houston, Houston, TX

1 Getting Away with More Network Pruning: From Sparsity to Geometry and Linear Regions

Junyang Cai, Bucknell University, Lewisburg, PA

In this work, we explore how sparsity also affects the geometry of the linear regions defined by a neural network, and consequently reduces the expected maximum number of linear regions based on the architecture. We observe that pruning affects accuracy similarly to how sparsity affects the number of linear regions and our proposed bound for the maximum number. Conversely, we find out that selecting the sparsity across layers to maximize our bound very often improves accuracy in comparison to pruning as much with the same sparsity in all layers, thereby providing us guidance on where to prune.

2 Retail on Autonomous Wheels: A Time-Sensitive Traveling Salesman Problem

Zhuolun Dong, University of Texas at Austin, Austin, TX

Wheeled vending stores are emerging in cities. We study a retail paradigm where a wheeled store transverses across an urban district, seeks suitable locations to perch at, and serves local demand. We propose a "time-sensitive TSP", which generalizes the TSP by incorporating three time-sensitive factors: service busyness, demand tardiness, and product freshness decay. We build the upper and lower bounds of the optimal reward in the asymptotic regime using the continuous approximation approach. Our findings suggest that mobile retail has the potential to become a more profitable paradigm.

3 Cornell University Uses Integer Programming to Optimize Final Exam Scheduling

Tinghan Ye, Georgia Institute of Technology, Atlanta, GA

This paper presents an integer programming framework for final exam scheduling at Cornell University. Assisting the University Registrar over three consecutive semesters, the flexible framework accommodates diverse constraints, including front-loading large courses and excluding specific time slots within the exam period. The flexibility to generate multiple schedules with different model variants facilitates trade-offs in varying levels of exam conflicts. Results showcase significant time and effort savings for the university administration while enhancing student and faculty satisfaction.

Sunday, October 15, 12:45 PM - 2:00 PM

SC81

Session.Location:CC-West 212B

The Importance of Mentorship in OR/ Analytics Fields

Community Committee Choice Session

Session Chair: Gabriela Gongora-Svartzman, Carnegie Mellon University, Pittsburgh, PA

1 Accompaniment: Experiences in Mentoring People Into and Through a PhD

Chris Ryan, Sauder Business School

I will discuss my experiences in accompanying undergraduate students in their decision to apply for a PhD, go through a PhD program, and ultimately graduate and find academic positions.

2 The Impact Of Mentorship Advice In Coding Project Courses

Gabriela Gongora-Svartzman[1], Larry Heimann[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Carnegie Mellon University, Pittsburgh, PA, Contact: ggongora@cmu.edu

Engagement and mentorship with students is a topic of great interest to universities, and with proper structure, software project courses provide a good avenue to make these connections between mentors and students. Knowing that mentors have different styles and provide advice in a broad spectrum of areas, the question arises as to what type of mentoring has the most significant impact. This study analyzed the communication patterns between mentors and teams using data collected from bi-weekly mentoring meetings and final project evaluations. Findings suggest that mentoring advice can positively impact project outcomes. Sentiment analysis shows that mentors who provided neutral advice had a lower impact on project outcomes than mentors who gave a mix of positive and negative advice. These findings suggest future steps to improve mentorship in analytics fields.

3 Mentoring New Faculty Members in a Liberal Arts Setting

Richard Forrester, Dickinson College, Carlisle, PA

In this talk, we discuss the nuanced and distinct aspects of mentoring new tenure-track faculty members in a liberal arts setting. The liberal arts environment requires a unique approach compared to research-focused institutions, and we will examine best practices for guiding new faculty towards achieving tenure, including excellence in teaching, scholarship, and service. Additionally, we will examine how new faculty can fully embrace the academic lifestyle, while providing guidance on advising students and integrating within the campus community.

4 Purposeful Pathways: Mentoring Undergraduates

Kevin Hutson, Furman University, Greenville, SC, Contact: kevin.hutson@furman.edu

At Furman University, we have embarked on an intentional plan of mentoring called Pathways to help undergraduates find their purpose. The first two years are designed to help students adjust to college and explore its opportunities. The final two years are designed to help students specialize in their chosen fields and transition to what is next. This talk focuses on mentoring in the final two years by helping students explore their desired interests through undergraduate research and internships. We discuss how to find the right project for each student and how to develop the foundational skills needed to help them succeed for their chosen pathway. We also talk about developing relationships with industry partners to provide real-world experiences for students to further develop their skills.

Sunday, October 15, 12:45 PM - 2:00 PM

SC82

Session.Location:CC-West 212C

Healthcare Operations

Contributed Session

Session Chair: Taranga Datta, ndian Institute of Management, Kolkata, India

1 Dynamic Incentive Design in the Medicare Shared Savings Program

Xinyue Fei[1], Frank Y. Chen[2], WEI ZHANG[3], [1]City University of Hong Kong, Hong Kong, Hong Kong; [2]City University of Hong Kong, Tat Chee Avenue, Hong Kong; [3]Zhejiang University, Hang Zhou, China. Contact: xinyuefei2-c@my.cityu.edu.hk

The Medicare Shared Savings Program (MSSP) has shown modest progress and an incentive-participation dilemma since its inception. This work redesigns the MSSP contract from a long-term perspective, considering providers' heterogeneity, private information, random savings generation, and uncontactable efforts. We construct optimal and approximated contracts, justifying the current contract form with differential tracks while refining the sharing rates and benchmarks to resolve the incentive-participation dilemma. It also suggests how to set appropriate targets in the healthcare pay-for-performance reform to prevent the ratchet effect. We show how the ratchet effect erodes healthcare performance and sustainability in the long run, suggesting the curse of public extracting provider efficiency developed from experience.

2 Personalized Disease Screening Decisions

Ali Hajjar[1], Oguzhan Alagoz[2], [1]MBSC of Business and Entrepreneurship, KAEC, Saudi Arabia; [2]University of Wisconsin-Madison, Madison, WI, Contact: hjaar@wisc.edu

The needs of patients with multiple chronic conditions (MCC) are poorly addressed by the clinical practice guidelines. We develop a stochastic modeling framework to personalize the disease screening decisions for patients with or at risk of developing a chronic condition. We present our framework by personalizing breast cancer screening for women with diabetes using our modeling framework. We uncover some crucial policy insights that the prior medical community did not acknowledge. We find some important policy insights that were not recognized before by the medical community.

3 Navigating Pharmacy Access: An Agent-Based Simulation of Consumer Preferences

Md Morshedul Alam, Lihui Bai, University of Louisville, Louisville, KY

Through a novel approach of combining Agent-Based Simulation and a Mixed Multinomial Logit (MMNL) model, this research studies consumer preference and decision making in choosing community pharmacies, considering both individual-specific and pharmacy-specific characteristics. The results, by analyzing choice probabilities and health-seeking behaviors, will provide insights to design efficient community pharmacy networks that promote improved accessibility and utilization of community pharmacies, therefore optimizing public health outcomes.

4 Understanding Factors Influencing Patient Resistance to Teleconsultation

Taranga Datta[1], Narain Gupta[2], Sumanta Basu[1], [1]Indian Institute of Management Calcutta, Kolkata, India; [2]MDI Gurgaon, Gurugram, India. Contact: tarangad18@iimcal.ac.in

In our research, we analyze the resistance behavior exhibited by both potential adopters and current users of teleconsultation. This resistance poses a significant barrier to the widespread acceptance of technology-driven innovations in healthcare, including teleconsultation services. We draw on a mixed-methods approach to study the factors leading to resistance. Our analysis combines quantitative surveys and qualitative interviews, offering a comprehensive view of patient resistance. We operationalize a conceptual model comprising barriers to the use of tele-consultation by the individual patients. The findings are significant for both healthcare providers as well as policymakers, with an aim to enhancing teleconsultation adoption and ultimately improving healthcare accessibility and delivery.

Sunday, October 15, 12:45

PM - 2:00 PM

SC83

Session.Location:CC-West 213A

Pandemic Management Applications

Contributed Session

1 Epidemic Dynamics of Network in Determining Optimal Human Mobility

ADEOLA C. ADEGBEMIJO[1], Oyekanmi Olatunde[2], Ademola Adedoyin[3], [1]State University of New York at Binghamton, Binghamton, NY, [2]State University of New York at Binghamton, Binghamton, NY, [3]State University of New York at Binghamton, Johnson City, NY, Contact: aadegbe1@binghamton.edu

Epidemics are a severe public health concern due to their ability to cause widespread illness, death, and economic disruption. The emergence of new infectious agents, such as the COVID-19 pandemic, has highlighted the need for effective intervention strategies to control the contagion dynamics. This research presents a network agent-based model to simulate the spread of infectious diseases in two spatial regions under different lockdowns. It uses data science techniques to predict the dynamics of the SIRS-RE model and explore the optimal frequency of interactions between individuals to reduce the effect of infectious diseases.

Session Chair: Weimar Ardila, University of Kansas, Lawrence, KS

2 Optimal Social Distancing Policy Under Partial Social Compliance

Hyelim Shin[1], Taesik Lee[2], [1]KAIST, Daejeon, Korea, Republic of; [2]KAIST, Daejeon, Korea, Republic of

Epidemics pose a significant global threat, and controlling their spread requires effective policies such as social distancing. As it can result in substantial social and economic costs, it is important to design a social distancing policy that balances its benefits and costs. Another factor to consider is the social feedback from community members, as pandemic fatigue can decrease compliance with the policy, negatively impacting its effectiveness. This study proposes a single-leader multiple-followers Stackelberg game that captures the relationship between policymaker, who sets the policy, and community members, who adjust their behavior accordingly. Observations on the optimal social distancing policies demonstrate the importance of considering the community members' compliance and offer practical insights into effective social distancing policy design.

3 Strengthening Community Resilience in Pandemic Mitigation: A Continuous-Time Markov Decision Model Approach

Weimar Ardila Rueda[1], Alex Savachkin[2], Daniel Hernando Romero Rodriguez[3], [1]University of Kansas, Lawrence, KS, [2]University of South Florida, Tampa, FL, [3]Universidad del Norte, Barranquilla, Colombia. Contact: weimar@ku.edu

In the face of a pandemic outbreak, effective mitigation strategies are crucial to minimizing human losses and maintaining essential services. However, depending only on a well-matched pandemic strain vaccine may not always be feasible. In such cases, non-pharmaceutical interventions (NPIs) are vital in reducing contact between infected and uninfected individuals. Nonetheless, implementing aggressive NPI measures can have significant economic implications for communities. To address this challenge, we propose a stochastic dynamic optimization model based on an infinite horizon Continuous-Time Markov Decision Process. This approach balances intervention investment and community resilience improvement. Specifically, we aim to reduce the initial performance drop during the post-disruption response.

Sunday, October 15, 12:45 PM - 2:00 PM

SC84

Session.Location:CC-West 213B

Topics in Healthcare

Contributed Session

Session Chair: Joseph Mollick, Texas A&M University - Corpus Christi, Corpus Christi, TX

1 A Precise Nursing Training System Integrating Conversational Artificial Intelligence and Mixed Reality

Kamelia Sepanloo[1], Yijie Chen[2], Young-Jun Son[1], [1]Purdue University, West Lafayette, IN, [2]University of Arizona, Tucson, AZ, Contact: ksepanlo@purdue.edu

Using mixed reality technology, we have developed a nursing training system that creates scenarios with different digital patients and symptoms, allowing nurses to practice interactions with digital patients in a safe, controlled, and realistic environment. In addition, the system is augmented with a conversational artificial intelligence (AI) model that allows the nurse to have regular conversations with a digital patient to practice communication and empathic skills, as well as to learn how to provide appropriate care and treatment. In this work, we delve deeper into our conversational AI model and the natural language processing methods to improve language comprehension, including text classification using feed forward and convolutional networks, part-of-speech tagging using maximum entropy Markov models, and local and global models for dependency parsing.

2 Managing Patient Safety Culture for Healthcare Organizations: An Exploratory Study with Correspondence Analysis at Cheng Ching General Hospital

Seung-Hwan Km[1], Shao-Jen Weng[2], Hsin-Hung Wu[3], Chih-Hsuan Huang[4], Wan-Lin Hsieh[5], Pao-Sheng Shen[5], Yii-Ching Lee[6], [1]Embry-Riddle Aeronautical University, Prescott, AZ, [2]Tunghai University, Taichung City, Taiwan; [3]National Changhua University of Education, Changhua City, Taiwan; [4]Hubei University of Economics, Wuhan City, China; [5]Tunghai University, Taichung, Taiwan; [6]Cheng Ching General Hospital, Taichung City, Taiwan

We investigate the relationships that the various safety characteristics have with gender, age, and workplace of medical staff in relation to patient safety culture. An exploratory study was performed by using the correspondence analysis with nine patient safety characteristics from the Chinese version of SAQ (Safety Attitude Questionnaire). The results showed Hospital Management Support for Patient Safety, Teamwork across Hospital Units, and Hospital Handoffs and Transitions showed significant relationships with the gender and age of employees, while Safety Climate, Stress Recognition, Hospital Management Support for Patient Safety, and Teamwork across Hospital Units resulted in significant relationships with the workplace and age of employees. We provide some implications to improve the patient safety culture of an organization.

3 Social Media Addiction, Its Effects on Addicts, and Its Relevance to Businesses: A Literature Review

Joseph Mollick, Texas A&M University - Corpus Christi, Corpus Christi, TX

We try to understand how individuals' social media addiction relates to business strategies. We analyze scholarly journal articles to classify the victims of this addiction based on dimensions such as demographics, sexual orientation, technostress, and social capital. We identify the effects of this addiction on one's contentment, job performance, achievements, community engagement, sense of belonging, habits, fatigue, anxiety, depression, emotions, and wellbeing. We identify businesses that are beneficiaries of individuals' addictive use of social media and generate relevant hypotheses.

Sunday, October 15, 12:45 PM - 2:00 PM

SC88

CC-North Exhibit Hall

Sunday Poster Session

Poster Session

Session Chair: Hrayer Aprahamian, Texas A&M University, College Station, TX

Session Chair: Bjorn Berg, University of Minnesota, Minneapolis, MN

Session Chair: Adolfo Raphael Escobedo, Arizona State University, Tempe, AZ

1 Improving Adversarial Robustness Through The Contrastive-guided Diffusion Process

Yidong Ouyang[1], Liyan Xie[1], Guang Cheng[2]; [1]The Chinese University of Hong Kong, Shenzhen, China, [2]University of California, Los Angeles, USA

Robust learning requires a significantly larger amount of training samples compared with standard classification. Therefore, how to improve the sample efficiency of synthetic data for the downstream task is of great importance. In this paper, we first analyze the optimality condition of synthetic distribution for achieving improved robust accuracy. We show that enhancing the distinguishability among the generated data is critical for improving adversarial robustness. Thus, we propose the Contrastive-Guided Diffusion Process (Contrastive-DP) to guide the diffusion model. We validate our theoretical results using simulations and image datasets.

2 Calibrating A Car-following Model To Capture Impacts Of Connected And Automated Vehicles On Human-driven Vehicles

Zhitong Huang, John Hourdos; Leidos, USA

The impacts of vehicle automation systems (VAS) on transportation operations must be accurately assessed to support different transportation agencies in preparing for the deployment and adoption of VAS technology. To this end, we calibrate the Intelligent Driver Model (IDM) using field data from a data collection project, which involved SAE level 1 and 2 VAS-equipped vehicles. Statistical testing confirms significant behavioral differences between human drivers interacting with VAS and those driving conventional vehicles.

We also employ a machine learning-based methodology to refine the IDM model calibration to investigate changes in human driver behavior when interacting with VAS

3 Improving Urban Sustainability Through Solar Panel Identification On Building Rooftops

Maryam Ahmadi; Clark University, USA

Climate change urgency requires reducing greenhouse gas emissions. Solar power integration is effective, needing detailed information on solar system locations and capacity. High-resolution imagery helps, but manual identification of solar panels is tedious and error-prone. The project develops a CNN model using satellite image processing to identify solar roofs and segment panels accurately. The model aids researchers, governments, and the public in uncovering rooftop patterns, monitoring usage, evaluating incentives, and supporting sustainable city development.

4 Understanding Social Perception, Interactions, And Safety Aspects Of Sidewalk Delivery Robots Using Sentiment Analysis

Yuchen Du, Tho V. Le; Purdue University, USA

This paper conducts an in-depth sentiment analysis of comments on YouTube videos concerning sidewalk delivery robots (SDRs). Through meticulous examination of these comments, we aim to decipher public attitudes, perceptions, and concerns regarding SDRs to effectively guide the progression of SDR-related industries. Utilizing both machine learning and neural network models, we classify manually annotated comments based on their sentiment. Additionally, this research investigates the temporal variation in public viewpoints on technology adoption. By synthesizing and analyzing these findings, we aspire to provide invaluable insights to stakeholders in the SDR sector.

5 Estimating Population Through Remote Sensing: A Novel Multi-Scale Building Classification Approach

Minseok Kim, Yao Zhao; Rutgers University, USA

Even in a data-driven era, reliable, affordable data collection remains a hurdle. Our study uses machine learning in remote sensing, providing a cost-effective census alternative. We offer a novel approach to building detection requiring needs only a binary mask for building footprints, eliminating costly labelling. The process then classifies building types by aggregating results from multi-scale classifiers, trained separately at various zoom levels of satellite images, thereby mimicking human-like thought in image interpretation. Post obtaining building data, our model predicts residential and work population based on building use and volume, derived from shadow-simulated height.

6 Real-time Decision Support For Human-machine Interaction In Digital Railway Control Rooms

Léon Sobrie[1], Marijn Verschelde[2]; [1]Ghent University, Belgium, [2]IÉSEG School of Management, France

In digital railway control rooms, traffic operators can on-the-spot choose to use automation. As these choices are frequently suboptimal, we propose a real-time decision support tool to improve human-machine interaction (HMI) at Infrabel, Belgium's railway infrastructure company. The tool provides predictive and prescriptive analytics on both expected and desirable HMI at the 15-minute level for each workstation. We perform an extensive benchmark for machine and deep learning approaches, with a focus on both accuracy and explainability. To obtain prescriptions, we compare the predictions of HMI with their desirable counterparts.

7 Federated Cooperative Multimodal Data Fusion

Mohammad Amini; University of Florida, USA

Multimodal data fusion is a technique that combines data from multiple sources to gain a comprehensive understanding of complex systems. However, multi-modal data is often decentralized, and sharing sensitive data can compromise individual privacy. To address this issue, we propose a cooperative federated multimodal data fusion approach that preserves the privacy of data sources. With a federated approach, computations are performed locally on each dataset without requiring direct access to data. The approach has potential applications in healthcare, finance, and transportation, where sensitive data is involved, to enable more effective and secure collaboration among organizations.

8 A Transformer Network For Longitudinal Modeling Of Low Birthweight Prediction Using A Large-scale Dataset In The U.S.

Yang Ren, Dezhi Wu, Yan Tong, Ana López-De Fede, Sarah Gareau; UNIVERSITY OF SOUTH CAROLINA, USA

Low birthweight (LBW) is a significant health issue causing infant mortality, chronic health problems, and higher healthcare costs. Previous studies proposed machine learning (ML) based LBW prediction models with limitations without incorporating important features derived from pregnant persons' previous delivery history, and thus bringing biases to the ML prediction models with a lower accuracy. We proposed a novel transformer-based model with the capability to model sequential relationships and capture contextual information across delivery history events to improve LBW prediction. Our model is also expected to further expand to other disease prediction applications.

9 Comparative Study Of Distillation-enabled Multi-stage And Other Incremental Learning Methods For Online Process Monitoring In Advanced Manufacturing

Boris Oskolkov, Zhangyue Shi; Oklahoma State University, USA

Incremental Machine Learning (IML) methods are a class of machine learning methods that can be used to train models on streaming data. In this work, we compare the performance of distillation-enabled multi-stage incremental learning (KDeMIL) with other IML for online process monitoring. We evaluate the methods on a real manufacturing process and show that KDeMIL outperforms the other methods in terms of F-score and robustness. Also, we discussed learning capabilities and potential advantages of observed models and considered computational cost.

10 Robust Self-Supervised Deep Tensor Decomposition For Corrupted Time Series Data

Zihan Zhang[1], Ziyue Li[2], Jianjun Shi[1]; [1]ISyE Georgia Tech, USA, [2]University of Cologne, Germany

Classification of time series data in machine learning faces challenges like multivariate properties, spatiotemporal dependencies, and high labeling costs, which reduce precision. Industrial scenarios intensify these with data noise and anomalies. We present Robust Self-Supervised Deep Tensor (RSDT) Decomposition to tackle these. RSDT augments data, then decomposes it into low-rank structures and anomalies, highlighting true data insights. Using contrastive self-supervised learning, RSDT captures class-aware features, tapping into generative networks for latent patterns. RSDT proves robust for time series classification.

11 Survival Of Heart Failure Disease Propensity Model Using Machine Learning

Grace T. Babalola[1], Ademola Adedoyin[1], Adeola C. Adegbemijo[1], Damilola Amire[2], Deborah Aransiola[3], Akintomiwa Akintunde, MD[4], Oluwatunmise D. Halim, RN[2]; [1]State University of New York at Binghamton, USA, [2]East Tennessee State University, USA, [3]Accenture, Canada, [4]Meharry Medical College, USA

Heart failure (HF) is the leading cause of death in the world, but if detected early, are easy to treat. With ML algorithms, EMR data could be analyzed to help detect patterns/associations otherwise undetectable by physicians. This study utilized multiple feature selection techniques with five ML algorithms to classify and predict HF patients' survival. The model precision, recall, and the AUC_ROC was used to evaluate the performance of the various classifiers implemented. Gradient boosting, followed by linear discriminant analysis showed better accuracy in classifying HF patient survival over SVM algorithm. The most important indicators of HF survival are age, cholesterol level, and gender.

12 Business Foot Traffic Prediction Using Graph Neural Networks

Mohsen Bahrami[1], Hasan Alp Boz[1], Selim Balcisoy[2], Alex Pentland[1]; [1]Massachusetts Institute of Technology, USA, [2]Sabanci University, Turkey

Accurately estimating the potential foot traffic for a new business is crucial for location decisions. Leveraging visit patterns and places (POI) datasets, we use a GNN architecture that relies on GraphSAGE neighborhood and POI embeddings. We use 2 stacked GraphSAGE layers to extract the node embeddings in a heterogeneous graph setting. The resulting neighborhood and POI embeddings are concatenated to be fed to 3 linear layers with leakyReLU activation functions to obtain the final logit values. We evaluate the model performance in 2 different urban settings: Monroe County, NY, & Boston MSA. The model yields significant scores of 0.66 and 0.64 AUROC outperforming all baseline models.

13 Analysis Of Factors Contributing To Diabetes-related In-patient Stays In The United States

Ruchi D. Kukde, Aindrila Chakraborty, Jaymeen Shah; Texas State University, USA

This research aims to identify the factors that could reduce the preventable hospitalizations of diabetic patients by examining the 2018 National Inpatient Sample (NIS) dataset. Utilizing this nationwide dataset, this research found that age, demographics, income, insurance policies, severity of illness, and comorbidities are critical and warrant further investigation. The findings suggest diabetes education, awareness, timely screening, and lifestyle changes can reduce diabetes-related complications and lower hospitalizations. The overall goal is to guide healthcare administrators and policy makers to develop initiatives to lower preventable hospitalizations.

14 Implementing Big Data Framework To Evaluate Transportation Infrastructure In Near Real Time And Improve Disaster Response Logistics

Adetola Odebode, Ashlea Bennett Milburn, Haitao Liao, Serhan Dagtas, Xiao Huang, Jose Azucena, Sharafat Hossain; University of Arkansas, USA

Emergency responders are driven by logistical issues like what resources are needed, when and where, and how those resources should be delivered during disaster events. For a disaster response to be successful and effective, situational awareness of the state of the transportation infrastructure along which key movements, such as supply distribution must occur, is crucial. To do this, we develop a framework that uses cutting-edge data analytics tools and techniques to route important resources while taking advantage of social media and other data sources for essential and timely information. We present the work in progress toward implementing this framework using Hurricane Harvey as a testbed.

15 Improving Fairness In Machine Learning With Subgroup Threshold Optimization

Cecilia Ying[1], Stephen Thomas[2]; [1]Queen's University, Canada, [2]Queen's University, Canada

In an effort to improve the accuracy of credit lending decisions, many financial intuitions are now using predictions from machine learning models. However, recent research has shown that the predictions have the potential to be biased and unfair towards certain subgroups of the population. We introduce a new fairness technique, called Subgroup Threshold Optimizer (STO) as a post-hoc adjustment technique to address this. STO works by optimizing the classification thresholds for individual subgroups in order to minimize the overall discrimination score between them. Our experiments on a real-world credit lending dataset show that STO can reduce gender discrimination by over 90%.

16 Integrating Developmental Flight Testing And Crew Served Weapons Using Image Classification

James B. Mackey; US Air Force, USA

The MH-139A, replacement for the UH-1N, is undergoing developmental testing to include integrating crew served weapons. Calculating safe trajectories and limitations on weapons use is time consuming not practical for the compressed testing timeline. Integrating high-speed camera photography with calibration measures and image classification techniques the analysis team developed a methodology to map rotor blade position during handling quality testing to determine blade location during typical engagement profiles. This approach enabled the team to rapidly model the safe employment envelope for the MH-139A crew served weapons and compress the test schedule to meet delivery timelines.

17 Forecasting With Moving Averages Time Series Methods: On The Importance Of The Time Lag

ILIAS NIKOLOPOULOS[1], Konstantinos NIKOLOPOULOS[2]; [1]Royal Lancaster Grammar School, United Kingdom, [2]Durham University, United Kingdom

Time Series Methods have been popular in industry and academia due to their simplicity, computational cost, replicability and yet surprisingly accuracy too; evidenced in many empirical forecasting competitions. Of special interest the Moving Average family of methods with focus on the moving window, and also the (understudied) importance of the calculation 'lag', the t axis difference between the moving average centroid t value and the point in time that the forecast refers to. This is the focus of this research with intuitively appealing results in the M3-competition annual dataset (645 time series) and clear implications for the theory and practice of OR/MS, and respective IS applications.

18 Financial Distress Prediction Using Machine Learning

Minh Nguyen; University of Hawaii, USA

This study explores financial distress prediction for public firms in Vietnam as a transition economy by combining variables from the Altman and Merton model. We employ four machine learning methods, including linear discriminant analysis, logistic regression, support vector machines, and neural networks. Our results show that the models combining the Altman's and Merton's variables outperform those that only use either of these lists of variables in terms of both balanced accuracy and Matthew coefficient correlation (MCC). Moreover, the predictive performances for the case of non-delisted firms are generally better than those for the case of delisted firms.

19 Dynamic Ensemble Weighting

Mohammad Fili, Parvin Mohammadiarvejeh, Guiping Hu; Iowa State University, USA

Complex data structures often require a blend of algorithms to accurately capture the intricate relationship between the response variable and the features. Numerous approaches exist for aggregating a collection of predictive models and harnessing the capabilities of strong learners. Ensemble techniques are one such set of algorithms that merge the predictions from individual learners using weights. However, assigning weights to models without considering the areas of expertise for each learner can result in suboptimal performance. To address this issue, we propose an algorithm that dynamically assigns weights to the learners in a pool, considering the spatial information of data points.

20 A Hybrid Model Approach For New Product Launch Forecast

Yujia Ke, Elenna Dugundji; Massachusetts Institute of Technology, USA

This research initializes a hybrid model to forecast new product launch, which consists of a linear base model and an add-on model. This model can be used for business scenario planning and gives guidance to material, inventory, and financial planning.

21 Multi-agent Reinforcement Learning For Optimal Integrated Operation Of Power Distribution Systems

Jiachen Xi[1], Alfredo Garcia[1], Roohallah Khatami[2], Christine Chen[3]; [1]Texas A&M University, USA, [2]Southern Illinois University, USA, [3]University of British Columbia, Canada

We propose a multi-agent decentralized reinforcement learning approach to efficiently adjust electricity demand, generation, and line power flow in a timely fashion to ensure the reliable operation of the electric power system with uncertainty. By formulating the optimal integrated operation of an interconnected but independently operated distribution system as a bi-level optimization problem, we leverage RL algorithm with a twin-actor-critic structure to determine the optimal policies for flow control between areas (upper level) and demand/generation adjustment inside each area (lower level).

22 Oversampling Multigenerational Families And Immigrant Groups In The New Jersey Population Health Cohort Study

Steven B. Cohen; RTI International, USA

The New Jersey Population Health Cohort Study is the largest study to explore factors that influence health and well-being in the state. More specifically, the study seeks to improve our understanding of how life events and stress affect health and resilience, and identify health disparities encountered by historically disadvantaged groups, multigenerational families, and immigrant groups. To help ensure precision targets for planned analytical investigations are achieved for the overall study and specifically for multigenerational families and immigrant groups, model-based oversampling strategies are employed. This presentation describes the modeling approach and its performance.

23 Causal Graph Discovery From Self And Mutually Exciting Time Series

Song Wei[1], Yao Xie[1], Christopher Josef[2], Rishikesan Kamaleswaran[2]; [1]Georgia Institute of Technology, USA, [2]Emory University School of Medicine, USA

We present a generalized linear structural causal model, coupled with a novel data-adaptive linear regularization, to recover causal directed acyclic graphs (DAGs) from time series. By leveraging a recent Variational Inequality (VI) formulation, we cast the causal discovery problem as a general convex optimization, and develop a non-asymptotic recovery guarantee. We demonstrate the effectiveness of our approach in recovering highly interpretable causal DAGs over Sepsis Associated Derangements (SADs) while achieving comparable prediction accuracy to powerful ``black-box'' models such as XGBoost.

24 Thermodynasmt: A Thermo-dynamic Surface Mount Technology Framework For Predictive Modeling And Component Localization In Reflow Soldering Processes

Abdelrahman Farrag, Jaewoo Kim, Daehan Won, Sangwon Yoon, Yu Jin; Binghamton University, the State University of New York, USA

Addressing thermal control complexities during reflow soldering in SMT, which affect solder joint quality and component self-alignment, ThermoDynaSMT emerges as a pioneering multi-physics framework. By integrating a Physics-Informed Neural Network (PINN) and a hybrid model, ThermoDynaSMT accurately predicts PCB thermal profiles and component displacement vector during reflow. This innovative approach overcomes limitations of previous models, including computational costs, sensitivity to measurement errors, data intensity, and adaptability. Ultimately, ThermoDynaSMT enhances solder joint quality and optimizes assembly, contributing to the advancement of SMT processes.

25 The Daily Question: Engage Students In Your Intro Or Non-majors Course

Matthew A. Hawks, PhD; US Naval Academy, USA

Introducing data science to non-major students is challenging. The daily question offers an unobtrusive way to build student trust, naturally creating an intimate classroom atmosphere. Integrating daily questions with the course content and using ice-breakers increases attentiveness, community, and engagement. Anonymous end-of-term student opinion forms demonstrate initial success.

26 Identifying Key Topics In EV Charging Technology Through Patent Analysis

HeeSeok Moon, Hyunhong Choi; KYUNG HEE UNIVERSITY, Korea, Republic of

In this study, we examine electric vehicle (EV) charging patents to identify key technology trends, maturity levels, and correlations among different topics. Specifically, we employ the Structured Topic Model (STM) which identify latent topics in patent data, enabling us to gain insights about the technological landscape and development trend in the EV charging sector. Our findings showcase major focus areas by country and investigate technology maturity level of identified topics to identify key technological topics. Results of our study can offer valuable insights for policymakers or industry players to develop targeted strategies and investments for the EV charging infrastructure sector.

27 Enabling Privacy-preserving Prediction For Length Of Stay In ICU-A Multimodal Federated-learning-based Approach

Tongnian Wang, Yuanxiong Guo, Kim-Kwang Raymond Choo; The University of Texas at San Antonio, USA

Medical data often sits in data silos due to various regulatory, privacy, and ethical considerations, which complicates efforts to fully utilize machine learning, and may eventually exacerbate health disparities. We propose a Multimodal Federated Learning approach to predict patients' accurate remaining length of stay (LOS) in the ICU using multimodal data in a privacy-preserving manner. By applying our approach to a real-world medical dataset, we demonstrate the predictive power of our approach in the presence of privacy and data governance challenges and the necessity of involving different modalities.

28 Learning To Allocate And Price In Multi-Sided Markets

Landon Butler[1], Yigit Efe Erginbas[1], Kannan Ramchandran[1], Soham Phade[2]; [1]University of California, Berkeley, USA, [2]Salesforce, USA

Many large-scale online platforms, such as on-demand food and grocery delivery services, manage the allocation and pricing of a limited number of goods in a multi-sided marketplace. Participants in the market possess private valuations or reserve prices for all possible transactions, which can be queried through observing whether the participant would accept or reject a potential transaction at a particular price. Combining results from adversarial bandits and dynamic pricing, we propose a revenue-maximizing framework achieving sub-linear regret. Empirical studies based on synthetic and real-world data are presented that corroborate the effectiveness of our framework.

29 Diffusion Models For Mri Images Generation In Alzheimer's Disease

CHENXI YUAN; University of Pennsylvania, USA

Missing data is a significant challenge in medical research and clinical practice. To address the problem of missing MRI data in AD applications, we propose a Diffusion model-based longitudinal structural MRI Imputation framework (DLMI) that relies on conditional generation of a missing image at a single designated visit. Specifically, the DMRI model imputes the missing 3D MRI image by taking the past visit or both past and future visits as conditions during the image generation. We evaluate our method on the ADNI dataset. Experimental results show that our method can generate high-quality individual 3D structural MRI with high similarity to the missing visit's ground truth image.

30 Unpacking The Impact Of Imputation On Fairness

Parian Haghighat[1], Hadis Anahideh[2], Nazanin Nezami[3]; [1]University of Illinois at Chicago, USA, [2]University of Illinois Chicago, USA, [3]University Of Illinois- Chicago, USA

The education sector recognizes the power of predictive analytics to enhance student success rates. However, there are challenges to widespread adoption, including perpetuation of inequalities. Large-scale education data often have missing values, impacting representativeness and accuracy. This study assesses disparities in college-student success prediction, investigating the impact of imputation techniques on fairness. We conduct a prospective evaluation for less biased success estimation. Our analysis reveals that imputation introduces bias if testing follows historical distribution. Addressing societal injustice equalizes observations, and reduces bias.

31 An Empirical Analysis Of Polarization Game Over Social Networks

Xilin Zhang, Emrah Akyol, Zeynep Ertem; Binghamton University, USA

This paper quantitatively analyzes a game over a social network of agents, some of which are controlled by two players who maximize and minimize polarization over this network. Agents' opinions evolve according to the Friedkin-Johnsen model, and players can change only the innate opinion of an agent. The practically motivated constraint on the set of players' choice of agents to be disjoint transforms this simple zero-sum game into a compelling nonzero-sum game. We first analyze the functional properties of this game, and next we analyze the properties of the Nash equilibrium. The modified fictitious play algorithm obtained equilibria in synthetic and real networks.

32 Explanatory Data Analysis: Kpis, Data Visualization And Storytelling

Alan Ferrandiz; Core Analitica Inc., USA

Data analytics is the scientific process of discovering and communicating the meaningful patterns by turning raw data into insights for making better decisions. Most of the time, we focus on the discovery part, also called exploratory data analysis, but we usually forget the importance of effectively communicating these findings to an audience to help them make better decisions. This "last mile" of the data analytics connects data with business needs and is referred to as Explanatory Data Analysis and combines three skills: data, to turn raw data into KPIs, visualization, to visually represent data using dashboards and reports, and storytelling, to create an impact in the audience through stories.

33 Variable Selection For Kernel Two-sample Tests
Jie Wang[1], Santanu Dey[2], Yao Xie[1]; [1]Georgia Institute of Technology, USA, [2]ISyE Georgia Tech, USA
We consider the variable selection problem for two-sample tests, aiming to select the most informative features to best distinguish samples from two groups. We propose a kernel maximum mean discrepancy (MMD) framework to solve this problem and further derive its equivalent mixed-integer programming formulations for linear, quadratic, and Gaussian types of kernel functions. Our proposed framework admits advantages of both computational efficiency and nice statistical properties. Experimental results demonstrate good performance of our framework.

34 Dynamic Treatment Regime By Reinforcement Learning For Precision Public Health In Sequential Decision Environment
Jimi Kim; University of Texas at Dallas, USA
Precision public health initiatives can benefit from personalized intervention strategies based on individual characteristics. Dynamic Treatment Regimes (DTRs) are decision rules that adapt interventions over time based on an individual's response to the action. One of the challenges encountered in this setting is incomplete, observational data. To address this, we utilize Causal Identification inside of a Reinforcement Learning algorithm to estimate the DTR. We explore the potential of using DTRs by RL for precision public health initiatives at the state level in a sequential decision setting and demonstrate the effectiveness of our approach in improving healthcare policies.

35 Flat Minima Generalize For Low-rank Matrix Recovery
Lijun Ding[1], Dmitriy Drusvyatskiy[2], Maryam Fazel[2], Zaid Harchaoui[2]; [1]University of Washington and University of Wisconsin - Madison, USA, [2]University of Washington, USA
Empirical evidence suggests that for a variety of overparameterized nonlinear models, most notably in neural network training, the growth of the loss around a minimizer strongly impacts its performance. Flat minima -- those around which the loss grows slowly -- appear to generalize well. This work takes a step towards understanding this phenomenon by focusing on the simplest class of overparameterized nonlinear models: those arising in low-rank matrix recovery. In almost all cases, we show that flat minima, measured by the trace of the Hessian, exactly recover the ground truth under standard statistical assumptions.

36 Harnessing The Power Of Reinforcement Learning To Optimise Timetable Rescheduling
Xuewu Dai[1], Qi Zhang[2], Zhiming Yuan[3], Yisheng Lv[4]; [1]Northumbria University, United Kingdom, [2]CHINA ACADEMY OF RAILWAY SCIENCES, China, [3]China Academy of Railway Sciences, China, [4]Institute of Automation Chinese Academy of Science, China
Train Timetable Rescheduling (TTR) is a crucial task in the daily operation of high-speed railways (HSR) to maintain punctuality and efficiency in the presence of unexpected disturbances. However, it is challenging to promptly create a rescheduled timetable in real-time. This talk presents a reinforcement-learning method for real-time HSR rescheduling. The TTR problem is transformed into a multi-stage decision process,and a transferable generalised dispatching policy is learnt from a large amount of samples. Extensive experimental results demonstrate the effectiveness of the proposed method.

37 Toward Integrating Operation Research And Machine Learning- A Closed-loop Predict-and-optimize Framework And Its Application In Power Systems
Xianbang Chen; Stevens Institute of Technology, USA
In the widely-used open-loop predict-then-optimize process, machine learnings predict uncertainties, and then the operation research optimizes decisions. However, the prediction generally ignores its impact on the optimization. As a result, we present a closed-loop predict-and-optimize method that can improve the optimization performance by feeding the optimization back to the prediction.

38 **Poster**
Saiara Samira Sajid, Guiping Hu; Iowa State University, USA
Accurate yield prediction is essential in precision agriculture. Soil, weather, and management data can provide valuable information on crop yield. Technological advancement has paved the way to look beyond weather, soil, and management data and obtain genotype information of crop breeds. Including genotype information to predict phenotype has promising outcomes. However, genotype data had many features compared to the number of observations. Our research proposed a CNN-GRU structure to include genotype, weather, management, and soil data for higher yield prediction. The proposed model architecture uses GRU to extract the weather features, and 1D-CNN combines other features into DNN.

39 Efficient Frontier: Introducing A Novel Metric And An Active Learning Bayesian Framework For Cost-effective Multi-objective Manufacturing Optimization
Hamed Khosravi[1], Taofeeq Olajire[1], Ahmed Shoyeb

Raihan[2], Imtiaz Ahmed[2]; [1]WEST VIRGINIA UNIVERSITY, USA, [2]West Virginia University, USA
Optimizing the selection of data collection points is crucial in manufacturing experiments to minimize costs and time while obtaining a comprehensive understanding of the process. This paper introduces a novel data-driven Bayesian optimization framework for efficiently optimizing complex systems with multiple conflicting objectives. The method is evaluated on a real-world manufacturing dataset, showing its superiority in achieving similar manufacturing decisions with reduced costs and time.

40 Fairpilot: An Explorative System For Hyperparameter Tuning Through The Lens Of Fairness

Nazanin Nezami[1], Francesco Di Carlo[1], Hadis Anahideh[2], Abolfazl Asudeh[3]; [1]University Of Illinois Chicago, USA, [2]University of Illinois Chicago, USA, [3]University Of Illinois-Chicago, USA
Despite the potential benefits of machine learning (ML) in high-risk decision-making domains, the nondiscriminatory deployment of ML is not accessible to practitioners. To establish trust and acceptance, democratizing ML tools and fairness consideration are crucial. We introduce FairPilot, an interactive system designed to promote the responsible development of ML models by exploring a combination of various models, hyperparameters, and fairness definitions. FairPilot aims to address the challenge of selecting the "best" ML model by allowing users to select a set of evaluation criteria and then displays the Pareto frontier of models and hyperparameters as an interactive map.

41 Meta-learning In Games

Keegan Harris[1], Ioannis Anagnostides[1], Gabriele Farina[2], Mikhail Khodak[1], Steven Wu[1], Tuomas Sandholm[1]; [1]Carnegie Mellon University, USA, [2]Massachusetts Institute of Technology, USA
In classic game theory focus is on solving a single game in isolation, but strategic interactions often evolve dynamically, leading to many similar games to be solved. To address this, we introduce meta-learning for equilibrium finding, and establish meta-learning guarantees for a variety of games. We obtain convergence rates to equilibria that depend on natural notions of similarity between games encountered, while still recovering the single-game guarantees if the game sequence is arbitrary. We evaluate our algorithms on endgames faced by the poker AI Libratus against human professionals, and find that games with varying stack sizes can be solved significantly faster using our techniques.

42 Learning Predictions For Algorithms With Predictions

Mikhail Khodak[1], Maria-Florina Balcan[1], Ameet Talwalkar[1], Sergei Vassilvitskii[2]; [1]Carnegie Mellon University, USA, [2]Google, USA
A burgeoning paradigm in algorithm design is the field of algorithms with predictions, in which algorithms can take advantage of a possibly-imperfect prediction of some aspect of the problem. We introduce a general design approach for algorithms that learn predictors: (1) identify a functional dependence of the performance measure on the prediction quality and (2) apply techniques from online learning to learn predictors, tune robustness-consistency trade-offs, and bound the sample complexity. We demonstrate the effectiveness of our approach by improving or providing the first learning-theoretic guarantees for bipartite matching, ski-rental, page migration, and job scheduling.

43 An Adaptive Language Model For Chatbots With Reinforcement Learning

Jeremy Curuksu; Amazon, USA
Large language models used in ChatGPT and Alexa are limited by their ability to assess the validity of their own answers i.e., to fall back on a clarification prompt or an "*I don't know*" statement when appropriate. I applied reinforcement learning to optimize fallback selection and adapt to semantic pitfalls of a given LLM in a given interaction environment. In the current example, the agent fulfills intents in < 2 interactions on average in 99% of dialogues, by optimizing when best to ask for clarifications. In multi-agent simulations where the user cooperates, the agent fulfills intents in 1.3 interactions on average in 100% of dialogues.

44 A Multi-stage Feature Selection Model To Recognize Super-agers Using The Structural Brain Magnetic Imaging Resonance - A Uk Biobank Classification Study

Parvin Mohammadiarvejeh, Mohammad Fili, Guiping Hu, Auriel Willette; Iowa State University, USA
Cognitive aging is defined as the longitudinal decline in multiple cognitive processes. Although the decline in cognitive function is considered as a natural process as people get older, adults with preserving and improving cognitive abilities have been observed. In this study on the UK Biobank, we developed a multi-stage feature selection model to discriminate adults with improving versus declining cognitive function using longitudinal structural brain magnetic imaging resonance (sMRI) features. This study

found the most relevant and resilient brain areas in successful cognitive aging. These findings help adults to enhance cognition in their lifetime and mitigate Alzheimer's disease.

45 Online Pricing For Multi-user Multi-item Markets

Yigit Efe Erginbas, Thomas Courtade, Kannan Ramchandran; UC Berkeley, USA

Online pricing has been the focus of extensive research in recent years, particularly in the context of selling an item to sequentially arriving users. However, what if a provider wants to maximize revenue by selling multiple items to multiple users in each round? In this study, we tackle this challenge by designing online algorithms that can efficiently offer and price items while learning user valuations from accept/reject feedback. We focus on three user valuation models (fixed valuations, random experiences, and random valuations) and provide algorithms with nearly-optimal revenue regret guarantees.

46 Improving Classification Performance With Conjecturing System.

Fatemeh Valizadeh Gamchi, Paul Brooks; Virginia Commonwealth University, USA

This study explores a conjecturing system's effectiveness for classification tasks, generating conditions for desired properties. It generates new binary features based on discovered bounds among continuous features by incorporating bounds for each class. To test the approach, a microbiome dataset was used to identify body fluid type. Conjectures were included as predictors in a random forest model, resulting in improved prediction accuracy. Moreover, this system improves interpretability, making it a valuable tool in the classification field.

47 BAYESIAN RISK-AVERSE Q-LEARNING WITH STREAMING OBSERVATIONS

Yuhao Wang; georgia institute of technology, USA

We consider a robust reinforcement learning problem, where a learning agent learns from a simulated training environment. We adopt a formulation of Bayesian risk MDP (BRMDP) with infinite horizon, which uses Bayesian posterior to estimate the transition model and impose a risk functional to account for the model uncertainty. Observations from the real environment arrives periodically and are utilized by the agent to update the Bayesian posterior to reduce model uncertainty. We theoretically demonstrate that BRMDP balances the trade-off between robustness and conservativeness, and develop a multi-stage Bayesian risk-averse Q-learning algorithm with provable performance guarantees.

48 Transformer-based Reinforcement Learning Framework For Job Shop Scheduling Problem

Jaejin Lee[1], Seho Kee[2], Mani Janakiram[2], Mark A Wilkinson[2], George Runger[1]; [1]Arizona State University, USA, [2]Intel, USA

The job shop scheduling problem has a long history and continues to be actively studied due to its wide applicability in the manufacturing and production industry. In this context, we introduce a transformer-based reinforcement learning framework to solve job shop scheduling problems. Our proposed framework is designed to be problem size agnostic, enabling the trained model in less complex environment to solve instances of any complexity efficiently. Through our experiments, we demonstrate that the proposed model significantly outperforms existing dispatching rules on both synthetic instances and public benchmark instances, across a range of complexities.

49 Learning Ensembles Of Interpretable Simple Structure

Gaurav Arwade, Sigurdur Olafsson; Iowa State University, USA

Non-linear machine learning models achieve high performance but lack interpretability, while simple models for complex data may provide poor performance. However, many complex datasets have simple structures where a subset of data is more predictable; and using an ensemble of simple models can improve interpretability and accuracy. Healthcare datasets often have such structures, and interpretability is vital. This presentation defines simple structures and proposes a bottom-up algorithm for identifying them given certain assumptions. Using synthetic data, we demonstrate the algorithm's robustness and its ability to identify natural decision boundaries.

50 Neural Network Based Topic Modeling

Jeongjoon Hwang, Dohyun (Norman) Kim; Myongji University, Korea, Republic of

Topic modeling is a technique used to uncover latent thematic structures within a collection of documents, aiming to identify and extract underlying topics or themes present in the text data. Existing topic modeling methods have been successful in extracting the topics that exist within documents. However, they have the limitation of not being able to extract embedding vectors for the topics. To address this drawback, we propose a novel approach that utilizes neural networks to discover topics within documents and simultaneously extract embedding vectors for these topics. This advancement enables various additional analyses and in-depth exploration of document topics.

51 Clustering Autoregressive Weather Parameters For Validating A Winter Storm Planning System

Tianyu Xu, Jingyu Wang, Tianyuan Liu; Boston University, USA

This poster describes the validation process of a winter storm planning system developed for the MBTA in Boston. It predicts severities associated with ice formation, snow weight, road slickness, and other issues that need resources to address. The system is validated using an hour-by-hour simulation that requires inputs (i.e., historical weather parameters) that are interrelated within each day and autoregressive across hours. Two analytical steps are conducted. First, the statistical features within the historical daily weather data are explored to gain insights into the relationships. Second, a k-means clustering is employed to categorize each weather parameter across hours of a day.

52 How Consecutive ICT Policy Influences Economy In ICT Industry? : Empirical Study With Did Approach In K-unicorn Policy And Its Follow-up Projects

SeYeon Seo, JaeHong Park; Kyung Hee University, Korea, Republic of

The relationship between ICT policy and the ICT economy is a dynamic and on-going process. ICT policy influences economic growth continuously, not just once. Many policies have often sub-projects to support the original policy. However, previous studies have primarily examined the policy effect once and showed how such policy effect has lasted. So, we examine the effect of sub-projects implemented year after year to support an original policy, and how is the ICT economy changing as sub-projects have implemented with difference-in-difference methodology. So, this study contributes to the related literature by examining how the consecutive follow-up policy influences on economy continuously.

53 Adjustment Of Tourist Expenditure: The Role Of On-site Attribute-by-attribute Satisfaction On Tourists' Spending Behavior

GaHyun Jo[1], HoJung Yoon[2], JaeHong Park[1]; [1]Kyung Hee University, Korea, Republic of, [2]Sejong University, Korea, Republic of

Every country has its unique touristic activities (e.g., K-POP in Korea). Depending on tourists' level of satisfaction with activities, they tend to adjust expenditure for each activity. We examine the influence of attribute satisfaction at the destination level on tourist activity expenditure. Using the multiple discrete-continuous extreme value model, we investigate the own- and cross-satisfaction effects on the adjustment of tourist expenditure. We find the positive own-satisfaction effects on expenditure while an asymmetry cross-satisfaction effects on expenditure. This study is distinct from the literature by examining the relations among touristic activities with the MDCEV model.

54 Evaluation Of Rehabilitation Exercise Of Disabled People Based On Machine Learning With Joint Angle Data

Chaeyun Yeo[1], Yongwon Jo[2], Jinhyeok Park[2], Sihu Ahn[2], Sangmin Kim[2], Jungin Kim[2], Sangmin Lee[3], Min-Goo Lee[4], Younghoon Kim[5]; [1]Department of Artificial Intelligence, Kyung Hee University, Korea, Republic of, [2]Department of Industrial and Management Engineering, Korea University, Korea, Republic of, [3]College of Software and Convergence, Kangwoon University, Korea, Republic of, [4]School of Physiology, College of Medicine, Korea University, Korea, Republic of, [5]Department of Industrial and Management Systems Engineering, Kyung Hee University, Korea, Republic of

This study evaluates the physical abilities of individuals with disabilities by analyzing joint angle data obtained from upper limb exercise through a skeleton-based human pose estimation method. Seven machine learning models, including SVM, Random Forest, XGBoost, LGBM, and Catboost, were trained to assess movement performance. The performance of the models was interpreted using SHAP, and the results indicated that LGBM achieved the highest performance. The joint angle data analysis conducted in this study will provide indicators of rehabilitation exercise performance for individuals with disabilities, aiding in the development of effective rehabilitation exercise programs.

55 Multi-branching Temporal Convolutional Network With Tensor Data Completion For Diabetic Retinopathy Prediction

Zekai Wang[1], Suhao Chen[2], Tieming Liu[3], Bing Yao[4]; [1]The University of Tennessee. Knoxville, USA, [2]South Dakota School of Mines and Technology, USA, [3]Oklahoma State University, USA, [4]The University of Tennessee Knoxville, USA

Diabetic retinopathy (DR) is the leading cause of vision loss among working-aged adults. Due to the low compliance rate of DR screening and expensive medical devices for ophthalmic exams, many DR patients fail to seek medical attention until DR develops to irreversible stages. The systematically collected electronic health record (EHR) data provide a great opportunity to develop inexpensive tools for DR detection. This paper proposes a Multi-branching Temporal Convolutional Network with Tensor

Data Completion (MB-TCN-TC) to model the multivariate longitudinal EHRs for DR prediction. Experimental results show that MB-TCN-TC outperforms existing methods.

56 Anomaly Detection In Rotating Machinery:Enhancing The Performance Of The Anomaly Transformer And Robustness To Noise.

Gyucheol Lee[1], Younghoon Kim[2]; [1]Department of Artificial Intelligence, Kyung Hee University, Korea, Republic of, [2]Department Industrial and Management System Engineering, Kyung Hee University, Korea, Republic of

In this study, we conducted an analysis of anomaly detection using rotating machine data. We compared four models, including the Anomaly Transformer for time-series anomaly detection. Our results demonstrate that the Anomaly Transformer exhibited the best performance among the tested models. Furthermore, we proposed a noise-robustness enhancing method for real-world industrial scenarios, addressing challenges in noisy environments commonly encountered in the industry. These findings have significant implications, particularly for the accurate detection and diagnosis of rotating machinery abnormalities in industrial settings.

57 Risk Aversion In A Data-driven Multi-period Inventory Control Problem

Xianghua Jiang; National University of Singapore, Singapore

We study the multi-period risk-averse inventory control problem in a data-driven setting. We adopt the popular nested formulation for risk-averse programs to formulate this multi-period problem and its data-driven counterpart under a coherent risk measure. Our objective is to study the sample complexity bound such that with high probability the data-driven policy is near-optimal, i.e., the relative error of the risk under the data-driven policy compared to the optimal risk is arbitrarily small.

. In this study, we develop a zero-order framework for establishing the complexity bound on the sample sizes to guarantee near-optimality of the data-driven policy with given accuracy levels.

58 Language Models For Parsing Clinical Text In Traumatic Brain Injury

Hayley Falk; University of Michigan, USA

In TBI, brain CT radiology reports contain detailed information regarding injury acuity and severity, which is critically important for clinical decision-making and prognostication. However, most of this information is inaccessible because it is not captured in structured data fields in the electronic health record, thereby necessitating manual extraction through chart review. Chart review requires domain expertise, extensive resources, is error-prone, and difficult to scale. Therefore, we leverage domain-adaptive pretraining to develop a specialized clinical language model to detect the presence of acute traumatic intracranial injury from free-text radiology reports.

59 Higher-order Gradient Play Vs. Nash Equilibrium

Sarah Toonsi, Jeff Shamma; University of Illinois Urbana-Champaign, USA

Learning in games explores how Nash equilibrium (NE) sometimes can be attained through an interactive learning process where players adapt their strategies in response to the evolving strategies of other players. We study higher-order uncoupled learning dynamics in games through higher-order gradient play dynamics. We show that for any game with an isolated mixed-strategy NE, there exist higher-order gradient play dynamics that lead (locally) to that NE. Conversely, we show that for any higher-order gradient play dynamics, there exists a game for which the dynamics do not lead to NE. Finally, we show that some certain mixed-strategy NE necessitate using inherently unstable learning dynamics.

60 Consistent Exploration-exploitation Trade-off In Active Learning Regression With Dirichlet Process Prior

Upala Junaida Islam; Arizona State University, USA

Approaches of active learning usually focus on either exploration or exploitation or use ad-hoc measures to control their trade-off in the design space that may not be optimal. We develop a Bayesian hierarchical approach with Dirichlet process prior to dynamically balance the trade-off as more data are queried. We subsequently formulate an approximate Bayesian computation approach based on the linear dependence of data samples in the feature space to sample from the posterior distribution of the trade-off parameter obtained from the model. Our approach performs better or at least as well as either pure exploration or pure exploitation, and achieves posterior consistency as well.

61 Roadway Safety Models: Before, During And After Covid-19

Ennis Marshall, Ali Shirazi; University of Maine, USA

We conducted an extensive critical review of traffic safety research and the models proposed following the COVID-19 pandemic. We used probe data from freeways in Maine to develop models on the change in roadway speeding following the stay-at-home orders of the pandemic. We then go on to investigate how the odds of crashes were affected in the state of Maine using random effect logistic regression models. The odds of speeding increased in Maine following the onset of the pandemic and continued after that. Data also shows shifts in distribution of speed (especially the average speed). In Maine, we found a strong relationship between the coefficient of variation of speed and crash occurrence.

62 Evaluating The Negative Binomial- Lindley Model For Crash Hotspot Identification

Jhan Gil-Marin, Ali Shirazi; University of Maine, USA

The Negative Binomial (NB) model is the most common model used in safety analyses and evaluations - including hotspot identification. Recently, the Negative Binomial-Lindley (NB-L) model has been proposed as an alternative to the NB. The NB-L model overcomes several limitations of the NB, such as addressing excess zero observations. However, it is not clear how the NB-L model compares with the NB regarding the hotspot identification. This research designs a Monte Carlo simulation protocol to generate a wide range of simulated data characterized by different mean, dispersion, and percentage of zeros. Then, the Full-Bayes NB, and NB-L models were compared for hotspot identification.

63 Evaluating The Performance Of Rumble Strip Installations Using An Empirical Bayes Approach

Jhan Gil-Marin, Ali Shirazi; University of Maine, USA

This research analyzes the effectiveness of rumble strip installations in prevention of roadway lane departure crashes in Maine, U.S. using the Empirical Bayes (EB) approach. The predicted number of lane departure crashes, in the short term, is computed using the regression analysis of count data (with a negative binomial model). Then, the estimated long-term mean of crash is computed using the EB approach, considering the information from the predicted and observed crash data. The results show the effectiveness of rumble strip installations in prevention of crashes.

64 Precipitation Prediction Based On Historical Data Using The K- Nearest Neighbor Method

Sean Guidry Stanteen; University of Texas Arlington, USA

Weather, particularly precipitation, is an environmental condition on which agriculture is wholly dependent. As such, prediction on precipitation and other weather factors is essential to proper management of farming. A non-parametric machine learning method, k-Nearest Neighbor (kNN), is utilized to match historical patterns for short term prediction, and preliminary data testing shows the validity of the methodology. This work is in collaboration with Dr. Xunchang John Zhang, USDA-ARS Grazinglands Research Laboratory, El Reno, Oklahoma.

65 Using Machine Learning To Identify The Initial Planting Date Of Crops

Angela Avila; University of Texas at Arlington, USA

This study focuses on training a neural network to accurately predict the planting date of any given field by leveraging time series leaf area index (LAI) data. Specifically, we utilize LAI data collected in Bushland, TX over a span of 35 years as the basis for our model. Through a third-degree polynomial regression, the LAI time series growth of different crops is fitted, and the resulting coefficients are utilized to train a neural network, enabling estimation of the field's initial planting date. To enhance the effectiveness of the neural network training, our dataset is augmented by creating various third-degree polynomials that mimic the LAI growth patterns of crops.

66 Early Detection Of Healthcare Misinformation: A Novel Transfer Learning Method

Minjia Mao[1], Xiao Fang[1], Xiaohang Zhao[2]; [1]University of Delaware, USA, [2]Shanghai University of Finance and Economics, China

The growth of the internet greatly fuels the spread of misinformation, particularly healthcare misinformation. During the COVID-19 infodemic, the wide dissemination of misinformation about COVID-19 has caused social panic and undermined pandemic response efforts. Existing machine learning-based methods for detecting misinformation require labelled instances. However, there is a scarcity of labeled healthcare information in the early stages of its dissemination due to limited manpower and expertise. In response to this challenge, we propose a novel transfer learning method for early detection of healthcare misinformation by leveraging labelled information from other domains.

67 Bankruptcy Prediction During COVID-19 Outbreak Based On M5P Model Tree

Aqsa Bilal Hussain, Jingchun Sun; Xian Jiaotong University, China, China

The COVID-19 outbreak incapacitated the world and divulged the critical concern of financial risk management. Although there exist numerous research contributions in the financial risk forecasting domain, bankruptcy prediction, in particular, is a remarkable problem to explore for its importance in modern economics. Many works have proposed various methods for predicting financial distress; however, the implementation complexity for the bankruptcy predictions with conventional classification techniques is a major drawback. This paper uses the M5P tree algorithm and decision tree classifier to create a stable model for bankruptcy prediction, transforming it into simple if-then instructions. Tested on firms during the pandemic, the framework achieves over 99% accuracy in forecasting bankruptcies.

68 Machine Learning Enabled Model To Predict Parental Depression Symptoms At Neonatal Intensive Care Units

Fatima Sadjadpour; Virginia Tech, USA

Ten percent of babies born in the United States are admitted to the Neonatal Intensive Care Unit (NICU), which is a stressful experience for parents and makes them twice more at risk of depression. Our objective is to develop a machine learning model to identify parents who are more likely to have depression. Data is from parents of infants admitted to the NICU at Children's National Hospital from 2016 to 2017. Our study uses eight machine learning algorithms to identify the main risk factors of parental depressive symptoms. Risk factors highly associated with parental depression could be targeted for personalized interventions for a more productive screening system in healthcare.

69 A Framework For Selecting Technology For Operational Efficiencies In Crop Cultivation

University Washington, Masha Shunko; University of Washington, USA

We study precision agriculture technologies and their use cases in farm settings. We present a value stream map of crop cultivation cycle to identify the operational decisions that a farmer makes.

70 Spatio-temporal Point Processes With Deep Non-stationary Kernels

Zheng Dong; Georgia Institute of Technology, USA

Point process data has become ubiquitous in modern applications. Recurrent neural networks, while expressive, struggle to capture complex non-stationary dependencies among data. Another type of deep point process adopts neural networks to represent influence kernels. In this study, we take the latter approach and introduce a novel deep non-stationary influence kernel for spatio-temporal point processes. Efficient representation is achieved through low-rank decomposition, while a log-barrier penalty maintains the non-negativity constraint of the conditional intensity. The superior performance of our method is demonstrated on simulated and real data.

71 Machine Learning In Practice: Applications Of The Yolo Model

Dennis Cui[1], Ian Zhang[2], Carol Song[3], Wen Xie[4]; [1]Wayzata High School, USA, [2]Duke University, USA, [3]The Harker School, USA, [4]University of Texas Houston, USA

The recent developments in machine learning and AI have brought significant impacts and challenges for academia and practitioners. The research focuses on how an object detection model You-Only-Look-Once (YOLO) can be utilized to extract the locations of objects for applications in various fields, such as in marketing and security.

72 Gaussian Process Regression For Ragged Data Structure With Application In Mental Health

Youssef Hebaish, Sohom Chatterjee, Lewis Ntaimo, Hrayer Aprahamian; Texas A&M University, USA

We propose an approach for handling ragged data structures by partitioning the original dataset into subsets based on the inconsistent feature. This allows us to construct individual models for each subset. Performance evaluation is carried out using k-fold validation. We consider a mental health application, where Gaussian Process Regression is leveraged to enhance treatment outcome prediction. This framework empowers counselors to determine optimal treatment plans, facilitating evidence-based decision-making and personalized interventions.

73 Is All Well With Your Models?: Strategies To Deal With Concept Drifts

SeongHyun Seo, Dong-Joon Lim; Sungkyunkwan University, Korea, Republic of

This poster presents a concept drift detection method that can give an insight into the situation when the performance of the model deteriorates due to concept drift, auto-modeling may not be carried out effectively. We adopt feature selection and various model update strategies into the baseline algorithm, which is a conventional AL Framework, to detect the concept drift effectively and efficiently. These advanced strategies could successfully detect concept drift in real-world scenarios, and ensure consistent performance, and reliable predictions in dynamic environments.

74 FORECASTING VESSEL TRAFFIC AT THE PORT OF AMSTERDAM

Amina Benhassine, Rohan Alexander, Shobhit K. Yadav, Adriele Pradi, Elenna Dugundji, Thomas Koch; Massachusetts Institute of Technology, USA

Accurate vessel traffic forecasting is a critical factor in achieving smooth towage operations, and thus improving service delivery in ports. This study focuses on forecasting vessel traffic in the Port of Amsterdam on a daily basis. Our results were obtained using an XGBoost model with time series features and exogenous variables, resulting in a 87% accuracy.

75 Enhancing 7 Hospitals' Operations: Ai Decision Support Tool In Action

Kimberly Villalobos Carballo[1], Liangyuan Na[2], Dimitris Bertsimas[1]; [1]Massachusetts Institute of Technology, USA, [2]Massachusetts Institute of Technolgy-Operations Research Ctr, USA

In collaboration with Hartford HealthCare, we develop machine learning models predicting inpatient outcomes, i.e., 24hr/48hr discharge, ICU transfers, mortality and discharge dispositions (AUC 76%-93%). These predictions enable more discharges (10%-29%) and fewer 7/30-day readmissions (p-value <1e-3). We implement an automated pipeline displaying daily predictions with user-friendly software. Over 200 medical staff currently use our tool, resulting in a significant reduction in patient-average length of stay (0.67 days) and projected annual benefits of $55-$72 million for the system.

76 Calibrating Physics-based Process-structure-property Models In Metal Additive Manufacturing

Jiahui Ye[1], John S. Coleman[2], Gerald L. Knapp[2], Matthew R. Rolchigo[2], Alex J. Plotkowski[2], Alaa Elwany[1]; [1]Texas A&M University, USA, [2]Oak Ridge National Laboratory, USA

Uncertainty Quantification (UQ) of physics-based process-structure-properties (P-S-P) linkages can aid the qualification and certification (Q&C) of parts made via metal additive manufacturing (AM). The state-of-the-art facilities at Oak Ridge National Laboratory (ORNL) are leveraged to create a digital twin of powder-based metal AM builds. In this study, we aim to reduce the influence of various input uncertainties on outputs using a Bayesian network to calibrate multi-level surrogates against experimental data. This research was sponsored by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Advanced Materials and Manufacturing Technology Office.

77 Consumer Behavior In Boosted Stream Of Livestream

Jingyun Hu; Clemson University, USA

High visibility in livestream is crucial and influencers and brands can enhance their visibility by purchasing increased stream exposure through the platform, this tactic may not always guarantee higher sales. On the one hand, high visibility is associated with increased exposure, as platforms like Douyin actively promote the livestream to a more extensive audience. On the other hand, several factors may prevent high stream visibility from translating to high sales, including poor performance by influencers or suboptimal timing for promotion. Or consumer may become annoyed with the platform for frequently pushing the same livestream. This paper is to investigate this problem.

78 Learning From Unfolding Dynamics: Forecast-driven Adaptive Scheduling In Multi-service Non-stationary Queues

Sohom Chatterjee, Youssef Hebaish, Hrayer Aprahamian, Lewis Ntaimo; Texas A&M University, USA

We consider the problem of scheduling scarce resources in multi-service queues with time-varying demand. As arrivals unfold, future estimates may shift, necessitating a schedule update. By combining optimization techniques with a novel forecasting method that learns from evolving dynamics, we construct adaptive policies. The auto-regressive model can handle limited data, and features period-wise trends and lags, calibrated via a sub-optimization problem. This is complemented by a tractable reformulation scheme to reduce wait times. The case study, conducted on Texas A&M's counseling center, shows the benefits of our approach in enhancing access to vital mental health services.

79 When Foot Prohibition, Do Investors Listen? The Role Of Pandemics Shock In Stock Market Reactions To Capital Efficiency Market

kungCheng ho; Guangdong university of finance and economics, China

This study examines the impact of crises caused by modern health pandemics on price efficiency, proxied by measures of stock price delay. We analyze 381,688 firm-year observations across 39 countries during six recent pandemic crises: SARS (2003), H1N1 (2009), MERS (2012), Ebola (2014), Zika (2016), and COVID-19 (2020). We find that pandemics have a significant positive effect on price efficiency. The results are robust for different analyses. In addition, these findings support regulator confidence, confirming that sound regulations and maintaining national stability effectively enhance the impact of price efficiency on the capital market.

80 Machine Learning Modeling For All-types Hospital-acquired Conditions For Elderly Adults With Multiple Chronic Conditions In Texas

Ajit Appari[1,2]; [1]Boston University, USA, [2]Northeastern University, USA

Prior research often focused on building machine learning models for specific Hospital-acquired condition (HAC) among elderly population with specific anchor chronic disease. My study develops composite risk prediction model for all-type HACs among working age adults with multiple chronic conditions (MCC) using all payer administrative data on 1,108,349 hospitalizations (age: 65-90+yrs) during 2015Q4-2016Q4 across 627 hospitals in Texas. I developed Poisson regression model (with random effects) for HACs count with predictors including MCC patterns {extracted using Bernoulli Mixture model clustering}, patient, hospital, & physician factors adjusting for admission type & time factors

81 Sustainable Traffic Signal Control Model Based On Reinforcement Learning Considering The Ratio Of EVs On The Road

Woong Kang, Gwang-jong Ko, Taesu Cheong; Korea University, Korea, Republic of

With the deepening of climate change, sustainability has become a major topic, leading to an increase in the promotion of Electric Vehicles (EVs) along with policy incentives. We propose a new reinforcement learning-based sustainable traffic signal control model for the Intelligent Transportation System (ITS) considering EVs. Through a comparison with existing traffic signal control models, our model demonstrates superior performance in terms of CO_2 emissions and total waiting time. Furthermore, by comparing the results of signal control with varying EV ratios, we evaluate the influence of EV integration on the reduction of CO_2 emissions and total waiting time in an automated signaling system.

82 Machine Learning-based Metamaterial Structure Generation For Shoe Sole

Ziyang Zhang, Chenang Liu; Oklahoma State University, USA

This research innovatively combines machine learning and metamaterials to design shoe soles based on foot pressure distribution. Customizable metamaterials are integrated with algorithms to tailor better suppport on foot. Prototypes demonstrate improved pressure distribution and comfort compared to conventional soles. The study paves the way for advanced, adaptive footwear.

83 In-app Ads Or Cross-brand Marketing? The Marketing Strategy Of On-demand Platform With Media Service Platform

Xinyue Tan[1], Mingyang Chen[2], Daozhi Zhao[1]; [1]Tianjin Univiersity, China, [2]Henan Univiersity, China

This paper studies the cross-brand cooperation between on-demand platforms and media service platform. We consider the characteristics of the network effect existing at both the on-demand platform's supply and demand and the self-scheduling behavior of on-demand service providers. We examine a game-theoretic structure including the on-demand market (service provider, on-demand platform, and consumer) and the media service market (media platform, and consumer) and construct two models (in-app advertising and cross-brand cooperation) to study the decision-making optimization of platforms and the model-selecting optimization of the on-demand platform.

84 Market Design For The Berth Allocation Problem With Just-in-time Arrivals And Transshipments

Roger Lloret-Batlle; NISCI, China

Berths are a scarce and expensive resource. In case of schedule disruptions, common berth priority rules which do not account vessels' preferences are used. This is economically inefficient and makes the operation of ports less competitive. We present the first mechanism for a secondary market for the Berth Allocation Problem in case of schedule disruptions. Vessels are charged the externality they create to other vessels and the terminal. The mechanism is incentive compatible, individually rational and financially self-sufficient under certain conditions.

85 Diffusion-based Generative Models in Augmenting Additive Manufacturing Layer-wise Images

Emmanuel Yangue; Oklahoma State University, USA

Despite the rapid adoption of deep learning models to additive manufacturing, quality assurance issues continue to be addressed for this technology, with the limited availability of sampling objects for advanced studies. Thus, this study leverages the powerful diffusion generative model, notably the denoising diffusion implicit models (DDIM), for layer-wise generation in FFF AM. The proposed model demonstrates great potential for similarity image synthesis generation addressing sampling issues while maintaining diversity to explore possible new pattern variations. The generated images are improved and evaluated using a two customized kernel inception distance metrics: mKID and KIDIS.

86 System-level Electricity Sector Impacts Of Direct Air Capture Deployment

Aniruddh Mohan, Fangwei Cheng, Chris Greig, Eric Larson, Jesse D. Jenkins; Princeton University, USA

Direct Air Capture (DAC) of CO_2 is energy intensive given the low concentration of CO_2 in ambient air, but offers relatively strong verification of removals and limited land constraints to scale. Here, we use the GenX capacity expansion model to study how deployment of DAC impacts achieving a least cost net-zero CO_2 emissions electricity system. We model a suite of DAC approaches, covering geothermal and natural gas heat based DAC to a fully electric process. We find that even at levelized costs of capture as high as \$1000/tCO_2, DAC at million ton CO_2 removal scale lowers costs compared to a scenario without DAC where grid decarbonization must rely fully on a large buildout of renewables and nuclear energy.

87 A Simulation Based Study For Assessing The Performance Of Production Floor

Shahriar Tanvir Alam[1], Moddassir Khan Nayeem[2], Omar Abbaas[2]; [1]University of Southern California, USA, [2]University of Texas at San Antonio, USA

The performance for "*Single Server Finite Queue Length Infinite Queue Population Model*" is most desirable where the raw materials have to wait for less time in the queue (approximately 55.65%) and reduces the queue length by approximately 57.68%. Based on the findings of the queue performance, an ARENA-based simulation has been illustrated to visualize the productivity of the production floor considering the impact of the raw materials queue. The simulation result shows that the implementation of the finding from the assessment of the queue performance increases the output by 2.4 times compared to the present condition.

88 Impact Of Lane Changing Prediction On Connected Vehicle's Energy Efficiency: A Study On Speed Control

Maziar Zamanpour[1], Michael Levin[2], Zongxuan Sun[2]; [1]University of Minnesota, College of Science and Engineering, USA, [2]University of Minnesota, USA

Optimal speed control in connected autonomous vehicles (CAVs) can provide energy benefits. However, it is likely to increase the gap in front of the controlled CAV, which induces lane changing. This study proposes a modified traffic flow model that predicts lane changing occurrence to enhance the control. The model is derived considering the additional flow during lane changing. An optimal control strategy is then developed, subject to the predicted trajectory. Lane change prediction estimates future speed and gap of vehicles, based on predicted traffic states. The proposed model outperforms standard traffic models, resulting in up to 20% energy savings for prediction 3-5 seconds in advance.

89 Efficiently Charging Fleets of E-bikes and E-scooters

Alyf Janmohamed, Shane Henderson, David B. Shmoys; Cornell University, USA

Shared e-bike and e-scooter systems have grown rapidly raising new challenges around charging. We quantify the efficiency of different charging mechanisms used in real-world systems (e.g. employees swapping batteries, charging stations, crowd-sourced).We model a dockless e-bike sharing system as a closed queueing network. A city is divided into non-overlapping regions, each having 2 queues: charged and uncharged bikes. We formulate and solve a pricing problem to set static prices for trips between regions and provide performance guarantees. We also show the queueing network can be reduced to a 1D open queue. A case study on Minneapolis illustrates the tradeoffs between charging mechanisms.

90 Addressing The Patenting Process Bottlenecks With Blockchain Technology

Afrooz Moatari-Kazerouni; Widener University, USA

The pace of global innovation is ever increasing, with over one million patents granted worldwide every year. Yet the ability to capture a true measurable competitive advantage from the significant investment in patents remains elusive. The purpose of this research is to demonstrate how blockchain technology may help with patent authentication and management. To explore the process of the existing system and its shortcomings, a comprehensive literature review is conducted, and the patenting process is mapped. To overcome the highlighted barriers and limitations, a novel architecture design of the blockchain-enable patenting system is proposed.

91 Credit Based Congestion Pricing: Equilibrium Properties And Optimal Scheme Design

Devansh Jalota; Stanford University, USA

Credit-based congestion pricing (CBCP) has emerged as a mechanism to alleviate the inequity concerns of road congestion pricing - a promising strategy for congestion mitigation - by providing low-income users with credits to offset some of their toll payments. While CBCP offers potential for addressing inequity issues that hamper the viability of congestion pricing, the deployment of CBCP in practice is nascent, and the potential efficacy and optimal design of CBCP schemes have yet to be formalized. To this end, we study the design of CBCP schemes to achieve certain societal objectives and investigate their influence on traffic patterns when routing users in a multi-lane highway with an express lane.

92 Long-distance Electric Vehicle Paths: Online And Offline Path Planning

Ridvan Aksu, Mesut Yavuz; University of Alabama, USA

Electric Vehicle (EV) popularity and market share are rising thanks to their sustainable nature and increase in their efficiency. Yet, long charging times, limited infrastructure, and limited driving autonomy remains as obstacles for a commercial widespread adaptation of EVs. We investigate several heuristic, and math-heuristic methods to generate offline path planning methods and an online recourse procedure to decrease the associated costs, given the non-linear discrete multi-stage stochastic nature of the problem. We achieve significant cost savings when we perform a proactive path planning that anticipates online recourse due to the stochastic nature of the problem.

93 Food Brought By A Robot: How Serving Robot Affects Perceived Naturalness Of Food

Kengo Hayamizu, Yuki Haga, Rina Saito, Naoto Onzo; Waseda university, Japan
Extant research has revealed that serving robots at a restaurant have an impact on service and food quality evaluations by consumers. However, none of the studies have considered the impact of serving robots on perceived naturalness of food. Thus, we conducted online experiments of consumers by showing a picture of an actual serving robot. Two studies demonstrated that the serving robot (vs. human staff) decreases consumers' perceived naturalness of food, which results in the decreased food evaluation. This finding gives practical insights about the way to introduce serving robots in the restaurant business.

94 To Be Completed
Mehdi Behroozi; Northeastern University, USA
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95 Rider Scheduling In Last-mile Delivery: Incorporating The Fluctuating Demand And Show-up Rate Dynamics
Moon Yuin, Dong Gu Choi; Pohang University of Science and Technology (POSTECH), Korea, Republic of
Last-mile delivery businesses face challenges in managing rider scheduling due to the fluctuating demand patterns and uncertainties in surrounding rider show-up rates, which differ from traditional employee scheduling problems. This study considers the rider scheduling problem through a two-stage mixed-integer stochastic programming, incorporating the above challenges and demand fluctuations.

96 Efficient Cloud Server Deployment Under Demand Uncertainty
Konstantina Mellou[1], Xiao-Yue Gong[2], Rui Peng Liu[3], Beibin Li[1], Thomas Coffee[3], Jeevan Pathuri[4], David Simchi-Levi[2], Ishai Menache[1]; [1]Microsoft Research, USA, [2]Massachusetts Institute of Technology, USA, [3]Amazon, USA, [4]Microsoft, USA
A main challenge faced by cloud providers is to ensure that they can accommodate the growing demand for compute resources. Towards that goal, providers need to deploy cloud servers agilely for uncertain future demand under many practical business constraints, without incurring unnecessarily large operational costs. In this work, we introduce the cloud server deployment problem, formulate it as a two-stage stochastic program and develop exact algorithms to efficiently obtain an optimal solution. We test our algorithms with real production traces from Microsoft Azure and demonstrate their effectiveness in cost reductions.

97 Dual Dynamic Programming For Stochastic Programs Over An Infinite Horizon
Caleb Ju[1], Guanghui Lan[2]; [1]Georgia Insitute of Technology, USA, [2]Georgia Institute of Technology, USA
We consider a dual dynamic programming algorithm for solving stochastic programs over an infinite horizon. We show non-asymptotic convergence results when using an explorative strategy, and we then enhance this result by reducing the dependence of the effective planning horizon from quadratic to linear. We then apply our algorithms to a class of problems called hierarchical stationary stochastic programs, which can model problems with a hierarchy of decision-making. We show that when the subproblems are solved inexactly via a dynamic stochastic approximation-type method, the resulting hierarchical dual dynamic programming can find approximately optimal solutions in finite time.

Sunday, October 15, 12:45 PM - 2:00 PM

SC88B

CC-North Exhibit Hall
MIF Student Poster Session 2023
Poster Session
Session Chair: Shannon Harris, Virginia Commonwealth University, Richmond, VA

1 Ventilation Considerations in Medium- and Short-Term Underground Mine Planning
John Ayaburi; Colorado School of Mines, USA
Underground mines may face schedule disruptions due to the accumulation of heat. Ventilation systems serve as the primary source of fresh air. We develop an integer program to determine the airspeed within a ventilation system that maximizes mine productivity in the medium term, accounting for equipment heat output. We correspondingly provide a mixed-integer quadratically constrained program that

minimizes schedule deviation between medium- and short-term plans and determines the distribution of air across operating mine levels.

2 Fast Mulitilevel Neural Networks to Overcome Bias in Healthcare Applications

Rachel Bennett[1], Talayeh Razzaghi[2]; [1]University of Oklahoma, USA, [2]University of Oklahoma, School of Industrial and Systems Eng, USA

Healthcare datasets often suffer from both class and racial imbalance, which leads to underperforming machine learning models for the underrepresented groups. To overcome the bias, we perform graph coarsening to reduce the size of the data, train a neural network on the resulting balanced dataset, and gradually refine the model using "flip points" that estimate and modify the decision boundary of the trained network.

3 Analysis of Search Time for Target Search Applications Under Different Behavior Policies

Carlos Hurtado; University of Pittsburgh, USA

In search theory, we want to find an object considering: kinematics, detection devices, and optimization of the search. Our goal is to minimize the time to find a hidden object with a static but unknown location. Using sequential decision-making, the agent has to make a trade-off between exhaustive searches(exploration) and efficient searches (exploitation). We provide upper bounds in the expected time for pure exploration, pure exploitation, and multi-armed bandit.

4 Deploying a Robust Active Preference Elicitation Algorithm: Experiment Design, Interface, and Evaluation for Covid-19 Patient Prioritization

Caroline Johnston[1], Patrick Vossler[2], Simon Blessenohl[1], Phebe Vayanos[1]; [1]University of Southern California, USA, [2]Stanford University, USA

Preference elicitation uses AI or optimization to learn stakeholder preferences. The online robust preference elicitation method of Vayanos et al. (2020) outperforms other methods in simulation in terms of learning individuals' true utility. However, it makes multiple assumptions that are hard to verify in reality. We validate the method's performance in deployment using policies for prioritizing COVID-19 patients for scarce resources. We build a platform for preference elicitation and recruit MTurk workers (n = 193) to give preferences via a small number of pairwise comparisons. We show that the robust method recommends a policy with higher utility for 21% more users compared to random queries.

5 The Blockchain Newsvendor: Value of Freshness Transparency and Smart Contracts

N. Bora Keskin, Chenghuai Li, Jing-Sheng (Jeannette) Song; Duke University, USA

Motivated by blockchain applications in the fresh produce industry, we consider a problem in which a retailer faces stochastic and freshness-dependent consumer demand. The retailer can adopt blockchain technology to have more transparency on the freshness of supply. We quantify the value of blockchain-enabled freshness transparency by analyzing the retailer's expected profit growth and food waste reduction brought by adoption. Despite this substantial value for the retailer, blockchain adoption can decrease the supplier's expected profit. Hence, we design a family of smart contracts contingent on a blockchain-based freshness consensus and examine the contracts' win-win propositions.

6 Nonprogressive Diffusion on Social Networks: Approximation and Applications

yunduan Lin[1], Heng Zhang[2], Renyu Zhang[3], Zuo-Jun Max Shen[4]; [1]University of California, Berkeley, USA, [2]Arizona State University, USA, [3]The Chinese University of Hong Kong, China, [4]University of California Berkeley, USA

Our paper proposes a model and a fixed-point approximation (FPA) scheme for characterizing adoption limits in nonprogressive diffusion on social networks. The scheme offers both theoretical guarantee and computational efficiency, with maximal deviation decreasing asnetwork size and density increase, making it suitable for dense networks. It can be applied to applications such as influence maximization and pricing problems. Numerical studiesdemonstrate 1,000 times faster computation time and small approximation error.

7 Quasi-Experimental Designs for Learning Health Systems

Valerie Odeh-Couvertier, Gabriel Zayas-Caban, Amy Cochran, Brian Patterson, Kenneth Nieser; University of Wisconsin-Madison, USA

Learning systems use data to improve operations, with risk prediction algorithms playing a key role in deriving knowledge from data. While these algorithms identify individuals or processes that may benefit from interventions, measuring their impact remains a challenge. We develop a causal inference framework, with specific application to learning health systems, for estimating the average causal effect of intervening according to these continually assessed and updating risk prediction algorithms.

8 Modeling Heavy Machinery in an Underground Mine to Optimize Ventilation

Aaron Swift; Colorado School of Mines, USA

An underground mine ventilation system provides fresh ambient air, and dilutes dust and gases produced by equipment and blasting activity. It is also is one of the largest ongoing costs of an underground mining operation. We investigate impacts from the operation of an electric equipment fleet in order to determine optimal airflow.

9 Predicting Roll Force at a Continuous Casting Steel Mill

Edikan Udofia; Colorado School of MInes, USA

We develop regression model to improve prediction of roll forces in a large, hot-roll steel mill at industrial scale. Based on real-world plant data, we derive information from a constitutive physical model and include variable transformations, variable selection and model comparisons. We show how our model can help inform mill best practice in their scheduling operations.

10 Pharmaceutical Supply Chain Design Under Geopolitical Strain: A Stochastic Programming Approach

Martha L. Sabogal De La Pava, Emily L. Tucker; Clemson University, USA

Pharmaceutical supply chains are global. Suppliers, manufacturing plants, and markets are worldwide, exposing the supply chain operation to geopolitical risks. We propose a two-stage stochastic program to locate manufacturing plants and decide material flows in the presence of geopolitical strains and operational uncertainties, i.e., demand and capacity. We study how geopolitical strains affect location decisions, global shortages, and shortages by income level classification of countries.

11 Deep Learning Classification in Presence of Uncertain Predictors for Medical Decision Making

Maryam Kheirandish, Shengfan Zhang; University of Arkansas, USA

Deep learning classification models are becoming increasingly applicable in healthcare but are also significantly challenging due to the inherent uncertainties in clinical and laboratory test data. These errors are usually presented as sensitivity and specificity measures and do not follow a normal but some discrete distribution. We demonstrate the impact of these uncertainties on predictions and develop a framework to handle and quantify these uncertainties in medical decision-making problems.

12 Clustered Multi-Task Learning for Prediction of Adverse Pregnancy Outcomes

Sun Ju Lee, Gian-Gabriel Garcia; Georgia Institute of Technology, USA

In clinical prediction models, combining individual indicators into a composite outcome can help overcome issues associated with single outcomes such as low predictability and low prevalence. However, this may obscure relationships between predictors and single outcomes. We aim to resolve this trade-off by developing an optimization model to simultaneously cluster related outcomes and learn model parameters for each cluster. We apply our formulation to indicators comprising maternal and neonatal morbidity and demonstrate that our approach can aid interpretability by finding underlying groups of related tasks and deriving an interpretable set of predictors.

Sunday, October 15, 2:15 PM - 3:30 PM

SD01

CC-North 120A

Mixed-Integer Programming Approaches to Generalized Submodular Optimization and its Applications

Tutorial Session

Session Chair: Douglas R. Shier, Clemson University, Pittsboro, NC

1 Mixed-Integer Programming Approaches to Generalized Submodular Optimization and Its Applications

Simge Kucukyavuz, Qimeng Yu, Northwestern University, Evanston, IL

Submodularity is an important concept in integer and combinatorial optimization. A classical submodular set function models the utility of selecting homogenous items from a single ground set, and such selections can be represented by binary variables. In practice, many problem contexts involve choosing heterogenous items from more than one ground set or selecting multiple copies of homogenous items, which call for extensions of submodularity. We refer to the optimization problems associated with such generalized notions of submodularity, Generalized Submodular Optimization (GSO). GSO is found in wide-ranging applications, including infrastructure design, healthcare, online marketing, and machine learning. Due to the often highly nonlinear (even non-convex and non-concave) objective function and the mixed-integer decision space, GSO is a broad subclass of challenging mixed-integer nonlinear programming problems. In this tutorial, we first provide an overview of classical submodularity. Then we introduce two subclasses of GSO, for which we propose polyhedral theory for the mixed-integer set structures that arise from these problem classes. Our theoretical results lead to efficient and versatile exact solution methods that demonstrate their effectiveness in practical problems using real-world datasets.

Sunday, October 15, 2:15 PM - 3:30 PM

SD03

CC-North 120D
GAMS
Technology Tutorial

1 The Best of Both Worlds - Integrating Python and Gams
Atharv Bhosekar, GAMS Development Corp, Fairfax, VA, Contact: abhosekar@gams.com
Optimization applications combine technology and expertise from many different areas, including model-building, algorithms, and data-handling. Often, the gathering, pre/post-processing, and visualization of the data is done by a diverse organization-spanning group that shares a common bond: their skill in and appreciation for Python and the vast array of available packages it provides. For this reason, GAMS offers multiple ways to integrate with Python on the data-handling side, as well as offering some packages of our own (e.g. GAMS Transfer, GAMS Connect). In this talk, we will explore the benefits of this integration and demonstrate them using a real-world example complete with results on performance.

Sunday, October 15, 2:15 PM - 3:30 PM

SD04

CC-North 121A
Fair and Socially Aware Practices in Operations Management
Community Committee Choice Session
Session Chair: Negin Golrezaei, Massachusetts Institute of Technology, Lexington, MA
Session Chair: Qinyi Chen, MIT, Cambridge, MA

1 Group Fairness in Dynamic Refugee Assignment
Daniel Freund[1], Thodoris Lykouris[2], Elisabeth Paulson[3], Bradley Sturt[4], Wentao Weng[1], [1]MIT, Cambridge, MA, [2]Massachusetts Institute of Technology, Cambridge, MA, [3]Harvard Business School, Cambridge, MA, [4]University of Illinois at Chicago, Chicago, IL
Ensuring that refugees and asylum seekers thrive (e.g., find employment) in their host countries is a profound humanitarian goal, and a primary driver of employment is the geographic location within a host country to which the refugee or asylum seeker is assigned. While recent research shows substantial positive impact by designing algorithms that maximize the average employment across all arriving refugees, we show that the impact of these algorithms can vary widely across key subgroups based on country of origin, age, or educational background. Thus motivated, we develop a simple and interpretable framework for incorporating group fairness into the dynamic refugee assignment problem and design algorithms with substantial improvements in group fairness compared to state-of-the-art algorithms with only small relative decreases (≈ 1%-2%) in global performance

2 Fair Markovian Search
Mohammad Reza Aminian[1], Vahideh Manshadi[2], Rad Niazadeh[1], [1]The University of Chicago, Booth School of Business, Chicago, IL, [2]Yale University, New Haven, CT
We start with the classic Pandora's box model under demographic parity constraints. Due to biases in prior data, group-unaware policies may lead to unfair treatment of groups. Candidates belong to two demographic groups and we constrain the policy to equalize the expected number of selection or opportunities across these groups. We show that optimal fair policy retains the index-based structure of the optimal unfair policy, but potentially randomizes between two policies that are dual-based adjustments of the unfair problem. Next, we consider richer search processes, such as search with rejection and multi-stage search, that can be modeled by joint Markov scheduling (JMS). Imposing general affine and convex ex-ante fairness constraints across an arbitrary number of groups or even individuals, we give a primal-dual algorithm to find the almost fair and optimal policy.

3 From AI Fairness to Justice: The Need for a Governance Ecosystem
Hoda Heidari, Carnegie Mellon University, Pittsburgh, PA
In this talk, I will provide an overview of the field that has come to be known as Fair AI. I will highlight the evolution of the field from narrowly-defined outcome-focused notions of fairness to broader conceptions of equity, procedural fairness, and societal justice and argue that the just use of AI in socially high-stakes domains will require strengthening the governance ecosystem around these technologies. I will unpack what that could look like and how researchers and educators can contribute to this effort positively.

4 Interpolating Item and User Fairness in Recommendation Systems

Jason Cheuk Nam Liang[1], Qinyi Chen[2], Negin Golrezaei[3], Djallel Bouneffouf[4], [1]MIT Operations Research Center, Cambridge, MA, [2]MIT, Cambridge, MA, [3]Massachusetts Institute of Technology, Lexington, MA, [4]IBM, Poughkeepsie, NY

In a multi-sided recommendation system where the platform interacts with diverse stakeholders such as sellers (items) and customers (users), each with their own desired outcomes, finding an appropriate middle ground becomes a complex operational challenge. In this work, we investigate the ``price of fairness'', which captures the platform's potential compromises when balancing the interests of different stakeholders. Motivated by this, we propose a fair recommendation framework where the platform maximizes its revenue while interpolating between item and user fairness constraints.We further examine the fair recommendation problem in a more realistic yet challenging online setting, and design a low-regret online optimization algorithm that preserves the platform's revenue while achieving fairness for both items and users.

5 Socially Fair Clustering and Its Generalizations

Ali Vakilian, Toyota Technological Institute at Chicago (TTIC), Chicago, IL

In center-based clustering (e.g., *k*-means), the clustering cost represents the quality of output and the lower the cost, the better the solution. This has motivated the ***socially fair clustering*** problem: the goal is to select *k* centers that minimizes the maximum clustering cost incurred by any of the *L* pre-specified groups of points in the input. This can be used to select a set of vaccination or polling sites to serve different communities in the population fairly.
In this talk, I present our tight O(log *L*/ log log *L*)-approximation for the problem which exponentially improves over the known O(*L*)-approximation. Moreover, I introduce a generalization of the problem called (*p*, *q*)-fair clustering which is a "relaxed" way of enforcing the fairness requirement and its objective interpolates between the objective of the classic *k*-clustering and that of socially fair clustering.

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SD05

CC-North 121B

New Applications and Theory in Revenue Management

Community Committee Choice Session

Session Chair: Meichun Lin, University of British Columbia, Vancouver, BC, Canada

1 Context-Based Dynamic Pricing with Separable Demand Models

Jinzhi Bu[1], David Simchi-Levi[2], Chonghuan Wang[2], [1]The Hong Kong Polytechnic University, Hong Kong, Hong Kong; [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: jinzhi.bu@polyu.edu.hk

Motivated by the empirical evidence from the real-world dataset, we consider context-based dynamic pricing with separable demand models. The demand function is endowed with a separable structure in the form of f(p)+g(x), where p and x denote the price and feature vector respectively. Under different structures of f(p) and g(x), we systematically characterize the statistical complexity of the online learning problem. Specifically, we consider three models: (i) f(p) is linear and g(x) is non-parametric; (ii) f(p) is non-parametric and g(x) is linear; and (iii) f(p) and g(x) are both non-parametric. For each model, we design an efficient learning algorithm with a provable regret upper bound and establish an almost matching regret lower bound.

2 Learning to Rank Under Strategic Manipulation in Small and Large Markets

Qinzhen Li[1], Yifan Feng[2], Hongfan Chen[3], [1]National University of Singapore, Singapore, Singapore; [2]NUS Business School, Singapore, Singapore; [3]The Chinese University of Hong Kong, Shatin, China. Contact: qinzhen@u.nus.edu

We consider a dynamic learning and ranking problem for a digital platform that must account for potential manipulation by sellers through "brushing" activities such as fake sales. We formulate an N-seller-T-period dynamic "brushing war" game and provide a (static) budget-competition equilibrium characterization. Further, an approximate mixed-strategy equilibrium is identified for small markets with two sellers. In a large market with a continuum of sellers, we formulate a novel non-atomic game and characterize two extremes of pure-strategy equilibria: no-brushing equilibrium for high brushing cost, and self-reinforcing equilibrium for low brushing cost, both achieving complete learning. We also establish the conditions for demand functions that achieve complete learning for all brushing costs.

3 Algorithms for Loot Box Design

Jiangze Han[1], Christopher Thomas Ryan[1], Xin T. Tong[2], [1]University of British Columbia, Vancouver, BC, Canada; [2]National university of Singapore, Singapore, Singapore. Contact: jiangze.han@sauder.ubc.ca

Loot boxes are a primary source of revenue in the video game industry. Loot boxes randomly “drop” items of differing value. To design a loot box, sellers much choose the purchase price and drop rate (or drop probability) of each item. We show that, in general, the loot box design problem is NP-hard. By restricting the form of player utilities, we can solve the problem exactly in polynomial time when the number of items is fixed. Under different restrictions, we solve the problem approximately in polynomial time with fixed precision. Both restrictions are satisfied by a class of exponential utility functions. Some of our results follow by relating loot box design with selecting prices for each item and selling them directly. Here, we leverage a natural connection between prices and drop rates.

4 Score Approximation, Optimization And Generalization Of Diffusion Models

Yinbin Han[1], Renyuan Xu[2], Meisam Razaviyayn[2], [1]University of Southern California, Los Angeles, CA, [2]University of Southern California, Los Angeles, CA, Contact: yinbinha@usc.edu

The score-based generative models or diffusion models have achieved huge success in various generation tasks. However, the theoretical foundation of the diffusion models, especially learning the score function through denoising score matching, falls far behind. In this work, we proved the convergence of the optimization and generalization of the denoising score matching with neural network parameterization.

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SD06

CC-North 121C

Design and Analysis of Marketplaces

Community Committee Choice Session

Session Chair: Chen Chen, New York University Shanghai

Session Chair: Pengyu Qian, Purdue University, West Lafayette, IN

1 Constant Regret Primal-Dual Policy for Multi-Way Dynamic Matching

Yehua Wei, Jiaming Xu, Sophie Yu, Duke University, Durham, NC

We study a discrete-time dynamic multi-way matching model with finitely many agent types that arrive stochastically and wait to be matched. State-of-the-art dynamic matching policies in the literature require the knowledge of all system parameters to determine an optimal basis of the fluid relaxation, and focus on controlling the number of waiting agents using only matches in the optimal basis (Kerimov et al., 2022a,b; Gupta, 2022). In this paper, we propose a primal-dual policy that schedule matches for future arrivals based on an estimator for the dual solution. Our policy does not require the knowledge of optimal bases, and is the first to achieve constant regret at all times under *unknown* arrival rates. In addition, we show that when the arrival rates are known, the primal-dual policy achieves the optimal scaling as the lower-bound described in (Kerimov et al., 2022a,b).

2 When a Platform Competes with Third-Party Sellers in Networked Markets: A Revenue Management Perspective

Hongfan(Kevin) Chen[1], Hai Wang[2], [1]The Chinese University of Hong Kong, Shatin, Hong Kong, China; [2]Singapore Management University, Singapore, Singapore. Contact: kevinchen@cuhk.edu.hk

We examine a platform marketplace that features both first-party and third-party sellers, with the platform charging commissions to third-party sellers and buyers for transactions. Meanwhile, the platform directly sets prices for first-party sellers in their dealings with buyers. We investigate how the platform’s profit-optimal price-commission decision is influenced by the network structure, which is characterized by complement and substitution of agents’ trading relationships in the marketplace. Furthermore, we develop an efficient $(1-\epsilon)$-approximation algorithm that ensures a fair distribution of surplus between the platform and its market participants in the equilibrium trades, taking into account fairness considerations.

3 Incentivizing Resource Pooling

Pengyu Qian[1], Chen Chen[2], Yilun Chen[3], [1]Purdue University, West Lafayette, IN, [2]New York University Shanghai, New York, NY, [3]CUHK Shenzhen, Shenzhen, China. Contact: qianp@purdue.edu

It is well known that resource pooling can significantly reduce congestion in multi-server queues. However, previous work has focused on centralized systems, and it is unclear whether similar results can be achieved in decentralized systems. We study a decentralized system where servers dynamically and strategically choose when to pool their processing capacity. Our results provide guidance for settings where servers belong to different entities, such as in the promising example of peer-to-peer cloud computing. We propose a simple protocol that uses artificial currency, and study an infinite-horizon stochastic game with multiple servers. We consider the mean-field equilibrium and explicitly characterize each server's optimal decision. We show that (surprisingly) our protocol can achieve performance similar to that of a fully centralized system (M/M/N queue).

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SD07

CC-North 122A

RMP Applications for Social Good

Community Committee Choice Session

Session Chair: Scott Rodilitz, UCLA Anderson School of Management, Los Angeles, CA

Session Chair: Francisco Castro, UCLA Anderson School of Management, Los Angeles, CA

1 Limiting The Manipulability Of Citizens' Assembly Selection

Bailey Flanigan, Carnegie Mellon University, Madison, WI

Citizens' assemblies - in which randomly-chosen citizens convene to deliberate on a policy issue - are growing in influence globally. We study the manipulability of the algorithms used to choose assembly participants: because these algorithms must satisfy representation constraints according to volunteers' self-reported features, an individual could misreport these features to increase their chance of being selected, decrease someone else's, and/or gain panel seats for their group.

We study whether one can limit these types of manipulability by recruiting more volunteers. Strikingly, we show empirically and theoretically that the two SOTA selection algorithms - one of which is widely used - are highly manipulable, no matter the number of volunteers. We then propose a new algorithm and show that its manipulability declines at an optimal rate as the pool grows.

2 the Awkward Art of Asking: Optimal Fundraising for Non-Profit Organizations

Zhengchao Wang, Heikki Peura, Wolfram Wiesemann, Imperial College Business School, London, United Kingdom. Contact: z.wang19@imperial.ac.uk

Non-profit organizations often rely on costly fundraising campaigns to existing and potential donors for their financial viability. We collaborate with a large global charity to develop and test a data-driven approach to improve the targeting of their campaigns to boost net revenue. In a static single-campaign setting, we propose a decision-tree based donor classifications system to capture heterogeneous donor preferences. Next, accounting for the charity's regular diverse campaign offers, we develop a Markov Decision Processes model to account for temporal effects in donations. Using real data from the partner organization, our method demonstrates the potential for data-driven approaches to improve the success of non-profit fundraising campaigns.

3 Does the Right to Repair Promote Competition?

Luyi Yang[1], Cungen Zhu[2], Chen Jin[3], [1]University of California, Berkeley, Berkeley, CA, [2]National University of Singapore, Singapore, Singapore; [3]National University of Singapore, Singapore, Singapore

The "right to repair" (RTR) movement calls for government legislation that requires manufacturers to provide repair information, tools, and parts so that consumers can independently repair their own products with more ease. The initiative has garnered attention globally. The advocates for the initiative believe that the RTR can break manufacturers' monopoly on the repair market, benefit consumers, and further help reduce the environmental impact. This study aims to examine those arguments in a competitive setting in which two manufacturers compete in the product market. Further, we also investigate how the RTR shapes manufacturers' competition in the product. To this end, by employing an analytical model, we find that the RTR can generally trigger non-monotone changes in manufacturer competition, manufacturer profit, consumer benefit, and environmental impact.

4 A Data-Driven Approach to Improve Artisans' Productivity in Distributed Supply Chains

Divya Singhvi[1], Somya Singhvi[2], Xinyu Zhang[1], [1]New York University, New York, NY, [2]USC Marshall School of Business, Los Angeles, CA

Despite their vital role in rural economy, artisanal supply chains continue to be plagued by low productivity and the highly fragmented nature of their upstream. This study presents research conducted in close collaboration with a leading exporter of handmade rugs in India, aimed at improving artisans' productivity in distributed supply chains. We provide robust empirical evidence that frequent supervisor visits can play a crucial role in improving artisans' productivity. To capitalize on the insight, we propose a novel predict-then-optimize framework for optimizing supervisor visits in the supply chain. By relating our problem to the celebrated prize-collecting TSP problem, we show the existence of a polynomial-time algorithm with provable performance guarantee. We see significant productivity improvement from extensive numerical analysis.

5 Design Variations in Digital Recommendations: An Experimental Study for Curating Visitor Experiences in Cultural Institutions

Ali Aouad[1], Abhishek Deshmane[2], Victor Martinez de Albeniz[2], [1]London Business School, London, United Kingdom; [2]IESE Business School, Barcelona, Spain. Contact: adeshmane@iese.edu
Cultural institutions use digital interfaces to enhance visitors' experience and guide them through art collections. This study examines the impact of design variations in digital recommendations on visitor engagement, satisfaction, and learning at the Van Gogh Museum. We use A/B testing and a switchback approach to evaluate the effect of differentiation across the "Highlights" and "Leisure" configurations of tours, along with better spacing. The outcomes measured include hit rates, time spent, selection rate, completion rate, and self-reported satisfaction levels. The results aim to identify factors that influence visitor experience and guide the design of recommended tours.

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SD08

CC-North 122B

APS Special Session: Transfer/Meta-Learning

Award Session

Session Chair: Christina Lee Yu, Cornell University, Ithaca, NY

Session Chair: Andrew Daw, University of Southern California, Marshall School of Business, Los Angeles, CA

1 Tutorial on Transfer/Meta-Learning

Hamsa Sridhar Bastani, Wharton School, Philadelphia, PA
In practice, we often encounter "small data" problems. This may be because data points are costly, the problem is high-dimensional, the environment is shifting, or the outcomes are rare/slow. In these cases, learning from problem-specific data is not sufficient, and we must additionally leverage data from related problems. Transfer/meta-learning estimators achieve this goal; we will survey several methods and their theoretical guarantees in different statistical regimes.

Sunday, October 15, 2:15 PM - 3:30 PM

SD09

CC-North 122C

Learning and Decision-Making in Platforms

Community Committee Choice Session

Session Chair: Yichun Hu, Cornell University, New York, NY

1 Optimal Multitask Linear Regression and Contextual Bandits Under Sparse Heterogeneity

Xinmeng Huang, University of Pennsylvania, Philadelphia, PA, Contact: xinmengh@sas.upenn.edu
Multitask learning methods improve efficiency by leveraging commonalities across tasks/datasets while accounting for possible differences. We study multitask linear regression and contextual bandits under *sparse heterogeneity*, where the task-wise parameters differ from a global parameter sparsely. We propose the MOLAR estimate that shrinks task-wise OLS estimates towards their covariate-wise median. MOLAR improves the dependence of the estimation error on the data dimension compared to naive OLS estimates. We then apply MOLAR to develop methods for sparsely heterogeneous contextual bandits, obtaining improved regret guarantees over single-task bandit methods. We further show that our methods are minimax optimal by providing a number of lower bounds. We support the efficiency of our methods with experiments on both synthetic data and the PISA dataset.

2 Robust Fitted-Q-Evaluation and Iteration Under Sequentially Exogenous Unobserved Confounders

David Bruns-Smith[1], Angela Zhou[2], [1]University of California, Berkeley, Berkeley, CA, [2]USC Marshall School of Business Data Sciences and Operations, Los Angeles, CA, Contact: bruns-smith@berkeley.edu
Offline reinforcement learning is important in domains where online experimentation is costly, dangerous or unethical, and where the true model is unknown. However, most methods assume all covariates used in the behavior policy's action decisions are observed. This untestable assumption may be incorrect. We study robust policy evaluation/optimization in the presence of sequentially exogenous unobserved confounders. We assume the extent of possible unobserved confounding can be bounded by a sensitivity model and propose and analyze an (orthogonalized) robust fitted-Q-iteration that uses closed-form solutions of the robust Bellman operator. Our algorithm enjoys the computational ease of fitted-Q-iteration and statistical improvements from orthogonalization. We provide sample complexity bounds, insights, and show effectiveness in simulations.

3 Strategyproof Decision-Making in Panel Data Settings and Beyond

Keegan Harris[1], Anish Agarwal[2], Chara Podimata[3], Steven Wu[4], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Amazon, Newton, MA, [3]UC Berkeley, Allston, MA, [4]Microsoft Research, New York, NY, Contact: keeganh@cs.cmu.edu

We propose a framework for decision-making in the presence of strategic agents with panel data, a standard setting in econometrics where one gets noisy, repeated measurements of multiple units. We consider a setup where there is a pre-intervention period, when the principal observes the outcomes of each unit, after which the principal uses these observations to assign treatments. Our model can be thought of as a generalization of the synthetic controls framework, where units may strategically manipulate their pre-intervention outcomes. We identify necessary and sufficient conditions for a strategyproof mechanism that assigns interventions in the post-intervention period to exist. Under a latent factor model, we show that whenever a strategyproof mechanism exists, there is one with a simple closed form. Finally, we provide an algorithm for learning such a mechanism.

4 Uniformly Bounded Regret in Dynamic Fair Allocation

Santiago Balseiro[1], Shangzhou Xia[2], [1]Columbia University, Armonk, NY, [2]Columbia University, New York, NY, Contact: sx2182@columbia.edu

We study a dynamic allocation problem where sequentially arriving resources need to be allocated to fixed agents with linear utilities. Most prior works maximize the utilitarian welfare and may result in unfair concentration of resources on certain high-utility agents while leaving others' demands under-fulfilled. In this paper, aiming at balancing efficiency and fairness, we instead consider the broad collection of Holder-mean welfare metrics, including the Nash social welfare. We show the simple fluid policy derived from a deterministic problem attains uniformly bounded regret under all but the egalitarian welfare. Finally, we propose a new policy consisting of infrequently re-solving the fluid problem and thresholding the solution, which attains uniformly bounded regret against the hindsight optimum under the egalitarian welfare.

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SD10

CC-North 123

Information Theory, Statistics and Online Learning

Community Committee Choice Session

Session Chair: Alankrita Bhatt, CalTech

1 Universal Probability Assignment and Its Applications

Alankrita Bhatt, Caltech, Pasadena, CA

In modern statistical and data science applications, the probability distribution generating the data in question is unknown (or even absent) and decisions must be taken in a purely data-driven manner. In this talk, the information-theoretic approach of universal probability is revisited and expanded upon. This approach gives us general principles and guidelines for assigning sequential probabilities to data (based on which a decision can then be made), and has been used successfully over the years to problems in compression, prediction and estimation among others. The utility of this approach is then demonstrated through the example of universal portfolio selection with side information.

2 Statistical Complexity and Optimal Algorithms for Non-Linear Ridge Bandits

Han Yanjun, New York University, New York, NY

We consider the sequential decision-making problem where the mean outcome is a non-linear function of the chosen action. Compared with the linear model, two curious phenomena arise in non-linear models: first, there is an "burn-in period" with a fixed cost determined by the non-linear function; second, achieving the smallest burn-in cost requires new exploration algorithms. For a special family of non-linear functions named ridge bandits, we derive upper and lower bounds on the optimal burn-in cost, as well as on the entire learning trajectory during the burn-in period via differential equations. In particular, a two-stage algorithm that first finds a good initial action and then treats the problem as locally linear is statistically optimal. In contrast, several classical algorithms, such as UCB and algorithms relying on regression oracles, are provably suboptimal.

3 Adaptive Oracle-Efficient Online Learning

Guanghui Wang, Georgia Tech, GA

Classical online algorithms offer optimal performance guarantees but face scalability limitations. Oracle-efficient methods address this by leveraging offline optimization oracles to search through an exponentially-large decision space. However, they encounter challenges in adapting to friendly environments. In this talk, we explore two friendly scenarios: (a) "small-loss" problems and (b) IID data. We provide a new framework for designing online algorithms that are oracle-efficient and adapt well to the small-loss environment, under a particular condition which we call approximability (which is spiritually related to sufficient conditions provided by Dudik et al., (2020)). We identify a series of real-world applications for which approximability holds. We also extend the algorithm to an IID data setting and establish a "best-of-both-worlds" bound.

4 Oracle-Efficient Online Learning for Beyond Worst-Case Adversaries

Nika Haghtalab[1], Yanjun Han[2], Abhishek Shetty[1], Kunhe Yang[1], [1]UC Berkeley, Berkeley, CA, [2]MIT, Cambridge, MA

We study oracle-efficient algorithms for beyond worst-case analysis of online learning. We focus on two settings. First, the smoothed analysis setting where an adversary is constrained to generating samples from distributions whose density is upper bounded by 1/□ times the uniform density. Second, the setting of K-hint transductive learning, where the learner is given access to K hints per time step that are guaranteed to include the true instance. We give the first known oracle-efficient algorithms for both settings that depend only on the offline complexity of the class and parameters □ and K that capture the power of the adversary. This contrasts the computational separation between online learning with worst-case adversaries and offline learning.

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SD11

CC-North 124A

Machine Learning Aided Causal Inference

Community Committee Choice Session

Session Chair: Harsh Parikh, Duke University, Durham, NC

1 Using Embeddings for Causal Estimation of Peer Influence in Social Networks

Irina Cristali[1], Victor Veitch[2], [1]University of Chicago, Chicago, IL, [2]Google / University of Chicago, Chicago, IL

We address the problem of using observational data to estimate peer contagion effects, the influence of treatments applied to individuals in a network on the outcomes of their neighbors. A main challenge to such estimation is that *homophily*—the tendency of connected units to share similar latent traits—acts as an unobserved confounder for contagion effects. We describe an approach to perform the required adjustment using node embeddings learned from the network itself. The main aim is to perform this adjustment nonparametrically, without functional form assumptions on either the process that generated the network or the treatment assignment and outcome processes. The key contributions are to nonparametrically formalize the causal effect in a way that accounts for homophily, and to show how embedding methods can be used to identify and estimate this effect.

2 Interpretable Causal Inference for Distributional Data Analysis

Srikar Katta, Duke University, Durham, NC, Contact: srikar.katta@duke.edu

Causal inference often focuses on estimating treatment effects when outcomes are Euclidean. However, distributions often better represent complex data like images, graphs, and high-frequency time series. By taking advantage of the geometry of the optimal transport-based Wasserstein space, we *learn a distance metric* that creates *almost exact matches* for high quality, heterogeneous treatment effect estimation with these distributional data. Because matching methods are naturally interpretable, we demonstrate how auditing matched groups can ensure trustworthy and robust decision making. We analytically guarantee the consistency of our estimation strategy and demonstrate via simulation that our approach outperforms state-of-the-art methods for distributional data analysis.

3 Graph Neural Network Based Double Machine Learning Estimator of Network Causal Effects

Baharan Khatami, UCSD, San Diego, CA

In this paper, we look into the problem of causal effect estimation in graph data in the presence of interference. We propose a novel framework that combines graph representation learning along with double machine learning to achieve a doubly robust estimator, robust to misspecification of one of the propensity or outcome models. We show that extending double machine learning framework to non-iid setting makes the estimator more robust compared to other types of estimators like prognostic modeling. We also show how expressive power of the graph representation technique contributes to the robustness of the estimation. Extensive experimental studies on multiple graph data, data generative processes using different embedding techniques show the effectiveness of our approach. We compare our method with existing baselines and outperform them in most of the cases.

4 Variable Importance Matching for Causal Inference

Quinn Lanners, Duke University, Durham, NC

Our goal is to produce methods for observational causal inference that are auditable, easy to troubleshoot, accurate for treatment effect estimation, and scalable to high-dimensional data. We describe a general framework called Model-to-Match that achieves these goals by (i) learning a distance metric via outcome modeling, (ii) creating matched groups using the distance metric, and (iii) using the matched groups to estimate treatment effects. Model-to-Match uses variable importance measurements to construct a distance metric, making it a flexible framework that can be adapted to various applications. Concentrating on the scalability of the problem in the number of potential confounders, we operationalize the Model-to-Match framework with LASSO. We derive performance guarantees for settings where LASSO outcome modeling consistently identifies all confounders (importantly without requiring the linear model to be correctly specified). We also provide experimental results demonstrating the method's auditability, accuracy, and scalability as well as extensions to more general nonparametric outcome modeling.

5 A Double Machine Learning Approach to Combining Experimental and Observational Studies

Harsh Parikh, Duke University, Durham, NC

In this work, we consider a setting where we have access to both an experiment and an observational study. The goal is to use both to improve our estimation of causal effects, knowing that either might be plagued by violations of the assumptions described above. To this end, we propose: (i) a test for either violation of conditional ignorability in the observational data or external validity of the experimental data and (ii) an estimator for the average treatment effect (ATE). Both (i) and (ii) draw strength from both experimental and observational datasets. Via double machine learning approaches, we prove that if external validity and conditional ignorability hold, the ATE estimator and the estimator underpinning our test are asymptotically normal, unbiased, and efficient. Furthermore, even if conditional ignorability fails, our ATE estimator is still consistent.

Sunday, October 15, 2:15 PM - 3:30 PM

SD12

CC-North 124B

Decision Making for Robotic Systems

Community Committee Choice Session

Session Chair: Michael Caldara, Amazon.com, North Reading, MA

1 Amazon Robotics: Allocation for Tote-Based Fulfillment Centers

Yashoda Dadkar[1], Michael Caldara[2], [1]Amazon Robotics, North Reading, MA, [2]Amazon.com, North Reading, MA

Amazon Robotic Fulfillment Centers utilize hundreds of robotic drive units to bring portable shelves to and from processing stations so that items can be added and removed to fulfill customer orders. This talk gives an overview of Robotic Fulfillment Centers and how we use optimization algorithms to efficiently assign tasks to robots. Additionally, we discuss how changes to the storage shelf design to help present items to employees in an ergonomically friendly position and the introduction of a new workflow has required us to rethink our historical optimization strategy to meet system level objectives.

2 Amazon Robotics: Sort Centers Drive Allocation Modeling

Suzan Iloglu, Benjamin McClosky, Michael Caldara, Daniel Sabin, Amazon Robotics, Boston, MA

Amazon's Robotic Sortation Centers utilize hundreds of robotic drive units to sort packages by postal code for delivery to the end customer. The drives accomplish this task by transporting packages from induct stations to destination specific eject chutes, creating granular bundles of packages for downstream processing. This talk gives an overview of Robotic Sortation Centers and how we use optimization algorithms to efficiently plan drive missions from induct stations to eject chutes and back to power this robotic system.

3 Queue Management for Robotic Fulfillment Systems

Victor Amelkin, Amazon.com, North Reading, MA, Contact: amelkin@amazon.com

Amazon's automated fulfillment centers (FCs) use robotic drives for inventory transport from storage to stations under minute-to-hour-scale deadlines. To hedge against delivery time uncertainty, stations use drive queues, and an important problem is to maintain these queues sufficiently full yet not overflowing. State-of-the-art planners often achieve one of the two. We propose a scalable heuristic for joint work allocation and delivery scheduling to queues, relying on geometric packing of jobs' anticipated presence times in the queue occupancy schedules, proven to be effective at eliminating station underutilization and queue overflow in simulation. It is applicable to FCs, and any other environment with plannable transportation to queues.

Sunday, October 15, 2:15 PM - 3:30 PM

SD13

CC-North 125A

Applied Analytics

Community Committee Choice Session

Session Chair: Nancy Albers, 1</sup

1 Impact Analytics: A Multi-Measure Approach for Assessing and Classifying Business Journals

Nancy D. Albers[1], Caitlyn S. Albers[2], Tami L. Knotts[3], [1]University of South Carolina Aiken, Aiken, SC, [2]University of South Florida, Tampa, FL, [3]Louisiana State University Shreveport, Shreveport, LA, Contact: albersc@usf.edu

Universities need an effective method for distinguishing exceptional publications from average ones. Determining an appropriate process for assigning impact measures to journals for the purpose of determining faculty qualifications has remained a challenge. The process is complicated when the measure must span various disciplines, topics, methods, and purposes. There are many sources of measures of journal quality with a variety of methods for scoring/ranking. Conceivably, not every source is equally rigorous and may not apply equally to all disciplines. This research proposes a multi-measure approach for journal impact in business disciplines. The results have implications across disciplines where journal impact measures are used.

2 Examining the Impact of the Covid-19 Pandemic on Consumer Search Patterns in the European E-Retail Environment

Ravi Narayanaswamy[1], Richard Heiens[2], [1]University of South Carolina Aiken, Aiken, SC, [2]University of South Carolina Beaufort, Beaufort, SC, Contact: ravin@usca.edu

The study examines the relative importance of seven distinct channels as drivers of website traffic in the European e-retail market between the years 2019 and 2021 - direct, display ads, email, organic search, paid search, referrals and social media. Using both a log-log model and Two-step cluster analysis, the results reveal a significant shift in consumer search patterns over the time frame studied, with consumers exhibiting a greater response to paid search and email marketing in the post-COVID period.

3 AI Versus AI: A Study on the Effectiveness of Machine Learning-Based Detection Techniques

Ellis Reeves[1], Monica Martin[2], [1]University of South Carolina Aiken, Aiken, SC, [2]University of South Carolina Aiken, Aiken, SC

Plagiarism has been a growing concern for educational institutions since the advent of the Internet. The magnitude of this problem has become exponential with the emergence of artificial intelligence technologies (AI) like ChatGPT. However, the advanced capabilities of AI can be leveraged in a positive manner. This study examines the efficacy of an AI grading assistant (Packback) to combat plagiarism and validate content. The findings will provide implications for educators on possible avenues to use AI for content authentication and design grading mechanisms.

4 Examining Cybersecurity Awareness Among Students in U.S. Southeast Region

Travis D. Albers, University of Central Florida, Orlando, FL

The recent Covid-19 pandemic has coerced higher learning institutions in the United States to transition to online learning to deliver course content to their students. The increased enrollment in online courses has augmented student exposure to cyberspace. This study aims to analyze the level of cybersecurity awareness among students enrolled in universities in the U.S. Southeast region.

5 The ESG Firm Value Model

Aaron Kim[1], Sung Ik KIm[2], Davide Lauria[3], Svetlozar Rachev[3], [1]Stony Brook University, Stony Brook, NY, [2]Louisiana State University Shreveport, Shreveport, LA, [3]Texas Tech University, Lubbock, TX

This study aims to investigate the impact of incorporating environmental, social, and governance (ESG) factors on firm value models. The growing recognition of the significance of a company's ESG performance on its long-term financial performance has led to increased demand for ESG data and analysis by investors and firms. The study creates an ESG-inclusive firm value model, selects appropriate ESG metrics, assesses the model's accuracy, and compares it to a traditional model. The results will provide insights into the significance of ESG factors on firm value and the effectiveness of ESG-inclusive models in predicting firm value.

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SD14

CC-North 125B

Food Waste Reduction in Retail and Foodservice

Community Committee Choice Session

Session Chair: Ekaterina Astashkina, Ross School of Business, University of Michigan, Ann Arbor

Session Chair: Fan Zhou, University of Michigan, Ann Arbor, MI

1 Artificial Intelligence Based Systems for Reducing Food Waste

Yu Nu[1], Elena Belavina[2], Karan Girotra[3], [1]Cornell University/Cornell Tech, New York City, NY, [2]Cornell University, New York, NY, [3]Cornell Tech/Johnson Cornell University, New York, NY, Contact: yn292@cornell.edu

In this study we evaluate the effectiveness of two kinds of AI-based systems for reducing food waste in commercial kitchens- a computer-vision based waste monitoring system, and a machine-learning based system for managerial-bias detection. In a quasi-experimental setting where 800+ commercial kitchens adopted Winnow in a staggered manner, we first estimate food waste reductions due to the use of a waste monitoring system and the upgrade to AI-powered waste capture via synthetic difference-in-differences method. We also explore methods that utilize the high-resolution waste data to identify the root causes behind the higher-than-necessary waste levels, such as systematic biases in managing inventories. The deep-learning based time-series classifier (LSTM-FCN) we developed, is able to identify managerial biases with 95%+ accuracy from the real-world test data.

2 Reducing Waste in Foodservice

Yuwen Hu[1], Ekaterina Astashkina[2], Izak Duenyas[3], Feng Tian[4], [1]University of Michgan, Ann Arbor, MI, [2]Ross School of Business, University of Michigan, Ann Arbor, [3]University of Michigan-Ann Arbor, Ann Arbor, MI, [4]HKU, Hong Kong, China. Contact: yuwenhu@umich.edu

Food waste is a global environmental problem that spans multiple industries, including foodservice. We build a stylized model of a food provider that faces a consumer with uncertain demand. We identify the most effective strategies that reduce post-consumer food waste.

3 Food Waste in Grocery Retail: The Impact of Store Characteristics

Fabian Schäfer, Konstantin Wink, Alexander Hübner, Technical University of Munich, Straubing, Germany. Contact: fab.schaefer@tum.de

Our research investigates how store characteristics impact in-store food waste for a European retailer. We analyze the proprietary transaction and geo data from 174 retail stores using Double Machine Learning models to test our hypotheses. Our findings indicate that grocery store density, city size, and nearby household numbers significantly affect food waste levels relative to revenue. Our study provides novel insights for practitioners to consider when strategically planning store locations and reducing food waste, a crucial sustainability issue for retailers. Retailers can decrease costs and carbon emissions by identifying which store attributes lead to increased food waste.

4 On The Management of Premade Foods

Jae-Hyuck Park[1], Dan Andrei Iancu[2], Erica Plambeck[2], [1]New Jersey Institute of Technology, Newark, NJ, [2]Stanford University, Stanford, CA, Contact: jaehyuck.park@njit.edu

We examine a grocer's management of a premade food product. The retailer's goal is to maximize a weighted sum of direct profit and customer welfare. The retailer chooses shelf life, whether to issue items in FIFO or LIFO order, and whether to indicate the time when each item is prepared (i.e., timestamp). We find that LIFO universally outperforms FIFO when shelf life and issuance are jointly optimized. We also show that the retailer should timestamp items only if customers have heterogeneous preferences, and a positive decision hinges on the disposal cost being sufficiently low or the retailer caring substantially about customer welfare. Lastly, we show how a mandate to donate unsold food items can incentivize a retailer to increase the shelf life or cease disclosing the time at which a food item was made, which harms shoppers and reduces the quantity and quality of donated items.

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SD15

CC-North 126A

Military Readiness

Community Committee Choice Session

Session Chair: Gregg J. Schell, CNA, Arlington, VA

1 Organic Repair Transfers to Increase Readiness

Gregg Schell, CNA, Arlington, VA

Managing the flow of spare parts through the supply chain is critical to ensuring high and sustained material readiness. Using a simulation model, we explored how alternative policies for repairing parts can affect costs and the probability of stock-outs at warfighter supply locations. We generated a decision-support framework for determining when the alternative policy should be implemented and estimated potential second-order effects on repair capacity and throughput.

2 Expanding Logistics Network Optimization Model for Novel Solutions

Lauren Claus, CNA, Arlington, VA

Future logistics distribution networks to support a distributed maritime operations (DMO) environment will require new sustainment strategies to supply the fleet. Novel logistics solutions, such as unmanned systems and shipboard additive manufacturing, are currently being explored as sustainment strategy options to meet these changing requirements. To evaluate the costs and operational benefits of these sustainment options, the scenario-based Constrained Optimization for Assessing Sustainment in Theater (COAST) model has been expanded to include these novel solutions alongside traditional logistics assets. The approach to incorporate these novel logistics solutions into the COAST model optimization framework will be presented.

3 Enhancing Military Medical Evacuation Dispatching with Armed Escort Management: Comparing Model-Based Reinforcement Learning Approaches

Andrew Gelbard, United States Air Force, Washington, DC

The military medical evacuation (MEDEVAC) dispatching problem involves determining optimal policies for evacuating combat casualties to maximize patient survivability during military operations. This study explores a variation of the MEDEVAC dispatching problem, focusing on controlling armed escorts using a Markov decision process (MDP) model and model-based reinforcement learning (RL) approaches. A discounted, continuous-time MDP model over an infinite horizon is developed to maximize the expected total discounted reward of the system. Two model-based RL solution approaches are proposed: one utilizing semi-gradient descent Q-learning, and another employing semigradient descent SARSA. A computational example, set in western and central Africa during contingency operations, serves to assess the performance of the RL-generated policies against the myopic policy, which is currently employed by military medical planners. The research also delves into sensitivity analysis and excursion scenarios to further evaluate the RL-generated policies. By explicitly controlling armed escort assets, dispatching authorities can better manage the location and allocation of these resources throughout combat operations. The findings of this study have the potential to inform military medical planning, operations, and tactics, ultimately leading to improved MEDEVAC system performance and higher patient survivability rates.

4 Allocation of Surveillance and Search Assets in Undersea Warfare

Sebastian Martin[1], Anna Svirsko[2], Daphne Skipper[2], Esra Toy[3], [1]United States Naval Academy, Annapolis, MD, [2]United States Naval Academy, Annapolis, MD, [3]Virginia Tech, Blacksburg, VA, Contact: m243966@usna.edu

The location of moving underwater targets requires initial detection by a sensor and follow-on tracking by an active search platform. We formulate a linear program that determines the placement of sensors and tactical search assets in a theoretical search area to maximize the number of tracked targets. Our model takes into account the different requirements of sensor types, sensor detection probabilities, and the effective placement of search assets in relation to sensors to enable timely response to detection. We test our model on theoretical scenarios of target movement in the open-ocean.

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SD16

CC-North 126B

Modeling and Analysis of Biopharmaceutical Manufacturing Systems

Community Committee Choice Session

Session Chair: Tugce Martagan, Eindhoven University of Technology, Eindhoven, Netherlands

Session Chair: Wei Xie, Northeastern University, Boston, MA

1 Biological System-of-Systems Framework for iPSC Culture in Aggregates

Wei Xie[1], Hua Zheng[1], Sarah Harcum[2], Keqi Wang[1], Paul Pei[1], [1]Northeastern University, Boston, MA, [2]Clemson University, Clemson, SC, Contact: w.xie@northeastern.edu

Large-scale production of induced pluripotent stem cells (iPSCs) is essential for cell therapies and regenerative medicines. Yet, due to strong cell-to-cell interactions, iPSCs self-aggregation can lead to insufficient nutrient supply and metabolic waste build-up for the cells located at core. We introduce a Biological System-of-Systems (Bio-SoS) framework characterizing causal interdependencies at individual cell, aggregate, and cell population levels. It quantifies spatial-temporal variations and predicts cell response to micro-environmental perturbation. This study can offer valuable insights to optimize the cell culture process and ensure that it follows the expected trajectory for successful cell growth and expansion.

2 Optimal Bleed-Feed Policies for Biomanufacturing

Coen Dirckx, 1</sup

We consider the bleed-feed method, which is a novel semi-continuous production strategy in biomanufacturing. The main trade-off concerning this strategy is the timing of the bleed-feed action. We show that a second trade-off regarding the bleeding amount exists. Optimizing this dual trade-off under uncertainty results in incremental productivity gains. We provide extensive numerical analysis and show that our model outperforms the current practice and the original bleed-feed model. A case study conducted at Merck Animal Health shows the practical application and value of our work.

3 Increasing the Productivity of a Multi-Stage Biomanufacturing Process Using MDP Modelling

Mirko Schoemig[1], Martin Grunow[2], [1]Technical University of Munich, Munich, Germany; [2]Technical University of Munich, Munich, Germany. Contact: mirko.schoemig@tum.de

Biopharmaceuticals are drugs produced in a multi-stage biomanufacturing process. The use of living cells introduces multiple operational uncertainties into the system. Today, the manufacturing stages are often treated as independent entities operated with fixed process control strategies, neglecting the trade-off these decisions create across stages. Further, process monitoring data routinely collected to prove regulatory compliance of the process, are not used for operational decision-making. We formulate the multi-stage biomanufacturing process as an MDP and determine an integrated policy. We show the applicability of the policy for a typical biomanufacturing process, focussing on the implementation of the operations policy in practice.

4 Applications of OR/MS Methodologies in Biomanufacturing: Our Vision and Future Research Directions

Tugce Martagan, Eindhoven University of Technology, Eindhoven, Netherlands

The applications of Operations Research and Management Science (OR/MS) methodologies created a significant impact on industries such as automotive and semiconductor manufacturing. However, there are only a limited number of papers and a few written accounts of success on OR/MS applications in biomanufacturing. Through our work presented in the 2022 Franz Edelman competition, we have proven that linking OR/MS with biomanufacturing drives sustainable and scalable productivity improvements. In this presentation, we will discuss our vision and future research directions to inspire and stimulate new research at the intersection of OR/MS and biomanufacturing.

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SD17

CC-North 127A

Humans and Machines with Applications in Operations

Community Committee Choice Session

Session Chair: Mirko Kremer, Frankfurt School of Finance and Management gGmbh, Frankfurt Am Main, Germany

1 The Omnichannel Service Desk: Live Agents, Chatbots or Both?

Brett Hathaway[1], Maqbool Dada[2], Evgeny Kagan[3], [1]Brigham Young University, Provo, UT, [2]Johns Hopkins University, Baltimore, MD, [3]Johns Hopkins Carey Business School, Baltimore, MD, Contact: brett_hathaway@byu.edu

We examine the problem of designing an omnichannel service desk that integrates chatbots and live agents to respond to inbound service requests from customers. At the heart of this problem are two decisions: (1) Which channels should be offered: the chatbot channel, the live-agent channel, or both? (2) For the offered channels, how should the customer experience be designed? If the live-agent channel is offered, should it use a more personalized "concierge service" approach or a more efficiency-driven "gatekeeper" approach, in which the work is split between a gatekeeper and an expert? If the chatbot channel is offered, what is the optimal level of chatbot sophistication?

2 When Systems Fail: Training Data Accuracy and Operational Transparency

Chris Parker[1], Jorge Mejia[2], [1]American University, Washington, DC, [2]Indiana University, Bloomington, IN, Contact: chris.parker@american.edu

AI systems rely on accurate training data created by workers interacting with a remote system that can be unreliable. We investigate 1) to what extent can system failures impact worker performance after a system fails and is restored, and 2) what remedies exist that can reduce the impact of these failures on worker performance. To answer these questions, we conducted eight lab experiments and one field experiment in which subjects were asked to perform tasks commonly used to train data used for an AI model. Our results show that a system failure leads to a decrease in task accuracy after the system recovers from failure and comes back online. Providing employees with operational transparency about the failure restoration status brings accuracy back to pre-failure levels.

3 Improving Human-Algorithm Collaboration: Causes and Mitigation of Over- and Under-Adherence

Maya Balakrishnan[1], Kris Johnson Ferreira[1], Jordan D. Tong[2], [1]Harvard Business School, Boston, MA, [2]University of Wisconsin Madison, Madison, WI, Contact: mbalakrishnan@hbs.edu

Even if algorithms make better predictions than humans on average, humans may sometimes have additional private information that can improve their performance. How can we then help humans effectively use recommendations made by algorithms? We hypothesize people are biased towards a naïve advice weighting heuristic where they take a weighted average between their own prediction and the algorithm's, with a constant weight across prediction instances regardless of whether they have valuable private information. This leads to humans over-adhering to the algorithm's predictions when their private information is valuable and under-adhering when it is not. We validate our results in two lab experiments and also find that feature transparency, even when the underlying algorithm is a black box helps users more effectively discriminate when and how to deviate from algorithms.

4 Learning From Mistakes: Algorithmic Recommendations Complimenting Humans

Bryce Mclaughlin, Jann Spiess, Stanford Graduate School of Business, Palo Alto, CA, Contact: brycem@stanford.edu

Research in prescriptive analytics seeks to develop predictions which can map to loss-minimizing decisions. However, some problems which could benefit the most from prescriptive analytics face an additional challenge: a human takes the final decision after receiving information about a prediction, often as a risk score or recommendation. In response we consider a simple prescriptive design question: how can we optimally deploy this recommendation? We introduce a model capturing the endogenous response of the human to the recommendation's deployment. Under monotonicity-like assumptions, we are able to show that a minimax optimal deployment of the recommendation (over the feasible set of human response to the recommendation) is implemented using a threshold rule on the propensity of the human to make mistakes given the recommendations inputs.

5 Delegating Decisions and Blame to Humans and Machines

Mirko Kremer[1], Hossein Nikpayam[2], Francis de Vericourt[3], [1]Frankfurt School of Finance and Management gGmbh, Frankfurt Am Main, Germany; [2]ESMT Berlin, Mannheim, Germany; [3]ESMT Berlin, Berlin, Germany. Contact: m.kremer@fs.de

We study human-machine interaction in an environment where a principal delegates to an agent a risky diagnostic decision and pays the agent a discretionary bonus after observing the outcome that results from a combination of decision and luck. To make better decisions in expectation, the agent can rely on two sources of information - their own privately observed information and a recommendation from a statistical model ("machine"). We predict that bonus payments depend on outcomes and on whether the agent's decision aligned with the machine recommendation, with the result that agents are prone to aligning decisions with machine recommendations even when they should not, effectively over-relying on the machine. We design experiments to test these predictions under controlled laboratory conditions.

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SD18

CC-North 127B

Pierskalla Best Paper Competition

Award Session

Session Chair: Hrayer Aprahamian, Texas A&M University, College Station, TX

1 Strategic Cross Subsidization in Healthcare Capitation Programs: Evidence from Medicare Advantage

Zhaowei She[1], Turgay Ayer[2], Bilal Gokpinar[3], Danny Hughes[2], [1]Singapore Management University, Singapore, Singapore; [2]Georgia Institute of Technology, Atlanta, GA, [3]UCL School of Managemen, London, United Kingdom

Healthcare Payers have increasingly adopted capitation payment models during the past decade. Utilizing a large commercial insurance database, we empirically characterize the allocation of capitation payments in Medicare Advantage (MA), the largest capitation program in the U.S.. The findings reveal that MA inadvertently encourages health plans to reallocate portions of the capitation payments intended for one group of patients to another, a practice known as strategic cross subsidization. By exploiting a policy-induced shock on MA capitation payments, we identify this cross subsidization practice through a difference-in-difference (DID) design.

2 Got (Optimal) Milk? Pooling Donations in Human Milk Banks with Machine Learning and Optimization

Timothy Chan[1], Rafid Mahmood[2], Rachel Wong[1], Ian Zhu[1], Sharon Unger[3], Debbie Stone[3], Deborah O'Connor[1], [1]University of Toronto, Toronto, ON, Canada; [2]Telfer School of Management, Ottawa, ON, Canada; [3]Sinai Health System, Toronto, ON, Canada

Human donor milk provides critical nutrition for the millions of infants that are born preterm each year. While the macronutrients in donor milk are critical to infant development, they vary by donation. In collaboration with Rogers Hixon Ontario Human Milk Bank, we developed a data-driven framework to pool multiple donations using machine learning and optimization. Over a one-year trial, our implementation yielded significantly higher macronutrient content than current pooling practices, with the proportion of pools meeting clinical fat and protein targets increasing by approximately 31%, with a 60% decrease in recipe creation time.

3 Can Predictive Technology Help Improve Acute Care Services? Investigating the Impact of Virtual Triage Adoption

Michael Freeman, Jiatao Ding, Sameer Hasija, INSEAD, Singapore, Singapore

This paper investigates the operational implications of virtual triage adoption within acute care services. A central problem in this context is patients' (in)ability to self-triage accurately, a notable contributor to ED overcrowding and treatment delays. Recent developments in predictive analytics have led to development of virtual triage tools, which offer immediate and cost-effective triage recommendations. This paper develops a queueing game model to examine how virtual triage influences patient behavior and system performance, and policy actions that maximize its operational advantages.

4 Reshaping National Organ Allocation Policy

Theodore Papalexopoulos[1], James Alcorn[2], Dimitris Bertsimas[1], Rebecca Goff[2], Darrin Stewart[3], Nikolaos Trichakis[1], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]United Network for Organ Sharing, Richmond, VA, [3]New York University Langone, New York, NY

The Organ Procurement & Transplantation Network (OPTN) initiated a major overhaul of its allocation policies, aiming to create a more efficient, equitable, and inclusive system. We introduce an analytical framework that illuminates tradeoffs and enables dynamic exploration of the efficient frontier. Jointly with OPTN, we applied our framework to design a new national allocation policy for lungs. Since March 9, 2023, all lungs in the U.S. are allocated according to this policy that we helped design. We extended our joint work to the redesign of kidney, pancreas, hearts, and liver allocation.

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SD19

CC-North 127C

Drones for Healthcare Delivery

Community Committee Choice Session

Session Chair: Shakiba Enayati, University of Missouri - Saint Louis, St Louis, MO

1 A Simulation-Heuristic Method for Drone Delivery in Rural Areas

Xueping Li, [1</sup]

2 Cost-Effectiveness of Drone Delivered Aeds

Muhammad Maaz[1], K.H. Benjamin Leung[2], Justin J. Boutilier[3], Sze-chuan Suen[4], Timothy Chan[2], [1]University of Toronto, Toronto, ON, Canada; [2]University of Toronto, Toronto, ON, Canada; [3]University of Wisconsin - Madison, Madison, WI, [4]University of Southern California, Los Angeles, CA, Contact: m.maaz@mail.utoronto.ca

Early application of a defibrillator is one of the most important determinants of mortality and morbidity in cardiac arrests. Drones are increasingly studied as a way to quickly get defibrillators to cardiac arrest patients. However, the cost-effectiveness of such programs has not been studied. We use a Markov model to study the cost-effectiveness of drone-delivered defibrillators, taking into account the costs of the drones themselves and costs to the healthcare system. Our results show that they are cost-effective.

3 Coordinated Truck-Drone Pickup and Delivery with Time Windows for Pharmacies

Nawin Yanpirat, Daniel F. Silva, Alice E. Smith, Auburn University, Auburn, AL

This work aims to reduce the total service time in last-mile logistics in distributing prescription medications and other items from pharmacies to customers. Prescription medications require preparation by a certified pharmacist and should be delivered promptly within time windows. Other items can be picked up and delivered at any time. Customers can receive multiple items from different pharmacies, due to differences in availability, which is common for medications. We propose a mixed-integer linear programming model with pickup and delivery services using a single truck and multiple drones with multi-payload capacity. We solve realistically sized instances by using a novel variant of Simulated Annealing and reduce the total service time significantly relative to traditional truck-only approaches.

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SD20

CC-North 128A

Medical Decision Making

Community Committee Choice Session

Session Chair: Narges Mohammadi, [1</sup]

1 More than Predictions: Machine Learning Interpretability for Clinically Actionable Bone Marrow Transplant Decisions

Yiyang Qu[1], Hamed Shourabizadeh[1], Dionne Aleman[1], Louis-Martin Rousseau[2], Fotios V. Michelis[3], [1]University of Toronto, Toronto, ON, Canada; [2]Polythechnique Montreal, Montreal, QC, Canada; [3]Princess Margaret Cancer Centre, Toronto, ON, Canada. Contact: aleman@mie.utoronto.ca

Allogeneic hematopoietic cell transplant (HCT) is a common treatment for leukemia and other hematological disorders, however, mortality remains high. We develop machine learning methods to better predict HCT outcomes for individual patient-donor pairs, using single-center data to best capture hidden but important factors. Our framework stratifies patients into risk-based Kaplan-Meier survival curves, facilitating more individualized treatment decisions compared to the standard survival analysis used in clinical research, which may not reflect specific patient characteristics. We then use explainable AI methods to discover new and impactful correlations between variables and outcomes that can be communicated to clinicians, specifically finding and verifying that the CD34+ stem cell dose should be tailored by patient age for acute leukemia patients.

2 Cost-Effectiveness of a Network of Lethal Ovitraps for the Prevention and Control of Dengue Fever

Yvonne Huijun Zhu[1], Joel Aik[2], Shuzhen Sim[2], Joel Goh[3], [1]National University of Singapore, Singapore, Singapore; [2]National Environment Agency, Singapore, Singapore; [3]NUS Business School, Singapore, Singapore. Contact: huijun96@u.nus.edu

We analyze the system-level cost-effectiveness of a network of lethal ovitraps for Dengue control. Benefits are modeled using an age-stratified multiple-infection epidemiological model and measured as reductions in disability-adjusted-life-years (DALYs). We estimate labor costs by modeling the workload needed for periodic maintenance of the traps via Traveling Salesmen Problems (TSPs).

3 Efficient Discovery of Cost-Effective Policies in Sequential, Medical Decision Making Problems

Narges Mohammadi[1], Reza Skandari[1], Anand Shah[2], [1]Imperial College Business School, London, United Kingdom; [2]Imperial College London, London, United Kingdom. Contact: n.mohammadi19@imperial.ac.uk

Policymakers use cost-effectiveness analysis to prioritize healthcare interventions. We develop an efficient algorithm that discovers the cost-effectiveness frontier and policies for sequential stochastic optimization problems and use it to devise easy-to-implement hearing loss screening strategies for patients with cystic fibrosis. We prove the theoretical properties of the solution methods.

4 Balancing Speed with Safety: An Analytical Approach to Improve FDA's Premarket Approval Pathway

Mohammad Zhalechian[1], Soroush Saghafian[2], Omar Robles[2], Anders Olsen[2], [1]Indiana University, Bloomington, IN, [2]Harvard University, Cambridge, MA

For a medical device to be approved under the FDA's Premarket Notification 510(K) pathway, the manufacturer can submit a claim indicating that it is as safe and effective as another legally marketed device. This vague regulatory process has led to a high recall rate for devices approved under this pathway, raising important concerns over the approach used by FDA. To find ways to improve this process, we have assembled a unique large-scale dataset that includes information on devices approved under this pathway from 2008 to 2020. We develop machine learning models capable of predicting the chance of recall for each applicant device, and make use of them to provide a data-driven policy for the FDA to improve its acceptance/rejection decisions.

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SD21

CC-North 128B

Statistical Learning Problems in Healthcare

Community Committee Choice Session

Session Chair: Ozge Yapar, Indiana University, Kelley School of Business, Bloomington, IN

1 Experimentation Levels and Social Welfare Under FDA's Flexible Approval Policy

Amin Khademi[1], Hamed Rahimian[1], Saeid Delshad[2], [1]Clemson University, Clemson, SC, [2]Clemson University, Central, SC, Contact: khademi@clemson.edu

The goal of this work is to study the impact of flexible approval standards on the experimentation levels and social welfare when pharmaceutical companies (firms) are strategic. Specially, one research question is under what conditions flexible approval standards can incentivize research for developing new drugs for rare diseases. We consider a Stackelberg game with the FDA and two firms in two distinct markets (diseases). The FDA sets the approval standards to maximize the social welfare consisting of benefit/cost of approving an effective/ineffective drug, and each firm seeks to maximize its payoff, consisting of the experimentation cost and potential benefit of taking the drug to the market upon approval, which is modeled by an optimal stopping of a diffusion process.

2 Combining Pre-Approval Clinical Trials and Post-Approval Spontaneous Adverse Event Reporting for Improved Safety Signaling

John M. Silberholz[1], Fernanda Bravo[2], Yunliang Chen[3], [1]University of Michigan Ross School of Business, Ann Arbor, MI, [2]UCLA Anderson School of Management, Los Angeles, CA, [3]University of California, Berkeley, Berkeley, CA

A classical question in pharmacovigilance is how to combine pre-approval RCTs and post-approval surveillance data to increase the power for side effect detection. A key step is to learn the degree to which the observational data is biased before one can combine it with unbiased clinical trial data. In this work, we propose a model that uses information about common toxicities to help de-bias the observational data on rare toxicities through the correlation of bias among different toxicities (e.g., correlation due to co-reported drugs, indications, and patient health). Using Bayesian statistics, we analyze the benefit of "cross"-debiasing and identify the situation where such benefit is largest. Numerical experiments using real data from the FDA Adverse Event Reporting System (FAERS) suggest significant values of using cross-debiasing to improve drug safety signaling.

3 Personalized Incentives for Weight Loss

Qiaomei Li[1], Yonatan Mintz[1], Corrine Voils[2], Kara Gavin[2], [1]University of Wisconsin Madison, Madison, WI, [2]University of Wisconsin Madison, Madison, WI

Financial weight loss incentives administered by a mobile app have been found to help patients lose weight. However, the efficacy of these interventions is dependent on patient adherence. Thus clinicians must find the appropriate incentives to administer to patients to ensure they adhere to the intervention and influence long term behavioral change. In this talk, we develop a personalized model for the patients' decision-making process in these interventions and use it to construct personalized incentives. To validate our model we perform a computational study using data from a randomized control trial. We find our method outperforms existing machine learning methods in terms of weight loss prediction at the end of the intervention using a short time-span of data and that our approach helps improve the efficacy of the intervention program with limited resources.

4 Learning From Observational Data In Healthcare

John R. Birge, University of Chicago, Chicago, IL

Many healthcare settings offer only observational data about treatments and their outcomes. Inferring causal relationships becomes complicated by the presence of hidden or partially observed confounding variables which can influence both treatments and their outcomes. Patterns of observations within and across individuals can be used to identify these factors. This talk will describe some approaches to this identification and implications for the design of optimal treatment protocols.

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SD22

CC-North 129A

Healthcare Analytics in Emerging Data Settings

Community Committee Choice Session

Session Chair: Gian-Gabriel P. Garcia, Georgia Institute of Technology, Atlanta, GA

Session Chair: Che-Yi Liao, Georgia Institute of Technology, Atlanta, GA

1 Data-Driven Counterfactual Optimization for Personalized Clinical Decision-Making

Che-Yi Liao[1], Gian-Gabriel P. Garcia[2], Esmaeil Keyvanshokooh[3], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, [3]Mays Business School, Texas A&M University, College Station, TX

Machine learning-based health tools are becoming popular for informing treatment targets for high-risk patients with chronic diseases. However, using these tools alone, it is challenging to identify personalized treatment targets that lower the risks of adverse outcomes to a clinically acceptable range and are realistic, actionable, and robust to changes in these tools. To this end, we propose a data-driven approach called Distributionally Robust Selection of Clinical Role Models via Counterfactual Optimization (DISC^{2}O). With a case study on 5-year cardiovascular disease, we show that our model can recommend treatment targets with much lower risks of adverse health outcomes and slightly higher costs, compared to clinical practice recorded in that dataset and other benchmarks including the clinical practice that does not consider uncertainty in these health tools.

2 A POMDP Approach to Develop Anal Cancer Screening Recommendations

Jingyu Li, Lauren N. Steimle, Georgia Tech ISyE, Atlanta, GA, Contact: jli928@gatech.edu

Although anal cancer (AC) is rare in the general population, certain groups are known to be at significantly elevated risk of developing AC. Routine AC screening is considered as a potential strategy to identify high-risk individuals early and to ultimately mitigate AC burdens in high-risk groups. However, standardized AC screening has not been established. Trade-offs between higher costs of high-quality tests and lower sensitivity of more economic tests need to be assessed. In this work, we develop a POMDP model to optimize anal cancer screening strategies for HIV-positive populations in North America. Our model considers the natural history of anal carcinogenesis and HIV status jointly. We also account for the imperfect screening tests and find the optimal policy under such uncertainty.

3 Assessment for Disparities in Access to High-Quality Trauma Care Among Sociodemographic Groups

Xiaonan Sun, Shan Liu, Rebecca Maine, University of Washington, Seattle, WA, Contact: xnsun@uw.edu

Although trauma systems have been effective in reducing mortality rates among severely injured patients, access to high-quality trauma care is not equally distributed across all populations in the US. To identify these disparities, we developed a set of geospatial and non-geospatial metrics derived from routinely collected state data and linked to improved trauma care outcomes. We conducted statistical analyses to compare care quality within sociodemographic factors, including race, ethnicity, sex, age, insurance type, urban or rural residence, and Social Deprivation Index level, which have historically experienced uneven access to trauma care. Based on our findings, we propose the development of an optimization model that allocates medical resources and adjusts hospital functions to improve trauma care quality while addressing equity concerns.

4 Novel Pooling Strategies for Genetic Testing, with Application to Newborn Screening

Hussein El Hajj[1], Douglas R. Bish[2], Ebru Korular Bish[3], [1]Santa Clara University, Santa Clara, CA, [2]University of Alabama, Tuscaloosa, [3]University of Alabama, Tuscaloosa, AL, Contact: helhajj@scu.edu

Cystic fibrosis is among the most prevalent life-threatening genetic disorders, and can be caused by a large number of mutational variants. For cost-effectiveness, most U.S. newborn screening processes for cystic fibrosis start with a biomarker test, followed by a more expensive and accurate genetic test (DNA), which uses a limited variant panel, for those newborns with elevated biomarker levels.To overcome the cost barriers of expanded genetic testing, we explore a pooled DNA testing approach. This leads to a novel decision problem, to determine the variants to screen for and their assignment into multiple panels, and a pool size for each panel. We establish key structural properties of optimal designs; develop an exact algorithm that generates the Pareto optimal set of pooled DNA designs at different budgets; and derive key insights for practitioners.

5 Prescriptive 0-1 Neural Networks for Personalized Medicine

Yonatan Mintz[1], Vrishabh Patil[2], [1]University of Wisconsin Madison, Madison, WI, [2]Carnegie Mellon University, Pittsburgh, PA

A key challenge in medical decision making is learning treatment policies for patients with limited data.This challenge is particularly evident in personalized healthcare decision making, where models need to take into account the intricate relationships between patient characteristics, treatment options, and health outcomes. To address this, we introduce prescriptive networks, shallow 0-1 neural networks trained with mixed integer programming that can be used with counterfactual estimation to optimize policies in medium data settings. These models offer greater interpretability then deep neural networks and can encode more complex policies than common models such as decision trees. We show our models can outperform existing methods in both synthetic data experiments and in a case study of assigning treatments for postpartum hypertension.

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SD23

CC-North 129B

SOLA Best Student Paper Award

Community Committee Choice Session

Session Chair: Ismail Capar, Texas A&M University, College Station, TX

1 Designing Layouts for Sequential Experiences: Application to Cultural Institutions

Abhishek Deshmane, Georgia Institute of Technology, Atlanta, GA

Experience providers - ranging from retail platforms to cultural institutions - need to decide on how to display an assortment of items for physical and digital interactions. In this paper, we develop a data-driven analytics framework to optimize these layout-related decisions for maximum user engagement. We develop a new dynamic choice model, called Pathway MNL, that represents visitor activity as a sequence of conditional logit experiments. Through an ongoing collaboration with the Van Gogh Museum, we validate the model on large-scale logs of visitor activity recorded through audio guides. We uncover significant relationships between visitors' choices and layout-related factors, among others. Finally, we analyze the resulting mathematical program for layout optimization and identify simple layout interventions that can significantly lift visitor engagement.

2 Robust Data-Driven Design of A Smart Cardiac Arrest Response System

Weiliang Liu, National University of Singapore, Singapore, Singapore

This paper studies the data-driven design of a smart emergency response system for out-of-hospital cardiac arrest that involves drones for automatic external defibrillator delivery and community responders alerted via a mobile application, in addition to ambulances. Based on a dataset with community responders' records from Singapore, we develop a robust joint deployment model of drone and ambulance to maximize the survivability of the response system while accounting for data uncertainty in OHCA occurrence and responders' behavior. We find that (i) hedging against uncertainty leads to a higher survival rate of the response system; (ii) a few drones are sufficient to increase the survival rate dramatically; and (iii) the impact of the behavior of responders on survival outcomes is more significant than that of simply adding drones/ambulances.

3 Charging Station Location and Sizing for Electric Vehicles Under Congestion

Omer Burak Kinay, Amazon, Toronto, ON, Canada

4 Planning Bike Lanes with Data: Ridership, Congestion, and Path Selection

Jingwei Zhang, Cornell University, Ithaca, NY

We study the bike lane planning problem considering its conflicting effects in reducing and increasing traffic congestion. In an extensive case study in Chicago, we estimate adding 25 miles of prescribed bike lanes can lift cycling mode share from 3.6% to 6.1%, with at most an 9.4% increase in driving times.

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SD24

CC-North 130

Social Network and Platform Operations

Community Committee Choice Session

Session Chair: yunduan Lin, University of California, Berkeley, Berkeley, CA

Session Chair: Zuo-Jun Max Shen, University of California Berkeley, Berkeley, CA

1 Optimal Subscription Pricing for Ridesharing Platforms

Shreyas Sekar[1], Hongyao Ma[2], Ben Berger[3], David C. Parkes[4], [1]University of Toronto, Toronto, ON, Canada; [2]Columbia University, New York, NY, [3]Tel Aviv University, Tel-Aviv, -, Israel; [4]Harvard University, Boston, MA

Ridesharing platforms have experimented extensively with subscription programs. Despite the large number of offers that users have been subject to, there seems to be little consensus on what a good subscription looks like. In this work, we study the design of subscription mechanisms in ridesharing with the goal of maximizing social welfare. Contrary to folk wisdom, any market equilibrium using *per-trip pricing only* is inefficient due to the presence of network effects.

We establish that when riders are homogeneous, a simple subscription (for example, pay a $10 fee to get $2 off every ride for a month) can in fact achieve the first-best social welfare. With a view towards operationalizing such a mechanism, we consider two extensions and show how to implement good subscriptions when a) many riders do not subscribe, and b) riders are heterogeneous in their trip frequency.

2 Contextual Stochastic Bilevel Optimization And End-to-end Learning

Yifan Hu[1], Jie Wang[2], Yao Xie[2], Andreas Krause[3], Daniel Kuhn[4], [1]EPFL, Lausanne, Switzerland; [2]Georgia Institute of Technology, Atlanta, GA, [3]ETH Zurich, Zürich, Switzerland; [4]Ecole Polytechnique Federale de Lausanne (EPFL), Lausanne, Switzerland. Contact: yifan.hu@epfl.ch

We introduce contextual stochastic bilevel optimization, a stochastic bilevel optimization template with the lower-level problem minimizing an expectation conditioned on some contextual information and the upper-level decision variable. This framework captures important applications such as meta-learning, causal optimal transport, and end-to-end learning. Due to the presence of contextual information, existing single-loop methods for classical stochastic bilevel optimization all fail. To overcome this challenge, we introduce an efficient double-loop gradient method based on the Multilevel Monte-Carlo technique and establish its sample and computational complexities. When specialized to stochastic nonconvex optimization, our method matches existing lower bounds. Extensive numerical experiments validate our theoretical results.

3 Dynamic Matching of Users and Creators on Social Media Platforms

Daniel Huttenlocher, Hannah Li, Liang Lyu, Asuman Ozdaglar, James Siderius, Massachusetts Institute of Technology, Cambridge, MA, Contact: lianglyu@mit.edu

Social media platforms are two-sided markets bridging content creators and users together. Existing literature on content recommendation algorithms used by platforms often focuses on user preferences, neglecting creator incentives to produce content. Creators may be dissatisfied with a small audience and leave the platform, which can deter their followers from engaging and induce more creators to leave. We propose a model of content recommendation where the platform matches users and creators sequentially, and players strategically decide to stay or leave at each time step. We show that only maximizing immediate engagement can perform poorly in the long run, but even approximating the first-best long-term engagement is NP-hard. We present heuristic-based algorithms with good long-term performance in a number of practical instances, with provable guarantees.

4 Nonprogressive Diffusion on Social Networks: Approximation and Applications

yunduan Lin[1], Heng Zhang[2], Renyu Zhang[3], Zuo-Jun Max Shen[4], [1]University of California, Berkeley, Berkeley, CA, [2]Arizona State University, Tempe, AZ, [3]The Chinese University of Hong Kong, Hong Kong, China; [4]University of California Berkeley, Berkeley, CA, Contact: yunduan_lin@berkeley.edu

Our paper proposes a model and a fixed-point approximation (FPA) scheme for characterizing adoption limits in nonprogressive diffusion on social networks. The scheme offers both theoretical guarantee and computational efficiency, with maximal deviation decreasing as network size and density increase, making it suitable for dense networks. Taking the widely studied influence maximization and pricing problems on a social network as examples, we further illustrate the broad applications of our FPA scheme. Finally, we conduct comprehensive numerical studies with synthetic and real-world networks. The FPA scheme shows 1,000 times more speed up in computation time than simulation. It achieves small approximation error, and outperforms conventional algorithms even when the social network is small and/or sparse.

5 Incentivizing High-Quality Content in Online Recommender Systems

Xinyan Hu, Meena Jagadeesan, Michael Jordan, Jacob Steinhardt, UC Berkeley, Berkeley, CA, Contact: xinyanhu@berkeley.edu

For content recommender systems, the platform's decision algorithm shapes the incentives of content producers. Many platforms employ online learning, which creates intertemporal incentives, since content produced today affects recommendations of future content. In this paper, we study the incentives produced by online learning, analyzing the quality of content produced at Nash equilibrium. We show that classical online learning algorithms, such as Hedge and EXP3, incentivize producers to create low-quality content. Motivated by this negative result, we design a different learning algorithm that correctly incentivizes producers to create high-quality content.

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SD25

CC-North 131A

Empirical Studies in Healthcare Operations

Community Committee Choice Session

Session Chair: Fanyin Zheng, Columbia University, New York, NY

Session Chair: Yiwen Shen, HKUST, New York, NY

1 The Impact of Surgeon Daily Workload and Its Implications for Operating Room Scheduling

Yiwen Shen[1], Carri Chan[2], Fanyin Zheng[3], Michael Argenziano[4], Paul Kurlansky[4], [1]HKUST, Hong Kong, China; [2]Columbia Business School, New York, NY, [3]Columbia University, New York, NY, [4]Department of Surgery, New York Presbyterian/Columbia University Irving Medical Center, New York, NY, Contact: yiwenshen@ust.hk

In healthcare service systems, the workload level can substantially impact service time and quality. We investigate this relationship in the context of cardiac surgery. Using 5,600 cardiac surgeries in a large hospital, we quantify how individual surgeon's daily workload (number of cases performed in a day) affects surgery duration and patient outcomes. To handle the endogeneity issue, we construct novel instrument variables using hospital operational factors. We find surgeon's high daily workload leads to longer OR times and post-surgery length-of-stay. We develop a scheduling model that incorporates the estimated effects and show that it can lead to substantial improvement.

2 Adaptive Server Behavior to Schedule Deviations and Its Consequences: Evidence from Operating Rooms

Yiwen Jin[1], Yichuan Ding[2], Steven Shechter[1], Jugpal Arneja[3], [1]Sauder School of Business, UBC, Vancouver, BC,

Canada; [2]McGill University, Montreal, QC, Canada; [3]UBC, Vancouver, BC, Canada

We study how clinical teams adaptively adjust their service speed in response to real-time deviations from the planned operating room schedules and the further impacts on post-surgical risks. Using a unique surgery data set with actual and scheduled surgery time stamps, we find clinical teams speed up when they fall behind and slow down when they get ahead of schedule, with the slowdown exhibiting a stronger effect. We leverage the deviations from the schedule as an instrument variable and present a causal study that a faster-than-scheduled procedure duration erodes quality by increasing readmissions and reoperations. In a counterfactual analysis, we obtain a convex relationship between readmissions/reoperations and end-of-shift (EOS). Our findings help managers in scheduling surgeries to achieve desired efficiency-quality trade-offs and predict EOS time better.

3 Learning from Quality Signal to Improve Fairness and Accuracy: Evidence from the Hospital Readmissions Reduction Program

Mohamad Soltani[1], Robert Batt[2], Hessam Bavafa[2], [1]Alberta School of Business, University of Alberta, Edmonton, AB, Canada; [2]Wisconsin School of Business, UW-Madison, Madison, WI, Contact: soltani@ualberta.ca

Policymakers often employ quality indicators to evaluate the performance of an organization and to provide incentives for quality improvements. A potential concern, however, is that a specific quality indicator may not truly reflect the quality that is attributed to the performance of the organization. We explore the effects of the Hospital Readmissions Reduction Program on 30-day readmissions in over 2,000 hospitals in the U.S. Whereas the policy is indifferent between readmission reduction during the 30-day time window, we find that the level of improvement depends on the timing of readmission. We attribute this difference to the control that hospitals have over readmissions. This finding shows that 30-day readmission rate does not provide an accurate quality signal, and thus HRRP is not fair toward hospitals that treat low-income patients with limited access to care.

4 Community/Committee'S Choice Submission

Kamalini Ramdas, London Business School, London, United Kingdom

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SD26

CC-North 131B

Crypto and Blockchain Economics

Community Committee Choice Session

Session Chair: Fasheng Xu, Syracuse University, Long Island City, NY

1 Equilibrium in a Defi Lending Market

Thomas Rivera[1], Fahad Saleh[2], Quentin Vandeweyer[3], [1]McGill University, Montreal, QC, Canada; [2]Wake Forest University, Winston-Salem, NC, [3]University of Chicago, Chicago, IL

We provide an economic model of lending on a blockchain. Such lending suffers a disadvantage when compared to traditional lending due to an inability to incorporate external information into setting interest rates (i.e., the Oracle Problem). For this reason, a blockchain lending equilibrium produces lower welfare than a competitive lending market equilibrium. We nonetheless show that an improvement in design is feasible to generate equilibrium interest rates, and therefore welfare, that is arbitrarily close to a competitive lending market equilibrium.

2 On The Security Of Optimistic Blockchain Mechanisms

Jiasun Li, George Mason University, Fairfax, VA

Many new blockchain applications (e.g., layer-2 scaling solutions, proof-of-stake layer-1 chains, and cross-chain bridges, etc.) adopt an "optimistic" design, that is, the system proceeds as if all participants are well-behaving, presumably sustained by some "stake-and-slash" mechanisms. We formulate the logic of such optimistic systems within a simple game and characterize all equilibria. We point out that such protocols cannot be secure if all participants are rational. Therefore, to ensure security, protocol designers have to either impose a trust assumption regarding the presence of altruistic participants or look for alternative designs (e.g., zero-knowledge proof-based designs).

3 Toward Understanding the Bitcoin Mining and Exchange Markets

Bowen Lou, University of Connecticut

We formulate a systematic framework that encompasses key dimensions of the Bitcoin exchange market, exchange rate and liquidity, and jointly model the entry and exit of the Bitcoin mining market, characterized by the supply and demand of mining rigs. By leveraging a unique dataset of the purchase and listing of mining rigs from a leading e-commerce platform, we find that the effects of key dimensions are pronounced for investors, as potential entrants to the Bitcoin mining market. They have a significant impact on the demand for mining rigs. Furthermore, our results indicate that the electricity consumption of mining Bitcoin moderates the effect of the Bitcoin exchange rate and liquidity on the demand for mining rigs.

4 Unobservable Investment Amount, Inventory Salvage Value, and Trade Credit

Jie Ning[1], Peter Ritchken[2], [1]Case Western Reserve University, Cleveland, OH, [2]Case Western Reserve, Cleveland, OH, Contact: jie.ning@case.edu

Input inventory fuels production and innovation. A cash-strapped firm with limited input inventory needs to borrow money to purchase more. In this case, the lender is an outside funder who does not observe the amount of inventory invested. We study such investment amount unobservability, accounting for inventory depreciation. Surprisingly, this financial friction has no effect on firms with risk-free production and random demand. In contrast, this friction may lead to high financing cost and under-investment for firms with risky innovation and fixed demand. We propose that the buyer-supplier interaction in trade credit (TC) mitigates this unobservability, and show that this mitigation creates value only if it goes all the way, i.e., when the firm offers full transparency to the supplier.

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CC-North 131C

Parity, Priority, and Platforms

Community Committee Choice Session

Session Chair: Luyi Yang, University of California, Berkeley, Berkeley, CA

Session Chair: Shiliang Cui, Georgetown University, McDonough School of Business, McLean, VA

1 Advance Selling and Upgrading in Priority Queues

Yaolei Wang[1], Ping Cao[2], Jingui Xie[3], Dongyuan Zhan[4], [1]USTC, Hefei, China; [2]U of Science and Technology of China, Hefei, China; [3]Technical University of Munich, Heilbronn, Germany; [4]University College London, London, United Kingdom. Contact: d.zhan@ucl.ac.uk

We study advance selling and upgrading in a priority queue setting that emerges in the amusement park industry. Customers choose to buy the fastrack or regular tickets depending on their heterogeneous waiting costs. Advance tickets are cheaper, but buyers suffer from congestion uncertainty. Upgrading options allow customers to purchase regular tickets in advance and upgrade onsite. The seller aims to find the optimal pricing scheme to maximize revenue. We find that advance selling always improves revenue but upgrading may not, and identify conditions when allowing upgrading generates more revenue. Specifically, it may be more profitable to focus advance and upgrading prices on online customers and focus spot prices on offline customers. The upgrading option, though providing greater flexibility and customized experience, hurts consumer surplus.

2 Potty Parity: Process Flexibility via Unisex Restroom

Setareh Farajollahzadeh[1], Ming Hu[2], [1]University of Toronto, Toronto, ON, Canada; [2]University of Toronto, Minneapolis, MN, Contact: ming.hu@rotman.utoronto.ca

Our paper analytically studies the issue of unequal access to restrooms for women and LGBTQ+ individuals and designs a plan to improve efficiency and fairness measured by totalitarian, Rawlsian fairness, and strict equality principles. While an all-unisex restroom design may seem like a viable solution, with everyone standing in the same line and pooling flexible servers, our analysis shows that it can lead to a decline in both efficiency and fairness measures. Instead, we suggest converting a men's restroom unit to a unisex restroom with some flexibility, improving both efficiency and fairness measures and reducing wait time disparities between gender-segregated restrooms. Therefore, a little-flexible system outperforms a fully flexible one.

3 Surge Pricing and Dynamic Matching for Hotspot Demand Shock in Ridehailing Networks

Philipp Afèche[1], Costis Maglaras[2], Zhe Liu[3], [1]University of Toronto, Rotman School of Management, Toronto, ON, Canada; [2]Columbia Business School, New York, NY, [3]Imperial College Business School, London, -, United Kingdom. Contact: afeche@rotman.utoronto.ca

We study a ride-hailing platform that matches price- and-delay sensitive riders with strategic drivers in the presence of an unpredictable demand shock at a hotspot. Our model captures the interplay of nonstationary demand, spatially distributed strategic supply, and delayed and risky supply response and incentives. We consider dynamic policies that jointly determine surge prices for riders, surge wages for drivers, and the spatial matching of riders to drivers. We characterize the structure and compare the performance of various policies that differ in terms of three attributes, temporal differentiation, spatial differentiation and risk sharing. Our results identify how system performance depends on the key timescales of rider patience and demand shock duration.

4 The Impact of Information Granularity and Priority in Managing Strategic Customers' Service Choices

Yue Hu[1], Ricky Roet-Green[2], Lin Zang[2], [1]Stanford University, Stanford, CA, [2]Simon Business School, University of Rochester, Rochester, NY, Contact: lzang@simon.rochester.edu

We study service systems with two types of service providers: the specialist and the generalist. The specialist can fulfill the service requirement of all customers, whereas the generalist can successfully serve customers with a probability that decreases with the customer's service complexity level. Upon an unfulfilled visit at the generalist, the customer needs a follow-up visit at the specialist. We model customers' strategic choices between the two service providers as a queueing game, and characterize the equilibrium of the queueing game and the socially optimal customer choices. We investigate the impact of information granularity, and find that improving customers' perception of their service complexity levels is not always optimal. This limitation can be overcome by simultaneously deploying a priority rule that can induce the social optimum.

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CC-North 132A

Socially Responsible and Sustainable Supply Chain Management

Community Committee Choice Session

Session Chair: Han Zhang, Michigan State University, East Lansing, MI

1 Buyer Engagement in a Supplier's Social Responsibility Risk Management: Prevention, Detection, and Remediation

Junhao Vincent Yu[1], Tim Kraft[2], [1]Miami University, Oxford, OH, [2]NC State - Poole College of Management, Raleigh, NC, Contact: vincentyu@miamioh.edu

We study how buyers can proactively manage their suppliers' responsibility risk. We focus on a retailer's risk management strategy and consider three tactics the retailer can deploy—prevention, detection, and remediation—and study how combining the three can help the retailer achieve optimal results.

2 Financing and Farm-Gate Pricing Strategies for Agricultural Cooperatives with Cash-Constrained Farmers

Tava Olsen[1], Xiaoyan Qian[2,3], Spring Zhou[4], [1]Melbourne Business School, Melbourne, Australia; [2]University of Auckland?, Auckland, New Zealand; [3]Dongbei University of Finance and Economics, Dongbei, China; [4]University of Wollongong, Wollongong, Australia

Capital investment in agricultural cooperatives (co-ops) is typically limited to farmer-members; yet farmers are usually cash-constrained. In addition to common stock that is required from farmer-members, many coops are changing their financial structures by raising capital from external funds. This helps co-ops to collect enough capital, but also imposes several regulatory constraints due to the unique features of co-ops. In this talk, we present a modeling framework to examine a co-op's farm-gate pricing and financing strategies, considering two types of external equity: preferred stock that bears a fixed dividend rate and outside stock that carries the same economic rights as common stock. We leverage our analysis to offer tangible insights that can help an agricultural co-op to relieve financial constraints.

3 Fairness Regulation of Prices in Competitive Markets

Xingyu Fu, Hong Kong University of Science and Technology, Hong Kong, Hong Kong. Contact: xingyu.fu@connect.ust.hk

The loyalty penalty is a pricing strategy where firms charge higher prices to loyal customers while offering lower prices to non-loyal customers. In this study, we study the implications of fairness regulation to curb this unfair practice. We examine duopoly competition in two markets, where consumers are loyal to different firms in each market. The regulation mandates that the price gap between the two markets must not exceed a threshold. Our analysis reveals an intriguing interplay between competition and fairness regulation. When competition is intense, fairness regulation can mitigate competition between firms, resulting in Pareto improvements. On the other hand, when competition is weak, fairness regulation can enhance firms' existing monopoly power, potentially leading to collusive high prices that are detrimental to consumers.

4 Data-Driven Design of Index-Based Yield Protection Policy

Kehan Lu, Jing-Sheng Jeannette Song, Can Zhang, Duke University, Durham, NC

We study the design of a novel index-based yield protection policy offered by the government to subsidize smallholder farmers from crop yield loss. This policy uses an index-projected yield based on accessible yield-related features to determine government subsidy payments, avoiding costly actual yield assessments. However, existing policy designs emphasize accurate yield prediction, which may not lead to maximized the net benefit (farmers' utility minus government expenditure), especially with risk-averse farmers. We propose a one-step learning and optimizing framework that directly aims to maximize the net benefit. We prove the superiority of our framework over popular methods and establish performance guarantees for the learning algorithm. We also quantify the value of our framework by applying it to real livestock mortality data in Kenya.

5 Shipment Monitoring, Allocation and the Impact on Food Waste

Tao Lu, University of Connecticut, Storrs, CT

Sensor technologies enable supply chain firms to monitor the condition of each product unit and allocate them to destination markets of different transportation distances based on their conditions. A firm purchases a fresh produce for sale in two markets with uncertain demands. Post-harvest processes render a (possibly random) proportion of the product likely to spoil in transit. The longer the transportation distance, the higher the spoilage risk. The firm solves a two-stage optimization: It first determines a purchase quantity, and then decide how to allocate each unit (in either good or risky condition) between markets. We characterize the structure of optimal allocation policies and then use it to solve the first-stage problem. We find that shipment monitoring, despite being advocated for the potential to reduce food waste, may increase the total waste.

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CC-North 132B

Value Chain Innovation: Pricing, Market Expansion, and Demand Learning

Community Committee Choice Session

Session Chair: Shi Chen, University of Washington, Foster School of Business, Seattle, WA

1 Dynamic Two-Part Pricing and Bidding for Display Ad Campaigns

Sami Najafi Asadolahi, Naren Agrawal, Stephen A. Smith, Santa Clara University, Santa Clara, CA, Contact: snajafi@scu.edu

Display advertising's growth has transformed business engagement with target audiences. Despite its benefits, managing campaigns is challenging due to uncertainties in arrival rates, user visits, and real-time auction outcomes. We aim to devise an optimization method for agencies to profitably price and bid for campaigns while maintaining clients expectations. We formulate real-time bidding strategies for impressions and pricing strategies for new campaigns, through a Markov decision process to maximize profits. Through analysis, we offer valuable insights, demonstrating the efficacy of strategies based on campaign arrival intensity. We present a practical, easily implementable heuristic that efficiently consolidates requested impressions into larger blocks, significantly reducing computation time while maintaining minimal impact on expected profit.

2 Supply Chain Contracting Under Nonparametric Demands

Shi Chen[1], Haipeng Luo[2], Yingfei Wang[3], Mengxiao Zhang[4], [1]University of Washington, Foster School of Business, Seattle, WA, [2]University of Southern California, Los Angeles, CA, [3]University of Washington, Seattle, WA, [4]University of Southern California, Los Angeles, CA, Contact: shichen@uw.edu

In this work, we re-consider the classic supply chain coordination and contracting problem but with unknown, nonparametric demands. We aim at developing online learning algorithms for the revenue-sharing and buy-back contracts such that both parties - the manufacturer and the retailer - achieve favorable regret bounds. For the retailer, our algorithm is essentially a stochastic online convex optimization problem with a high-probability regret guarantee. For the manufacturer, our algorithm is based on but different from the classic binary search, as the observation at each time period is not i.i.d but adaptively changing, noting that the retailer is also using an online algorithm to learn the optimal order quantity given the changing contract parameter values.

3 A Non-Parametric Learning Algorithm for a Stochastic Multi-Echelon Inventory Problem

Cong Yang[1,2], Tim Huh[3], [1]University of British Columbia, Vancouver, BC, Canada; [2]University of British Columbia, Vancouver, BC, Canada; [3]University of British Columbia, Vancovuer, BC, Canada

We consider a periodic-review single-product multi-echelon inventory problem with instantaneous replenishment. In each period, the decision-maker makes ordering decisions for all echelons. Any unsatisfied demand is backordered, and any excess inventory is carried to the next period. In contrast to the classic inventory literature, we assume that the information of the demand distribution is not known a priori, and the decision-maker observes demand realizations over the planning horizon. We propose a non-parametric algorithm that generates a sequence of adaptive ordering decisions based on the stochastic gradient descent method. We compare the T-period cost of our algorithm to the clairvoyant, who knows the underlying demand distribution in advance, and we prove that the expected T-period regret is at most O(√ T), matching a lower bound for this problem.

4 Startup Blitzscaling and the Venture Capital Method

Yishen Cai[1], Lingxiu Dong[2], Fasheng Xu[3], [1]University of Miami Herbert Business School, Miami, FL, [2]Washington University in St. Louis, Saint Louis, MO, [3]Syracuse University, Long Island City, NY, Contact: c.yishen@wustl.edu

Blitzscaling is a business strategy that prioritizes growth over efficiency in profit and it is typically found among expansion-stage startups. It attempts to expand both the market and the size of the operation with significant costs financed by serious investors such as Venture Capitalists (VCs). In practice today, the standard equity finance mechanism between a VC and a startup is derivative of Venture Capital Method. Contrary to other equity finance schemes, VC finance features an investor whose entire profit model pivoted on exit rather than profit sharing. The investee is a long-term (3-7 years) high-risk (90% failure) startup venture. We try to close the gap between practice and literature by modeling an expansion stage VC-backed startup with operational decisions that allocate a limited budget on marketing and capacity under different types of VC contracts.

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CC-North 132C

Business Model Innovation: Models and Empirical Analysis

Community Committee Choice Session

Session Chair: Guangwen (Crystal) Kong, Temple University, Philadelphia, PA

Session Chair: Jingxuan Geng, Temple University, Philadelphia, PA

1 Inducing Effort and Adoption of Agriculture Innovation from Risk-Averse Farmers

Ruiping Ke[1], Lingxiu Dong[1], Jie Ning[2], [1]Washington University in St. Louis, Saint Louis, MO, [2]Case Western Reserve University, Cleveland, OH, Contact: k.ruiping@wustl.edu

It is challenging to induce risk-averse farmers to adopt agriculture innovations that are inherently risky and require set-up effort. We propose a novel debt-like contract to address this challenge. We investigate how this contract incentivizes a farmer to exert effort and provide conditions under which it yields a win-win outcome.

2 When Less is More: An Analytical Analysis and Empirical Evidence of a Telemedicine Platform

Jingxuan Geng, Guangwen (Crystal) Kong, Marco Qin, Temple University, Philadelphia, PA, Contact: jingxuan.geng@temple.edu

We consider a telemedicine platform that allows patients to seek multiple medical diagnoses from doctors online. We find that the pricing mechanism alone may yield a downward distortion on price to prevent doctors' over-participation compared to a centralized benchmark. With a control limit on the diagnosis number per inquiry, the platform can charge higher while maintaining an appropriate number of doctors' responses. When patients are delay sensitive, a platform may benefit from their increased delay sensitivity, and the profit improvement from the control limit may decrease with delay sensitivity. When doctors are heterogeneous in their service quality, the low-quality doctors may drive out all high-quality doctors. A control limit could increase high-quality doctors' participation. We empirically test the predictions and they support the analytical results.

3 Project Selection in Strategic Alliances

Pascale Crama[1], Guiyun Feng[2], Wenqi Lian[3], [1]Singapore Management University, Singapore, Singapore; [2]Singapore Management University, singapore, Singapore; [3]Lingnan University, Hong Kong, Hong Kong. Contact: pcrama@smu.edu.sg

Firms join in strategic R&D alliances to collaborate on multiple projects by combining R&D and marketing capabilities. The formation and structure of such an alliance must consider incentive and project selection issues in the presence of technical and market uncertainty, resource and market interactions, and varying levels of capabilities. Upfront contracts allow to reduce resource constraints, but reduce the ability to react to market uncertainty. We show how high levels of market uncertainty increase the impact of the innovator's marketing capabilities, where intermediate levels of marketing capabilities may be preferred.

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CC-North 221A

AI / OR Applications in Sustainability and Climate Change

Community Committee Choice Session

Session Chair: Dr. Kedar Kulkarni, Jio AI Center of Excellence, Bangalore, India

1 AI Driven Predictive Maintenance of Photovoltaic (PV) Panel Junction Boxes

Anand Thirwani, Kedar Kulkarni, Rahul Nair, Jio AI Center of Excellence, Bengaluru, India

PV (photo-voltaic) panel manufacturing is a complex process and requires a high degree of precision to produce high-quality PV cells. A junction box is a crucial component in PV panels that shields the electrical connections between PV panels and the power generation system. Faults in junction boxes could adversely impact the system's performance, safety, and lifespan. Soldering issues in the junction box may result in high resistance and heating, which may lead to a fire. Identifying defective junction boxes is difficult and requires expert intervention. We propose an automated approach using machine learning and computer vision to detect defects using images of junction box inter-connect bends. This could significantly enhance the durability and performance of solar power generation systems.

2 From Disclosure to Action: Data-Driven Decarbonization for Enterprises

Vinamra Baghel[1], Ayush Jain[2], Jagabondhu Hazra[1], Manikandan Padmanaban[3], Ranjini Guruprasad[4], [1]IBM Research India, Bangalore, India; [2]IBM Research India, Lucknow, India; [3]IBM Research Labs, Bangalore, India; [4]IBM Research India, Bengaluru, India. Contact: jahazra1@in.ibm.com

Enterprises face immense pressure to address climate change by disclosing and reducing their GHG emissions across activities. While many companies have committed to long-term net-zero targets, there is a need for a systematic approach that can help enterprises to identify opportunities that can help them reduce their emissions. We address this gap by leveraging enterprise environmental data available in open domain and using data-driven approaches to create a sustainability knowledge base. We further perform clustering of enterprises based on parameters such as sector, geography, size, etc. We use the knowledge base and clusters to learn from similar enterprises and supply chains in to identify enterprise decarbonization projects.

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CC-North 221B

Conic Optimization: Theory and Methods

Community Committee Choice Session

Session Chair: Mohammadhossein Mohammadisiahroudi, Lehigh University, PA

Session Chair: Pouya Sampourmahani, Lehigh University, PA

1 Spectral Bundle Methods for Primal and Dual Semidefinite Programs

Feng-Yi Liao[1], Lijun Ding[2], Yang Zheng[1], [1]University of California San Diego, San Diego, CA, [2]Wisconsin Institute for Discovery, Madison, WI, Contact: fliao@ucsd.edu

In this work, we present an overview and comparison of spectral bundle methods for solving both *primal* and *dual* semidefinite programs (SDPs). In particular, we introduce a new family of spectral bundle methods for solving SDPs in the *primal* form. The algorithm developments are parallel to those by Helmberg and Rendl, mirroring the elegant duality between primal and dual SDPs. The new family of spectral bundle methods achieves linear convergence rates for primal feasibility, dual feasibility, and duality gap when the algorithm captures the *rank of the dual solutions*. The original spectral bundle method by Helmberg and Rendl is well-suited for SDPs with low-rank primal solutions, while on the other hand, our new spectral bundle method works well for SDPs with low-rank dual solutions. These theoretical findings are supported by a range of large-scale numerical experiments.

2 On the Longest Chain of Faces of Completely Positive and Copositive Cones

Mitsuhiro Nishijima[1,2], [1]Tokyo Institute of Technology, Tokyo, Japan; [2]The Institute of Statistical Mathematics, Tokyo, Japan. Contact: nishijima.m.ae@m.titech.ac.jp

We study the *length of the longest chain of faces* and the *distance to polyhedrality* of closed convex cones. These lengths are related to various quantities in linear algebra and optimization, such as the Carathéodory number and the singularity degree. We establish that for any closed convex cone K sandwiched between a completely positive cone and a doubly nonnegative cone of order n, the length of the longest chain of faces of K is $n(n+1)/2 + 1$, and if $n \geq 2$, the distance to polyhedrality of K is $n(n+1)/2 - 2$, which are the worst cases possible for these lengths. The same results also hold for the dual cone, where K lies between the dual of a doubly nonnegative cone and a copositive cone.

3 A Higher-Order Interior Point Method for Semidefinite Optimization Problems Failing Strict Complementarity Condition

Pouya Sampourmahani[1], Ali Mohammad Nezhad[2], Tamás Terlaky[1], [1]Lehigh University, Bethlehem, PA, [2]University of North Carolina at Chapel Hill, Chapel Hill, NC

Semidefinite optimization (SDO) problems are known to be solved efficiently using interior point methods (IPMs), however superlinear convergence is achieved only under the strict complementarity condition. Failing strict complementarity leads to losing analyticity of the central path at optimality. Based on a semi-algebraic description of the central path, we reparametrize the central path and then propose an IPM that exploits higher-order derivatives of the parametrized central path. We discuss the local convergence of our higher-order IPM and then present the numerical results.

4 Interior-Point Algorithms for Solving Sufficient Linear Complementarity Problems Based on a New Class of AET Functions

Tibor Illés, Corvinus University of Budapest, Budapest, Hungary

We propose new interior-point algorithms to solve sufficient linear complementarity problems. To define the search directions, we apply the algebraic equivalent transformation (AET) technique. We introduce a new class of AET functions, which differs from the classes used in the literature to determine search directions. We provide example AET function from our new class, which does not belong to the class of concave functions proposed by Haddou et al. Furthermore, the kernel function belonging to this AET function is neither eligible, nor self-regular kernel function. We prove that the interior-point algorithms using any member of this new class of AET functions have polynomial iteration complexity in the size of the problem, bit length of the data and in a special parameter, called handicap.

5 Solving Choice-Based Linear Programs in Huge Scale

Donghao Zhu[1], Hanzhang Qin[2], Kenji Fukumizu[3], [1]Techinical University of Munich, Munich, Germany; [2]Amazon, Jersey City, NJ, [3]The Institute of Statistical Mathematics, Tokyo, Japan. Contact: donghao.zhu@in.tum.de

Addressing huge-scale (extremely large) modeling challenges, like optimizing product assortments for online shopping platforms during promotional campaigns, can be daunting. To tackle such scenarios, we propose a choice-based linear programming approach. By developing a decentralized algorithm, we convert the original problem into a series of smaller sub-problems. This method has demonstrated its effectiveness in producing approximate solutions, with robust outcomes in both practical applications and theoretical contexts.

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CC-North 221C

Recent Advances in Cutting Planes

Community Committee Choice Session

Session Chair: Aleksandr M. Kazachkov, University of Florida, Gainesville, FL

1 Learning Cutting Planes for Power Systems Optimization

Álinson Xavier, 1</sup

Tight formulations and cutting plane methods have been proposed for various optimization problems in power systems. However, because cuts can be computationally expensive to generate, and can make the linear programming relaxation of the problem significantly harder to solve, such approaches often fail to provide meaningful improvements in running time. This talk explores the usage of AI/ML to accelerate and improve the generation and selection of cutting planes. Computational experiments are conducted on the Security-Constrained Unit Commitment problem.

2 Solid Angle Measure for the Importance of Facets of Cyclic Group Polyhedra

Yuan Zhou, University of Kentucky, Lexington, KY, Contact: yuan.zhou@uky.edu

Solid angles of polyhedral cones, which indicate the proportion of space occupied by the cones, are of significant interest in integer programming. For example, researchers have used shooting experiments to predict the importance of facets of the cyclic group polyhedra introduced by Gomory, which are useful for generating cutting planes. However, the obtained facet sizes were not always consistent due to randomness. We propose utilizing the solid angle measure and comparing it with results from shooting experiments. The solid angle of a simplicial cone can be computed using a multivariable hypergeometric series, provided that the cone satisfies a certain condition related to positive-definiteness. We provide decomposition methods to ensure that the positive-definite criterion is met. We examine the asymptotic error of the series. Joint work with Allison Fitisone.

3 Curated Data Generation for Machine Learning-Based Cut Selection

Oscar Guaje[1], Aleksandr M. Kazachkov[2], Elias Khalil[1], [1]University of Toronto, Toronto, ON, Canada; [2]University of Florida, Gainesville, FL, Contact: o.guaje@mail.utoronto.ca

Cutting planes are a critical component of Mixed Integer Programming (MIP) solvers. In practice, decisions about which and how many cuts to add are usually made heuristically based on empirical evidence. A recent stream of research has explored the use of machine learning (ML) to inform cut selection decisions in MIP solvers. However, the performance of any cut selection strategy is tied to the strength of the generated cuts, and the possible impact of ML in cut generation remains unexplored. In this work, we present a framework to generate cuts for general MIP instances. The aim of our work is to build a curated dataset for learning to cut. Our framework addresses the following challenges that often arise in cut generation: the heuristic nature of separators, the discrepancy between traditional cut quality measures and bound improvement, and numerical issues.

4 Thinning the Herd of Open and Hard MIPLIB Models

Ed Klotz, Gurobi Optimization, Incline Village, NV, Contact: klotz@gurobi.com

The MIPLIB Mixed Integer Programming Library (https://miplib.zib.de/) classifies its models as easy (green), hard (yellow), or open (red).

This talk will consider one or two MIPs that are open or take days to solve and show how to solve them to optimality. Tactics used include visualization of the underlying process being modeled to discover useful reformulations, customized cuts to tighten the formulation, and solver parameter tuning.

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CC-North 222A

Extended Formulations for Network Optimization: Modeling, Decomposition and Applications

Community Committee Choice Session

Session Chair: Alexandre Jacquillat, MIT Sloan School of Management, Cambridge, MA

1 A New Exact Algorithm For Electric Vehicle Routing With Subpath-Based Pricing Problem Decomposition

Sean Lo[1], Alexandre Jacquillat[2], [1]MIT Operations Research Center, Cambridge, MA, [2]MIT Sloan School of Management, Cambridge, MA, Contact: seanlo@mit.edu

A critical challenge in transportation decarbonization lies in the electrification of long-haul operations along highways. To support this transition, this paper tackles the electric vehicle routing problem, and proposes a modeling and algorithmic approach to solve it without time or charge discretization. Starting with column generation for the path-based set-partitioning formulation, we develop a novel algorithm for the pricing subproblem which generates and stitches together non-dominated subpaths. We also use *ng*-route relaxations iteratively, expanding neighborhoods until one obtains elementary paths. Numerical results show that our approach outperforms state-of-the-art algorithms and scales to realistic problem sizes.

2 Design and Operation of Demand-Responsive Microtransit Systems

Bernardo Martin-Iradi[1], Kayla Spring Cummings[2], Alexandre Jacquillat[3], [1]Technical University of Denmark, Copenhagen, Denmark; [2]Massachusetts Institute of Technology, Somerville, MA, [3]MIT Sloan School of Management, Cambridge, MA, Contact: bmair@dtu.dk

Demand-responsive microtransit defines a middle ground between public transit (reference route) and on-demand mobility (real-time routing adjustments). We formulate a two-stage stochastic program to optimize network design (in the first stage) and system operations (in the second stage). We propose an effective model representation based on time-space-load networks with subpath variables. We solve it via a tailored algorithm combining Benders decomposition and column generation. Results on real-world data indicate that the proposed algorithm outperforms baseline modeling and computational approaches, and that microtransit systems can provide win-win benefits compared to transit and ride-sharing systems —higher level of service, lower operating costs, and smaller environmental footprint.

3 Fragment Based Solution Methods for Vehicle Routing Problems

Lucas Sippel, Michael Forbes, The University of Queensland, Brisbane, Australia. Contact: lucas.sippel@uq.net.au

An emerging framework for solving vehicle routing problems uses a formulation with variables for sub-paths of routes, sometimes called fragments. Previously arc-flow and route based formulations have been used. Route based formulations often have stronger linear relaxations than arc-flow formulations, at the cost of having an exponential number of variables. Fragment based formulations usually have fewer variables than their route based counterparts, and so commercial solvers can be used following variable enumeration. We will outline the fragment based formulation and describe recent advancements for solving it, particularly incorporating Dynamic Discretization Discovery and leveraging the tight lower bound of the route based formulation.

4 Multiple-Vehicle Subadditive Dispatching: Formulations, Bounds and Column Generation

Ignacio Erazo[1], Alejandro Toriello[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Tech ISyE, Atlanta, GA, Contact: iien3@gatech.edu

Motivated by applications in production scheduling, e-commerce distribution and warehousing with a trade-off between batching economies and idleness while waiting for orders, we consider a multiple-vehicle subadditive dispatching problem. The problem is strongly NP-Hard, and we propose four different MILP formulations. We devise column generation procedures to solve the linear relaxations, and then derive theoretical results on the relaxation bounds. We test the empirical performance of our methods with machine scheduling instances, and perform a case study for tactical design of a same-day-delivery system.

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CC-North 222B

On Hierarchical and Federated Optimization

Community Committee Choice Session

Session Chair: Farzad Yousefian, Rutgers University, Piscataway, NJ

1 Randomized Zeroth-Order Federated Methods for Nonsmooth Nonconvex and Hierarchical Optimization

Yuyang Qiu[1], Uday Shanbhag[2], Farzad Yousefian[1], [1]Rutgers University, Piscataway, NJ, [2]Pennsylvania State University, University Park, PA, Contact: yq117@scarletmail.rutgers.edu

Federated learning (FL) has recently emerged as an enabling framework for communication-efficient decentralized training. In this talk, we consider the development of zeroth-order FL methods for nonsmooth nonconvex and hierarchical stochastic optimization problems. We first develop a new randomized zeroth-order FL method where we leverage convolution-based smoothing and Clarke's subdifferential calculus. Secondly, we devise a unifying randomized implicit zeroth-order FL method. Importantly, this method enjoys employing single-timescale local steps, which results in significant reduction in communication overhead when addressing hierarchical problems. We provide performance guarantees for both methods. We validate the theory using numerical experiments on nonsmooth and hierarchical problems.

2 An Incremental Gradient Method for Optimization Problems with Variational Inequality Constraints

Harshal D. Kaushik[1], Sepideh Samadi[2], Farzad Yousefian[2], [1]Bayer, St Louis, MO, [2]Rutgers University, Piscataway, NJ, Contact: sepideh.samadi@rutgers.edu

We aim to minimize a sum of local nondifferentiable convex functions over the solution set of a distributed variational inequality (VI) problem with a monotone mapping. This problem finds an application in the efficiency estimation of transportation and communication networks. We develop an iteratively regularized incremental gradient method where agents communicate over a directed cycle graph to update their iterates using their local information. This method is single-timescale as it does not involve any excessive hard-to-project computation per iteration. We derive convergence rates for the global objective function's suboptimality and the VI constraints' infeasibility measured by a dual gap function. We present a numerical experiment for a transportation network problem to validate our results.

3 An Inexact Conditional Gradient Method for Constrained Bilevel Optimization

Nazanin Abolfazli[1], Ruichen Jiang[2], Aryan Mokhtari[3], Erfan Yazdandoost Hamedani[4], [1]the University of Arizona, Tucson, AZ, [2]University of Texas at Austin, Austin, TX, [3]University of Texas at Austin, Austin, TX, [4]the University of Arizona, Tucson, AZ, Contact: nazaninabolfazli@email.arizona.edu

In this talk, we focus on a class of constrained bilevel optimization problems. For those methods that can handle constrained problems, either the convergence rate is slow or the computational cost per iteration is expensive. To address this issue, in this talk, we introduce a novel single-loop projection-free method using a nested approximation technique. Our proposed method has an improved per-iteration complexity, surpassing existing methods, and achieves optimal convergence rate guarantees matching the best-known complexity of projection-free algorithms for solving convex constrained single-level optimization problems. In particular, when the upper-level objective function is convex, our method converges with the rate of ▯(▯$^{-1}$) and when it is non-convex the convergence rate will be ▯(▯$^{-2}$).

4 Stochastic and Hierarchical Multiagent Optimization

Farzad Yousefian, Rutgers University, Piscataway, NJ

In noncooperative Nash games, equilibria are known to be inefficient. This is exemplified by the Prisoner's Dilemma and was first provably shown in 1980s. We present single-timescale decentralized optimization methods for computing the best Nash equilibrium. We also discuss methods to compute the worst equilibrium.

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CC-North 222C

Optimization and Surrogate Methods for Black-Box Systems

Community Committee Choice Session

Session Chair: Hadis Anahideh, University of Illinois at Chicago, Chicago, IL

1 Scalable Grey-Box Bayesian Optimization

Raul Astudillo[1], Peter Frazier[2], [1]California Institute of Technology, Pasadena, CA, [2]Cornell / Uber, Ithaca, NY, Contact: raul.astudillo@caltech.edu

Bayesian optimization (BO) is a framework for global optimization of expensive-to-evaluate objective functions. Classical BO methods assume the objective function is a black box. However, internal information about objective function computation is often available. Recently, "grey-box" BO methods leveraging such internal information have been proposed. These methods have shown promising results, often improving performance by multiple orders of magnitude. At the same time, however, they are typically computationally challenging and thus limited to problems of moderate "size". In this talk, I will discuss recent advances improving the scalability of grey-box BO.

2 Dynamic Exploration-exploitation Pareto Approach for High-dimensional Expensive Black-box Optimization

Nazanin Nezami[1], Hadis Anahideh[2], [1]University Of Illinois at Chicago, Chicago, IL, [2]University of Illinois at Chicago, Chicago, IL, Contact: nnezam2@uic.edu

Surrogate-based optimization is prevalent in engineering to determine optimal performance parameters for costly simulations. This study proposes a Pareto sampling approach coupled with dynamic discretization for high-dimensional black-box optimization. The proposed Dynamic Exploration-Exploitation Pareto Approach (DEEPA) incorporates dynamic coordinate importance for effective sample generation in high-dimensional solution space. Incorporating dynamic coordinate importance, DEEPA employs model-based and model-agnostic feature selection to enhance sample generation. Perturbing coordinates based on importance probabilities aids convergence to near-optimal solutions. DEEPA's versatility in fixed-batch evaluation environments is demonstrated, outperforming current optimization methods in intricate problems with multiple local minima.

3 Kernelized Lipschitz Constant Estimator: A Non-Linear Lower Bound Construction Approach for Efficient Global Optimization

Mohammadsina Almasi[1], Hadis Anahideh[1], Jay Michael Rosenberger[2], [1]University of Illinois at Chicago, Chicago, IL, [2]University of Texas-Arlington, Arlington, TX

Global optimization is a challenging task due to the complexity of objective functions and high-dimensional search spaces. Lower bounds play a crucial role in guiding optimization algorithms, improving their speed and quality. While Lipschitz constant-based lower bound construction is an effective technique, the quality of the linear bounds depends on the objective's topological properties. Our approach improves upon this by incorporating non-linear kernels to generate higher-quality bounds. We emphasize the importance of using a flexible kernel that can adapt to any function, especially in scenarios where the function is accessible only through a surrogate model. Combining surrogate models and non-linear kernels for Lipschitz constant estimations results in high-quality lower bounds that can contribute to more effective exploration and exploitation.

4 Optimizing Latent Spaces for Mixed Input Domains in Bayesian Optimization

Ng Szu Hui[1], Mingyu Pu[1], Songhao Wang[2], [1]National University of Singapore, Singapore, Singapore; [2]Southern University of Science and Technology, Shenzhen, China

Bayesian optimization (BO) faces significant challenges when applied in mixed categorical and numerical search spaces. The traditional approach to constructing the Gaussian process surrogate and acquisition functions in BO becomes problematic in such mixed-input scenarios. Our study addresses this by exploring encoding methods to convert the mixed inputs into numerical ones in a latent space. Additionally, instead of fixing the latent space, we develop a framework to further learn and search for optimal ways of encoding along with the sequential optimization process. This enables more adaptive and effective latent spaces to be learned and applied as the algorithm sequentially collects more data and optimizes the objective function.

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CC-North 223

Topics in Bayesian Optimization and Reinforcement Learning

Community Committee Choice Session

Session Chair: Daniel Jiang, Meta, Menlo Park, CA

1 Weakly Coupled Deep Q-Networks

Ibrahim El Shar[1], Daniel Jiang[2], [1]Pittsburgh, PA, [2]Meta, Menlo Park, CA

We propose weakly coupled deep Q-networks (WCDQN), a novel deep reinforcement learning algorithm that enhances performance in structured problems known as weakly coupled Markov decision processes (WCMDP). WCMDPs consist of multiple independent subproblems connected by an action space constraint. Despite this appealing structure, WCMDPs quickly become intractable as the number of subproblems grows. WCDQN employs multiple DQN agents, each addressing a subproblem, combining their solutions to establish an upper bound on the action value. This guides the main DQN agent towards optimality. We show that the tabular version, weakly coupled Q-learning (WCQL), converges almost surely. Numerical experiments show faster convergence compared to DQN/Q-learning and related techniques.

2 Bayesian Optimization with Adaptively-Optimized Early Stopping Rules

Jiayue Wan[1], Peter Frazier[2], Daniel Jiang[3], [1]Cornell University, Ithaca, NY, [2]Cornell / Uber, Ithaca, NY, [3]Meta, Menlo Park, CA, Contact: jw2529@cornell.edu

When Bayesian optimization (BO) is applied in settings where function evaluations return partial data (e.g., machine learning training), early stopping rules can be used to terminate unpromising trials and reduce unnecessary computational cost. However, these stopping rules are typically considered separately from the BO acquisition function, leading to two challenges: (1) poor performance due to lack of consistency between suggested points and the stopping rule and (2) difficulty for practitioners to select the "right" parameters for the stopping rule. In this paper, we present an MDP formulation of the joint BO and stopping problem and propose a lookahead acquisition function for jointly optimizing the suggested points and parameters of the stopping rule.

3 High-Dimensional Bayesian Optimization in Mixedspaces via Nested Random Subspaces

Matthias Poloczek, Amazon, San Francisco, CA

Bayesian optimization (BO) has become a powerful method for the sample-efficient optimization of expensive black-box functions. Use cases arise in AutoML, e.g., when tuning an ML model, in RL when optimizing a policy, etc. Recent advances have scaled BO to dozens of variables and also extended the scope to discrete variables in addition to the usual continuous variables. However, a closer examination reveals that the state-of-the-art suffers from degrading performances or even failures if the instance doesn't meet certain unverifiable properties.

I will show how to leverage nested random subspaces to reliably achieve excellent results on high dimensional problems on continuous and mixed spaces.

Based on joint work with Leonard Papenmeier and Luigi Nardi (Lund University, Sweden).

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CC-North 224A

Optimization with Rare Events

Community Committee Choice Session

Session Chair: Anirudh Subramanyam, The Pennsylvania State University, University Park, PA

1 Optimization Under Rare Chance Constraints

Shanyin Tong[1], Anirudh Subramanyam[2], Vishwas Rao[3], [1]Columbia University, New York, NY, [2]Penn State University, State College, PA, [3]Argonne National Lab, Lemont, IL, Contact: st3503@columbia.edu

Chance constraints provide a framework to mitigate the risk of high-impact extreme events by modifying the controllable properties of a system. The rare occurrence of such events imposes severe sampling and computational requirements on classical methods. This work proposes a novel sampling-free method for solving rare chance constrained optimization problems affected by uncertainties that follow Gaussian mixture distributions. By integrating large deviation theory with bilevel optimization, we propose formulations that can be solved by off-the-shelf solvers. Computational experiments from applications in portfolio management, structural engineering, and fluid dynamics illustrate the broad applicability of our method and its advantages over classical sampling-based approaches in terms of accuracy and efficiency.

2 Randomized Approaches for Optimal Experimental Design

Vishwas Rao[1], Arvind Saibaba[2], Srinivas Eswar[1], [1]Argonne National Laboratory, Lemont, IL, [2]North Carolina State University, Raleigh, NC

This work describe connections between optimal experiment design (OED) for PDE-based Bayesian linear inverse problems and the column subset selection problem (CSSP) in matrix approximation.We derive bounds, both lower and upper, for the D-optimality criterion via CSSP for the independent and colored noise cases.Additionally, we describe ways to interpolate "left-out" sensor data using the "selected" sensors along with the errors in the data completion process. We develop and analyse randomized algorithms which achieve these bounds.Finally, we experimentally verify these results on a model advection-diffusion problem.

3 Rare Event Estimation in High-Dimensional Spaces Through Hamiltonian Mcmc and Inverse Importance Sampling

Elsayed Eshra[1], Kostas G. Papakonstantinou[1], Hamed Nikbakht[2], [1]Penn State, University Park, PA, [2]Risk Management Solutions Inc., Newark, CA, Contact: eme5375@psu.edu

This work presents the *Approximate Sampling Target with Post-processing Adjustment* framework, a computationally efficient method for accurately estimating rare events probabilities, often encountered in optimization under chance constraints. The approximate sampling target, constructed utilizing a cumulative distribution function and the system performance expression, successfully places greater importance on the rare event domain in the random variable space. Our developed Quasi-Newton mass preconditioned Hamiltonian MCMC is then used to efficiently sample the constructed target. To compute the target probability, a post-processing adjustment step is employed to normalize the sampling target, involving a devised *inverse importance sampling* procedure, that utilizes an importance sampling density suggested based on the already acquired samples.

4 Network Cascade Vulnerability Using Constrained Bayesian Optimization

Albert Lam[1], Mihai Anitescu[1], Anirudh Subramanyam[2], [1]Argonne National Laboratory, Lemont, IL, [2]The Pennsylvania State University, University Park, PA, Contact: albert3033@gmail.com

Measures of power grid vulnerability are often assessed by the amount of damage an adversary can exact on the network. However, the cascading impact of such attacks is often overlooked, even though cascades are one of the primary causes of blackouts. This paper explores modifications of transmission line protection settings as candidates for adversarial attacks, which can remain undetectable as long as the network equilibrium remains unaltered. This forms the basis of a black-box function in a Bayesian optimization procedure, where the objective is to find settings that maximize network degradation due to cascading. Our experiments reveal that, even when the degree of misconfiguration is resource constrained, it is still possible to find settings that produce cascades comparable in severity to instances where there are no constraints.

5 Importance Sampling for Optimization with Chance Constraints

Anirudh Subramanyam, The Pennsylvania State University, University Park, PA

Optimization problems with randomly constrained rare events present a significant challenge due to the difficulty of computing the probability that a potential decision meets the random constraints. Importance sampling, a recognized variance reduction method, attempts to alter the probability measure from which the random variables are sampled. However, the issue of selecting a suitable importance distribution tha functions well for all decision variables across a diverse range of problems remains unresolved. Most existing strategies are problem-dependent and require deep knowledge of the system's dynamics. Using recent developments in rare event quantification, this paper presents a generic importance sampling approach that does not suffer from these limitations and is capable of addressing a broad spectrum of chance-constrained problems.

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Optimization in Drones and Novel Applications

Community Committee Choice Session

Session Chair: Gino J. Lim, University of Houston, Houston, TX

Session Chair: Yanchao Liu, Wayne State University, Detroit, MI

1 Scheduling Diagnostic Testing Kit Deliveries with the Mothership and Drone Routing Problem

Gino J. Lim[1], Hyung Jin Park[2], Reza Mirjalili[1], Murray J. Cote[3], [1]University of Houston, Houston, TX, [2]Defense Security Support Command, Seoul, Korea, Republic of; [3]Texas A&M University, College Station, TX, Contact: ginolim@uh.edu

We propose a delivery scheduling approach for COVID-19 diagnostic testing kits using a truck and multiple drones with the ultimate goal of minimizing the spread of virus due to human contact. Heuristic algorithms are developed to solve the MIP model faster so that the approach can be practically useful. The experiments show that the proposed method has the potential to significantly reduce human contact; hence, it can reduce disease spread. We observed a 7.5 times reduction on a modified measure of the basic reproduction rate.

2 Mothership-Based Drone Routing and Truck Scheduling Using Branch-And-Price-And-Cut

Reza Mirjalili[1], Gino J. Lim[2], Taewoo Lee[3], [1]University of Houston, TX, [2]University of Houston, Houston, TX, [3]University of Pittsburgh, Pittsburgh, PA

We present a mothership scheduling and multi-visit drone routing problem. The goal is to minimize the total flight duration of drones, including the waiting times of both vehicles. Due to the computational complexity of solving the optimization model, we propose a branch-and-price-and-cut (BPC) method based on Dantzig-Wolfe decomposition. We propose a pruning policy to prevent the unnecessary expansion of BPC, and derive a new lower bound on the number of flights and a valid inequality for wait-hover of vehicles are introduced. A significant improvement in computation time has been observed.

3 Routing Battery-Constrained Delivery Drones in a Depot Network

Yanchao Liu, Wayne State University, Detroit, MI, Contact: yanchaoliu@wayne.edu

We propose a new business model for on-demand package shipment services using drones: customers' shipment orders of arbitrary origins and destinations, payload weights and bid values are collected every five minutes, and available drones from multiple depots are dispatched to fulfill a subset of these orders in a way to maximize profit. A drone path starts from a depot, serves one or more customer orders in sequence, and ends at a depot for battery recharging, which incurs a fixed cost. A compact and a path-based formulation of the dispatch and routing problem are compared, and column generation and brute-force solution approaches are evaluated. Managerial insights gained from an optimization-simulation framework will be discussed.

4 Multiple UAVs' Coverage Path Planning in Rectangular Area Under Windy Conditions

Sina Kazemdehbashi[1], Yanchao Liu[2], [1]Wayne State University, Detroit, MI, [2]Wayne State University, Detroit, MI, Contact: hm3369@wayne.edu

Using drones for surveillance operations comes with its own challenges such as the risk of collision and environmental factors. To deal with these challenges, we develop path planning algorithms to enable a fleet of drones to efficiently search a target area in windy conditions. We first propose a mixed-integer programming model to formulate the problem. Then, to design a practical solution approach, we investigate a special case of the problem where the search area is a rectangular grid. For this special case, we prove that the optimal search time can be calculated using a mathematical formula. We then design an algorithm to obtain the optimal search pattern for multiple drones in polynomial time. Finally, the effectiveness of the algorithms is demonstrated in some simulated scenarios.

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CC-North 225A

Applications of Machine Learning Powered Computational Techniques in Transportation Systems

Community Committee Choice Session

Session Chair: Jiawei Lu, 1</sup

1 Leveraging Imitation Learning for Traffic Flow Harmonization in Mixed Autonomy Environment

Zhe Fu, UC Berkeley, Berkeley, CA, Contact: zhefu@berkeley.edu

In this presentation, we explore methods for generating traffic-regulating behaviors by automated driving systems through imitation learning. Imitation learning has become a staple within a number of driving applications, with many replacing rule-based behavioral systems with those trained to imitate human drivers. In dense traffic situations, however, imitating humans alone is likely insufficient, as humans often contribute to the proliferation of traffic congestion. Instead, we construct an expert policy that, in simulation, exploits knowledge of global states of traffic to homogenize the movement of vehicles towards their desirable uniform-flow equilibrium. We then demonstrate that imitation learning techniques can successfully capture such behaviors using only local/decentralized observations and relatively few interactions with the environment.

2 Physics-Informed Neural Networks for Integrated Traffic State and Queue Profile Estimation: A Differentiable Programming Approach on Layered Computational Graphs

Jiawei Lu, Georgia Institute of Technology, Atlanta, GA, Contact: jlu486@gatech.edu

This study presents an integrated framework for physics-informed joint traffic state and queue profile estimation (JSQE) on freeway corridors. The integrated modeling framework aims to maximize the benefits of information from physics-informed analytical traffic flow models and field observations. A nonlinear programming model is formulated for the JSQE problem, taking into account traffic flow models and observations from both corridor and local segment levels. At the corridor level, a fluid queue approximation is employed to model queuing dynamics. To preserve the differentiability of traffic state variables, continuous space-time distribution functions are introduced to model traffic flow variables and partial differential equations. A computational graph is constructed to represent the nonlinear programming model in a layered structure.

3 Bayesian Tucker Tensor Decomposition For Dynamic Origin-destination Demand Analysis

Zihan Wan, Hong Kong Polytechnic University, Hong Kong, Hong Kong. Contact: 22062327r@connect.polyu.hk

Origin-Destination demand usually appears as a multi-way tensor, useful for mobility companies for taxi deployment or transportation authority for congestion reduction. But spatiotemporal prediction is a challenge due to high dimensionality and temporal patterns. To characterize the uncertainty in O-D demand, we propose a hierarchical Bayesian 3-way tensor decomposition. By using low-rank assumption, our model can characterize features of origins and destinations in an interpretable fashion. Another feature is that posteriors of latent factors enable demand prediction. Due to intractability of exact posteriors, Stochastic Variational Inference techniques are used to find the closest posteriors measured by Evidence Lower Bound. Further, we can develop a more reliable prediction of future O-D demand with quantified uncertainty.

4 Identifying Car-Following Dynamics from Trajectory Data via Automatic Learning

Ohay Angah, Xuegang Ban, University of Washington, Seattle, WA

Most of the commonly used car-following models are based on human knowledge. There may still exist other driving behaviors that can be generalized undiscovered. This study aims to generalize car-following dynamics from data using automatic learning models. We first validate the capability of the automatic learning models using simulation data. The models are then used to discover car-following behaviors from a real trajectory dataset. The aim is to identify a mathematical expression that is able to generalize car-following behaviors. We pre-process and split the trajectory dataset into multiple categories based on driving styles. A coordinate-learning framework is then developed to extract the physical patterns from the split categories.

5 Network-Wide Traffic State Evolution Prediction: Integrating Traffic Dynamics Model and Deep Neural Network

Hanyi Yang, 1</sup

This study develops a macroscopic traffic flow model integrated deep learning framework for traffic state evolution prediction, integrating temporal-spatial flow dependency, traffic flow theory, and data analysis techniques. First, traffic state evolution on every road section is mathematically described by the CTM model given traffic initial and boundary conditions. Next, a temporal-spatial traffic dependency attention (TSTD) recurrent neural network is developed to predict boundary conditions factoring the traffic temporal-spatial dependency. The numerical experiments illustrate that the proposed method predicts the traffic state evolution in a freeway network within 30 minutes with accuracy varying from 75%-95%. It has a better performance compared to the tested baseline models (APTN, Graph CNN-LSTM, and so on).

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SD41

CC-North 225B

Learning and Optimization for Emerging Mobility Systems

Community Committee Choice Session

Session Chair: Qi Luo, Clemson University, Clemson, SC

1 Data-Driven Stochastic Programming for Electric Vehicle Charging Station Location with Decision-Dependent Demand Learning

Huangrong Sun[1], Guzin Bayraksan[2], Xian Yu[2], [1]Ohio State University, Columbus, OH, [2]The Ohio State University,

Columbus, OH, Contact: sun.3394@osu.edu
We consider an electric vehicle charging station location problem with uncertain customer demand where the demand depends on the location decisions. We formulate a two-stage stochastic program, where in the first stage, we optimize the location decisions to minimize the investment cost, and in the second stage, we allocate resources to meet the customer demand and minimize the operational cost. We use a regression model to learn the dependence between customer demand and charging station locations and apply an empirical residual-based Sample Average Approximation to solve the two-stage stochastic program. Numerical studies are conducted on synthetic data and real-world data in New York State to evaluate result sensitivity and compare different approaches.

2 Optimal Joint Battery Swapping Van Routing and Battery Redistribution Plans for Mobile On-Demand Charging Service

Lili Du, Jiahua Qiu, University of Florida, Gainesville, FL, Contact: lilidu@ufl.edu

Range anxiety hinders electric vehicle (EV) adoption. On-demand battery swapping, enabling quick replacements, is an emerging solution. However, efficient operation of Battery Swapping Vehicles (BSVs) requires effectively managing demand uncertainty, supply-demand imbalances in the transportation network, and drained battery distribution in the power grid. This paper presents a Model Predictive Control model, embedded with a mixed-integer nonlinear optimizer, to optimize the BSV service in these regards. A deep reinforcement learning and sampling-aided heuristic algorithm was developed to adapt solutions to large-scale instances. Numerical experiments confirmed the algorithm's efficiency and demonstrated the BSV service's robustness against demand uncertainty and heterogeneity.

3 Mixture Model for Contextual Route Choice in Multimodal Transportation Systems

Yan Wu[1], Qi Luo[2], Yuyuan Ouyang[2], [1]Clemson University, Clemson, SC, [2]Clemson University, Clemson, SC, Contact: yw8@clemson.edu

Predicting route behavior based on trip data becomes a challenging task because of the diversification of intermodal options and latent factors such as trust in the recommended routes. In this paper, we propose an Inverse Mixture Model (IMM) composed of two interconnected components: (1) a set of dynamic route choice models with arc-to-arc transition functions contingent on the contextual traffic conditions, and (2) mixture probabilities determining the selection of route choice models. The mixture probabilities are influenced by the expected value of following recommended routes, thus emulating travel behavior in dynamic and convoluted traffic networks. Two EM algorithms are tailored for estimating IMMs in the following scenarios: (1) mixture probabilities are predetermined upon arriving at the origin, (2) mixture probabilities vary at each intersection.

4 Learning Generalized Mean-Field Games for Day-To-Day Departure Time Choice with Dynamic Population

Ben Wang[1], Qi Luo[2], Yafeng Yin[3], [1]Univerisity of Michigan, Ann Arbor, MI, [2]Clemson University, Clemson, SC, [3]University of Michigan, Ann Arbor, MI, Contact: papaver@umich.edu

We investigate the day-to-day departure time choice (DDTC) problem for travelers, where they choose their modes and departure times to minimize travel costs. Our research uses a customized hierarchical soft actor-critic (HSAC) algorithm, which considers the interactions between travelers in a dynamic game. The algorithm finds an approximate Markovian Perfect Equilibrium (MPE) and sheds light on the impact of emerging mobility and travel information technology on travel behavior. Our findings provide a foundation for promoting socially optimal travel plans through adaptive traffic control policies.

5 Service Network Design with Hub Constraints

Ozgur Satici[1], Iman Dayarian[1], Teodor Gabriel Crainic[2], [1]University of Alabama, Tuscaloosa, AL, [2]Université du Québec à Montréal, Montréal, QC, Canada. Contact: osatici@crimson.ua.edu

This study focuses on the service network design of intra-city operations for courier companies. It proposes a physical network of package drop-off and pick-up hubs within the city, with limited parking and storage capacity. The problem is divided into two phases: Phase I creates itineraries for each commodity, while Phase II constructs vehicle routes based on Phase I outputs. For Phase I, we develop a MIP model and enhance it with network reduction and warmstart techniques. Phase II is formulated as a Vehicle Routing Problem with Time Windows and solved using a Tabu Search-based algorithm. Preliminary tests highlight the effectiveness of the proposed approach, demonstrating potential cost reduction and improved computational efficiency.

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CC-North 226A

Recent Trend in Machine Learning Theory and Its Application in Operations Management

Community Committee Choice Session

Session Chair: Hongyang Zhang, Northeastern University, Boston, MA

Session Chair: Wei Hu, 1</sup

1 Popart: Efficient Sparse Regression and Experimental Design for Optimal Sparse Linear Bandits

Chicheng Zhang, University of Arizona, Tucson, AZ, Contact: chichengz@cs.arizona.edu

In sparse linear bandits, a learning agent sequentially selects an action and receive reward feedback, and the reward function depends linearly on a few coordinates of the covariates of the actions. In this work, we propose a simple and computationally efficient sparse estimation method called PopArt that enjoys a tighter l1 recovery guarantee compared to Lasso in many problems. Our bound naturally motivates an experimental design criterion that is computationally efficient to solve. Based on our novel estimator and design criterion, we derive sparse linear bandit algorithms with improved regret upper bounds upon the state of the art (Hao et al., 2020), especially with respect to the geometry of the given action set. Finally, we prove a matching lower bound for sparse linear bandits in the data-poor regime, closing the gap between upper and lower bounds in prior work.

2 Pseudo-Labeling for Kernel Ridge Regression Under Covariate Shift

Kaizheng Wang, Columbia University, New York, NY

We develop and analyze a principled approach to kernel ridge regression under covariate shift. The goal is to learn a regression function with small mean squared error over a target distribution, based on unlabeled data from there and labeled data that may have a different feature distribution. We propose to split the labeled data into two subsets and conduct kernel ridge regression on them separately to obtain a collection of candidate models and an imputation model. We use the latter to fill the missing labels and then select the best candidate model accordingly. Our non-asymptotic excess risk bounds show that in quite general scenarios, our estimator adapts to the structure of the target distribution as well as the covariate shift. It achieves the minimax optimal error rate up to a logarithmic factor. Pseudo-labels for model selection do not have major negative impacts.

3 Identification of Negative Transfers in Multitask Learning Using Surrogate Models

Hongyang Zhang, Northeastern University, Boston, MA

Multitask learning is widely used in practice to train a low-resource target task by augmenting it with multiple related source tasks. Yet, naively combining all the source tasks with a target task does not always improve the prediction performance for the target task due to negative transfers. Thus, a critical problem is identifying subsets of source tasks that would benefit the target task. This problem is challenging since the number of subsets grows exponentially with the number of source tasks; efficient subset selection heuristics does not always capture the relationship between task subsets and multitask performances. In this paper, we introduce an efficient procedure to address this problem via surrogate modeling. We show that our approach predicts negative transfers much more accurately than existing measures and consistently improves upon existing methods.

4 Nonlinear Benign Overfitting

Wei Hu, University of Michigan, Ann Arbor, MI, Contact: vvh@umich.edu

Benign overfitting is the intriguing phenomenon that a model overfits the noisily labeled training data while still generalizing near optimally. Recent work rigorously proved benign overfitting in a number of settings, but they are limited to linear models or data distributions that are linearly separable. We provide the first benign overfitting result in a nonlinear setting, in which we also show an interesting delayed generalization phenomenon not present in previous work.

5 Advertising Media and Target Audience Optimization via High-Dimensional Bandits

Wenjia Ba[1], Michael Harrison[2], Harikesh Nair[3], [1]University of British Columbia, Vancouver, CA, Canada; [2]Stanford University, Palo Alto, CA, [3]Stanford University, Stanford, CA, Contact: wenjiaba8@gmail.com

This paper introduces a data-driven algorithm, LRDL (Logistic Regression with Debiased Lasso), to automate digital ad-campaigns for advertisers at online publishers. The algorithm actively explores and identifies the optimal audience-ad combination for a campaign from numerous choices, despite very low success probabilities. It addresses challenges like high-dimensional search formulations and prior uncertainty by integrating a multiarmed bandit framework, a Lasso penalty function, a debiasing kernel, and a semi-parametric regression model for cross-learning. Implemented as a Thompson Sampler, LRDL demonstrates superior performance in simulations against several high-dimensional bandit literature benchmarks.

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CC-North 226B

Simulation-based Optimization for UAM Integration

Community Committee Choice Session

Session Chair: Xuan Jiang, 1</sup

1 Evaluation of Vertiport Arrival Operations with the U-Sky Simulator

Carlos Querejeta, Boeing, Madrid, Spain. Contact: Carlos.Querejeta@boeing.com

The development of critical aspects that enable future autonomous UTM operations like tactical deconfliction, contingency management or vertiport operations is still in its infancy and their evolution will undoubtedly involve the analysis of dense traffic simulations suitable to evaluate technical proposals. This presentation showcases the application of Boeing's UTM oriented U-Sky simulator to evaluate vertiport arrival operations. Different methods are considered to manage convergent traffic to vertiports, suitable dense traffic simulations are conducted, and the data analysis of their outcomes is presented to evaluate the impact of the different methods in the efficiency and safety of the operations.Overall, U-Sky is presented as a versatile tool suitable to support the development of key components that support the future autonomous UTM operations.

2 Simulating the Integration of Urban Air Mobility into Existing Transportation Systems: A Survey

Yuhan Tang, University of California, Berkeley, CA

Urban air mobility (UAM) has the potential to revolutionize transportation in metropolitan areas, alleviating congestion and improving accessibility. Integrating UAM into existing systems poses complex challenges, requiring an understanding of its impact on traffic flow and capacity. In our study, we undertake a comprehensive survey of prevailing traffic simulators and evaluate their general capabilities. Subsequently, we identify key challenges and opportunities associated with integrating UAM into urban transportation systems, encompassing the effects on existing traffic patterns and congestion, safety and risk assessment, and potential economic and environmental benefits. By offering an overview of the current state of research related to simulation and UAM, our survey underscores crucial areas necessitating further research and development.

3 Assessing Advanced Air Mobility for Cargo Operations

Nick Gunady, 1</sup

Advanced Air Mobility (AAM) is an emerging aerial transport system that relies on electric aviation. Cargo operations are seen as a potential viable entry into service and a lucrative operational concept due to the lower operating costs of electric aviation. Middle Mile Delivery (MMD) is the segment of cargo logistics within an operator's network between the distribution or ship centers of the operator. To understand the usage of future AAM vehicles for cargo operations in MMD, we utilize a vehicle routing problem to model fleet allocation across several metropolitan areas. Economic sensitivities and environmental impact assessments are presented to compare vehicle and metro-specific implications of this nascent market, and the connection to electrified Last Mile Delivery are considered in the context of system-of-systems operations.

4 UTM V0.1: A Simple System to Keep Drone Traffic Safe

Valentin Polishchuk, Linköping University, LiU, Norrköping, Sweden

We estimate the capacity of very low level (VLL) airspace via simulations. We observe that the probability of occurrence of large conflicts exhibit a phase transition as the traffic density is increased. The traffic density at the phase transition i.e. the capacity, increases with decreasing minimum separation tolerance. This suggests a way to establish UTM v0.1 -- a simple and efficient system which could keep the drone traffic safe while bypassing the complicated operations approval process. Joint work with UC Berkeley

5 Community/Committee'S Choice Submission

Shangqing Cao, 1</sup

Placements of vertiports affect the total addressable market and value proposition of Urban Air Mobility (UAM). We propose a simulation-based optimization scheme with machine learning surrogates to identify the optimal number and locations of vertiports. Our methodology consists of three key stages: (1) Leverage the DBSCAN algorithm to cluster the origins and destinations of UAM passengers. Randomly generate sets of vertiport locations as candidates. (2) Assess the proposed candidates through a simulation model. (3) Construct and tune surrogate machine learning models to create a reliable predictor of the objective function. Use a genetic algorithm to find local optimality. By implementing our method in the San Francisco Bay region, we found a set of vertiport locations that achieve local optimality over all candidates sampled in (1).

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CC-North 226C

Network Analytics

Community Committee Choice Session

Session Chair: John Rios, University of Georgia, Athens, GA

1 How Has Covid-19 Shaken up the Global Supply Chain Networks? - the Role of Location and Firm Performance

John Rios[1], Kang Zhao[2], Elaheh Seyedalikhani[3], Suyong Song[4], [1]University of Georgia, Athens, GA, [2]University of Iowa, Iowa City, IA, [3]University of Iowa, Iowa City, IA, [4]University of Iowa, Iowa City, IA

Maximizing firm value is the ultimate goal of the managers and shareholders. A strong and stable supplier-customer relationship creates value for both trade parties, leading to higher returns for investors of the partner firms. This research implements a stochastic actor-oriented model to analyze the evolution of supply chain networks across different years. We study how various company features (like location or financial performance) and external disruption events (like the COVID-19 pandemic) affect the formation of ties between business partners. While this is an ongoing project, our current results identify changes in companies' mechanisms to select their business partners. Our final goal is to understand how disruptive events change the way companies decide to start businesses with new customers and suppliers or to stop trading with their current ones.

2 A New Index Measuring Occupational Exposure To Artificial Intelligence

Yuanyang Liu[1], Chuanren Liu[1], Tingliang Huang[2], [1]University of Tennessee, knoxville, TN, [2]The University of Tennessee-Knoxville, Knoxville, TN, Contact: yliu191@utk.edu

We develop a new AI index to quantify the occupational exposure to artificial intelligence (AI) technologies. Our methodology utilizes the text embedding vectors to quantify the similarity between occupation descriptions and AI patents. We find that occupations located at the two extremes of the skill distribution are least exposed to AI technologies. Further, for high-skill occupations, those with higher AI index also see the non-routine work activities becoming more important, consistent with the prediction of the routinization hypothesis. However, for low-skill occupations, non-routine tasks become less important in occupations more exposed to AI. These results suggest a possible differential impact of AI on the nature of work for low-skill and high-skill workers.

3 Mining Actionable Insights for Effective Marketing on Social Web Using Context-Aware Multimodal Knowledge-Infused Learning

Ugur Kursuncu[1], Lane Fronczek[2], Manya Rampuria[3], Trilok Padhi[3], Yaman Kumar[4], Valerie L. Shalin[5], [1]Georgia State Unviersity, Atlanta, GA, [2]Georgia State Unviersity, Atlanta, GA, [3]Georgia State Unviersity, Atlanta, GA, [4]Adobe Research, Delhi, India; [5]Wright State Unviersity, Dayton, OH, Contact: ugur@gsu.edu

Marketing a human-centered process exchanging multimodal content (e.g., text/image/video) as behavioral dynamics between marketers and consumers determine the success of a campaign. While online multimodal content provides an enhanced experience to the users, such richness of multimodality also brings the challenge of computational modeling, as the semantic contextual cues span across modalities to make the meaning of the multimodal content. Identifying and incorporating psycho-social cues and contextual connections is crucial in retrieving the true holistic meaning and; thus, more meaningful insights for decision-making. We will discuss our approach for mining actionable insights for effective marketing, challenges and opportunities for building intelligent systems to retrieve insights through multimodal data on the social web.

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CC-North 227A

Machine Learning for Integer Programming

Community Committee Choice Session

Session Chair: KHALIL Elias, University of Toronto, toronto, ON, Canada

1 Faster Multi-Objective Integer Programming with Learned Variable Orderings: A Case Study of Knapsack

Rahul Patel[1], Elias B. B. Khalil[2], [1]University of Toronto, Toronto, ON, Canada; [2]University of Toronto, Toronto, ON, Canada. Contact: rm.patel@mail.utoronto.ca

Binary decision diagram (BDD)-based approaches have achieved state-of-the-art results for multiobjective integer programming. The variable ordering (VO) employed in BDD construction significantly affects its size and the quality of bounds obtained from relaxed/restricted BDDs for single-objective problems. In the context of multiobjective problems, we not only demonstrate the impact of VO on the enumeration time of the Pareto frontier (PF), but also utilize

black-box optimization to identify effective VO strategies that reduce PF enumeration time. However, the computational overhead incurred by black-box optimization outweighs the aforementioned reduction in PF enumeration time. To address this issue, we propose a learning-based approach for VO. Experimental results on Knapsack instances validate the effectiveness of our proposed method.

2 Learn2aggregate: Supervised Generation of Chvatal-Gomory Cuts Using Graph Neural Networks

Arnaud Deza, University of Toronto, Toronto, ON, Canada. Contact: arnaud.deza@mail.utoronto.ca

Recent years have witnessed a number of research efforts to enhance the strength of cutting plane subroutines, specifically cutting plane selection using machine learning (ML). This work has a similar goal by aiming to assist a computationally expensive separator, the Chvatal-Gomory (CG) cut generator, in integer programming (IP) solvers using data-driven analysis. We embed ML into the generation of valid inequalities and show how optimized cut selection can be incorporated into the learning phase for cut generation. Our ML framework uses a graph neural network to generate CG cuts which leverages cut integrality. Although we only focus on CG cuts, our approach can be extended to other families of cuts. Preliminary experiments on synthetic IP instances demonstrate promising results regarding the validity of ML research for cut generation.

3 Pyepo: A Pytorch-Based End-To-End Predict-Then-Optimize Library for Linear and Integer Programming

Bo Tang[1], Elias B. B. Khalil[2], [1]University of Toronto, Toronto, ON, Canada; [2]University of Toronto, Toronto, ON, Canada. Contact: botang@mie.utoronto.ca

In deterministic optimization, all problem parameters are fixed and known. In practice, however, some parameters may be priori unknown but can be estimated. Compared to the traditional two-stage method, end-to-end predict-then-optimize has become an attractive alternative. This work presents the PyEPO package, a PyTorch-based end-to-end predict-then-optimize library, which is the first such generic tool for linear and integer programming. It provides four base algorithms: a convex surrogate loss, a differentiable black-box solver, and two perturbation-based methods, which enable us to conduct experiments comparing end-to-end and two-stage approaches along axes such as prediction accuracy, decision quality, and running time. Furthermore, we extend the framework to a multi-task setting that enables information sharing between tasks for improved learning.

4 A Deep Reinforcement Learning Framework for Column Generation

Khalil Elias, University of Toronto

Column Generation (CG) is an iterative algorithm for solving linear programs (LPs) with an extremely large number of variables (columns). CG is the workhorse for tackling large-scale integer linear programs, which rely on CG to solve LP relaxations within a branch and bound algorithm. Two canonical applications are the Cutting Stock Problem (CSP) and Vehicle Routing Problem with Time Windows (VRPTW). In VRPTW, for example, each binary variable represents the decision to include or exclude a route, of which there are exponentially many; CG incrementally grows the subset of columns being used, ultimately converging to an optimal solution. We propose RLCG, the first Reinforcement Learning (RL) approach for CG. Unlike typical column selection rules which myopically select a column based on local information at each iteration, we treat CG as a sequential decision-making problem, as the column selected in an iteration affects subsequent iterations of the algorithm. This perspective lends itself to a Deep Reinforcement Learning approach that uses Graph Neural Networks (GNNs) to represent the variable-constraint structure in the LP of interest. We perform an extensive set of experiments using the publicly available BPPLIB benchmark for CSP and Solomon benchmark for VRPTW. RLCG converges faster and reduces the number of CG iterations by 22.4% for CSP and 40.9% for VRPTW on average compared to a commonly used greedy policy.

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CC-North 227B

Operationalizing Public Sector Data for Social Good

Community Committee Choice Session

Session Chair: Geri Dimas, Worcester Polytechnic Institute, Worcester, MA

Session Chair: Weixiao Huang, Worcester Polytechnic Institute, Worcester, MA

1 Optimizing Sponsored Humanitarian Parole

Fatemeh Farajzadeh[1], Ryan Killea[2], Alexander Teytelboym[3], Andrew C. Trapp[2], [1]Worcester Polytechnic Institute, WORCESTER, MA, [2]Worcester Polytechnic Institute, Worcester, MA, [3]University of Oxford, Oxford, United Kingdom. Contact: ffarajzadeh@wpi.edu

We introduce a novel algorithmic matching system, RUTH, that relocates Ukrainian refugees to US sponsors for the first time according to their preferences. RUTH (Refugees Uniting Through HIAS) implements Thakral's (2016) Multiple Waitlist Procedure with refugee relocation preferences and sponsor priorities. We analyze whether periodic matching can improve match quality and which locations require the highest sponsor arrival rates in the long run. Our algorithmic design uniquely puts a lot of weight on refugees' preferences, promotes equity and opportunity access for refugee protection and is applicable to other humanitarian parole schemes.

2 Collecting Data in the Human Trafficking Domain: Youth-Informed and Data-Driven Recommendations for Runaway and Homeless Youth in Nyc

Renata Alexandra Konrad[1], Geri Dimas[1], Yaren Bilge Kaya[2], Andrew C. Trapp[1], Kayse Lee Lee Maass[2], Meredith Dank[3], Andrea Hughes[3], [1]Worcester Polytechnic Institute, Worcester, MA, [2]Northeastern University, Boston, MA, [3]New York University, New York, NY, Contact: rkonrad@wpi.edu

Runaway and homeless youth (RHY) are particularly vulnerable to human trafficking (HT) and exploitation, and prevention is a powerful tool for countering trafficking. Access to appropriate housing and associated support services can significantly decrease a youth's likelihood to experience sexual or labor exploitation. We discuss our process and results from collecting over 300 surveys from RHY in New York City (NYC). These data are being deployed in a youth-informed capacity expansion model and benefit to cost-ratio framework for data-driven recommendations. The results of this work are currently being developed into an interactive interface for decision makers in NYC. We underscore the importance of understanding RHY needs by incorporating them to effectively allocate resources and discuss the challenges and lessons learned throughout this process.

3 Data Analytics in the Public Sector: Challenges and Critical Considerations

Geri Louise Dimas[1], Renata Alexandra Konrad[2], Andrew C. Trapp[2], [1]Bryant University, Smithfield, RI, [2]Worcester Polytechnic Institute, Worcester, MA, Contact: gldimas@wpi.edu

Data science and applied analytics are powerful tools that hold immense promise in supporting the operations of governmental agencies, non-governmental and nonprofit organizations. However, implementing these methods in the public sector poses unique challenges that require careful consideration. We open this discussion with first-hand experiences working in domains such as immigration, anti-human trafficking, and social programming to explore the benefits and challenges of data-driven decision-making. Through case studies and practical examples, we will show how data science and applied analytics can help organizations better understand their operations, identify patterns, and improve resource allocation. By leveraging these insights, public sector organizations can make more informed decisions and evaluate the impact of policies and their programs.

4 Operations Research for Addressing Homelessness Crises

Dashi Singham, Naval Postgraduate School, Monterey, CA, Contact: dsingham@nps.edu

We present multiple approaches for employing operations research to develop analytics solutions for communities with large homeless populations. Discrete-event simulation models can track the flow of people through a resource-constrained housing system. Queueing theory approaches assess stability of the system by analyzing blocking mechanics. Simulation optimization can be used to determine the best allocation of investments across specialized housing pathways. A case study using data from the Bay Area in California is presented. We summarize a portfolio of current and future efforts to address homelessness modeling.

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CC-North 227C

IISE Transactions Invited Session

Panel Session

Session Chair: Jionghua Jin, University of Michigan, Ann Arbor, MI

1 IISE Transactions Invited Session

Jionghua Jin, University of Michigan, Ann Arbor, MI, Contact: jhjin@umich.edu

This is a special panel session for the Focus Issue of IISE Transactions on Data Science, Quality and Reliability. In the session, the Focus Issue Editor will firstly briefly review the journal's promotion areas and the review process. Then, three selected representative papers will be presented by authors. Afterwards, the questions and discussion about the journal will be followed with the audience.

2 Panelist

Michael Biehler, GT

3 Panelist
Juan Du, HUST-GuangZhou, Hong Kong, China

4 Panelist
Hui Yang, 1</sup

Sunday, October 15, 2:15 PM - 3:30 PM

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CC-North 228A
QSR Student Introduction & Interaction Session
Panel Session
Session Chair: Akash Deep, Oklahoma State University, Stillwater, OK
Session Chair: Hao Yan, Arizona State University, Tempe, AZ

1 Student Introduction & Interaction Session
Hao Yan, Arizona State University, Tempe, AZ

Sunday, October 15, 2:15 PM - 3:30 PM

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CC-North 228B
Federated Learning: Methodologies and Applications
Panel Session
Session Chair: Bing Si, State University of New York at Binghamton, Binghamton, NY
Session Chair: Nathan B. Gaw, Air Force Institute of Technology, Wright-Patterson AFB, OH

1 Federated Learning: Methodologies and Applications
Bing Si, State University of New York at Binghamton, Binghamton, NY

2 Panelist
Raed Al Kontar, University of Michigan, Ann Arbor, MI

3 Panelist
Mostafa Reisi, University of Florida, Gainesville, FL

4 Panelist
Paritosh Ramanan, Oklahoma State University, Stillwater, OK

5 Panelist
Ana Maria Estrada Gomez, Purdue University, West Lafayette, IN

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SD50

CC-North 229A
Decision Support for the Path to Net-Zero Emissions: Beyond Least-Cost Portfolios
Community Committee Choice Session
Session Chair: Jesse D. Jenkins, ZERO Lab, Princeton University, Princeton, NJ
Session Chair: Michael Lau, Princeton University, Princeton, NJ
Session Chair: Qian Luo, Andlinger Center for Energy and the Environment, Princeton University, Princeton, NJ

1 Measuring Exploration: Review and Comparison of Modelling to Generate Alternatives Methods
Michael Lau, Princeton University, Princeton, NJ, Contact: ml6802@princeton.edu
Modern macro-energy systems (MES) modelling increasingly focuses on outcomes of interest beyond cost. Modelling to Generate Alternatives (MGA) is a method that maps the near-optimal feasible space of an MES model, enabling exploration of technically feasible system outcomes that balance multiple quantifiable or unquantifiable objectives. This research explores three canonical MGA algorithms and constructs an original method, along with a flexible testbed to benchmark their speed and efficacy in mapping the near-optimal feasible space of a series of random linear programs with *n* variables and *2n* constraints. We find the randomized search algorithm increases in efficiency with search dimension and performs the best out of the methods tested.

2 Next-Generation of Energy Modeling at U.S. the Energy Information Administration
Sauleh Siddiqui, Energy Information Administration, Washington, DC
As the energy system evolves and transitions, so should the way we model long-term energy projections. We will go over the latest efforts at the U.S. Energy Information Administration to build a next-generation modeling framework that is open, nimble, and flexible. This new framework will endogenously model uncertainty and consider modern energy issues associated with technology advancement, industrial policy, and community-level impacts.

3 Impacts of Transmission Network Expansion on Air Quality and Public Health

Qian Luo, Andlinger Center of Energy and the Environment, Princeton, NJ, Contact: ql7299@princeton.edu

Reaching net zero emissions economy-wide requires a significant amount of renewable energy in the power sector. To facilitate the integration of this clean energy resource, a major expansion of transmission lines is expected. Prior studies have demonstrated the critical role of grid transmission in power sector decarbonization. However, few investigate public health impacts of transmission expansion. In this work, we use one regional electricity market as a case study to examine how transmission expansion would impact power system planning, smokestack emissions, and public health associated with air pollution in local communities. To do this, we first design scenarios with different levels of transmission availability within the system. Then a state-of-art power system planning model and a reduced-complexity air quality model are combined to analyze the impacts.

4 Computational Advances for Modeling to Generate Alternatives

Gord Stephen, University of Washington, Seattle, WA

Modeling to generate alternatives (MGA) has been recognized as a valuable tool for identifying a broad set of viable energy system designs that can be ranked and filtered according to qualitative criteria, which may defy inclusion in a traditional mathematical optimization framework. However, the vast majority of established MGA approaches require re-solving large optimization problems with adjusted objective functions to generate each alternative. This can be very limiting for large planning problems, the very class of problems for which MGA methods may be most valuable. This presentation will outline a new approach for alternative generation that maintains mathematical guarantees about the viability of generated solutions while avoiding the need to repeatedly resolve expensive optimization problems.

5 Revealing the Effect of Zoning Ordinances and State-Level Land-Use Restrictions in Renewable Resources' Potential

Edgar Virguez[1], Xianxun Wang[2], John Fay[2], Timothy Johnson[3], Dalia Patino-Echeverri[2], [1]Carnegie Institution for Science, Stanford, CA, [2]Duke University, Durham, NC, [3]Duke University, Durham, NC, Contact: edgar.virguez@duke.edu

This study assesses the effect of incorporating land-use parcel-level data and local zoning ordinances when quantifying the resource potential for renewable energy projects. Examining utility-scale solar photovoltaics (PV) as a case study, we perform suitability and supply cost analysis of PV projects in North Carolina, incorporating the classification of more than 2.3 million parcels based on their local zoning ordinances.
Exploring three scenarios that represent conditions ranging from restrictive to favorable, the study finds a substantial reduction of PV resource potential when incorporating land-use and local zoning ordinances, reducing current estimates of land for PV in NC as much as ~8 million acres.
The study's findings highlight the necessity of integrating land-use restrictions into siting models while increasing their spatial granularity.

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SD51

CC-North 229B

Energy Analytics and Energy System Modeling

Community Committee Choice Session

Session Chair: Sonja Wogrin, Graz University of Technology, Graz, Austria

1 Towards Renewable Power Systems: Analyzing the Technical and Economic Effects Using a Linked Modeling Framework

Robert Gaugl[1], Mark Sommer[2], Claudia Kettner[2], Udo Bachhiesl[1], Thomas Klatzer[1], Lia Gruber[1], Michael Böheim[2], Kurt Kratena[3], Sonja Wogrin[1], [1]Graz University of Technology, Graz, Austria; [2]Austrian Institute of Economic Research (WIFO), Vienna, Austria; [3]Centre of Economic Scenario Analysis and Research (CESAR), Vienna, Austria. Contact: robert.gaugl@tugraz.at

The transition to renewable power systems is both technically and economically challenging. We take a novel approach by coupling a macroeconomic model of Austria's economy with a technical model of the European power system. With the linked modeling framework, we can provide insights towards the transformation to a highly renewable power system and its impact on emissions as well as its macroeconomic and distributional effects. Using the novel model framework to analyze Austria's renewable electricity transformation shows that gas-fired power plants are still needed in 2030 to balance variable renewable generation. Furthermore, the results show that the investments do not lead to high multiplier effects from a socio-economic perspective.

2 Modeling Novel Electricity Market Products for Management of Net Load Forecast Errors

Elina Spyrou, Imperial College London, London, United

Kingdom. Contact: elina.spyrou@ic.ac.uk

As the integration of variable energy resources increases in power systems around the world, power system operators propose or revise products and services to manage net load forecast errors. Modeling supply of those products by energy-limited resources is challenging. This presentation analyzes net load forecast errors for a realistic case study of ERCOT and concludes with recommendations for product design to leverage flexibility of energy-limited resources for management of net load forecast errors.

3 Load Shifting Versus mFRR: Which One is More Appealing to Flexible Loads?

Peter Gade, DTU

This paper investigates how a flexible TCL can deliver flexibility either in form of manual frequency reserves (mFRR) or load shifting, and which one is more appealing for such a load. A supermarket freezer is considered as a representative flexible load, and a grey-box model describing its temperature dynamics is developed. Taking into account price and activation uncertainties, a two-stage stochastic mixed-integer linear program is formulated to maximize the flexibility value from the freezer, where two solution strategies for mFRR are presented: one with a simple policy and the other one with a dynamically updated policy. Examined on an ex-post out-of-sample simulation, load shifting shows to be more profitable than the provision of mFRR, but is also more consequential for the temperature in the freezer than flexibility provision for mFRR.

4 Time Series Aggregation for Energy System Models

Sonja Wogrin, Graz University of Technology, Graz, Austria

One of the fundamental problems of using optimization models that use different time series as data input, is the trade-off between model accuracy and computational tractability. In this talk, we discuss some typical challenges of time series aggregation methods when used for energy system models.

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SD52

CC-North 230

Modeling and Optimization for Power Grid Resilience Enhancement

Community Committee Choice Session

Session Chair: Feng Qiu, Argonne National Laboratory, Lemont, IL

1 Set Theoretic Approaches for Performance Guaranteed Control in Low Inertia Power Systems

Yichen Zhang, University of Texas at Arlingotn, Department of Electrical Engineerring, Arlington, TX

Most renewable sources are inverter-based and do not respond to grid events. With increasing renewable penetration, it is inevitable for inverter-based resources (IBRs) to provide grid supportive functions like inertia emulation. However, designing such multi-mode IBRs control to guarantee the grid-level performance is challenging. This presentation will demonstrate how to employ backward and forward reachability for such a control design as well as advanced computation approaches for accurate reachability estimation.

2 County-Level Assessment of Behind-The-Meter Solar and Storage to Mitigate Short but Frequent Power Interruptions for Residential Customers

Sunhee Baik, Lawrence Berkeley National Laboratory, Berkeley, CA

Behind-the-meter solar-plus-storage (BTM PVESS) has been adopted to address concerns over electric system reliability and resilience, but its technical benefits are poorly understood. Building on our previous work on resilience value analysis, this paper uses the PVESS dispatch algorithm and Reliability Event Simulator to analyze the impacts of short, frequent power outages. We investigate how battery size, state of charge, climate, load, and outage profiles affect BTM PVESS's ability to meet power demands during interruptions at the county level at 15-minute intervals. Our findings show that BTM PVESS can improve power system reliability, but its ability to provide backup power is mainly influenced by battery power constraints and outage profiles. Finally, we discuss how to evaluate tradeoffs between backup power and competing value streams.

3 Resilience-Oriented Robust Routing Optimization for Smart Grids Under Extreme Events

Luo Xu, Princeton University, Princeton, NJ, Contact: luoxu@princeton.edu

Due to the in-depth interdependence between electric power systems and advanced information systems, extreme weather events may result in cyber-physical coupling failures. Most existing literature control physical power systems. However, as a coupled system, there is still tremendous flexibility in the information system to be explored. We developed a resilience-orient optimization strategy for integrated systems by scheduling the communication routing of power system remedial control services, which can minimize the loss of load in extreme scenarios.

4 Applying a Comprehensive View of Resilience to Power Distribution Network Optimization

Benjamin P. Riley, Prodromos Daoutidis, Qi Zhang, University of Minnesota, Minneapolis, MN, Contact: riley718@umn.edu

Prior works on the resilience of power systems have primarily limited their focus to one type of stressor at a time. In this work, we propose an optimization model that enables distribution system operators to employ a variety of resilience-enhancing measures to respond to a variety of uncertain stressors. In particular, we develop a scenario-based two-stage stochastic program that considers line hardening projects, mobile battery storage systems, mobile ammonia-based energy storage systems, and line switching procedures to respond to line faults, generating unit failures, and demand uncertainty. Computational case studies are performed using the model, and large-scale problem instances are solved using a tailored decomposition algorithm.

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SD53

CC-North 231A

AI/ML for Transportation Electrification

Community Committee Choice Session

Session Chair: Diwas Paudel, Tampa, FL

1 A Dynamic Pricing Strategy by EV Charging Hubs in Competitive Environment

Diwas Paudel, University of South Florida, Tampa, FL

As the number of electric vehicles (EVs) on the road continues to grow, EV charging hubs present a lucrative business opportunity. This profitability leads to the emergence of multiple competing EV charging establishments, similar to present-day gas stations, at street corners. To remain competitive, these hubs must dynamically adjust retail prices to attract an adequate number of EVs while ensuring profitability. This paper presents a multi-agent deep reinforcement learning framework for dynamic pricing in competitive EV charging environments. Performance validation is accomplished through a numerical case study, demonstrating the efficacy of the proposed framework in enabling effective pricing strategies for EV charging hubs within a rapidly evolving market.

2 Quantifying the Supply Potential and Value of Vehicle-To-Grid as an Energy Storage

Wonjong Lee[1], Yoonmo Koo[2], [1]Seoul National University, Seoul, Korea, Republic of; [2]Seoul National University, Seoul, Korea, Republic of. Contact: leewing159@snu.ac.kr

Renewable energy (RE) and electric vehicles (EV) are deployed faster than ever to combat the climate crisis. However, there would be mismatch in supply and demand given intermittency of RE and drivers' charging preference. In this situation, vehicle-to-grid (V2G) which allows bidirectional power flow between EV and grid can alleviate the mismatch by selling back power in EVs and absorbing excessive RE generation. However, the supply potential and the effectiveness of V2G as an ES are still unclear. In this research, choice experiment and expansion planning are both used to identify drivers' V2G participation and how much ES could be replaced with V2G. The results show drivers prefer to participate in night but could be encouraged to enroll in evening with higher reward. Also, more than half of ES are replaced (most in short-term ES) with V2G with a decrease in overall cost.

3 Mixed Integer Linear Programming for Critical Mineral-Efficient Fleet Electrification Planning

Jack Weissman[1], Nicolò Daina[2], [1]Center on Global Energy Policy, New York, NY, [2]Columbia University, New York, NY, Contact: jw3764@columbia.edu

Ensuring the security of the critical mineral supply has been at the forefront of geo-strategic aspects of recent transportation electrification policies such as the Inflation Reduction Act in the United States. Furthermore, economic, ethical, and environmental concerns are associated with the unprecedented scale of critical mineral mining required to achieve zero-emission targets. To mitigate such impacts, both policymakers and fleet owners need to explicitly consider the tradeoffs between cost and critical mineral requirements in fleet electrification planning. We present a MILP formulation accounting for these tradeoffs in optimal decisions for vehicles and charging infrastructure configurations.

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SD54

CC-North 231B

Data-Driven Optimization and Explainability

Community Committee Choice Session

Session Chair: Alexandre Forel, Polytechnique Montreal, Montreal, QC, Canada

1 Cluster Explanation via Polyhedral Descriptions

Connor Lawless, Cornell University, Ithaca, NY, Contact: cal379@cornell.edu

This talk focuses on the cluster description problem where, given a dataset and its partition into clusters, the task is to explain the clusters. We introduce a new approach to explain clusters by constructing a polyhedron around each cluster while minimizing either the complexity of the resulting polyhedra or the number of features used in the description. We formulate the problem as an integer program and present a column generation approach to search over an exponential number of candidate half-spaces that can be used to build the polyhedra. To deal with large datasets, we introduce a novel grouping scheme that first forms smaller groups of data points and then builds the polyhedra around the grouped data. Compared to state of the art cluster description algorithms, our approach is able to achieve competitive interpretability with improved description accuracy.

2 Explainable Data-Driven Optimization

Alexandre Forel[1], Axel Parmentier[2], Thibaut Vidal[3], [1]MAGI, Polytechnique Montreal, Montréal, QC, Canada; [2]Ecole des Ponts, Champs sur Marne, France; [3]MAGI, Polytechnique Montreal, Montréal, QC, Canada. Contact: alexandre.forel@polymtl.ca

Data-driven optimization uses contextual information and machine learning algorithms to find solutions to decision problems with uncertain parameters. While a vast body of work is dedicated to interpreting machine learning models, explaining decision pipelines involving learning algorithms remains unaddressed. This lack of interpretability can block the adoption of data-driven solutions as practitioners may not understand or trust the recommended decisions. We bridge this gap by introducing a counterfactual explanation methodology tailored to explain solutions to data-driven problems. We introduce two classes of explanations and develop methods to find nearest explanations of random forest and nearest-neighbor predictors. We evaluate our approach by explaining key problems in operations management such as inventory management and routing.

3 Bilevel Optimization for Feature Selection in the Data-Driven Newsvendor Problem

Breno Serrano de Araujo[1], Stefan Minner[2], Maximilian Schiffer[1], Thibaut Vidal[3], [1]Technical University of Munich, Munich, Germany; [2]Technical University of Munich, München, Germany; [3]MAGI, Polytechnique Montreal, Montréal, QC, Canada

We study the feature-based newsvendor problem, in which a decision-maker has access to historical data with demand observations and exogenous features. In this setting, we investigate feature selection, aiming to derive sparse, explainable models with improved out-of-sample performance. Current methods utilize regularization, which penalizes the number of selected features or the norm of the solution vector. As an alternative, we introduce a novel bilevel program and present a MILP reformulation, which we solve to optimality with standard optimization solvers. Our experiments show that the method accurately recovers ground-truth features for instances with a few hundred samples, while other methods often require thousands of samples to obtain similar accuracy. Regarding out-of-sample generalization, we achieve improved or comparable cost performance.

4 Hyperboost: A Scalable Stacking Algorithm for Binary Classification

Ingo Meise, Zuse Institut Berlin, Berlin, Germany. Contact: meise@zib.de

Boosting is a popular, well-interpretable ensemble method. However, the larger the training data set, the harder it gets to (1) fit the training data and (2) apply existing regularization techniques like sparsification and generalization bounds which harms scalability in practice. We circumvent both problems by stacking boosted classifiers. This significantly decreases training error while we still ensure a scalable worst case running time and space complexity. Moreover, our algorithm enjoys a logarithmic approximation guarantee w.r.t. the sparsity of the set of base classifiers. It also iteratively minimizes strong PAC-Bayesian generalization bounds that are formulated as provably small linear programs. In extensive experiments on data sets from LIBSVM, we compare our stacking algorithm to popular ensemble methods like Boosting, Random Forests and XGBoost.

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SD55

CC-North 231C

Platforms Operations

Community Committee Choice Session

Session Chair: Pnina Feldman, Boston University, Boston, MA

1 Order Stacking in On-Demand Delivery Platforms

N. Bora Keskin, James Scott, Robert Swinney, Duke University, Durham, NC

To increase efficiency, On-Demand Delivery Platforms often “stack” (or batch) orders together and assign them to a single driver to deliver. We investigate the circumstances in which a platform can benefit from allowing the customer to decide whether their order is stacked with other orders or delivered directly for an additional fee. We also investigate the effect this has on customer surplus in equilibrium.

2 Multi-Homing Across Platforms: Friend or Foe

Gerard P. Cachon[1], Tolga Dizdarer[2], Gerry Tsoukalas[3], [1]University of Pennsylvania, Philadelphia, PA, [2]Boston College, Boston, MA, [3]Boston University, Boston, MA, Contact: dizdarer@bc.edu

Multi-homing gives platforms access to a larger pool of supply; however, it also changes the nature of competition between platforms in a market. It is not clear whether this works to the advantage of platforms or not. In light of this, we ask a fundamental question: When is it better for two-sided platforms to pool their workers? We answer this question through a game-theoretic study. We identify the key trade-offs associated with pooling decision and highlight the key role of scale.

3 Community/Committee'S Choice Submission

Zhen Lian, Yale School of Management, New Haven, CT, Contact: zhen.lian@yale.edu

Conventional wisdom in ride-hailing suggests that disclosing trip details to drivers hurts the platform, as drivers become selective about trips ("cherry-picking"). Still, recent shifts in regulations and labor are nudging platforms toward more transparency for drivers. We analyze a platform with two levers towards drivers: the pay, and the transparency of this pay. The platform faces uncertain demand, characterized by multiple demand scenarios. We find that, surprisingly, revealing full information is optimal, providing that the pay is set properly in each scenario. However, if the platform cannot dynamically adjust the pay, then full information can backfire, worse than not sharing any information at all. Our results highlight the intricate relationship between the information policy and the driver pay policy in ride-hailing.

4 Platform Disintermediation: Information Effects and Pricing Remedies

Shreyas Sekar[1], Auyon Siddiq[2], [1]University of Toronto, Toronto, ON, Canada; [2]University of California-Los Angeles, Los Angeles, CA, Contact: auyon.siddiq@anderson.ucla.edu

Many two-sided platforms face the risk of disintermediation, where sellers transact offline with buyers to bypass platform commission fees. While transacting offline allows sellers to avoid paying commission, it also leaves them fully exposed to risky buyers given the absence of the platform's protections. In this work, we examine how disintermediation and information quality -- specifically, the accuracy of the signal sellers receive about a buyer's type -- jointly impact a platform's revenue and optimal commission rate. Our results generate prescriptions for platforms seeking to mitigate revenue losses from disintermediation.

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SD56

CC-North 232A

Telecommunication and Network Design

Community Committee Choice Session

Session Chair: Marziehsadat Rezaei, [1]</sup

Session Chair: Sepideh Mohammadi, Lubbock, TX

1 A Compact Formulation and Efficient Solution Procedure for Fixed-Charge Network Flow

Eli Olinick[1], Yulan Bai[2], Ronald L. Rardin[3], [1]Southern Methodist University, Dallas, TX, [2]Towson University, Towson, MD, [3]University of Arkansas, Mckinney, TX, Contact: olinick@lyle.smu.edu

The triples formulation is a compact formulation of multicommodity network flow problems that provides a different representation of flow than the traditional and widely used node-arc and arc-path approaches. We show that the triples formulation significantly reduces the number of variables and constraints in the mixed integer programming formulations of the fixed-charge network flow problem (FCNF). For dense problem instances, the triples-based formulation of FCNF is found to produce better solutions than the node-arc formulation early in the branch-and-bound process. This observation leads to an effective hybrid method which combines the respective advantages of the smaller size of the triples formulation and the stronger linear programming relaxation of the node-arc formulation.

2 A Fairness-Aware Attacker-Defender Model for Optimal Edge Network Operation and Protection

Duong Thuy Anh Nguyen[1], Jiaming Cheng[2], Ni Trieu[3], Duong Tung Nguyen[1], [1]Arizona State University, Tempe, AZ, [2]University of British Columbia, Vancouver, BC, Canada; [3]Arizona State University, Tempe, AZ, Contact: dtnguy52@asu.edu

While various aspects of edge computing (EC) have been studied extensively, the current literature has overlooked the robust edge network operations and planning problem. To this end, this letter proposes a novel fairness-aware attacker-defender model for optimal edge network operation and hardening against possible attacks and disruptions. The proposed model helps EC platforms identify the set of most critical nodes to be protected to mitigate the impact of failures on system performance. Numerical results demonstrate that the proposed solution not only ensures good service quality but also maintains fairness among different areas during disruptions.

3 The Hop-Bounded Steiner Tree Problem with Budget Constraint

Sepideh Mohammadi, Hamidreza Validi, Texas Tech University, Lubbock, TX, Contact: sepideh.mohammadi@ttu.edu

The Steiner tree problem (STP) is an important combinatorial optimization problem with a wide range of applications (e.g., cable routing, chip design, and drug repositioning.) Given a weighted graph with a specific root, the hop-bounded STP with budget constraint seeks to maximize the vertex profits while keeping (i) the distances of vertices from the root in a specific range and (ii) the edge costs less than or equal to the budget. In this talk, we propose a cut-based mixed integer programming (MIP) formulation for the problem and compare its strength with two existing MIP formulations. We also propose multiple procedures that accelerate the solving process. We finally conduct a set of experiments on the benchmark instances to provide a computational comparison between the formulations and to assess the efficacy of the proposed enhancement procedures.

4 The Virtual Network Embedding Problem with Latency Constraints

Marziehsadat Rezaei[1], Hamidreza Validi[2], Illya V. Hicks[3], [1]Texas Tech University, LUBBOCK, TX, [2]Texas Tech University, Lubbock, TX, [3]Rice University, Houston, TX, Contact: marrezae@ttu.edu

We study the virtual network embedding problem with applications in cloud-based and telecommunication systems. This NP-hard problem seeks to find feasible mappings of virtual workloads onto an infrastructure with respect to constraints like capacities, placement, routing, and latency. We propose three mixed integer programming formulations for solving the problem: (i) a path-based model, (ii) a clique-based model, and (iii) a cut-based model. We also discuss the strength of the proposed formulations and the hardness of their corresponding separation problems. We finally present computational results on benchmark instances of the problem.

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SD57

CC-North 232B

Quantum Computing and Optimization I

Community Committee Choice Session

Session Chair: Brandon Augustino, Lehigh University, Landing, NJ

1 Universal Quantum Speedups for Branch-And-Bound Algorithms

Shouvanik Chakrabarti, 1</sup

Exact solvers for mixed integer optimization problems are primarily based on the Branch-and-Bound meta algorithm. These solvers have many important applications across science, engineering, and the financial industry. Finding quantum speedups for branch-and-bound is therefore of interest both from an applications perspective, and to demonstrate that quantum speedups in optimization are possible over the classical state-of-art (as opposed to naïve brute force algorithms). In 2015, Montanaro developed an algorithm that was theoretically demonstrated to obtain a quadratic speedup for Branch-and-Bound in terms of the number of nodes explored to find all optimal solutions in the worst case. We develop an algorithm where this speedup is extended to be universal: for almost any choice of search heuristic, and any problem instance, the quantum algorithm explores quadratically fewer nodes than the actual number of nodes explored by the classical equivalent. In particular, we show how the quantum Branch-and-Bound algorithm may be integrated with arbitrary early stopping conditions through an incremental tree search procedure.

2 Hamiltonian-Oriented Quantum Algorithm Design

Jiaqi Leng, Joseph Li, Xiaodi Wu, University of Maryland, College Park, College Park, MD, Contact: xwu@cs.umd.edu

The conventional design of quantum algorithms is centered around the abstraction of quantum circuits, a theoretically appealing but expensive-to-implement model given the limited computing resources of near-term quantum machines. We propose another paradigm where the design of quantum algorithms is directly built on the abstraction of continuous-time Hamiltonian evolution. Namely, we treat quantum machines as programmable and efficient solvers for the Schrodinger equation and directly develop applications on top of that. We showcase that a few leading quantum applications (e.g., quantum walk and quantum PDE solvers) can be re-derived in this way, which share the same features (e.g., efficiency, input/output assumptions) as their known circuit-model counterparts but could be likely implemented on near-term analog quantum simulators with minimal overheads.

3 Quantum Computing for Combinatorial Optimization
Carleton Coffrin, Los Alamos National Laboratory, Los Alamos, NM
This talk will review recent developments in solving combinatorial optimization problems with quantum computing hardware.

4 New Perspectives on Quantum Interior Point Methods
Brandon Augustino, Lehigh University, Bethlehem, PA, Contact: bra216@lehigh.edu
Existing quantum interior point methods seek to speedup their classical counterpart by using quantum linear systems algorithms to solve the Newton linear system at each iteration. While this approach yields polynomial speedups in the dimension, it introduces a dependence on a condition number bound which may prohibit any overall advantage. In this talk we present two new approaches to quantizing IPMs. The first approach draws on a recently established relationship between interior point methods and simulated annealing, while the second seeks to derive a quantum central path.

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SD58

CC-North 232C
Emerging Topics in Computational Optimization
Contributed Session
Session Chair: Samiran Kawtikwar, University of Illinois at Urbana Champaign, Urbana, IL

1 New Advances for Quantum-Inspired Optimization
Yu Du, University of Colorado Denver, Denver, CO, Contact: duyu197@gmail.com
The QUBO model has become highlighted as an effective alternative method for representing and solving a wide variety of combinatorial optimization problems. Additional momentum has resulted from the arrival of quantum computers and their ability to solve the Ising Spin Glass problem, another form of the QUBO model. This paper highlights advances in solving QUBO models and extensions to more general PUBO models as important alternatives to traditional approaches. Computational experience is provided that compares the performance of unique metaheuristic solvers NGQ, and NGQ-PUBO for QUBO and PUBO models with the performance of CPLEX and a leading Quantum solver. Extensive results disclose that our solvers outperform both CPLEX and the Quantum Solver by a wide margin in terms of both computational time and solution quality.

2 The Quantum Tortoise and the Classical Hare: Which Problems Will Quantum Computing Accelerate?
Neil Thompson[1], Sukwoong Choi[2], [1]MIT, Cambridge, MA, [2]University at Albany, SUNY, Albany, NY
Quantum computing promises transformational gains for solving some problems, but little to none for others. For firms hoping to use quantum computers now or in the future, it is important to know which problems will benefit. In this paper, we answer this question by analyzing the relative strengths of classical and quantum computers. This analysis then provides insights for which types of problems faced by businesses will benefit from quantum and which will not.

3 Hylac***:*** Hybrid Linear Assignment Solver in Cuda
Samiran Kawtikwar[1], Rakesh Nagi[2], [1]University of Illinois at Urbana Champaign, Urbana, IL, [2]Industrial Enterprise Systems University of Illinois, Urbana, IL, Contact: samiran2@illinois.edu
This paper presents a hybrid GPU-accelerated solver for the Linear Assignment Problem (LAP) that achieves significant performance improvements. The LAP is a fundamental combinatorial optimization problem. The Hungarian algorithm is a well-known approach for solving LAP, with $O(N^4)$ Munkres' and $O(N^3)$ Lawler's implementations having different speed advantages depending on the sparsity of problem instances. The proposed solver, HyLAC, blends the GPU solutions of above implementations and improves memory access and CPU-GPU synchronization. HyLAC achieves a speedup of up to 6.14x over existing GPU solvers for both sparse and dense instances. Additionally, a tiled LAP solver is developed to solve a list of small LAPs, it performs 22.59x faster than existing solvers.

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CC-West 101A
Structuring and Building Multicriteria Decision Model
Community Committee Choice Session
Session Chair: Adiel Teixera de Almeida, Brazil
Session Chair: Eduarda Asfora Frej, Universidade Federal de Pernambuco, Recife, Brazil

1 Choice of Method by Using a Framework for Structuring and Building Multicriteria Decision Models

Adiel Teixeira De Almeida[1], Lucia Roselli[2], Eduarda Asfora Frej[2], Danielle C. Costa Morais[3], [1]Universidade Federal de Pernambuco, Recife PE, Brazil; [2]Universidade Federal de Pernambuco, Recife, Brazil; [3]Universidade Federal de Pernambuco - UFPE, Recife - PE, Brazil. Contact: adielta@gmail.com

A Framework for structuring and building multicriteria decision models is discussed. The framework focuses on the decision process, in which the choice of MCDM/A methods is considered. Regarding this matter, compensatory and non-compensatory preferences are analyzed in the preference modeling process. This is considered a first step in choosing the MCDM/A method.

2 Multicriteria Decision Model for Portfolio Selection in Natural Gas Companies

Carolina Lino Martins[1], João Batista Sarmento dos Santos Neto[1], Lucas Borges Leal Silva[2], Eduarda Asfora Frej[3], Adiel Teixeira de Almeida[4], [1]Universidade Federal de Mato Grosso do Sul, Campo Grande MS, Brazil; [2]Universidade Federal do Rio Grande do Norte, Natal RN, Brazil; [3]Universidade Federal de Pernambuco, Recife, Brazil; [4]Universidade Federal de Pernambuco, Recife PE, Brazil. Contact: carolina.lino@ufms.br

The availability of new technology and rising demand have caused the energy sector to undergo restructuring. Due to its adaptability, natural gas can compete with practically all other alternative fuels. Planning its use is extremely difficult, as it depends on multiple criteria. Thus, this study proposes a GIS-Based Multicriteria Decision Support System for portfolio selection in natural gas companies. The study uses the Framework of twelve steps to define potential projects for expanding natural gas distribution networks. The multicriteria model is based on additive aggregation with a benefit-to-cost ratio-based approach and is integrated with a Geographic Information System (GIS). Consequently, companies can benefit from models comprising spatial and multicriteria analytical tools to improve and support strategic decisions to achieve efficient results.

3 A Multicriteria Decision Approach for Ranking Potential Investors in the Economic Development Agency of Pernambuco with the Fitradeoff Method

Geyse da Silva[1], Eduarda Asfora Frej[1], Adiel Teixeira De Almeida[2], [1]Universidade Federal de Pernambuco, Recife, Brazil; [2]Universidade Federal de Pernambuco, Recife PE, Brazil. Contact: eafrej@cdsid.org.br

In this work, a problem of attracting companies for direct investments in the state of Pernambuco, Brazil is addressed. The main goal is to aid the Economic Development Agency of Pernambuco (ADEPE) to rank the potential investors, based on a structured decision process. In order to address the multiple and conflicting objectives inherently involved in this problem, the FITradeoff method is applied, with the use of its Decision Support System. The combination of two preference modeling paradigms - elicitation of decomposition and holistic evaluations - within the structure of the FITradeoff method is widely explored in this work, with a view to show how such integration can bring improvements to the decision process. As a result, a ranking of 25 alternatives that could match the proposal of the Pernambuco state as a win-win investment movement is obtained.

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CC-West 101B

Student Participation in DEI: A Bottom-Up Approach to creating More Diverse, Equitable and Inclusive Departments and Universities

Panel Session

Session Chair: Justin Rist, The Pennsylvania State University, State College, PA

1 Student Participation in DEI: A Bottom-Up Approach to creating More Diverse, Equitable And Inclusive Departments and Universities

Susan E. Martonosi, Harvey Mudd College, Claremont, CA

As existing social, cultural, and educational practices are not inclusive to all learners, they restrict diverse engagement in STEM-based, thus OR/MS, higher education, which is the foundation for our research and development, cultivating equitable and inclusive learning experiences and environments will result in sustainable diversity in OR/MS fields. The “Promising Tomorrow” theme takes a student-focused bottoms-up approach with three strategic panel discussions to develop collaborative and inclusive learning OR/MS communities. Student communities can accelerate Equitable and inclusive OR/MS community development. This panel discussion outlines future collaborative student DEI efforts to strengthen the sense of belonging in our community.

2 Panelist

Abigail Rose Lindner, Worcester Polytechnic Institute,

Worcester, MA

3 Panelist
Jeremy Watts, University of Tennessee, Knoxville, TN

4 Panelist
Haroula Marianthe Tzamaras, Pennsylvania State University

5 Panelist
Marie Pelagie Elimbi Moudio, UC Berkeley

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SD61

CC-West 101C
Equity and Fairness in Resource Allocation Settings
Community Committee Choice Session
Session Chair: Faidra Monachou, Harvard University, Cambridge, MA

1 Group Fairness in Dynamic Refugee Assignment
Wentao Weng, MIT, Cambridge, MA
Recent research proposed algorithms that assign refugees and asylum seekers to geographic locations in a manner that maximizes the global average employment. While these algorithms can have substantial overall positive impact, using data from industry collaborators we show that the impact of them can vary widely across key subgroups. Thus motivated, we develop a framework for incorporating group fairness into the dynamic refugee assignment problem. Equipped with our framework, we propose two bid-price algorithms that maximize overall employment while simultaneously yielding provable group fairness guarantees. Through extensive numerical experiments using real-world data, we show that our algorithms can yield substantial improvements in group fairness compared to state-of-the-art algorithms with only small decreases in global performance.

2 Learning Optimal Fair Decision Trees: Trade-Offs Between Interpretability, Fairness, and Accuracy
Nathanael Jo, Stanford University, San Francisco, CA
The increasing use of machine learning (ML) in high-stakes domains creates an urgent need for interpretable, fair, and accurate algorithms. With these needs in mind, we propose a mixed integer optimization (MIO) framework for learning optimal decision trees that can be augmented with arbitrary fairness constraints. In order to better quantify the “price of interpretability”, we also propose a measure of model interpretability called decision complexity that allows for comparisons across ML models. We benchmark our method against existing approaches for fair classification on popular datasets; given a fixed disparity threshold, our method has a price of interpretability of about 4.2 percentage points in accuracy compared to the best performing, complex models. However, our method consistently finds decisions with almost full parity, while other methods rarely do.

3 The Determinants of U.S. College Admission
Allen Sirolly, Columbia Business School, New York, NY
Many colleges and universities in the United States take a “holistic” approach to undergraduate admissions which evaluates applicants on both academic and non-academic dimensions. We use a novel data set--containing students’ application information and admissions outcomes--to quantify the relative importance of these factors across the spectrum of college selectivity and student characteristics. We give evidence that the magnitude of “noise”--the part of admissions outcomes which is not attributable to merit-based factors--is significant, especially at highly selective colleges.

4 Protecting Vulnerable Communities From Flooding Under Climate Change
Yuki Miura, Columbia University, New York, NY

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CC-West 102A
Humanitarian Operations and Disaster Management
Community Committee Choice Session
Session Chair: Christopher W. Zobel, Virginia Tech, Blacksburg, VA
Session Chair: Andrew N. Arnette, Virginia Tech, Blacksburg, VA

1 Optimizing Food Bank Operations for Equity and Efficiency: A Case Study of Food Bank Quebec
Duygu Pamukcu[1], Julie Paquette[1], Burcu Balcik[2], Marie-Ève Rancourt[1], [1]HEC Montreal, Montreal, QC, Canada; [2]Ozyegin University, Istanbul, Turkey. Contact: duygu.pamukcu@hec.ca
Food banks are long-term continuous aid organizations, vital in combatting food insecurity by collecting and distributing food donations to agencies that then offer them to those in need. However, they encounter several challenges in

their operations, including logistical constraints and the variable nature of food donations. This study delves into the complexities of food bank supply chain operations and aims to develop a decision-support tool to optimize the allocation of diverse donations to the agencies while considering logistical constraints. Also, we consider the long-term equity targets of such organizations while maintaining their operational efficiency, a critical component in providing continuous aid. Leveraging a comprehensive case study of the Food Bank Quebec network, this research seeks to better understand the tradeoffs between the efficient and equitable allocation of diverse food donations over extended periods.

2 Changes in Community Emergency Reporting During the Covid Pandemic

Michelle Seref[1], Onur Seref[2], Christopher W. Zobel[2], [1]Virginia Tech, Blacksburg, VA, [2]Virginia Tech, Blacksburg, VA, Contact: mmhseref@vt.edu

We analyze 311 community emergency calls from Orlando, FL and San Diego, CA over a period spanning 3 months before the Covid Pandemic in the United States through the first 3 months of the pandemic. Using temporal context tracking, we analyze changes to emergency report categories and consider implications to future emergency reporting strategies and resource allocation planning.

3 Modeling and Managing Food Insecurity Through Assessment of Agricultural Practices

Deniz Besik[1], Shital Thekdi[2], Felipe Aros-Vera[3], [1]University of Richmond, Richmond, VA, [2]University of Richmond, Richmond, VA, [3]Ohio University, Athens, OH, Contact: dbesik@richmond.edu

In recent years, innovations in food production have improved efficiencies in agricultural practices, such as through factory farming. However, there is no clear optimal mix between food production practices, given that various food production practices have limited constrained production capabilities and are subject to vulnerabilities to changing conditions. This paper introduces a mathematical framework that aims to minimize the impact of food insecurity, specifically the deprivation from fresh, healthy produce over a period of time. To achieve this, we analyze various agricultural practices, from production to distribution, and their effectiveness in alleviating food insecurity. We present a numerical study on agricultural firms in Central Virginia, serving agricultural products in the form of fresh produce to community members in various neighborhoods.

4 Value of Sorting and Recovery in Post-Disaster Relief Aid Distribution

Mehmet Alegoz[1], Muge Acar[1], F.Sibel Salman[2], [1]Eskisehir Technical University, Istanbul, Turkey; [2]Koc University, Istanbul, Turkey

In-kind donations gathered from the public after a disaster typically consist of an unknown and disorganized composition of both “useful” and “useless” items. Sending the donations directly to the affected people without any pre-processing leads to not only extra shipment and handling costs but also congestion in the disaster areas, and even chaos in local distribution. We investigate the effect of relief aid sorting and subsequent recovery of items that do not fulfill immediate needs under demand, donation quantity, and donation type uncertainties. We propose a supply network configuration with sorting centers for pre-processing and optimize it by a three-stage stochastic programming model. We compare the case of the sorted donations with the case where donations are directly sent to points of distribution to victims. We apply the proposed model to the Istanbul earthquake case under different parameter settings and derive various managerial insights.

5 Offline Incentives and Online Volunteers’ Productivity

Eunae Yoo[1], Gloria Urrea[2], [1]Indiana University, Bloomington, IN, [2]University of Colorado Boulder, Boulder, CO

Online volunteering platforms are valuable tools for mobilizing individuals from around the world to work virtually on projects. However, this type of volunteering is typically a solitary commitment with limited incentives to boost productivity. We study the role of providing offline incentives in the productivity of online volunteers. We collect data from an online volunteering platform that has been giving microgrants to communities worldwide with the goal of providing offline incentives to online volunteers (e.g., training, access to technology, and even monetary incentives). The data allow us to identify the projects and online volunteers who benefit from these offline incentives. Using a difference-in-difference analysis, we investigate the effect of providing offline incentives on online volunteers’ productivity and the evolution of this effect over time.

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CC-West 102B

AI in Service Science

Community Committee Choice Session

Session Chair: Alan Scheller-Wolf, Tepper School of Business, Pittsburgh, PA

Session Chair: Yanhan Tang, 1</sup

1 Online Facility Location: Running Stores on Wheels with Spatial Demand Learning

Junyu Cao[1], Wei Qi[2], Yan Zhang[3], [1]The University of Texas at Austin, Austin, TX, [2]Tsinghua University, Beijing, Canada; [3]McGill University, Montreal, QC, Canada. Contact: yan.zhang13@mail.mcgill.ca

We formulate an online facility location problem, joint with operational-level decisions. The scope of facility location problems continues to expand, while the models of facility location problems have been so far largely restricted to be in a static, offline fashion, prescribing one-shot facility placement based on past and current data on hand. In an online setting, the decision maker is subject to parameter uncertainties. However, they are able to adjust facility locations over time while updating her parameter estimation from historical observations. To this end, we propose an online algorithm that integrates the continuous approximation approach. The algorithm is both computationally efficient and has a near-optimal regret guarantee.

2 Multi-Armed Bandits with Endogenous Learning Curves: An Application to Split Liver Transplantation

Yanhan (Savannah) Tang[1], Andrew A. Li[2], Alan Scheller-Wolf[3], Sridhar R. Tayur[1], [1]Carnegie Mellon University, Pittsburgh, PA, [2]CMU Tepper, Pittsburgh, PA, [3]Tepper School of Business, Pittsburgh, PA, Contact: yanhanta@andrew.cmu.edu

Proficiency in many sophisticated tasks is attained through learning by doing. For example, transplant surgeons need to practice difficult surgeries to master surgical skills. This experience-based learning may affect other stakeholders, for example, patients eligible for transplant surgeries. Such a situation illustrates the classical exploration-exploitation tradeoff: A central planner may want to identify and develop surgeons with high aptitudes while ensuring that patients still have excellent outcomes. We formulate a multi-armed bandit model with parametric reward functions to capture endogenous, experience-based learning. We propose the L-UCB and FL-UCB algorithms, prove their O(log t) regrets, and show that they have superior numerical performance compared to standard bandit algorithms when experience-based learning exists.

3 Bayesian Dynamic Pricing and Subscription Period Selection with Unknown Customer Utility

Yuan-Mao Kao[1], N. Bora Keskin[2], Kevin Shang[2], [1]Baruch College, CUNY, New York City, NY, [2]Duke University, Durham, NC, Contact: yuan-mao.kao@baruch.cuny.edu

We consider a provider offering subscription services to customers over a multiperiod planning horizon. The provider has a prior belief about the customers' utility model and updates its belief based on the transaction data of new customers and the usage data of existing subscribers. The provider aims to minimize its regret—the profit loss relative to a clairvoyant who knows the utility model. We first develop a method to resolve the curse of dimensionality in obtaining the clairvoyant's optimal policy. In the absence of full information, we show that a certainty-equivalence policy may perform poorly due to incomplete learning, slow learning, or offering a suboptimal and long contract at the beginning. We design an information-threshold policy that adaptively collects information, and show that this policy achieves asymptotically optimal performance.

4 Aruba: Efficient and Adaptive Meta-Learning with Provable Guarantees

Mikhail Khodak, Carnegie Mellon University, Pittsburgh, PA

Meta-learning has recently emerged as an important direction for multi-task learning, dynamic environments, and federated settings. We present a theoretical framework for designing practical meta-learning methods that integrates natural formalizations of task-similarity with the extensive literature on online convex optimization and sequential prediction algorithms. Our approach, which works by learning surrogate losses bounding the within-task regret of base learning algorithms, enables the task-similarity to be learned adaptively and leads to straightforward derivations of average-case regret bounds that improve if the tasks are similar. We highlight how our theory can be extended to numerous settings, especially for deriving multi-task guarantees for bandit algorithms.

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CC-West 102C

Influencer Marketing

Community Committee Choice Session

Session Chair: Jessie Liu, 1</sup

1 Imbalanced Impact of AI Matching on Influencer Marketing: Implications for Social Media Platforms

Z. Jessie Liu[1], Yi Liu[2], [1]Johns Hopkins University, Baltimore, MD, [2]University of Wisconsin - Madison, Madison, WI,

Contact: jzliu@jhu.edu
This paper examines the impact of adopting an Artificial Intelligence (AI) technology that matches marketers with influencers in social media platforms. We theoretically show that improving AI accuracy may not always benefit the platform. On the one hand, AI enhances the matching between influencers and marketers; on the other hand, it intensifies competition between influencers of different types. Improving such matching technology has an imbalanced impact on influencers: the matching outcome for influencers with a narrower audience ("niche" influencers) is more sensitive to AI accuracy than that for those with a broader audience ("general" influencers). As more niche influencers begin to participate in the marketing campaigns, the general influencers are pressured to reduce their prices, which gives rise to a possible decline in platform revenue.

2 Racial Pay Gap in Influencer Marketing

Amy Pei[1], Yakov Bart[2], Koen Pauwels[3], Chan Kwong[1], [1]Northeastern University, Boston, MA, [2]Northeastern University, Boston, MA, [3]Northeastern University, Newton, MA
Is there a racial pay gap for influencers? Using a novel data set, we find that Black macro-influencers were paid significantly more than their White counterparts in months with increased public attention to racial inequality. In contrast, micro-influencers did not experience any significant changes in pay during the same months. These findings are consistent with firms' virtue signaling during times of predictable visibility of Black influencers. Indeed, we find that the pay for Black-macro influencers did not change when an increase in public attention to racial inequality was triggered by an exogenous shock. Our empirical findings imply that firm response to racial inequality is opportunistic and only benefits more visible Black influencers.

3 Influencers: The Power of Comments

Cristina Nistor[1], Matthew Selove[2], [1]Chapman, Orange, CA, [2]Chapman University, Orange, CA, Contact: nistor@chapman.edu
Many customers choose products based on information from social media influencers. Companies can pay these influencers to promote their products. We develop a model in which customers read an influencer's sponsored post for a mix of entertainment and product information, and those who purchase the product can leave comments for future customers. We derive conditions in which a large celebrity influencer endorses all products, whereas a micro-influencer adopts a policy of endorsing only high quality products. In equilibrium, the micro-influencer screens for high quality products so his followers do not waste time reading informative comments about low quality products. By contrast, the celebrity influencer attracts many uninformative comments, and the value of his endorsement arises solely from generating product awareness.

4 Metaverse is Near: The Impact of Virtual Influencers on Human Influencers

Serim Hwang[1], Xiao Liu[2], Kannan Srinivasan[1], [1]Carnegie Mellon University, Pittsburgh, PA, [2]New York University, New York, NY, Contact: serimh@andrew.cmu.edu
Brands partner with AI virtual influencers because they are affordable and exempt from human misconduct (e.g., moral issues, feuds, scandals). However, it is unclear whether virtual influencers complement or displace human influencers. Using Instagram data, deep learning techniques (CNN, autoencoder, DeepFace), and three identification strategies, we study how the entry of virtual influencers affected human influencer jobs. We find that virtual influencers tend to displace previously sponsored human influencers, while complementing those who were not sponsored. Vulnerability to displacement was greatest for older, male, and less-attractive influencers; experience goods did not embrace virtual influencers as much as other categories. Finally, human influencers responded to this AI threat by increasing their usage of human-oriented verbs.

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CC-West 103A

Contemporary Challenges in Technology and Innovation Management

Community Committee Choice Session

Session Chair: Anant Mishra, Carlson School of Management, University of Minnesota, Minneapolis, MN

Session Chair: Yasaman Asayesh, 1</sup

1 Peer Effects and Learning with New Technology

Deepanshi Bhardwaj[1], Bilal Gokpinar[2], Ashwini Chhatre[3], [1]University College London, London, United Kingdom; [2]UCL School of Management, London, United Kingdom; [3]Indian School of Business, Hyderabad, India. Contact: deepanshi.bhardwaj.20@ucl.ac.uk
With the growth of new technologies and an increase in the knowledge-intensive nature of work, service agents have become a central part in service delivery and use. Using a unique transaction level dataset of bank-service agents, we investigate how agents adapt to new technologies and whether peers play a role in performance improvement. We find that at the onset of a technological change,

agents with peers adapt better to the new technology as compared to agents working in isolation and exhibit a 4% lower error rate in transactions. However, the peer effects do not hold in the presence of competition. We also find that while a major part of learning rests on an agent's own experience, the experience of peers also plays a critical role in performance improvement.

2 Leveraging the Potential of Outsourcing and Offshoring in Complex Product Development

Ole Frauen[1], Arnd Huchzermeier[2], Jurgen Mihm[3], [1]Volkswagen AG, Wolfsburg, Germany; [2]WHU - Otto Beisheim School of Management, Vallendar, Germany; [3]Insead, Fontainebleau, France

Leveraging the potential of outsourcing and offshoring remains a major challenge in complex product development. It is a question about effectively decomposing and distributing work across geographical and organizational boundaries while providing high quality products. The sourcing decisions must clearly depend on the product's characteristics and the emerging collaborative network. The study is based on an extensive data set containing 380,000 components from 121 vehicle projects of one of the largest car manufacturers worldwide. We demonstrate that a precise distinction between outsourcing and offshoring, as well as the introduction of a network perspective, are crucial to evaluate the effects in more detail.

3 The Development of Precision Medicines: An Economic Impediment or a New Model of Drug Innovation?

Jingwen Yang[1], Anant Mishra[2], [1]Lee Business School, University of Nevada Las Vegas, Las Vegas, NV, [2]Carlson School of Management, University of Minnesota, Minneapolis, MN

We study the development of precision medicines over the last decade. The study finds that precision medicines lead to market expansion. The effects are further strengthened by the availability of companion diagnostics. These findings suggest that the drug market responds to precision medicine innovation despite the concern surrounding the innovation targeting small, segmented drug markets. Overall, precision medicine innovation presents a viable new model of drug innovation departing from the traditional blockbuster innovation approach.

4 The Effect of Relatable Role Models on Increasing Female Participation in Stem Entrepreneurship

Jon Eckhardt[1], Brent Goldfarb[2], Minah Park[1], Subra Tangirala[2], Molly Carnes[1], Jennifer Sheridan[1], Markus Brauer[1], [1]University of Wisconsin–Madison, Madison, WI, [2]University of Maryland, College Park, MD

This study aims to generate greater interest in entrepreneurship for women in STEM through a large-scale field experiment involving incoming freshmen at a Carnegie R1 university. Students were randomly assigned to a relatable or unrelatable role model condition. Preliminary analysis on female and male students indicates that entrepreneurial identity aspiration and self-efficacy were driving the difference in entrepreneurial intention between the two conditions. Female students with STEM interest in the relatable role model condition found the video more relatable, but no significant difference in entrepreneurial intention was observed. We suggest that interventions may have the potential to increase interest in STEM entrepreneurship among undergraduates.

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CC-West 103B

Innovation and Relative Incentives

Community Committee Choice Session

Session Chair: Sanjiv Erat, University of California-San Diego, La Jolla, CA

1 Exclusive or Not? an Experimental Analysis of Parallel Innovation Contests

RAMAZAN Kizilyildirim[1], Ersin Korpeoglu[1], Mirko Kremer[2], Gizem Korpeoglu[3], [1]UCL, LONDON, United Kingdom; [2]Frankfurt School of Finance & Management, Frankfurt, Germany; [3]Eindhoven University of Technology, Eindhoven, Netherlands

We study parallel innovation contests where contest organizers elicit innovative solutions to a set of problems from a group of solvers with limited (financial, time, cognitive) resources. The quality of a solver's solution improves with their effort, yet it is also subject to an output uncertainty. Prior theoretical work shows that organizers should discourage solvers from participating in parallel contests under low output uncertainty. In this case, organizers should benefit from solvers focusing all of their efforts on a single “exclusive” contest rather than splitting them across multiple “non-exclusive” contests. We test this prediction with controlled laboratory experiments. Our main result is that non-exclusive contests are attractive to organizers even in environments with low output uncertainty where contest theory favors exclusive contests.

2 Designing Knowledge-Driven Innovation Contests

Lakshminarayana Nittala[1], Sanjiv Erat[2], [1]University of Dayton, Dayton, OH, [2]University of California-San Diego, La Jolla, CA

We develop a framework for Innovation Contests that explicitly considers knowledge generation and transfer under different modes of learning. We characterize the effort allocation of contestants from a knowledge management perspective and derive insights for optimal contest design.

3 Sequential Product Innovation and Inventory Planning in Startups

Sreekumar R. Bhaskaran[1], Karthik Ramachandran[2], Ankur Goel[3], [1]Southern Methodist University, Dallas, TX, [2]Georgia Institute of Technology, Atlanta, GA, [3]PNC Bank, Pittsburgh, PA, Contact: sbhaskar@mail.cox.smu.edu

While developing innovative and novel products, startups typically use intermediate products as bridges to help them manage the transition and generate revenue to continue the development process. However, the development process for the new product is also risky with several challenges including regulatory obstacles and uncertainty about the product-market fit which can require significant time and resources. However, operational decisions including inventory levels for the intermediate product would have to be made before this uncertainty is resolved. In this paper, we jointly model the inventory and new product development decisions of sequentially improving hardware products developed by startups. Impact of supply disruptions, product architecture and development capability on the startup's transition strategy are also explored.

4 Duration Overlapping and Online Contest Performance

Sanjiv Erat, Xiaofeng Liu, University of California San Diego, La Jolla, CA

With the increasing popularity of online contests, many companies are embracing this approach to source innovative solutions. As the number of contests grows, some need to run concurrently. This study introduces a model that considers multiple solvers and contests, investigating the impact of overlapping durations on contest performance. The findings indicate that overlapping with other contests can result in fewer solvers and lower submission quality, especially when those end prior to the focal contest. Furthermore, the study uncovers a positive externality on submission quantity and quality when the duration overlapping occurs with similar contests. Empirical evidence from a prominent online contest platform supports the analytical model.

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Data Mining Best Student Paper Competition

Award Session

Session Chair: Nathan B. Gaw, Air Force Institute of Technology, Wright-Patterson AFB, OH

Session Chair: Young Woong Park, Iowa State University, Ames, IA

Session Chair: Andi Wang, Arizona State University, Mesa, AZ

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CC-West 104B

Applications of Deep Learning to Real World Problems

Community Committee Choice Session

Session Chair: Bruce Cox, Air Force Institute of Technology, Dayton, OH

1 Transfer Learning for Emotion Classification of Indonesian Tweets

Connor Shaw, Air Force Institute of Technology, OH

This research utilizes Bidirectional Encoder Representation from Transformer (BERT) and Recurrent Neural Networks (RNNs) to perform emotion classification for Indonesian Twitter data. It explores the merits and demerits of both approaches. Ultimately, Bilateral Long Short-Term Memory (Bi-LSTMs) utilizing five emotion classes were able to achieve a macro-level F1 score of 70.83% and a fine-tuned Indonesian BERT performed at 79.1%. This additional performance comes with a longer training time, the requirement of using a pre-trained large language model (LLM), and other attributes discussed in this presentation.

2 Automated Registration of Titanium Metal Imaging of Aircraft Components Using Deep Learning Techniques

Nathan Johnston, Air Force Institute of Technology, OH

Studies have identified a connection between the microtexture regions (MTRs) found in certain titanium alloys and early onset creep fatigue failure of rotating turbomachinery. Microtexture regions are defined by their size and orientation, which can be characterized via scanning electron microscopy (SEM) Electron Backscatter Diffraction (EBSD). However, doing so is impractical at the component-scale. A novel method of characterizing MTRs is needed to qualify new engine components. Researchers in the Air Force Research Lab Materials and Manufacturing Directorate have proposed fusion of two inspection methods (eddy current testing (ECT) and scanning acoustic microscopy (SAM)) to achieve the goal of MTR characterization. Our research focuses on development of a Convolutional Neural Network to automatically register two polarized light microscopy images.

3 Entering Hyperspace: Conditional Hyperspectral Reflectance Image Generation Using Convolutional Neural Networks

Bret Wagner, Air Force Institute of Technology, OH

The Afit Sensor and Scene Emulation Tool (ASSET) produces accurate synthetic electro-optical and infrared (EO/IR) data. ASSET currently uses broadband reflectance inputs to produce a realistic scene. The radiometric accuracy of that scene may by improved through the implementation of hyperspectral reflectance data. This research uses a Pix2Pix generative adversarial network (GAN) and a U-Net convolutional neural network (CNN), trained on pixel matched satellite images to produce synthetic hyperspectral reflectance data. The networks generate multiple narrow band reflectance maps from a single panchromatic image, which ASSET will use as source material for synthetic background signature generation. The contributions herein are relevant to improving ASSET's radiometric accuracy and generating synthetic hyperspectral data sets.

4 Garbage in ≠ Garbage Out: Exploring Gan Resilience to Image Training Set Degradations

Nicholas Crino, AFIT/ENS, Dayton, OH, Contact: nicholas.crino.1@us.af.mil

Generative Adversarial Networks (GANs) are a class of powerful generative models. While research has yielded GAN variants robust to training set shrinkage and corruption, we focus on quantifying the resilience of a GAN architecture to specific modes of image degradation. We determine empirically the effects of 10 fundamental image degradation modes applied to the training image dataset on the Fréchet inception distance (FID) of images generated by a conditional DCGAN. We find that at the ▯ = 0.05 level, brightening, darkening, and blurring are significantly more detrimental to GAN image quality than full data loss, while other degradations are typically safe to keep in datasets. Additionally, we find that only in the case of randomized partial occlusion does the FID of resulting GAN images approach that of the degraded training set for increasing levels of corruption.

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CC-West 105A

Issues in Renewable Energy Auctions and Market Design

Community Committee Choice Session

Session Chair: Joseph Edward Duggan, University of Dayton, Dayton, OH

1 Pricing Indivisibilities in the Investment Problem

Nicolas Stevens, UCLouvain, Louvain-la-Neuve, Belgium

Pricing non-convexities in power markets has been explored vividly in the literature and among practitioners for the past twenty years. The debate has been focused on indivisibilities in short-term auctions, the computational tractability of the pricing proposals and their economic analysis. In this work, we introduce another non-convexity that is less discussed: the indivisibilities in investment decisions. We analyze the problem from a theoretical point of view, characterizing the long-term incentives of the agents. We derive theoretical results relative to the incentives of the participants to deviate from the social optimum when the market grows. We analyze the ability of a capacity market to improve the incentives. We illustrate our findings on a stylized example and numerical simulations conducted on a model that covers the entire European region.

2 Multi-Product Balancing Market and Cross-Border Platforms

Jacques Cartuyvels, UCLouvain, Ottignies-Louvain-la-Neue, Belgium. Contact: jacques.cartuyvels@uclouvain.be

This paper provides a framework for understanding multi-product European balancing markets. We characterize the optimal strategies of price-taking flexibility providers that can participate in sequential capacity auctions for secondary and tertiary reserves, followed by a real-time power auction conducted by the system operator. Equilibria are then derived depending on three market characteristics: (i) the capacity demand curves, (ii) the system operator's activation strategies, and (iii) the imbalance pricing scheme. The results are then extended to the cross-border setting with the integration of balancing platforms.

3 The Effects of Long-Term Market Design Choices on Low-Carbon Electricity System Outcomes

Mark Noll, Argonne National Laboratory, Washington, DC

In this work, we examine how different choices of electricity market design parameters affect market outcomes in low-carbon systems. We apply a least-cost capacity expansion model to a simplified version of the New York power grid to compare system costs and unit-level operational outcomes and profitability under an "energy-only" market design to a "capacity-based" market design that features a reserve margin requirement and lower energy and ancillary service price caps. We enforce an increasing clean energy standard in both cases and capture aspects especially relevant to high-VRE systems, including declining capacity contributions of VRE renewable resources and battery storage and flexible operations of reservoir-based hydro power plants and battery storage.

4 Funding Mechanisms in Green Finance: The Creation of Commitment with Green and Sustainability-Linked Bonds

Philip Zilke[1,2], [1]Leibniz Centre for European Economic Research, Mannheim, Germany; [2]University of Cologne, Cologne, Germany. Contact: philip.zilke@zew.de

I study a problem of moral hazard in corporate funding which arises due to the time lag between funding and investment. The investors decide at which funding terms to invest in the company before the company has to decide in what projects to invest the funding. I show that if investors with green preferences participate in the funding process, the company can benefit from committing to invest in green projects ex ante. In Green Finance, companies can create commitment by the issuance of Green or Sustainability-linked Bonds. If the project's sustainability is observable by the investors ex ante, both bond types yield the same outcome. If investors can only observe the project's sustainability ex post, the outcomes of Green Bonds are distorted due to the information asymmetry. I show that Green Bonds yield more investment in green projects compared to Sustainability-linked Bonds.

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The Future of Digital Platforms

Community Committee Choice Session

Session Chair: Jing Peng, University of Connecticut, Storrs, CT

1 Team Purchase as a Marketing Strategy

Huiyan Chen[1], Jing Peng[1], Mengcheng Guan[2], Jianbin Li[2], [1]University of Connecticut, Storrs, CT, [2]Huazhong University of Science and Technology, Wuhan, China. Contact: huiyan.chen@uconn.edu

Team purchase is marketing strategy that encourages customers to purchase discounted products together with friends. Over the past few years, team purchase has become a popular strategy for online sellers to acquire new customers. However, the impact of team purchase on the sales of sellers' other products remains unclear. Using a dataset from an e-commerce platform, we find that that enrolling a few products in team purchase increase the sales of the sellers' other unpromoted products, and this effect varies across different types of sellers. Moreover, we find that the spillover effect exhibits similar heterogeneity at the brand level, except that the spillover effect on highly popular brands can be negative. This finding suggests that the sellers may gain from team purchase at the expense of large brands. We discuss the implications of our findings for sellers and brands.

2 Privacy and Content Contribution of Fact Checkers

Sameer Borwankar, Jinyang Zheng, Purdue University, West Lafayette, IN, Contact: sborwank@purdue.edu

Researchers have studied different solutions for preventing the generation and spread of misinformation on social media. Previous research on crowd-based solutions has shown that such programs effectively improve the quality of the content generated by fact-checkers. But it comes at the cost of the quantity of the content. To avoid such higher costs in terms of reduction in content, Twitter has allowed fact-checkers to do the monitoring anonymously. Our paper studies the effectiveness of this privacy protection feature of the crowd-based Community Notes program on Twitter. Some of the questions we address are:
1. whether the privacy-protecting feature reduces the cost involved in crowd-based fact-checking programs
2. Whether the quality of the content generated by the fact-checkers, after enabling the privacy protection feature, remains the same.

3 Unveiling The Effects Of LLMs: Shifting UGC Contribution In An Online Coding Community

Xinyu Li, Keongtae Kim, The Chinese University of Hong Kong, Shatin, NT, Hong Kong. Contact: xinyu.li@link.cuhk.edu.hk

Large language models (LLMs) like ChatGPT are reshaping content creation and knowledge sharing on user-generated content (UGC) platforms. While they enable AI-assisted content generation and potentially increase interactions among users, concerns arise regarding possible discouraging effects on user participation through increased competition for visibility and eroded trust stemming from an influx of low-quality content. This study presents timely evidence on changes in user contributions following the introduction of ChatGPT. Our findings underscore the necessity of monitoring LLM impacts on UGC platforms and formulating harmonious human-AI collaborations. Overall, this study offers critical insights into the emerging influence of generative AI on UGC platforms.

4 Stimulating Consumption on a Limited Budget with AI vs. Human: Evidence from a Large-Scale Randomized Field Experiment

Chen Liang[1], Tong Shen[1], Chunxiao Li[2], Xi Jing[2], Shuliu Yuan[3], Bin Gu[4], [1]University of Connecticut, Storrs, CT, [2]Shanghai Jiao Tong University, Shanghai, China; [3]T3 Chuxing Technology Co., Nanjing, China; [4]Boston University, Boston, MA, Contact: tong-shen@uconn.edu

This study examines the effectiveness of AI vs. human decision-making in stimulating consumption based on coupons in ride-hailing platforms. Results from a randomized experiment show that both AI and human-optimized coupons can drive consumption effectively, with AI coupons excelling during lower demand periods. Furthermore, we find that human-optimized coupons are highly effective in increasing the ride completion rate for users with low prior coupon redemption rates, whereas AI-optimized coupons are highly effective for users with high prior coupon redemption rates. Our study highlights the importance of designing coupons tailored to specific trip types and user segments.

5 Estimating Online Community Evolvement with Social Networks

Yanhao Wei[1], Wensi Zhang[2], Sha Yang[1], Xi Chen[3], [1]University of Southern California, Los Angeles, CA, [2]The University of Texas at Dallas, Richardson, TX, [3]Zhejiang University, Zhejiang, China. Contact: wensi.zhang@utdallas.edu

Incorporating online community features has become a popular strategy for digital platforms to engage consumers and foster social interactions, highlighting the importance of understanding how online communities form and develop over time. Our paper builds a model that captures the co-evolvement of both online communities and social networks, accommodating rich unobserved heterogeneity at the user level in both communities and networks. To address the computational challenge, we embrace the trend of fusing machine learning techniques with economic modeling of decision-making, utilizing a neural net-based estimator (NNE) to recover our model parameters. We demonstrate the accuracy and scalability of this estimation method through simulation and discuss the implications using real data from online gaming.

Sunday, October 15, 2:15 PM - 3:30 PM

SD71

CC-West 105C

Business Analytics with Modern AI/ML

Community Committee Choice Session

Session Chair: Junming Yin, Carnegie Mellon University, Pittsburgh, PA

1 Market Segmentation Using Deep Learning

Wenjun Zhou, University of Tennessee Knoxville, Knoxville, TN

Segmentation is an important task for businesses to understand their customer base. In this presentation, we explore opportunities in using deep learning techniques to conduct market segmentation.

2 Consumer Search and Preference Formation: A Deep Structural Econometric Model

Yicheng Song, University of Minnesota, Minneapolis, MN

We propose a theory-driven deep learning model called Customer Preference Transformer (CPT), which leverages the Transformer model to learn dynamic customer preferences and sequential search theory to model customers' search and purchase decisions. CPT integrates these two building blocks into a unified model that can be estimated via end-to-end learning. Unlike regular deep learning methods, we incorporate economic theory into the model learning process, opening up the black box of the model and providing reasonable interpretations of the formation process of dynamic customer preferences.

3 Someone is Mimicking You: Investigating Competition Network in Social Trading

Ye Liu, University of Washington, Seattle, WA

Social trading platforms are gaining popularity due to their high level of information transparency. While greater information transparency can benefit investors, it also enables strategic investors to mimic original traders' trading strategies with little cost, pretend to be original traders, and compete with other traders. Using data from a leading social trading platform, we investigate the effect of the competition network. We then model the dynamic change of the network and traders' attributes (the number of followers) using the coevolution model.

4 Text Versus Video for Knowledge Communication: Combining Quasi-Experiment and Interpretable Video Analytics

Gujie Li, Jui Ramaprasad, Lauren Rhue, Wen Wang, University of Maryland, College Park, MD, Contact: gujieli@umd.edu

In this study, we examine the effect of video on viewers' psychological processes including cognitive, affective, social, and perceptual process, which are essential for knowledge transfer. Leveraging a quasi-experiment, we find that knowledge communicated in video significantly elicits affective, social, and perceptual process as compared with that in text, whereas they do not differ in evoking cognitive process. We also explore the heterogeneity of knowledge content (fact-based and opinion-based knowledge). We further decompose videos into interpretable audio-visual features and investigate their differential influences on the four psychological processes. Our findings help to offer actionable insights for knowledge content creators, educators, and managers of knowledge sharing platforms.

Session Chair: Gujie Li, Hyattsville, MD

Sunday, October 15, 2:15 PM - 3:30 PM

SD72

CC-West 106A

Recent Development in Modeling Complex Spatial and Temporal Dependent Data

Community Committee Choice Session

Session Chair: Wenbo Wu, The University of Texas at San Antonio, San Antonio, TX

1 A General Spatial-Temporal Framework for Short-Term Building Temperature Forecasting at Arbitrary Locations with Crowdsourcing Weather Data

Renhao Sun, 1</sup

This paper presents a novel approach by utilizing crowdsourcing weather data from neighboring personal weather stations (PWS) to improve the weather forecast accuracy around buildings using a general spatial-temporal modeling framework. Our approach leverages PWS data in addition to public data sources, resulting in finer time and spatial resolutions. Additionally, the proposed model incorporates spatial-temporal correlation information of weather variables between the target building and neighboring PWSs, effectively capturing underlying correlation. To evaluate our framework, we compare it against the benchmark models on temperature forecasting for a building located in San Antonio. Overall, our proposed model framework demonstrates a 50% improvement over persistent model and has a 90% chance to outperform airport forecasts in short-term prediction.

2 On Partial Envelop Approach for Modeling Spatial-Temporally Dependent Data

Reisa Widjaja, 1</sup

Modeling multivariate spatial-temporally dependent data is a challenging task due to the dimensionality of the features and the complex spatial-temporal associations among the data. We use a parsimonious approach by proposing a spatial-temporal partial envelop model to achieve efficient estimations in modeling the spatial-temporal data. We extend our model to a group-wise spatial-temporal partial envelop model to adjust the heterogeneity existing at different locations. We provide both theoretical justifications and conduct thorough empirical simulations to demonstrate the effectiveness of our proposed method. We also apply the proposed model to analyzing the crowdsourcing weather data collected from personal weather stations in the United States.

3 Dimension Reduction for Spatial Regression

Hossein Moradi Rekabdarkolaee, South Dakota State University, Brookings, SD

Natural sciences often utilize regression models for spatial data with highdimensional predictors and moderate sample sizes. Therefore, efficient estimation of the regression parameters is crucial for both model interpretation and prediction. The predictor envelope is a dimension reduction method for linear regression that assumes certain linear combinations of the predictors are immaterial to the regression. While predictor envelopes have been developed and studied for independent data, no work has been done adapting predictor envelopes to spatial data. In this work, we proposed the spatial predictor envelope that provides efficient estimate for regression coefficients while taking spatial autocorrelation into account. The effectiveness of the proposed model is illustrated through simulation studies and real data analysis.

4 Scalable Semiparametric Spatio-Temporal Regression for Large Data Analysis

Ting Fung Ma, University of South Carolina, Columbia, SC

Spatio-temporal data are becoming increasingly abundant in a diverse array of disciplines. Here, we develop a spatio-temporal regression methodology for analyzing large amounts of spatially referenced data collected over time. We specify a semiparametric autoregressive model without the Gaussian assumption and devise a computationally scalable procedure with linear computational complexity. Asymptotic properties are further established that inform the computational procedure to be efficient and scalable. A simulation study is conducted to evaluate the finite-sample properties of the procedure. We illustrate our methodology with a dataset with over 2.96 million observations of land surface temperature, and comparison with an existing approach highlights the advantages of our method.

Sunday, October 15, 2:15 PM - 3:30 PM

SD73

CC-West 106B

Stochastic Control and Its Applications in Finance

Community Committee Choice Session

Session Chair: Xuedong He, Chinese University of Hong Kong, Hong Kong

1 Exit Strategies of CPT Gamblers in Asymmetric Random Walks

Sang Hu, The Chinese University of Hong Kong, Shenzhen, Shenzhen, China. Contact: husang@cuhk.edu.cn

In this paper we consider the optimal stopping strategy of a CPT gambler in an asymmetric casino betting problem. After a geometric transformation on the underlying process, we use the Skorokhod embedding technique with randomization to change the decision variables from stopping times to probability distributions of accumulated gains or loss at exit time. Different from fair betting problem that was studied in He et al. (2019), we show that even in an infinite time horizon the asymmetric gambling problem could be well-posed for a wide range of specifications of probability weighting functions. We also present the optimal solution of randomized path-dependent stopping time in the case of power distortion functions.

2 Strategic Investment Under Uncertainty with First- and Second-Mover Advantages

Min Dai[1], Zhaoli Jiang[2], Neng Wang[3], [1]The Hong Kong Polytechnic University, Hong Kong, China; [2]Chinese University of Hong Kong, Shenzhen, Shenzhen, China; [3]Columbia University, New York, NY, Contact: zljiang@cuhk.edu.cn

We analyze a duopoly real-option entry game where the second mover has a cost advantage over the first mover. The equilibrium solution features five regions. In addition to the option-value-of-waiting and competing-to-enter (first-mover-advantage) regions (Fudenberg and Tirole, 1985; Grenadier, 1996), three new regions appear due to the second-mover advantage: a waiting-to-be-Follower region and two disconnected probabilistic-entry regions. Only when market demand is very high does Follower immediately enter after Leader does. The second-mover advantage causes firms to use state-contingent mixed strategies, significantly delaying their entry timing. Our model generates new predictions, e.g., entry likelihood is non-monotonic in market demand.

3 Recovering Time-Consistency in the Mean-Variance Problem

Cagin Ararat[1], Emre Duzoylum[2], [1]Bilkent University, Ankara, Turkey; [2]University of California Santa Barbara, Goleta, CA, Contact: cararat@bilkent.edu.tr

The dynamic mean-variance problem is a well-studied optimization problem that is known to be time-inconsistent. The main source of time-inconsistency is that the family of conditional variance functionals indexed by time fails to be recursive. We consider the mean-variance problem in a discrete-time setting and study an auxiliary dynamic vector optimization problem whose objective function consists of the conditional mean and conditional second moment. We show that the vector optimization problem satisfies a set-valued dynamic programming principle and is time-consistent in a generalized sense. Finally, we propose a computational procedure that relies on convex vector optimization and convex projection problems, and we use this procedure to calculate time-consistent solutions in discrete market models.

4 Optimal Liquidity Provision on Decentralized Exchanges

Xuedong He[1], Chen Yang[2], Yutian Zhou[1], [1]The Chinese University of Hong Kong, Shatin, Hong Kong; [2]Eidgenossische Technische Hochschule Zurich Departement Mathematik, Burwood

Automated Market Makers (AMMs) are a popular type of decentralized exchanges in which users trade tokens with each other directly and automatically through a liquidity pool and a fixed pricing function. Liquidity providers can contribute to the liquidity pool by supplying tokens to the pool and in return they earn transaction fees from users who trade through the pool. We propose a model of optimal liquidity provision in which a risk-averse liquidity provider decides the number of tokens she would like to supply to the pool and trade in an open market and the amount of consumption in multiple periods. We derive the liquidity provider's optimal strategy by dynamic programming and study the impact of the transaction fees and pricing function on the number of tokens supplied by the liquidity provider.

Sunday, October 15, 2:15 PM - 3:30 PM

SD74

CC-West 106C

Economics and Computation IV

Award Session

Session Chair: Yanqiu Ruan, Singapore University of Technology and Design, Singapore, Singapore

1 On the Timing of Auctions: The Effects of Complementarities on Bidding, Participation, and Welfare

Hayri Alper Arslan[1], Alex Arsenault-Morin[2], Matthew Gentry[3], [1]University of Texas at San Antonio, San Antonio, TX, [2]Queen's University, Kingston, ON, Canada; [3]Florida State University, Tallahassee, FL

This paper empirically explores how varying the timing of a sequence of auctions affects both bidder behavior and the welfare of procurers and bidders. We develop a structural auction model with endogenous participation in which bidding may be either simultaneous or sequential, and bidders may perceive auctioned objects as either complements or substitutes. We then apply this model to data on auctions for roof-maintenance projects in Montreal. We show that complementarities can account for as high as 17% of the total size of a contract combination. Finally, we develop an algorithm to search a schedule of auctions and show that the total cost of projects can be reduced by more than 8%.

2 Algorithmic Assistance with Recommendation-Dependent Preferences

Bryce McLaughlin, Jann Spiess, Stanford Graduate School of Business, Stanford, CA, Contact: jspiess@stanford.edu

When we use algorithms to produce risk assessments, we typically think of these predictions as providing helpful input to human decisions, such as when risk scores are presented to judges or doctors. But when a decision-maker obtains algorithmic assistance, they may not only react to the information. The decision-maker may view the input of the algorithm as recommending a default action, making it costly for them to deviate, for example when a judge is reluctant to overrule a high-risk assessment of a defendant or a doctor fears the consequences of deviating from recommended procedures. In this article, we consider the effect and design of algorithmic recommendations when they affect choices not just by shifting beliefs, but also by altering preferences. We motivate our model from institutional factors, such as a desire to avoid audits, as well as from well-established models in behavioral science that predict loss aversion relative to a reference point, which here is set by the algorithm. We show that recommendation-dependent preferences create inefficiencies where the decision-maker is overly responsive to the recommendation. As a potential remedy, we discuss algorithms that strategically withhold recommendations, and show how they can improve the quality of final decisions.

3 Choice Architecture, Privacy Valuations, and Selection Bias in Consumer Data

Tesary Lin[1], Avner Strulov-Shlain[2], [1]Boston University, Cambridge, MA, [2]University of Chicago, Chicago, IL

How much are consumers' privacy valuations influenced by choice architecture? How does this influence affect the volume and representativeness of the data shared? To answer these questions, we run an experiment to elicit consumers' valuation for their personal data while randomizing the default option and price anchor that they face. An opt-out default decreases valuations by 14-22% compared to opt-in, while a $0-50 anchor decreases valuation by 37-53% compared to a $50-100 anchor. We find that choice architecture that maximizes the supply of data can have opposite effects on its representativeness: A bias exacerbating effect emerges when consumers' privacy valuations and frame effects are negatively correlated. However, such a volume-maximizing frame may also mitigate the bias by improving sample coverage.

4 A Nonparametric Approach with Marginals for Modeling Consumer Choice

Yanqiu Ruan[1], Xiaobo Li[2], Karthyek Murthy[3], Karthik Natarajan[3], [1]Singapore University of Technology and Design, Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore; [3]Singapore University of Technology and Design, Singapore, Singapore

This paper aims to develop parsimonious models for predicting consumer choice behavior using the marginal distribution model (MDM). By establishing necessary and sufficient characterizations of choice data for consistency with MDM, the paper achieves an exact representation of choice probabilities. Verifying the consistency of choice data with this characterization is equivalent to solving a polynomial-size linear program. MDM strikes a balance between tractability and representational power, allowing a nonparametric prediction approach where data informs marginal distributions based on the task at hand. Inconsistent choice data with MDM leads to solving a mixed integer convex program for the best-fitting MDM. These results extend to the case where the alternatives can be grouped based on the marginal distribution of their utilities.

Sunday, October 15, 2:15 PM - 3:30 PM

SD75

Session.Location:CC-West 208A

Operations Planning to Ensure Food Security

Contributed Session

Session Chair: David C. Novak, University of Vermont, Burlington, VT

1 Volunteer Allocation and Route Planning for Non-Profit Food Banks with Fairness Requirements

Maria Cabarcas[1], Faisal M. Alkaabneh[2], Leila Hajibabai[1], Ali Hajbabaie[1], [1]North Carolina State University, Raleigh, NC, [2]North Carolina A&T State University, Greensboro, NC, Contact: mcabarc@ncsu.edu

This research studies the assignment of volunteers to appropriate routes to service centers in a non-profit food network. The problem involves food banks, volunteers, and service locations. The routes include picking up volunteers, taking them to service locations where they assist food-insecure households, and returning them home. The problem is formulated as a specialized network flow model that considers volunteers' unique locations and availability status. The objective is to maximize the number of volunteers assigned to service locations while minimizing the routing cost. To solve this problem, a branch and price based technique is devised. Numerical experiments are conducted to validate the effectiveness of the proposed methodology.

2 A Location Routing Model for Equitable Food Distribution to Insecure Households

Kuangying Li, Maria Cabarcas, Asya Atik, Leila Hajibabai, Ali Hajbabaie, North Carolina State University, Raleigh, NC, Contact: lhajiba@ncsu.edu

This study aims to develop an optimal plan for location and routing of food rescue operations by volunteers considering food supply and demand under resource and vehicle capacity constraints. A multi-objective mixed-integer linear model is formulated that aims to maximize the total demand served and minimize the total travel cost of volunteers. An integrated solution technique based on Lagrangian relaxation and column generation is proposed to solve the problem. The proposed methodology decomposes the problem into location and routing components and solves them iteratively using a case study in Raleigh, North Carolina. The preliminary results indicate that the proposed methodology can solve the problem efficiently and outperform the solutions obtained by a benchmark.

4 Hospital Food Waste: A Stochastic Approach Minimizing Food Waste While Fulfilling Nutritional Requirements Under Different Demand Scenarios

Mariana Arriz-Jorquiera, Jorge Andrés Acuna, Jose L. Zayas-Castro, University of South Florida, Tampa, FL, Contact: arrizjorquiera@usf.edu

Up to 5% of the global environmental damage is contributed by the healthcare system, whose solid waste is 71% produced by hospitals, 10-15% of which is food waste. Not only is food waste a global environmental concern, but it also affects patient nutrition. This talk presents a stochastic approach to building the plates of patients by using a Mixed Integer Programming (MIP) model to minimize food waste, applied under different scenarios of the weekly demand of a 1000-bed Hospital in Florida. The discussion includes the difference between the plates that are built without considering the food waste and the plates that include extra food to cover the loss of nutritional intake when the food is wasted.

5 Transportation-Based Food Accessibility Considering Social Vulnerability

David C. Novak[1], James Sullivan[2], [1]University of Vermont, Burlington, VT, [2]University of Vermont, Burlington, VT, Contact: david.novak@uvm.edu

In this research, we address the lack of analytical research focused on food accessibility in rural communities, particularly with respect to marginalized or vulnerable populations. We develop a measure for identifying the most important roadway components in facilitating access to food and apply the measure in a real-world case setting via agent-based simulation. The case example includes a detailed discussion of data sources, how household origins and grocery destinations are mapped to a GIS, and employs a unique statistical technique to map aggregate publicly available demographic data at the census block level to the household level.

Sunday, October 15, 2:15 PM - 3:30 PM

SD76

Session.Location:CC-West 208B

Stochastic Models of Airline Transportation Networks

Contributed Session

Session Chair: Qianwen Guo, Florida International University, Miami, FL

1 Hybrid Classical-Quantum Benders Decomposition for Optimal Edge Network Design

The Duong Do[1], Duong Nguyen[1], Ni Trieu[2], [1]Arizona State University, Tempe, AZ, [2]Arizona State University, Tempe, AZ, Contact: duongdo@asu.edu

This study proposes a mixed-integer linear programming model that addresses the challenge of optimal edge server placement and workload allocation in edge computing, which is known to be NP-hard, meaning that it is computationally complex and difficult to solve. To address this challenge, the study explores the potential of leveraging quantum computing, an emerging computational paradigm that has shown promise in offering more effective solutions to complex problems than classical computing. The proposed approach decomposes the original MILP problem into a quadratic unconstrained binary optimization problem and a linear program subproblem. Extensive numerical results verify that the proposed approach has shown significant performance enhancements in terms of computational time over the classical, indicating the efficiency of the proposed model and algorithm.

2 Optimal Baggage Allowance Design for Passenger Airlines

Prabhupad Bharadwaj, R K Amit, Atul Malik, Indian Institute of Technology Madras, Chennai, India. Contact: pbharadwaj@smail.iitm.ac.in

We propose a stochastic optimization approach to determine baggage allowances for a travel class in a passenger aircraft, with the objective of maximizing expected profit in an uncertain baggage demand scenario. Our analysis incorporates the dynamics of the baggage allowance and its effect on passengers and their baggage demand. Results from a “pooled demand” case with realistic price and cost assumptions show that baggage allowance decisions depend upon baggage handling costs. We extend the model to a two-class capacity-sharing scenario where we demonstrate that a higher allowance is given to the business class. As average fare is also a decision criterion for airlines while calculating total revenue, we treat it as a decision variable for the model and compute the optimal value along with the free baggage allowance for each passenger type (economy and business).

3 Robust Capacity Planning with General Upgrading

Zhaowei Hao[1], Zhenyu Hu[2], Long He[3], JUN JIANG[2], [1]Institute of Supply Chain Analytics (ISCA), Dongbei University of Finance and Economics, Dalian, China; [2]NUS Business School, Singapore, Singapore; [3]George Washington University, Washington, WA, Contact: haozhaowei@dufe.edu.cn

In this paper, we consider the capacity planning problem to decide the initial capacity for multiple products to maximize the expected total profit when general upgrading is allowed. Given the marginal mean and variance information of the demand distribution for each product, we formulate it as a two-stage distributionally robust optimization (DRO) model. We derive a compact binary extended formulation for the extreme points of the dual polyhedron by corresponding the extreme points to the shortest path network. Utilizing such formulation, we provide the polynomially solvable SOCP reformulation.

4 Airport Runway Capacity Expansion Planning Under Stochastic Demand

Qianwen Guo, Florida International University, Miami, FL

The objective of this paper is to propose a stochastic model for the airport runway capacity expansion problem. We seek to minimize the cumulative airport runway system costs over the planning horizon time by determining The dynamic model assumes that demand grows deterministically over time, and the investment decision involves a trade-off between system cost savings and the additional costs of capacity expansion. Numerical analyses show important findings regarding the relationships between investment timing, expansion size, and system cost. The findings suggest that larger expansions require a longer wait for the project to become advantageous over the initial capacity. Insufficient expansion size will lead to limited capacity that cannot meet growing demand, causing delays and cumulative costs.

Sunday, October 15, 2:15 PM - 3:30 PM

SD77

Session.Location:CC-West Lecture Hall

Perspectives on Integrating AI and Automation into Workforce

Contributed Session

Session Chair: Akram Khattab, The University of Toledo, Rochester, MI

1 AI Divide Versus Inclusion: Evidence from Algorithmic Task Assignment of a Food Delivery Platform

Tae Jung Yoon, Yeonseo Kim, Jiyong Eom, KAIST College of Business, Seoul, Korea, Republic of. Contact: taejung.yoon@kaist.ac.kr

The adoption of AI task assignment systems in gig economy has raised growing concerns about whether the systems benefit all platform stakeholders. In a unique setting of a food delivery platform, we study the impact of AI task assignment on delivery workers' productivity and the quality of customer service. Our results show that the adoption improves worker productivity by nearly 3%, with the improvement primarily concentrated among medium-skilled workers. However, it takes more hours for low-skilled workers to complete extended stacks of orders. For high-skilled workers, there is no apparent benefit or loss. These results indicate that AI task assignment can partially alleviate existing productivity disparities among workers. We also find that the adoption reduces customer waiting time for a single order delivery, but this is not the case for a stacked order delivery.

2 The Moderating Role of Work Autonomy in the Relationship Between AI Advancement and Team Creativity: A Task-Technology Fit Perspective

Meng Zhang[1], Jinlong Zhu[1], Chu-Ding Ling[1], Qin He[2], [1]Renmin University of China, Beijing, China; [2]Capital University of Economics and Business, Beijing, China. Contact: mengzhang@ruc.edu.cn

Despite growing interest in the role of artificial intelligence (AI) in enhancing team creativity, little is known about the conditions that maximize its potential benefits. In this research, we attempt to investigate when and how AI advancement enhances team creativity. Drawing on the task-technology fit theory, we propose that work autonomy moderates the positive relationship between AI advancement and team creativity via perceived AI assistance. Findings based on multisource data from 375 employees in 75 teams supported the hypotheses. These findings suggest that work autonomy can be a significant facilitator in reaping the benefits of AI in a team setting and underscore organizations to enhance team creativity by encouraging work autonomy in conjunction with AI advancement.

4 Employees' Response to Artificial Intelligence

Paul Owusu, University of North Texas, Denton, TX, Contact: paul.owusu@unt.edu

This study explores the emotional responses of individual employees towards the introduction of Artificial Intelligence (AI) in their work. Previous research has focused on the macroeconomic and labor market impacts of AI, but little attention has been given to employees' emotional reactions. Drawing on existing frameworks, the study examines employees' appraisals of AI adoption, their emotional responses, and their subsequent reactions. By investigating the emotional aspects of AI implementation, this research aims to provide valuable insights into the human experiences and perceptions associated with this transformative technology.

5 The Effect of the Automation of Managerial Controls on Organizational Outcomes: An Experimental Examination of the Hidden Costs of AI-Based Controls

Akram Khattab[1], HEBA ABDEL-RAHIM[2], [1]The university of Toledo, Toledo, OH, [2]The university of Toledo, Toledo, OH, Contact: akram.khattab@rockets.utoledo.edu

The reliance on automation and AI in managerial controls in the workplace has been subject to a heavy debate in recent years. Automated workplace controls range from installing a surveillance camera to microchipping employees to track their whereabouts. This study uses a controlled experiment to examine whether and how the automation of managerial controls impacts organizational outcomes. We manipulated between-subjects workplace controls at 3 levels (low, medium, and high automation) and recruited 630 US employees. Results show that the automation of controls increases employee performance, yet, decreases organizational commitment and citizenship while increasing turnover rate. In addition, employees demand higher wage premiums when controls are automated. However, the negative effects of increased control automation are moderated for younger generations.

Sunday, October 15, 2:15 PM - 3:30 PM

SD78

Session.Location:CC-West 211A

Carbon Emission Analysis in Supply Chains

Contributed Session

Session Chair: Nuri Onat, University of Qatar, Doha, Qatar

1 Impact Analysis of Environmental Policies on Liner Ship Fleet Planning Under Demand Uncertainty

Yonzheng Jerry Chua[1,2], Irfan Soudagar[3], Szu Hui Ng[4], Qiang Meng[5], [1]National University of Singapore, Singapore, Singapore; [2]Agency for Science and Technology Research, Singapore, Singapore, Singapore;

[3]National University of Singapore, Singapore, Singapore; [4]National University of Singapore, Singapore, Singapore; [5]National University of Singapore, Singapore, Singapore. Contact: e0202647@u.nus.edu

Considerations to decarbonize maritime shipping by implementing the Emissions Trading System (ETS) are underway at the International Maritime Organization (IMO). We propose a fleet planning model accounting for carbon emissions to evaluate the decision-making nuances of a liner company to investigate the short-term impact of the ETS. Numerical experiments are conducted on various proposed policy design parameters. Our findings indicate that, for liner shipping which is cross-regional by nature, regional ETS implementations are inadequate due to carbon leakage; Open ETS policies have limited efficacy, particularly when carbon prices are low; strict carbon purchase caps integrated with robust carbon price-setting mechanisms are critical to designing an effective ETS.

2 Estimate Supply Chain Emission Using Large Language Model

Manikandan Padmanaban[1], Jagabondhu Hazra[1], Ayush Jain[2], Shantanu Godbole[1], Kommy Weldemariam[3], [1]IBM Research Labs, Bangalore, India; [2]IBM Research India, Gurugram, India; [3]IBM Research Labs, Yorktown Heights, NY, Contact: manipadm@in.ibm.com

Estimating the carbon emission embodied in the supply chain product is imperative for understanding the climate impact and its actions. The US Environmentally Extended Input-Output (USEEIO) model provides a carbon emission factor per dollar spend for a set of industry sectors. This provides an opportunity to classify the product transaction data into one of the predefined USEEIO industry classes. But the presence of acronym and the limited words in the transaction data poses a challenge in mapping an expense data to an industry sector. To address this challenge, we propose to incorporate the enterprise specific novel embeddings into the NLP foundation model leveraging enterprise contextual data. This helps to improve the disambiguation with industry abbreviations and the results show an improved accuracy in comparable to annotation by domain expertise.

3 Disambiguation of Product Expense Data for Carbon Emission Estimation

Ayush Jain[1], Manikandan Padmanaban[2], Jagabondhu Hazra[2], [1]IBM Research Labs, Gurugram, India; [2]IBM Research Labs, Bangalore, India. Contact: ayush.jain@ibm.com

Estimating the carbon emission embodied in the supply chain product is imperative for understanding the climate impact and its actions. The US Environmentally Extended Input-Output (USEEIO) model provides a carbon emission factor per dollar spend for a set of industry sectors. This provides an opportunity to classify the product transaction data into one of the predefined USEEIO industry classes. But the presence of acronym and the limited words in the transaction data poses a challenge in mapping an expense data to an industry sector. To address this challenge, we propose to incorporate the enterprise specific novel embeddings into the NLP foundation model leveraging enterprise contextual data. This helps to improve the disambiguation with industry abbreviations and the results show an improved accuracy in comparable to annotation by domain expertise.

4 Scope-Based Corporate Carbon Footprint Accounting and Reporting: Insights from a Real-World Application

Nuri Onat[1], Murat Kucukvar[2], [1]Qatar University, Doha, Qatar; [2]University of Denver, Denver, CO, Contact: nonat@asu.edu

Carbon footprint accounting and reporting have gained tremendous interest in recent years due to the pressing impacts of Global Climate Change. Managing and reducing a company's carbon footprint requires comprehensive systems-based approaches where companies require to map all their value chains and operations, develop important performance metrics, and composite indicators, and adopt integrated data management and visualization approaches. In this research, we present a real-world application of corporate carbon footprint accounting and reporting and demonstrate the benefits of using advanced carbon footprint accounting methods for calculating Scope 3 emissions, the development of composite sustainability indicators, and data visualization.

Sunday, October 15, 2:15 PM - 3:30 PM

SD79

Session.Location:CC-West 211B

George Nicholson Student Paper Competition II

Award Session

Session Chair: He Wang, Georgia Tech, Atlanta, GA
Session Chair: Anton Braverman, Northwestern University, Evanston, IL

1 Mean-field Analysis for Load Balancing on Spatial Graphs

Daan Rutten, Georgia Institute of Technology, Atlanta, GA

The analysis of parallel-server load balancing systems has relied heavily on mean-field analysis. A pivotal assumption is that servers are exchangeable. However, modern data-centers have data locality constraints, such that tasks of one type can only be routed to a small subset of servers. An emerging line of research considers load balancing algorithms on bipartite graphs where vertices represent task types and servers, respectively. In this talk, I will present a novel coupling-based approach to establish mean-field approximation for a large class of graphs which includes spatial graphs.

2 Bayesian Design Principles for Frequentist Sequential Learning
Yunbei Xu, Massachusetts Institute of Technology, Cambridge, MA
We develop a general theory to optimize the frequentist regret for sequential learning problems, where efficient bandit and reinforcement learning algorithms can be derived from unified Bayesian principles. We propose a novel optimization approach to create “algorithmic beliefs” at each round, and use Bayesian posteriors to make decisions. This is the first approach to make Bayesian-type algorithms prior-free and applicable to adversarial settings, in a generic, optimal, and efficient manner.

3 Estimate-Then-Optimize Versus Integrated-Estimation-Optimization: A Stochastic Dominance Perspective
Haofeng Zhang, Columbia University, New York, NY
In data-driven stochastic optimization, model parameters of the underlying distribution need to be estimated from data in addition to the optimization task. The integration of the estimation and optimization processes can be readily shown to outperform ``estimate then optimize” when the model is misspecified, while we argue that when the model class is rich enough to cover the ground truth, the performance ordering between the two approaches is reversed for nonlinear problems in a strong sense. Analogous results also hold under constrained settings and when contextual features are available.

Sunday, October 15, 2:15 PM - 3:30 PM

SD80

Session.Location:CC-West 212A
2023 INFORMS Prize
Award Session
Session Chair: Nilay Noyan, Amazon, Bellevue, WA

1 2023 INFORMS Prize Winner
Rishi Bhatia[1], Kenneth Kuhn[2], Prakhar Mehrotra[3], [1]Walmart, Bentonville, AR, [2]Walmart Global Tech, Pasadena, CA, [3]Walmart, Sunnyvale, CA
Each week, approximately 240 million customers and members visit more than 10,500 Walmart stores and numerous eCommerce websites in 20 countries. Every Day Low Price (EDLP) is the cornerstone of Walmart’s strategy. Walmart provides the deep assortment that customers appreciate.A variety of Operations Research and Analytics-based services empower Walmart associates to manage vast quantities of diverse merchandise. Projects of interest in recent years include planning routes for pickers at Walmart Fulfillment Centers, recommending box sizes for eCommerce shipments, last mile delivery routing and scheduling, assortment selection, and predicting the arrivals of online order customers.

Sunday, October 15, 2:15 PM - 3:30 PM

SD81

Session.Location:CC-West 212B
K-12 Education Outreach in a Post-COVID World
Panel Session

1 K-12 Education Outreach in a Post-COVID World
Zihan Zhang, Georgia Tech, Atlanta, GA
In March 2020, the start of the COVID-19 pandemic brought a sea change to K-12 education in the U.S. Every school district was forced into virtual learning overnight. Now that the pandemic is fading into the rear-view mirror, those who value the success of K-12 students have the opportunity to begin anew K-12 education outreach projects. Successful, sustained programs will simultaneously work within longstanding constraints facing public education in this country and leverage new opportunities resulting from pandemic response. Lessons learned from first-hand experience will be discussed.
Session Chair: Zihan Zhang, Georgia Tech, Atlanta, GA

2 Panelist
Afrooz Jalilzadeh, The University of Arizona, Tucson, AZ

3 Panelist
Pascal Van Hentenryck, ISyE Georgia Tech, Atlanta, GA

4 Panelist
Mary Ogidigben, Pennsylvania State University, State College, PA

5 Panelist

Paul Hand, 1</sup

6 Panelist
Neil Desnoyers, Saint Joseph's University, Philadelphia, PA

Sunday, October 15, 2:15 PM - 3:30 PM

SD82

Session.Location:CC-West 212C

Machine Learning Applications in Health Care

Contributed Session

Session Chair: Yujia Xie, Georgia Tech, Atlanta, GA

1 Investigating Distance Decay and Social Determinants on Healthcare Outcomes Using Meta-Ensembles Predictive Models in Broome County, Ny

Anemone Kasasbeh[1], Mohammad AlDarabseh[2], Amy Booth[1], Hiroki Sayama[2], [1]United Health Services Hospitals, Inc., Vestal, NY, [2]State University of New York at Binghamton, Binghamton, NY, Contact: akasasb1@binghamton.edu

To improve access to healthcare, issues associated with distance decay and social determinants need to be addressed. In this work we developed an automated Artificial Intelligence application to generate a list of patients who could benefit from interventions to improve their healthcare outcomes. We inspected the effect of distance decay on healthcare outcomes by performing meta-ensembles predictive models. Data used in this paper is retrieved from a local hospital in Broome County, NY. Proposed models were evaluated for generalizability. The stacked Model (RF-NB-Nnet, GBM Top Layer) outperformed the rest of the models. The model identified contributing factors to poor health outcomes, such as unavailability of transportation, no-show rate, insurance type, and travel distance. The developed application is used by population health nurses for outreach purposes.

2 Enhancing Diagnosis and Prognosis of Diseases of Despair: An Attention Network Approach

Haya Alshayji[1], Paul Griffin[1], Soundar Kumara[1], Vasant Honavar[2], [1]The Pennsylvania State University, State College, PA, [2]The Pennsylvania State University, State College, PA, Contact: hka5222@psu.edu

We leverage structured medical claims data of patients suffering from diseases of despair and associated social determinants of health (SDOH) to improve disease diagnosis and prognosis. Utilizing attention network methods, we aim to identify and prioritize critical factors in the complex interplay between patient demographics, medical history, and SDOH, enabling more accurate and personalized treatment recommendations and timely interventions for at-risk individuals.

3 A Bayesian Network Model for Early Detection of Students' Course Failure

Yi Tan, The University of Alabama in Huntsville, Huntsville, AL

Motivated by the need of early detection of students' course failure, we propose a hierarchical Bayesian network model which can be used as a screening tool to assess the immediate probability of course failure for each student throughout the semester. The model takes into consideration of students' demographic information, previous academic records, target course attendance/engagement, and has demonstrated its effectiveness on the UAH 2022-23 academia year data. We also conduct the feature importance analysis, which helps us better understand the mechanism of the students' course failure.

4 Reformulation For TSP Under Clustered Layout

Yujia Xie, Georgia Tech, Atlanta, GA, Contact: yxie@gatech.edu

Traveling Salesman Problem (TSP) aims to find the shortest path while visiting all nodes in a given graph, and it has long been proven hard and computationally challenging to obtain optimal solution when the graph size explodes. However, if the underlying graph reveals special layout, especially modular layouts, we can reformulate the well-known Dantzig-Fulkerson-Johnson MIP formulation to reduce the size of TSP computation. With this reformulation approach, we can effectively bring down the computational cost for solving large-sized TSP instances.

5 Harnessing User-Generated Content and Large Language Models for Depression Analysis on Social Media

Jie Li, Juheng Zhang, University of Massachusetts Lowell, Lowell, MA

Depression, characterized by persistent sadness, hopelessness, and disinterest in activities, is a serious mental health concern. As more individuals express their emotional distress online, we identify and analyze these narratives to understand depression better and evaluate community responses' impact on recovery trajectories. This analysis informs the potential of online interventions in mitigating depression and tailoring strategies for specific depression types. We employ lexicon-based methods, benchmarked with large-language models, to analyze depressive narratives,

offering profound insights into online depression expressions. Additionally, we examine how individual personality traits and user profiles shape emotional expression on social media.

Sunday, October 15, 2:15 PM - 3:30 PM

SD83

Session.Location:CC-West 213A

COVID-19 Vaccine Demand and Distribution

Contributed Session

Session Chair: Kuangying Li, North Carolina State University, Raleigh, NC

1 Association Between Vaccination Rates and Covid-19 Health Outcomes in the United States: A Population-level Statistical Analysis

Hongru Du, Samee Saiyed, Lauren Gardner, Johns Hopkins University, Baltimore, MD, Contact: hdu9@jhu.edu

COVID-19 vaccines have been consistently proven to be safe and effective in clinal trials, however the emergence of new variants and other confounding factors make it challenging to determine their real-world effectiveness. We analyzed the association between vaccination rates and COVID-19 severity for 48 states in the U.S. at the population level using Generalized Additive Models (GAMs). We modeled the different COVID-19 variant-driven waves separately while controlling for testing, purpose-specific travel behaviors, underlying population immunity, policies, and critical static factors such as comorbidities, vulnerability, race, and state healthcare expenditures. Our study found a significant inverse association between vaccine uptake and COVID-19 severity across variant waves while assessing the impact of all controlled variables on COVID-19 severity.

2 Getting Hundreds of Thousands Vaccinated Using Optimization to Direct Data-Based Ads

Theodore T. Allen[1], Antor Rashid[2], Long Wang[2], [1]Ohio State University, Columbus, OH, [2]FactSpread, Columbus, OH, Contact: allen.515@osu.edu

In late 2020 and early 2021, we clustered counties with the lowest vaccination rates using integer programming into homogeneous groups. Then, we ran optimally planned experiments sharing different combinations of keywords and charts. We implemented an optimized ad strategy which caused hundreds of thousands to vaccinate proven using intervention analysis.

3 A Location-Allocation Model for Optimizing Covid-19 Vaccine Distribution with Equity Constraints

Kuangying Li, Asya Atik, Dayang Zheng, Leila Hajibabai, Ali Hajbabaie, North Carolina State University, Raleigh, NC

This study presents a maximal covering location problem that aims to minimize the total cost of vaccine distribution and maximize the total number of vaccines allocated to population blocks. Equity constraints are included in the proposed mixed-integer linear model considering age, race, and gender groups. A modified Voronoi diagram technique embedded in a Lagrangian relaxation framework is proposed to solve the problem. A set of empirical case studies in North Carolina and Pennsylvania are conducted based on the real-world data collected from the Centers for Disease Control and Prevention (CDC) and health department websites. The numerical results indicate that the proposed model can solve the problem effectively and outperform those of a column generation-based benchmark.

4 Location Routing Problem in a Megacity

Jihyun Jo, Soundar Kumara, Pennsylvania State University, University Park, PA, Contact: jzj5077@gmail.com

In this study, we address the urgent vaccine distribution problem within a megacity, incorporating a location routing problem. We first compare the solutions from two distinct approaches: the vehicle routing problem and the location routing problem. Furthermore, we assess the solutions derived from two heuristics to solve the location routing problem. The first heuristic approach involves solving the location allocation problem to determine the optimal satellite locations within the network. Subsequently, we determine individual routes using a multi-depot vehicle routing problem. The second heuristic approach entails identifying individual routes within the delivery network first and then determining suitable satellite locations along these routes. During the satellite location finding process, we re-optimize the individual routes to improve the solution.

Sunday, October 15, 2:15 PM - 3:30 PM

SD84

Session.Location:CC-West 213B

MSOM Service Operations I

Contributed Session

Session Chair: Ruben Lobel, Airbnb, San Francisco, CA

1 Optimizing Queues when Customers Commit the Sunk Cost Fallacy

Shining WU, Liutao YANG, The Hong Kong Polytechnic University, Hong Kong, China. Contact: liutao.yang@connect.polyu.hk

We study a service system where customers make an enter-or-leave decision before observing the queue and a purchase-quantity decision when they are served. Customers form references of the waiting times and are influenced by the sunk cost/time when making their purchasing decisions. We model this sunk cost fallacy, characterize customers' decisions in equilibrium, and study the firm's optimal operations strategies.

2 Pooled Testing in the Presence of Congestion

Bingnan Lu[1], Saif Benjaafar[2], Benjamin Legros[3], Oualid Jouini[4], [1]National University of Singapore, Singapore, Singapore; [2]University of Minnesota, Minneapolis, MN, [3]EM Normandie, PARIS, France; [4]CentraleSupelec, Gif-sur-Yvette, France. Contact: luke_lu@nus.edu.sg

We study the operation of a testing facility that diagnoses infected individuals. In particular, we focus on how the facility should select the sample pooling size that minimizes the total waiting time for testing results. We model the testing process as a two-stage tandem queueing system with batch service and re-entry. We provide conditions on the disease prevalence rate and the arrival intensity that guarantee system stability (i.e. a finite expected waiting time). We provide analytical expressions for estimating the expected time spent in the system by each sample. We also develop an algorithm to obtain the batch size that minimizes the delay in delivering test results. We show that, in general, the optimal batch size decreases in the prevalence rate and increases in the testing times.

3 A Decision-dependent Optimization Model For Restructuring Bank Networks After Mergers And Acquisitions

Zeyu Wang, George Washington University, Washington, DC, Contact: zywang@gwu.edu

This study introduces a decision-dependent model designed to improve operations for closing and resizing bank branches due to mergers and acquisitions. The model incorporates uncertainties in the customer's choice of new service location that arise from the relocation decisions into the decision-making process. We formulate the scheme as a mixed-integer nonlinear programming (MINLP) problem, then present efficient linearization techniques that transform the model into equivalent mixed-integer linear programming (MILP) formulations.

4 Value-Based Routing: Optimizing Airbnb'S Customer Service System

Ruben Lobel[1], Peggy Shao[1], Ryan Lucas[2], Paul Roeseler[2], David Gamarnik[2], [1]Airbnb, San Francisco, CA, [2]Massachusetts Institute of Technology, Cambridge, MA

Airbnb has over 4 million hosts who have welcomed more than 1 billion guest arrivals around the globe. Whenever guests or hosts have an issue they can't resolve, they contact the Customer Service team through one of many channels. The contact is placed in one of many queues, depending on the predicted contact reason, until an agent is available to provide support. In this research, we propose a redesign of the ticket routing system to optimize long term engagement of the user with the platform. To achieve this, we develop a simulation platform that replicates this complex system. We then build an optimization model that leverages the state of the queues, issue prediction, and the heterogenous skills of the agents to find the best match between contact and agent. Finally, we introduce a novel experimentation framework to validate the model.

Sunday, October 15, 4:00 PM - 5:15 PM

SE03

CC-North 120D
DataRefiner
Technology Tutorial

2 Powering Complex Data Projects with DataRefiner's Topological Data Analysis

Edward Kibardin, DataRefiner, London, United Kingdom. Contact: info@datarefiner.com

Discover how Topological Data Analysis can be used in complex data analysis projects such as cyber security, aircraft engine analysis, fraud detection, and autonomous vehicles. Observe data connections via causal discovery and uncover distinct clusters exhibiting unforeseen patterns through the utilization of the DataRefiner platform. This talk will equip attendees with practical knowledge of how TDA can help discover novel patterns in their areas of interest.

Sunday, October 15, 4:00 PM - 5:15 PM

SE04

CC-North 121A
Online Decision Making, beyond the Worst-Case Adversaries
Community Committee Choice Session

Session Chair: Nika Haghtalab, 1</sup
Session Chair: Abhishek Shetty, University of California, Berkeley, Berkeley, CA

1 Efficient Sequential Decision Making Through Smoothed Analysis

Abhishek Shetty, University of California, Berkeley, Berkeley, CA

Sequential decision making is often plagued with impossibility results indicating that both its statistical and computational difficulty. Given the importance of these problems, both in theory and practice, a pertinent question is to understand and remedy the source of this difficulty, for real-world instances. Towards this end, we establish novel techniques to analyze online algorithms in the smoothed analysis model. In this setting, the algorithm's input is perturbed slightly by noise. One of our framework is to show that, in this model, online learning is as easy as offline learning, both statistically and computationally. That is, we show that the regret against smoothed adversaries is captured by the offline complexity measure, VC dimension. Furthermore, we design efficient algorithms for online learning, circumventing impossibility results in the worst case.

2 Beyond Iid: Data-Driven Decision-Making in Heterogeneous Environments

Omar Besbes, Will Ma, Omar Mouchtaki, Columbia University, New York, NY, Contact: ob2105@gsb.columbia.edu

How should one leverage historical data when past observations are not perfectly indicative of the future? Motivated by this question, we study a data-driven decision-making framework in which historical samples are generated from unknown and different distributions assumed to lie in a heterogeneity ball with known radius and centered around the (also) unknown future (out-of-sample) distribution on which the performance of a decision will be evaluated. This work aims at analyzing the performance of central data-driven policies but also near-optimal ones in these heterogeneous environments.

3 Adaptive Oracle-efficient Online Learning

Vidya Muthukumar, ISyE Georgia Tech, Atlanta, GA

Classical online algorithms offer optimal performance guarantees but face scalability limitations. Oracle-efficient methods address this by leveraging offline optimization oracles to search through an exponentially-large decision space. However, they encounter challenges in adapting to friendly environments. In this talk, we explore two friendly scenarios: (a) “small-loss” problems and (b) IID data. We provide a new framework for designing online algorithms that are oracle-efficient and adapt well to the small-loss environment, under a particular condition which we call approximability (which is spiritually related to sufficient conditions provided by Dudik et al., (2020)). We identify a series of real-world applications for which approximability holds. We also extend the algorithm to an IID data setting and establish a “best-of-both-worlds” bound.

4 Optimal Robustness-Consistency Tradeoffs for Learning-Augmented Metrical Task Systems

Nicolas Christianson, Junxuan Shen, Adam Wierman, California Institute of Technology, Pasadena, CA, Contact: nchristianson@caltech.edu

We discuss recent developments in the design of learning-augmented algorithms for the metrical task systems problem. In this setting, a decision-maker must choose decisions online to minimize the sum of per-round hitting and switching costs, while incorporating (potentially unreliable) advice from an AI/ML algorithm. The decision-maker seeks to exploit good AI/ML performance while ensuring worst-case guarantees in case of poor AI/ML performance due to, e.g., distribution shift. We propose an algorithm, DART, which obtains an exponential tradeoff between consistency (exploitation of the AI/ML advice) and robustness (worst-case performance), and prove a lower bound showing that this tradeoff is the best obtainable for general decision spaces and cost functions. Nonetheless, we demonstrate several special cases in which improved tradeoffs can be achieved.

Sunday, October 15, 4:00 PM - 5:15 PM

SE05

CC-North 121B

Analytics in Revenue Management

Community Committee Choice Session

Session Chair: Joline Uichanco, University of Michigan, Ross School of Business, Ann Arbor, MI

1 Collaborative Learning and Decision-Making on Pricing and Recommendation: A Simple Framework for Planning

Junyu Cao, The University of Texas at Austin, Austin, TX

We formulate a collaborative learning and decision-making problem involving contextual information. In current business practices, pricing and recommendation decisions often are made jointly by multiple teams in sequence. The decision-making processes for different teams can be controlled by either a centralized or decentralized planner. We propose a simple collaboration framework that integrates the learning about decision-making in an unknown environment. The main challenge in a decentralized framework is that the decision-making process in other teams is unknown, but the subsequent decisions are mutually dependent. We test our algorithm using real data from JD.com, a large e-commerce retailer. Numerical studies validate the superior performance of the two proposed frameworks for different types of planners.

2 Empirical Investigation of Side Effects of Price Change

Ozalp Ozer[1], Inki Sul[2], Serdar Simsek[3], [1]Amazon, Richardson, TX, [2]Carnegie Mellon University, Pittsburgh, PA, [3]The University of Texas at Dallas, Richardson, TX, Contact: isul@andrew.cmu.edu

Modern day retailers use pricing policies that involve frequent price changes according to a complex algorithm and/or the pricing of competitors. Most academic research leaves room for deeper understanding of customer's perception towards frequent price changes. We assess the impact of a retailer's frequent price adjustments on customers' long term expenditure in the retailer. We take multiple empirical strategies including endogenous treatment model and doubly robust learning to find consistent evidence of negative impact of additional price change. We find additional evidence of non-linear impact of increasing price change magnitude, and dissipating negative effect after multiple price change observations. From our counterfactual analysis, we find that not considering the negative effect of price can lead up to 3.05% of revenue loss per product.

3 Ordering and Ranking Products for an Online Retailer

Zijin Zhang, Hyun-Soo Ahn, Lennart Baardman, University of Michigan, Ann Arbor, MI, Contact: zijinz@umich.edu

In e-commerce, product ranking and display affect customer choices and sales. For retailers who sell items from the inventory they have purchased and owned, product ranking has a profound impact on future demand as well as the amount of inventory to be ordered. In this paper, we show that it is important to consider inventory ordering and product ranking decisions as a joint problem, and study how this can be done. We investigate three widely-used rank-choice models from the literature and we develop tractable solution methods through approximating the choice behavior with a simpler model in a variety of ordering-and-ranking problems. We show that our algorithms results in significant profit gain and can solve problems with a large number of products and generate high-quality solutions when it is not possible to get an optimal solution efficiently with the exact demand model.

4 Voice of the Customer? Negative Review as a Double-Edged Sword

Hanqi Wen[1], Izak Duenyas[2], Joline Uichanco[3], [1]Ross School of Business, University of Michigan, Ann Arbor, MI, [2]University of Michigan-Ann Arbor, Ann Arbor, MI, [3]University of Michigan, Ross School of Business, Ann Arbor, MI, Contact: hanqiwen@umich.edu

Nowadays online reviews have become an important factor in influencing the sales of products, where negative reviews usually hurt sales in the long run. To mitigate the negative impact of critical reviews, a simple solution is to disallow reviews. However, doing so not only removes a convenient channel for unsatisfied customers to complain, but eliminates an important source of feedback that the firm can use to make further improvements to the product. This paper explores the optimal dynamic review management policy when negative reviews have double-edged effects. We find that the net impact of negative reviews and whether a negative review's marginal value in providing feedback is increasing or decreasing in the number of reviews collected together decide the optimal policy. We also extend to consider positive reviews, and simple but effective heuristics are designed.

Sunday, October 15, 4:00 PM - 5:15 PM

SE06

CC-North 121C

Design and Operation of Ridesharing Platforms

Community Committee Choice Session

Session Chair: Francisco Castro, UCLA Anderson School of Management, Los Angeles, CA

Session Chair: Hongyao Ma, Columbia University, New York, NY

Session Chair: Chiwei Yan, University of Washington, Seattle, WA

1 Pricing Shared Rides

Chiwei Yan[1], Julia Y. Yan[2], Yifan Shen[3], [1]University of California, Berkeley, Berkeley, CA, [2]University of British Columbia, Vancouver, BC, Canada; [3]University of Washington, SEATTLE, WA, Contact: yan.cw08@gmail.com

Despite ride-hailing services gaining wide popularity, major ride-sharing platforms have long been struggling with maintaining a healthy and profitable shared rides product, a critical product for sustainable urban transportation. We study how smart pricing strategies can help to densify demand and increase adoption. In stylized cases, we show a profit-maximizing policy has a simple closed-form solution and is intrinsically altruistic in improving adoption and cost efficiency compared to status-quo pricing policies. We develop efficient computational approaches to scale this policy to large networks. Experiments using NYC taxi data show promising results.

2 Iterative Network Pricing for Ridesharing Platforms

Chenkai Yu, Columbia University, New York, NY

Ridesharing platforms match riders and drivers, using dynamic prices to balance supply and demand. The origin-based "surge pricing", however, does not depend on the market condition of trip destinations, leading to inefficient trip flows in space and incentivizes drivers to strategize. In this work, we introduce the *Iterative Network Pricing (INP)* mechanism, addressing a main challenge in the practical implementation of optimal origin-destination (OD) based prices, that the model for rider-demand is hard to estimate. Assuming that the platform's surge algorithm clears the market for each origin in real-time, our mechanism updates the OD-based price adjustments week-over-week, using only information immediately observable during the same time window in the prior week. We prove that our mechanism converges to an outcome that is approximately welfare-optimal. Using data made public by the City of Chicago, we illustrate (via simulation) the resulting substantial improvements in social welfare under the INP mechanism.

3 Two-Sided Platform Flexibility

Daniel Freund[1], Sebastien Martin[2], Jiayu (Kamessi) Kamessi Zhao[3], [1]MIT, Boston, MA, [2]Kellogg School of Management, Northwestern University, Evanston, IL, [3]MIT, Canbridge, MA, Contact: dfreund@mit.edu

We study a parsimonious model of two-sided platform flexibility, wherein nodes form random edges in a bipartite graph before a centralized market designer finds a maximum matching. In order to increase the size of the matching, the designer can (at a cost) incentivize parts of the market to be more flexible, thus increasing the chance that they form edges. Surprisingly, in many instances of interest, the optimal solution incentivizes nodes on only one side of the market to be flexible, even when the instance is entirely symmetric. However, when both sides are managed by distinct managers with the same objective, they may face a suboptimal Nash equilibrium in which they incentivize their respective sites equally. In summary, our work initiates the study of multi-sided platform flexibility, and identifies a range of unexpected patterns and technical challenges associated to it.

4 Life Cycle Air Pollution, Greenhouse Gas, and Traffic Externality Benefits and Costs of Electrifying Uber and Lyft

Aniruddh Mohan, Princeton University, Princeton, NJ, Contact: aniruddh@princeton.edu

Uber and Lyft have pledged to fully electrify their ridesourcing fleets by 2030 in the United States. We introduce AgentX, a novel agent-based model built in Julia for simulating ridesourcing with high geospatial and temporal resolution. Using AgentX, we model the life cycle local air pollution, CO_2, and traffic externality benefits and costs of serving rides based on Chicago trip data from 2019-2022 with fully electric vehicles. We estimate that electrification reduces life cycle CO_2 emissions by 40-45% but increases externalities from criteria pollutants by 6-11% on average across our simulations. A novel finding is that electrification may increase deadheading due to additional travel to and from charging stations and this increases congestion, crash risk, and noise externalities by 2-3%. Overall, electrification reduces net external costs to society by 3-11%.

Sunday, October 15, 4:00 PM - 5:15 PM

SE07

CC-North 122A

Pricing and Assortment Optimization

Community Committee Choice Session

Session Chair: Anran Li, The Chinese University of Hong Kong, Hong Kong, China

Session Chair: Zhe Liu, Imperial College Business School, London, -, United Kingdom

1 Balancing Risk and Return in Product Line Pricing

Hongmin Li, Scott Webster, Arizona State University, Tempe, AZ, Contact: hongmin.li@asu.edu

Product line pricing in a multi-product environment can be intriguing because the decision affects both the expected profit and the variability of profit. We study firms' pricing decisions with the goal of optimally balancing the expected profit and the risk associated with uncertain customer choices. Two alternative settings are considered: (1) a monopolist managing a complex product line where the firm strategically prices its products based on risk preference; (2) a competitive equilibrium of multiple firms each with distinct risk preference, where we analyze the effect of risk on a firm's competing power and its interaction with market entry cost.

2 Duopoly Price Competition with Reference Effects Under Logit Demand

Mengzi Amy Guo[1], Zuo-Jun Max Shen[2], [1]University of California, Berkeley, Berkeley, CA, [2]University of California Berkeley, Berkeley, CA, Contact: mengzi_guo@berkeley.edu

We consider a duopoly price competition with potential asymmetric reference effects under the MNL model. In the one-shot game, we show the existence and uniqueness of Nash equilibrium (NE) in loss-neutral and loss-averse scenarios, while for the the gain-seeking scenario, the NE exists but may not be unique. We also extend to dynamic games with periods connected by reference price updates. Our analysis examines long-run market dynamics of the repeated game under two practical pricing policies. For fully rational firms employing equilibrium pricing, we show convergence to a stationary Nash equilibrium (SNE) for loss-neutral and loss-averse products, with SNE being unique and independent of initial reference price in the loss-neutral scenario. For firms with bounded rationality using best-response pricing, we prove the same conclusion for short-term memory consumers.

3 Dynamic Pricing Under Stochastic Hawkes Arrival Processes

Longyuan Du[1], Ming Hu[2], Quan Yuan[3], [1]University of San Francisco, San Francisco, CA, [2]University of Toronto, Minneapolis, MN, [3]Zhejiang University, Hangzhou, China. Contact: ldu5@usfca.edu

The paper investigates how a seller adjusts prices to maximize profit under the Hawkes process, where demand is influenced by previous customers. The problem is formulated as a dynamic program, and the optimal pricing strategy is characterized. We show that the optimal intensity increases with the effect of the previous process and decreases over time. The asymptotic analysis shows that the revenue of the stochastic and deterministic problem differ by a constant, and the heuristic that adopts the optimal price in the deterministic problem achieves a performance loss at the scale of a constant. The paper is extended to cover general information spreading and multiple identical products.

Sunday, October 15, 4:00 PM - 5:15 PM

SE08

CC-North 122B

APS Student Paper Competition

Award Session

Session Chair: Jose Blanchet, Columbia University, Dallas

1 On the Statistical Benefits of Temporal Difference Learning

David Cheikhi, Columbia University, New York, NY

Given a dataset on actions and long-term rewards, a direct estimation approach fits value functions that minimize prediction error on the training data. Temporal difference learning (TD) instead fits value functions by minimizing inconsistency between estimates made at successive time-steps. For finite state Markov chains, we provide a crisp asymptotic theory of the statistical advantages of TD. First, we show that an intuitive inverse trajectory pooling coefficient completely characterizes the reduction in mean-squared error of value estimates. Depending on problem structure, the gain could be enormous or nonexistent. Next, we prove that there can be dramatic improvements in estimates of the difference in value-to-go for two states: TD's errors are bounded in terms of a novel measure - the trajectory crossing time - which can be much smaller than the time horizon.

2 Bayesian Design Principles for Frequentist Sequential Learning

Yunbei Xu, MIT, Cambridge, MA

We develop a general theory to optimize the frequentist regret for sequential learning problems, where efficient bandit and reinforcement learning algorithms can be derived from unified Bayesian principles. We propose a novel optimization approach to create "algorithmic beliefs" at each round, and use Bayesian posteriors to make decisions. This is the first approach to make Bayesian-type algorithms prior-free and applicable to adversarial settings, in a generic, optimal, and computationally efficient manner. As a major application, we present a novel algorithm for multi-armed bandits that achieves the "best-of-all-worlds" empirical performance in the stochastic, adversarial, and non-stationary environments. And we illustrate how these principles can be used in linear bandits, bandit convex optimization, and reinforcement learning.

3 A New Class of Bounds for Convergence of Markov Chains to Equilibrium

Yanlin Qu, Peter W. Glynn, Jose Blanchet, Stanford University, Stanford, CA

We introduce a unified framework to derive computable convergence bounds for Markov chains. Under this framework, bounds with various rates, ranging from polynomial to exponential, are derived from a single "contractive drift" (CD) condition. These bounds are computable, as all elements are explicitly defined in terms of one-step transition expectations. Various techniques are devised to verify CD for examples from queueing theory and stochastic optimization. For these examples, we obtain sharp bounds that scale correctly with respect to model parameters such as the traffic intensity in queueing models and the step size in optimization algorithms.

4 On the Convergence of Policy Iteration-Based Reinforcement Learning with Monte Carlo Policy Evaluation

Anna Winnicki, University of Illinois at Urbana-Champaign, Urbana, IL

A common technique in reinforcement learning is to evaluate the value function from Monte Carlo simulations of a given policy, and use the estimated value function to obtain a new policy which is greedy with respectto the estimated value function. A well-known longstanding open problem in this context is to prove the convergence of such a scheme when the value function of a policy is estimated from data collected from a single sample path obtained from implementing the policy (see page 99 of Sutton and Barto (2018), page 8 of Tsitsiklis (2002)). We present a solution to the open problem by showing that a first-visit version of such a policy iteration scheme indeed converges to the optimal policy provided that the policy improvement step uses lookahead Silver et al. (2016), Mnih et al. (2016), Silver et al. (2017b) rather than a simple greedy policy improvement. We provide results both for the original open problem, which was stated for the tabular setting, and also present extensions to the function approximation setting, where we show that the policy resulting from the algorithm performs close to the optimal policy within a function approximation error. The key technical contribution in the paper is the following: the proof in Tsitsiklis (2002) relies on policy iteration ideas extended to the stochastic approximation setting when the probability of a visit to any state is known. In our trajectory-based setting, this approach does not work because the number of visits to each state is policy dependent and unknown; therefore, we employ very different ideas by combining contraction properties of the Bellman operator along with stochastic approximation techniques.

Sunday, October 15, 4:00 PM - 5:15 PM

SE09

CC-North 122C

Frontiers of Data-Driven Decision-Making

Community Committee Choice Session

Session Chair: Hamsa Bastani, UPenn Wharton
Session Chair: Kan Xu, University of Pennsylvania, Philadelphia, PA

1 The Disparate Impacts of User Strategizing in Recommendation Systems

Chara Podimata, MIT, Boston, MA, Contact: podimata@mit.edu

An important assumption in recommendation systems is that users consume the content they like with no other considerations in mind. But as we document in a large survey, in fact, users choose content strategically in order to influence their future recommendations. We show that at equilibrium differences in users' preferences get accentuated. This effect is very strong among minority users, who must avoid signaling interest in mainstream content to ensure the algorithm will show them content related to their minoritized identities. This puts minorities at a disadvantage; they cannot access mainstream content without the algorithm suppressing their identities. We propose 3 interventions to improve the recommendation quality on average and for minorities. Finally, we describe a methodology to inform applied theory modeling in strategic learning settings with surveys.

2 Optimizing and Learning Sequential Assortment Decisions with Platform Disengagement

Mika Sumida[1], Angela Zhou[2], [1]Marshall School of Business, University of Southern California, Los Angeles, CA, [2]USC Marshall School of Business Data Sciences and Operations, Los Angeles, CA, Contact: zhoua@marshall.usc.edu

We consider a problem where customers repeatedly interact with a platform. At every interaction, the customer is shown an assortment of items and selects among these items according to a Multinomial Logit choice model. The probability that a customer logs onto the platform in the next period depends on the customer's past purchase history. The goal of the platform is to maximize the total revenue obtained from each customer over a finite time horizon. First, we study a non-learning version of the problem with known preferences. We formulate the problem as a dynamic program and prove structural properties of the optimal policy. Next, we formulate a contextual episodic reinforcement learning setting, where the parameters governing consumer preferences and return probabilities are unknown and learned over multiple episodes. We develop an algorithm and provide a regret bound.

3 Online Resource Allocation with Predictions

Lin An, Andrew A. Li, Benjamin Moseley, CMU Tepper, Pittsburgh, PA, Contact: linan@andrew.cmu.edu

An emerging line of work has shown how to incorporate machine-learned predictions into decision-making in a manner that is robust to the accuracy of those predictions. We do this for an online resource allocation problem, under both stochastic and adversarial arrivals. Our main contribution is a single algorithm which, without a priori knowledge of the accuracy of the predictions, achieves the optimal consistency-robustness tradeoff simultaneously for both settings.

4 Stochastic Low-rank Tensor Bandits For Multi-dimensional Online Decision Making

Emma Jingfei Zhang, Emory University, Atlanta, GA, Contact: emma.jzhang@emory.edu

Multi-dimensional online decision making plays a crucial role in online recommendation and digital marketing. In these problems, a decision at each time is a combination of choices from different types of entities. We introduce stochastic low-rank tensor bandits, a class of bandits whose mean rewards can be represented as a tensor, and consider two settings, tensor bandits without and with context. In the first setting, the platform aims to find the optimal decision with the highest expected reward. In the second setting, some modes of the tensor are contexts and the rest are decisions, and the goal is to find the optimal decision given the context. We propose learning algorithms under each setting and analyze their regret bounds. Simulations and analysis of online advertising data show that our algorithms outperform alternative approaches that ignore the tensor structure.

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SE10

CC-North 123

Queueing and Learning

Community Committee Choice Session

Session Chair: Xinyun Chen, Chinese University of Hong Kong, Shenzhen, Shenzhen, China

1 A Two Timescale Evolutionary Game Approach to Multi-Agent Reinforcement Learning

Nan Chen, Chengli Ren, Chinese University of Hong Kong, Shatin N T, Hong Kong. Contact: nchen@se.cuhk.edu.hk

We propose a two-time scale evolutionary game theoretic approach to solving multiagent reinforcement learning (MARL) problems. The new approach incorporates three innovative designs. First, we represent each agent by a population of pure-action-playing individuals and use the action distribution in each population to approximate the agent's mixed policy. Second, we propose a simple optimization based protocol to update policies, avoiding the computationally expensive step of finding the exact equilibrium at each state. Third, the updating of population states and Q-values is set in two different time scales to ensure the convergence. The new approach provably converges to approximate Nash equilibria of MARL problems without imposing the global optima or saddle point conditions, two restrictive assumptions that are typically needed in the literature.

2 Performance of the Gittins Policy in the G/G/1 and G/G/K, with and Without Setup Times

Yige Hong[1], Ziv Scully[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Cornell University, Berkeley, CA, Contact: yigeh@andrew.cmu.edu

How should we schedule jobs with unknown sizes to minimize the mean queue length? In the preemptive M/G/1 queue, we know the Gittins policy is the optimal policy. Recent results also show that Gittins policy is heavy-traffic optimal in M/G/k. But allowing multiple servers is just one way of extending the M/G/1. Does Gittins policy still perform well when there are non-Poisson arrivals or setup times? In this paper, we give the first analysis of the Gittins policy that can handle any combination of (a) multiple servers, (b) non-Poisson arrivals, and (c) setup times, bounding its suboptimality gap in each case. Our results thus cover the G/G/1 and G/G/k, with and without setup times, implying the heavy-traffic optimality in all the systems we consider. Another consequence of our results is that Gittins is optimal in the M/G/1 with setup times at all loads.

3 A Unified Fluid Model for Service Systems with Service Times that Depend on the Delay or the Abandonment Times

Deniz Simsek[1], Achal Bassamboo[1], Ohad Perry[2], Chenguang Wu[3], [1]Northwestern University, Evanston, IL, [2]SMU, University Park, TX, [3]Hong Kong University of Science and Technology, Hong Kong, China. Contact: deniz.simsek@kellogg.northwestern.edu

We propose a unified fluid model to approximate two separate queueing models for service systems: In the first, customers' service times depend on their patience, and in the second, the service times depend on their delay in queue. The unified fluid model is shown to provide accurate approximations for the mean transient dynamics of the queue process, and guidance regarding its stationary behavior. In particular, we show that the fluid model may possess multiple equilibria, some of which are (locally) stable, and others which are unstable. Having more than one stable equilibrium in the fluid model suggests that the stochastic system experiences large oscillations over large time periods and congestion collapse.

4 Steady-State Analysis of Queues with Hawkes Arrival

Guiyu Hong[1], Xinyun Chen[2], [1]The Chinese University

of Hong Kong, Shenzhen, Shenzhen, China; [2]Chinese University of Hong Kong, Shenzhen, Shenzhen, China. Contact: guiyuhong@link.cuhk.edu.cn

We investigate single-server queues with Hawkes arrivals and general service distributions. In specific, we show that under mild conditions, single-server queues with Hawkes arrivals converge to their steady-states in an exponential rate. Since the initial state of Hawkes queues contains future information of arrivals, we develop a semi-synchronous coupling technique to show the exponential ergodicity. As an application of the ergodic rate, we further consider a online learning method for the staffing problem of the Hawkes queues (dubbed GOLiQ-Hawkes) and establish the regret bound of GOLiQ-Hawkes based on the ergodic results. Finally, comprehensive numerical experiments are conducted to contrast the Hawkes queues with conventional GI/GI/1 queues. The results turn out a sharp difference due to the auto-correlation of Hawkes arrivals.

5 Stochastic Approximation MCMC And Online Inference For Dynamic Pricing And Capacity Sizing In Queues

Jiadong Liang[1], Xinyun Chen[2], Xiang Li[3], Zhihua Zhang[3], [1]Peking University, Peking, China; [2]Chinese University of Hong Kong, Shenzhen, Shenzhen, China; [3]Peking University, Beijing, China

In this talk, we explore the application of Stochastic Approximation MCMC (SAMCMC) in optimal control of queueing systems. Unlike traditional SA methods, SAMCMC generates samples using Markovian dependence on current iteration parameters and past samples. Leveraging parameter-dependent Poisson equations, we establish convergence rates and a functional CLT for SAMCMC, and introduce a novel inference method that can be executed streamingly based on this result. Addressing challenges with abstract assumptions regarding SAMCMC's Poisson equation, we propose a practical, testable assumption framework. Through meticulous derivations, we align the queueing setting with these assumptions.Through numerical experiments, we validate our conclusions, highlighting SAMCMC's superior performance compared to benchmark methods.

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SE11

CC-North 124A

New Topics in Applied Probability

Community Committee Choice Session

Session Chair: Jamol Pender, Cornell University, Ithaca, NY

1 Queueing for Epidemics

Laurel Newman, Cornell University

While most studies concerning queueing models focus solely on customer behavior in the aggregate, our work draws inspiration from COVID-19 applications and seeks to explore the interaction between customers as a new model for infectious disease spread. Our model considers a queue where a proportion of the arriving population p is infected and the remaining population is susceptible. When an infected person overlaps in the queue with a non-infected customer for more than I units of time, then the non-infected person becomes infected. We compute the probability that a non-infected person becomes infected depending on the model parameters.

2 Overlap Times in the Infinite Server Queue

Sergio Palomo, Cornell University

Imagine, you enter a grocery store to buy food. How many people do you overlap with in this store? How much time do you overlap with each person in the store? In this paper, we answer these questions by studying the overlap times between customers in the infinite server queue. We compute in closed form the steady state distribution of the overlap time between a pair of customers and the distribution of the number of customers that an arriving customer will overlap with. Finally, we define a residual process that counts the number of overlapping customers that overlap in the queue for at least δ time units and compute its mean, variance, and distribution in the exponential service setting.

3 Overlap Times in Two Dimensional Tandem Queue

Ruici Gao, Jamol Pender, Cornell University, Ithaca, NY, Contact: rg585@cornell.edu

In this paper, we investigate overlap times in a two-dimensionalinfinite server tandem queue. Specifically, we analyze the amount oftime that a pair of customers spend overlapping in any station of thetwo dimensional tandem network when the stations have independentand identically distributed service times that follow an exponentialdistribution. Our main contribution is the derivation of the joint taildistribution, the two marginal tail probabilities and several momentsof the overlap times. We extend our results to the non-identicallydistributed case as well. Our results shed light on how customersoverlap downstream in serial queueing systems.

4 Stochastic Models for Double Reservation Parking

Ryan McCleary, Cornell University

We will discuss a stochastic model used to study reservation policies in vehicle sharing systems. The basic set-up for this talk is a station-based car sharing system having N stations, each of which consists of K parking spaces. Users entering the system can either reserve only a car at their starting station and not a parking space at their destination ("single reservation"), or both a car and a parking space ("double reservation"). We will first introduce a Markov process which describes this system, which is of dimension O(N^2), where N is the number of stations. For large N, this becomes computationally infeasible, so we then shift our attention to a process of dimension O(N), which is not Markov. We can, however, prove a convergence theorem relating this lower-dimensional process to a Markov process, which will be the subject of this talk.

5 Waiting for Justice: Stochastic Models for Bail Funds

Jamol Pender, Cornell University, Ithaca, NY

Bail funds have a long history of helping those who cannot afford bail in order to wait for trial at home. They have also had a large impact on the verdict of the defendant. In this talk, we present the first stochastic model for capturing the dynamics of a community bail fund. Our bail fund model integrates traditional queueing models with classic insurance/risk models to represent the bail fund's intricate dynamics. We employ simulation techniques to assess Gaussian-based approximations that estimate the probability of a defendant being denied access to the bail. We also propose a new simulation-based algorithm that leverages a deterministic infusion of capital as a control variable to stabilize the probability that defendants have access to the bail fund. It reveals that our Gaussian-based approximations are suitable for highly active bail funds.

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SE12

CC-North 124B

Some Recent Advancements in Simulation

Community Committee Choice Session

Session Chair: Zeyu Zheng, University of California, Berkeley, Berkeley, CA

1 Efficient Input Uncertainty Quantification for Regenerative Simulation

Linyun He[1], Mingbin Feng[2], Eunhye Song[3], [1]Georgia Institute of Technology, Atlanta, GA, [2]University of Waterloo, Waterloo, ON, Canada; [3]Georgia Institute of Technology, Atlanta, GA, Contact: lhe85@gatech.edu

This work tackles quantification of input uncertainty for a regenerative simulation model when its input distributions are estimated from finite data. In particular, our aim is to construct a bootstrap-based confidence interval (CI) with correct coverage for the true simulation output mean performance at a significantly less computational cost than traditional methods. Exploiting the regenerative structure, we propose a k-nearest neighbor (kNN) ratio estimator for the steady-state performance measure at each set of bootstrapped input parameters and construct a bootstrap CI from the computed estimators. Asymptotically optimal choices for k and bootstrap sample size are discussed. We further improve the CI by combining the kNN and likelihood ratio methods. The efficiency of the proposed estimators over the standard estimator are empirically demonstrated.

2 Pseudo-Bayesian Optimization

Haoxian Chen, Henry Lam, Columbia University, New York, NY

Bayesian Optimization is a popular approach for optimizing black-box functions. Its key idea is to use a surrogate model to approximate the objective and quantify the uncertainty for sequential search of query points that balance exploitation-exploration. Gaussian process (GP) has been a primary candidate for the surrogate model, thanks to its Bayesian-principled uncertainty quantification power and modeling flexibility, and has spurred an array of more efficient variants in recent years. In our study, we take a distinct view based on an axiomatic framework that elicits the minimal requirements on any surrogate model to guarantee black-box optimization convergence. Our framework, which we call Pseudo-Bayesian Optimization, substantially enhances the design freedom and subsequently bypasses the scalability issues faced by GP methods.

3 A Tree-Base Continuous Simulation Optimization Procedure

Jianzhong Du[1], Jeff Hong[1], Ying Zhong[2], [1]Fudan University, Shanghai, China; [2]University of Electronic Science and Technology of China, Chengdu, China. Contact: jianzhodu2-c@my.cityu.edu.hk

In this work, tree-based procedures are proposed to solve continuous optimization via simulation (COvS) problems. The procedures search for the optimal solution by adaptively partitioning the design space and allocating more sampling efforts to the area where the optimal solution tends to lie. We establish different lower bounds on the minimax convergence rate for the optimization error when the objective function satisfies different local smoothness assumptions. Then we show that our procedures can solve these problems without necessarily knowing the objective function's smoothness condition and achieve the optimal minimax convergence rates. Numerical results show the procedures are efficient.

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SE13

CC-North 125A

Analytics for Sustainable Development

Community Committee Choice Session

Session Chair: Ville Satopaa, INSEAD, Paris, France

1 Improving Transport for People with Reduced Mobility: Leveraging Matheuristics and Analytics to Optimize the Dial-A-Ride Problem in Barcelona

Laura Portell, Helena Ramalhinho, University Pompeu Fabra, Barcelona, Spain. Contact: portell.laura@gmail.com

The rich heterogeneous Dial-a-Ride Problem (rHDARP) is introduced to optimize door-to-door transport for individuals with reduced mobility in Barcelona. Leveraging matheuristics, specifically Iterated Local Search (ILS) and Set Partitioning (SP), we address the multi-constraint problem considering user and vehicle heterogeneity, time windows, ride/waiting times, and accompanying people requirements. We evaluate our approach using a real-world case study of the Transport Service for People with Reduced Mobility in Barcelona, demonstrating its effectiveness in reducing costs and improving service quality compared to existing routes.

2 Vehicle Routing with Stochastic Demand, Service and Waiting Times - a Case of the Food Bank Collection Problem

Meike Reusken, Tilburg University, Tilburg, Netherlands. Contact: m.c.d.reusken_1@tilburguniversity.edu

We present a matheuristic for the capacitated vehicle routing problem with stochastic demand, service and waiting times. The problem is inspired by the donation collection of food banks, where the donated food that needs to be collected only becomes known upon arrival and the time spent on waiting and service depends on the size of the donation. We present a matheuristic that decomposes this problem into its individual decisions to obtain a feasible solution: (i) select the number of districts into which the service area should be divided, (ii) cluster customers into these districts, (iii) plan routes for each district, (iv) enter iterative procedure in case no feasible solution is found. Computational experiments demonstrate that the matheuristic can effectively solve problems sizes of up to 100 consumers and contains practical value to Canadian and Dutch food banks.

3 On the Trade-Offs Between Affordability, Nutritional Value and Environmental Impact of Food Baskets

Melissa Koenen[1], Claudia Damu[2], Marleen Balvert[1], [1]Tilburg University, Tilburg, Netherlands; [2]World Food Programme, Rome, Italy. Contact: m.f.koenen@tilburguniversity.edu

Diet optimization is used by humanitarian organizations such as the World Food Programme to get a cost estimate for a nutritious food basket in a certain region. This analysis helps to identify local food barriers and to propose policies to improve the situation. Besides the affordability and nutritiousness of a food basket, there are many other goals that these baskets should achieve. That is, an ideal food basket should be culturally appropriate, affordable, nutritious and environmentally friendly. In most cases it is not possible to achieve this, as goals can be conflicting. In order to investigate how these different goals interact with each other we use a weighted sum sandwich algorithm to show all trade-offs. In our research we focus on making these trade-offs understandable using visualizations, and we explain what kind of insights can be gained for informing policy.

4 Web-Based Decision-Support System for Integrated Home Care Planning

Jesica De Armas, Bruno Vieira, Helena Ramalhinho, Universitat Pompeu Fabra, Barcelona, Spain

Planning combined home health and social services is a very difficult task for decision-makers due to the high number of working regulations, user-related necessities and the need for synchronizing both types of services. We propose two heuristic methods to optimize routing and scheduling decisions for the synchronized home health and social care problem. We use data from current care providers in Barcelona to build and test our models and provide insights into the trade-off between the associated operating costs, continuity of service and number of unscheduled services. The proposed tool is made available via a web-based decision support system that allows decision-makers to obtain efficient solutions in an intuitive manner.

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SE14

CC-North 125B

Applications of OR and Analytics to Socially Impactful Problems

Flash Session

Session Chair: Mechack Ciyola, Lawyer Office, Kinshasa, AZ

1 Fairness and Strategies in Multi-Member Districts

Sanyukta Deshpande[1], Nikhil Garg[2], Sheldon H. Jacobson[3], [1]University of Illinois Urbana-Champaign, Champaign, IL, [2]Cornell Tech, New York, NY, [3]University of Illinois Urbana-Champaign, Champaign, IL, Contact: spd4@illinois.edu

Given the well-documented flaws in single-member plurality systems, there's a growing demand for alternatives. This work investigates the viability of the sought-after 'multi-winner ranked choice voting (RCV) system' and its susceptibility to strategic influences. We analyze the feasibility, computability, and effectiveness of employing strategies in RCV. Treating voter data as objects in space, tagged with unique social choice orders, we model game-like dynamics between candidates. They aim to enter preferred regions, using campaign and cooperative strategies. This research sheds light on strategic aspects of multi-winner RCV systems, providing insights for electoral reform.

3 To Convert or to Deter? Combat Counterfeiting in an Emerging Market

Liling Lu, singapore management university, singapore, Singapore. Contact: liling.lu.2018@pbs.smu.edu.sg

"Super fakes" are becoming popular in emerging markets. A brand-name firm may combat counterfeiting by converting the counterfeiters into authorized overseas suppliers, instead of deterring the entry to sell counterfeits. With the option of converting, we investigate under what conditions a brand-name firm optimally chooses to convert the counterfeiter into an authorized overseas source when facing with a licit domestic supplier.

4 Developing a Sustainable Network Design for Agricultural Waste Supply Chain in Ireland

Maryam Roudneshin, Amanda Sosa, University College Dublin, Dublin, Ireland. Contact: rudneshinmaryam@yahoo.com

This paper presented a methodology applying Geographic Information System (GIS) and mathematical programming to design a sustainable supply chain network for converting agricultural waste into high-value-added products. This approach aims to optimize sustainability factors as well as supply chain design. Ireland, as one of the largest agricultural producers in Europe, is considered a case study to validate the proposed methodology.

5 Student Performance Differences in High School Physics Education Using Big Data

Harry Wu, Walter Payton College Preparatory High School, Chicago, IL, Contact: wuharry53@gmail.com

This study uses TIMSS data to identify topic areas where US students perform well or poorly. I developed a unique index to measure the performance in the seven topic areas and three cognitive areas covered in high school curricula. I found that US students perform the worst in magnetism and electromagnetic induction compared to students in other countries. I also found that US students perform better in multiple-choice questions than in critical responses and that their performance in reasoning skills is consistently poor. I identified various contextual variables that may explain student performance and propose leveraging artificial intelligence (AI) strategies in teaching high school physics to improve student performance.

6 Municipal Bond Market Price of Risk

Dan Li[1], Peter Adriaens[1], Romesh Saigal[2], [1]University of Michigan, Ann Arbor, MI, [2]University of Michigan, Ann Arbor, MI, Contact: kency@umich.edu

Public water utilities are pivotal in ensuring access to safe drinking water, serving about 90% of the U.S. population. As user fees and tax earnings fall short of maintaining infrastructure, issuing municipal bonds has emerged as the primary financing method for public water infrastructure. The emergence of climate change is reshaping freshwater dynamics, impacting both water resources and the pricing of municipal bonds issued by water utilities. This study presents empirical evidence showcasing the impact of flooding and drought risks on municipal bond spreads. Notably, our research reveals a trend of reduced issuance spreads for water bonds associated with flooding risks since 2013. Furthermore, a scenario analysis based on the Merton model is employed to assess the economic implications of the observed climate risk premium within the domain of water bonds.

4 How Does Executive Incentive Perceptions Mediate the Effect of Environmental Regulations on Green Process Innovation? Moderating Effects of Executive Age and Ownership Type

Hesong REN, Wang Nengmin, Xi'an Jiaotong University, Xi'an, China. Contact: renhesong@stu.xjtu.edu.cn

Green process innovation (GPI) is an efficient way to reduce pollution, but there are no uniform findings on the effect of environmental regulations (EGs) on GPI. Using survey data from 309 Chinese manufacturing firms, we examine how EGs affect GPI, considering the mediating role of executive perceived political incentives (PPIs) and perceived wealth

incentives (PWIs). We also investigate the contingent role of executive age and further explore how these effects vary between state-owned enterprises (SOEs) and privately-owned enterprises (POEs). We find that executive age weakens the positive influences of EGs on both PPIs and PWIs. Additionally, PPIs and PWIs enhance GPI. The partial effect related to PPI is stronger for SOEs, while the partial effect related to PWI is stronger for POEs. This study contributes to the literature by disentangling the effects of EGs on GPI.

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SE15

CC-North 126A

Decision Support for Military Air Operations

Community Committee Choice Session

Session Chair: Matthew JD Robbins, Air Force Institute of Technology, WPAFB, OH

1 Evaluating the Joint Reliability of Multiple Distinct Servers for a Comprehensive Military Medical Evacuation Scenario

Virbon Frial, Air Force Institute of Technology, WPAFB, OH, Contact: virbon.frial@afit.edu

The Golden Hour policy requires that the medical evacuation (MEDEVAC) of casualties to medical treatment facilities (MTFs) occurs within an hour from the time of injury. To maximize the number of casualties evacuated within an hour, it is vital that military MEDEVAC planners effectively determine where to locate MEDEVAC facilities, such as mobile aeromedical staging facilities and MTFs, and allocate their associated servers, such as MEDEVAC units and beds. Furthermore, MEDEVAC servers conduct joint operations to ensure successful casualty evacuations. Therefore, we develop an approximate hypercube queueing algorithm and joint-coverage models that consider the dependencies between servers. The results in this research highlight the importance of considering the joint operations of servers within a comprehensive MEDEVAC system to improve system performance.

2 Efficient Dynamic Threat Avoidance Routing for Combat Aircraft in Advanced Framework for Simulation, Integration, and Modeling (AFSIM)

Dante Reid, Lance E. Champagne, Nathan B. Gaw, Air Force Institute of Technology, Wright Patterson AFB, OH

Simulating pre-planned routes and dynamic threat avoidance routing represents a significant problem for operations analysts. Without automated methods to create operationally valid routes, the analyst is faced with hard coding individual routes for aircraft over the entirety of the mission set. This research implemented threat avoidance routing based on Dijkstra's algorithm for aircraft attempting to operate in an anti-access area denial environment capable of dynamically updating the mission route as new threat information is learned. A designed experiment determined the impact of grid parameters on operational effectiveness and computational costs. Results show that the algorithm produced the best operational performance with grid spacing set to 50% of the smallest surface to air missile threat radius without incurring prohibitive computational costs.

3 Predicting Success in United States Air Force Pilot Training Using Machine Learning Techniques

Phillip R. Jenkins, Air Force Institute of Technology, Wright-Patterson Air Force Base, OH, Contact: phillip.jenkins@afit.edu

The US Air Force is struggling with a chronic pilot shortage, and not all pilot candidates are completing the necessary training, which exacerbates the problem. This study uses machine learning techniques to analyze historical data on pilot training candidates to gain insights into their success rates. The study finds that the extremely randomized tree technique can predict candidate success with 94% accuracy, and that degree type and commissioning source are the most important factors in determining success. The findings can inform modifications to future candidate selection criteria and Air Force personnel policies.

4 A Similarity-Based Admission Control Methodology for Experience Replay Within a Deep Reinforcement Learning Algorithm: Solving an Air Battle Management Problem

Joseph M. Liles, Matthew J. Robbins, Brian J. Lunday, Air Force Institute of Technology, WPAFB, OH

This paper introduces a novel similarity-based admission control methodology for the experience replay memory buffer in reinforcement learning problems. By updating the buffer only with sufficiently dissimilar experiences, the efficiency and speed of learning algorithms can be improved. We demonstrate the efficacy of our approach by analyzing an air battle management problem, extending previous work by including navigational waypoints and a probability-of-kill model for enhanced realism. We employ a neural network-based approximate policy iteration algorithm in a unique simulation environment, performing computational experiments to evaluate various algorithm designs. Analysis shows that using a memory buffer with the top 50% most distinct experiences allows a learning algorithm to converge about 10% faster than using prioritized experience replay alone.

5 A Game Theoretic Approach to Search for a Moving Target

Thuy Bui, Rutgers University, Newark, NJ, Contact: tb680@business.rutgers.edu

We present a zero-sum game between a Hider and a Searcher. The Hider places a target in one of n boxes. The target then moves among boxes according to a time-homogeneous Markov chain. Each box i has a detection probability q_i. That is, given the target is in box i, a search of that box will find the target independently with probability q_i. The Searcher picks a search sequence of length m corresponding to the order in which the boxes are searched. The payoff is the probability of finding the target in m searches, which the Searcher wishes to maximize, and the Hider wishes to minimize. We prove the game has a value and each Player has an optimal strategy. We also present the solution of the game for some classes of Markov chains.

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SE16

CC-North 126B

Advanced Topics in Biomedical Informatics

Community Committee Choice Session

Session Chair: Haifeng Wang, Mississippi State University, Mississippi State, MS

1 Characterizing the Complex Dynamic Properties of Rem Sleep Using Nonlinear Dynamical System Analysis

Cheng-Bang Chen, University of Miami, Coral Gables, FL, Contact: cxc1920@miami.edu

Rapid eye movement (REM) sleep is a crucial stage of sleep for brain health, but it is difficult to quantify. REM is a complex and dynamic process that requires characterization methods that can capture its complexity and dynamism. While existing approaches, such as power spectrum analysis, have made significant contributions to sleep research, they do not adequately capture the intricate nonlinear and nonstationary dynamic patterns within REM. To address this gap, this research introduces a novel framework based on nonlinear dynamical system analysis to quantify the dynamic properties of REM. The proposed metrics offer an objective and quantitative approach to characterizing REM sleep, enabling further advancements in sleep research.

2 Generating Counterfactual Explanations for Causal Inference Using Generative Modeling

Zhou Siqiong[1], Upala Islam[1], Imon Banerjee[2], Bhavika Patel[2], Ashif Iquebal[1], [1]Arizona State University, Tempe, AZ, [2]Arizona State University, Phoenix, AZ, Contact: aiquebal@asu.edu

We leverage the concept of counterfactual explanations to extract causal relationships between various imaging phenotypes, clinical information, molecular features, and the treatment response after neoadjuvant systemic therapy. Our approach is based on learning the sampling distributions of counterfactual instances using a regularized generative adversarial network such that the resulting counterfactuals are realistic. We demonstrate the method on benchmark datasets and a real-world case study on breast cancer.

3 Early Detection of Metastatic Tumor Recurrence Using Brain MRI

Oyekanmi O. Olatunde[1], William M. Duggar[2], David M. Caballero[2], Toms V. Thomas[2], Neha Adari[2], Mohammad T. Khasawneh[1], Hyunsoo Yoon[3], [1]Binghamton University, Vestal, NY, [2]University of Mississippi Medical Center, Jackson, MS, [3]Yonsei University, Seoul, Korea, Republic of. Contact: oolatun1@binghamton.edu

Due to the lack of clarity and standardization among experts regarding the treatment of metastatic brain tumors, it is important to monitor the effectiveness of any treatment plan and update it if necessary. This monitoring task involves predicting metastatic tumor recurrence using a binary classification approach. Therefore, we studied the effectiveness of using tumor radiomic features obtained from MRI to that of using 2D/3D deep neural networks on the ROI from brain MRI and radiotherapy dose. We used data from the University of Mississippi central hospital for this study. Our results show that radiomic features from MRI alone may be sufficient to discriminate stable from recurrent tumors. In addition, we showed different splitting strategies and how they affect the model's ability to learn discriminative feature representations between stable and recurrent tumors.

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SE17

CC-North 127A

Advances in Public Sector Operations

Community Committee Choice Session

Session Chair: Vibhuti Dhingra, Schulich School of Business, York University, Toronto, ON, Canada

1 Nudging Patients Towards Cost-Effective Providers: Analysis of an Insurer's Effort-Based and Cash Reward-Based Mechanisms

Mili Mehrotra, University Of Illinois Urbana Champaign, Champaign, IL

Misalignments between patients' choices of providers and those of the health insurance company (HIC) can result in significant costs. Misalignments may occur either because enrollees are unaware of their options or because they do not have an incentive to choose the cost-effective provider. Motivated by emerging mechanisms in the industry, we examine how an insurer can exert effort and/or offer cash rewards to nudge patients towards cost-effective providers. We build an analytical model that captures the salient aspects of an HIC's decision problem while incorporating how enrollees choose providers. With this versatile framework, we analyze the HIC's optimal effort and reward, individually and jointly, under different cost-share structures (i.e., copayment and coinsurance). Comparing the HIC's savings with the effort and cash reward-based approaches, we find that when coinsurance is high, the HIC prefers the effort-based approach. Conversely, the cash reward-based approach is better when coinsurance is low and the price difference between the two providers is high. With copayment, the HIC prefers to use a cash reward when the price difference is high; otherwise, it prefers to exert effort. Thus, neither a reward-only nor an effort only approach uniformly outperforms the other. The two approaches can serve as tactical complements as indicated by the superiority of the joint approach in some cases. This work provides a framework for the HIC to tailor the nudge (effort or reward or both) for different procedures and geographies based on the cost-share structure and the relative magnitude of related costs.

2 Effect of Expedited Payments on Project Delays: Evidence from the Quickpay Reform

Vibhuti Dhingra[1], Volodymyr O. Babich[2], Harish Krishnan[3], Jie Ning[4], [1]Schulich School of Business, York University, Toronto, ON, Canada; [2]Georgetown University, Washington, [3]University of British Columbia, Vancouver, BC, Canada; [4]Case Western Reserve University, Cleveland, OH, Contact: vibhutid@schulich.yorku.ca

Contractors are typically not paid instantaneously upon completing the project tasks and furnishing the invoice. We study the impact of payment timings on project delays. We develop theories that explain how payment duration affects project completion, and generate testable hypotheses. We empirically test these hypotheses using data on U.S. public projects. Our identification strategy uses a policy amendment that expedited payments to certain federal contractors as an exogenous shock.

3 Are Chief Sustainability Officers Guardians Of Environmental Justice? An Empirical Evaluation

Finn Petersen[1], Vibhuti Dhingra[2], Rachna Shah[1], [1]University of Minnesota, Minneapolis, MN, [2]Schulich School of Business, York University, Toronto, ON, Canada. Contact: pet03435@umn.edu

Environmental justice is a pressing issue in the US, as marginalized communities, primarily composed of people of color and those living in poverty, continue to bear the disproportionate burden of pollution and toxic emissions from manufacturing facilities.

Recently, firms have signaled an increased commitment to responsibility and sustainability by appointing Chief Sustainability Officers (CSOs). However, the impact of such appointments on overall sustainability, especially in environmental justice context, remains unclear. We analyze the effects that CSO appointments have on facility-level toxic chemical releases and explore how the effect varies by the type of community in which a facility is located. Our research sheds light on the pivotal role CSOs play in fostering sustainable business practices and mitigating instances of environmental injustice.

4 How Do Private Sector Firms Respond to a Supply Shock from the Public Sector?

Anant Mishra, Carlson School of Management, University of Minnesota, Minneapolis, MN

The study analyzes the response of domestic and foreign firms in the private sector to a sudden reduction in competition from public sector units (PSUs) in India, caused by a suspension of production licenses for vaccine-manufacturing PSUs. The suspension created uncertainty, but domestic firms were able to introduce new products and experience performance gains, while foreign firms did not benefit much. The study suggests that domestic firms' ability to navigate political challenges arising from lack of alignment between national and subnational governments is a key factor in their outperformance of foreign firms. The study highlights that even a transitory and uncertain reduction in competition from the public sector can lead to fundamental market restructuring by domestic firms.

Sunday, October 15, 4:00 PM - 5:15 PM

SE18

CC-North 127B

HAS Distinguished Speakers Session 2

Community Committee Choice Session

Session Chair: Jonas Oddur Jonasson, MIT Sloan School of

Management, Somerville, MA
Session Chair: Mariel Sofia Lavieri, University of Michigan, Ann Arbor, MI

1 Optimal Treatment Models: Past, Present and Future

Andrew J. Schaefer, Rice University, Houston, TX

Optimal disease treatment models were first proposed over 50 years ago, and continue to be an active area of research. We summarize the literature, survey the state of the art, and discuss exciting areas of future research.

2 Teaching, Research, and Practice: A Virtuous Cycle in Healthcare

Amy Cohn, University of Michigan, Ann Arbor, MI

For many operations researchers working on healthcare applications in an academic setting, it can be a sizeable challenge to have impact in teaching, research, *and* clinical practice. There just aren't enough hours in the day! My training in optimization, however, has assisted me in maximizing the synergies to be found in building a virtuous cycle where teaching influences and informs (no pun intended) research, which influences and informs practice, which influences and informs teaching, and counter-clockwise as well. I will discuss my experiences working as: a) professor of Industrial and Operations, b) Faculty Director of the Center for Healthcare Engineering and Patient Safety, and c) Chief Transformation Officer of Michigan Medicine, with the hopes of not only sharing my insights but stimulating future discussions amongst attendees.

Sunday, October 15, 4:00 PM - 5:15 PM

SE19

CC-North 127C

Behavioral Aspects of Healthcare Operations

Community Committee Choice Session

Session Chair: Craig Froehle, University of Cincinnati, Cincinnati, OH

1 Physician Collaboration and Multisiting: Implications for Care Efficiency in Emergency Departments

Bogdan C. Bichescu[1], Haileab Hilafu[2], Hui Jia[3], [1]The University of Tennessee, Knoxville, TN, [2]University of Tennessee, Knoxville, TN, [3]University of La Verne, La Verne, CA

Effective collaboration is crucial for temporary healthcare teams as it facilitates information sharing and reduces duplicated actions that hinder the care delivery efficiency. This study, based on data from Florida EDs, found that physician collaboration, operationalized based on physician familiarity and partner exposure, has a positive impact on care efficiency, by reducing visit durations and the number of procedures received. Additionally, physician multisiting, which represents a physician's tendency to work at multiple ED locations, weakens the benefits of familiarity but strengthens the benefits of partner exposure. These insights suggest that hospital administrators should consider physician collaboration and multisiting when forming care teams and scheduling shifts.

2 Patient Prioritization in Emergency Departments

Daniel Adelman[1], Thomas Spiegel[2], Kanix Wang[3], Gizem Yilmaz[4], [1]University of Chicago, Booth School of Business, Chicago, IL, [2]University of Chicago, Chicago, IL, [3]University of Cincinnati, Cincinnati, OH, [4]University of Chicago, CHICAGO, IL, Contact: wang2xk@ucmail.uc.edu

In this study, we aim to unravel the decision-making process underlying the assignment of patients to available beds in Emergency Departments (EDs) and examine the ramifications of queue jumping on waiting times and medical outcomes. Leveraging historical data, we train an array of machine learning algorithms to accurately forecast the subsequent patient to be assigned to a bed, evaluate the resulting patient outcomes, and recommend operational refinements. We then assess the impact and externalities of patient prioritization, focusing on waiting times and medical outcomes such as length of stay (LOS), mortality, risk of admission, and ED bounce-backs. This empirical research, conducted within the framework of personalized medicine, offers valuable insights into improving patient prioritization in emergency care settings.

3 Understanding Determinants of Patient Appointment Punctuality

Hedayat Alibeiki, California State University San Marcos, San Marcos, CA

Understanding the causes of patient unpunctuality can help better design the queuing systems and appointment arrival policies. This study aims to investigate the potential factors that may affect the patients' arrival time to their outpatient appointments. Potential factors considered in this analysis include patient appointment characteristics and patient demographic and socio-economic information.

4 Scheduling Effects on Service-Worker Fatigue: Evidence from Emergency Department Physicians

Chia-Chun Yang[1], Craig Froehle[2], Elizabeth Leenellett[3], [1]University of Cincinnati, Cincinnati, OH, [2]University of Cincinnati, Cincinnati, OH, [3]University of Cincinnati, Cincinnati, OH, Contact: craig.froehle@uc.edu

Employee fatigue is known to have deleterious consequences for work quality. Less is known about how scheduling, and shift structure specifically, influences front-line service-worker fatigue. Using primary data collected via a fatigue-monitoring program we developed and implemented in a large hospital's emergency department, we examine how shift duration and timing influence fatigue. We also assess how workers' between-shift activities influence the effectiveness of what should be their fatigue-recovery time. We find both shift structure and downtime activities influence the fatigue experienced by workers, but not always in intuitive ways, and we recommend organizations consider worker fatigue more specifically in their scheduling policies.

5 Capacity Expansion in Emergency Department Network: Impact of Opening Hospital and Hospital-Based Emergency Department on Patient Demand Shift and Operational Performance

Hyun Seok (Huck) Lee[1], Eric Park[2], Timothy H. Rainer[3], Robert Batt[4], [1]Korea University Business School, Seoul, Korea, Republic of; [2]Wake Forest University, Winston-Salem, NC, [3]Li Ka Shing Faculty of Medicine, The University of Hong Kong, Hong Kong Island, Hong Kong; [4]Wisconsin School of Business, UW-Madison, Madison, WI, Contact: parke@wfu.edu

We study how patients respond to easier access to emergency care in the form of new EDs opening closer to their location. Our study exploits individual patient's decision on ED visit choice and tendency and its impact on care outcomes and operational performances due to shift in overall demand and subsequent change in ED congestion levels in two different settings. One ED/hospital opening in a region without any public hospital within 25 km and another ED/hospital opening in a region with already two other EDs within 10 km.

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SE20

CC-North 128A

Data-driven Research in Healthcare Operations

Community Committee Choice Session

Session Chair: Masoud Kamalahmadi, University of Miami

Session Chair: Iman Attari, Indiana University, Bloomington, IN

1 A Data-Driven Analytical Framework for the Opioid Prescription Epidemic

Alireza Boloori[1], Soroush Saghafian[2], Stephen Traub[3], [1]University of Washington, Tacoma, WA, [2]Harvard University, Cambridge, MA, [3]Brown University, Providence, RI, Contact: aboloori@uw.edu

Opioid epidemic is attributed to the over-prescription of opioid painkillers. Medical guidelines have urged healthcare providers to lessen opioid prescriptions in their medical practices. This, however, could negatively affect those patients who suffer from acute or chronic pain symptoms. Utilizing commercial insurance claims and encounters data, we (1) analyze the trade-off between the side effects and potential benefits of using pain treatments, and (2) provide an analytical framework that helps physicians in prescribing these treatments.

2 The Benefits-Value-Advisor (BVA) Program for Shoppable Medical Procedures

Jingyao Huang[1], Diwakar Gupta[2], [1]University of Missouri-Kansas City, Kansas City, KS, [2]University of Texas, Austin, TX, Contact: jhhkq@umkc.edu

Large price variation is prevalent for routine medical procedures such as MRI and CT Scan, which has led insurers to introduce payment innovations to reduce the medical expenditure. We focus on one beneficiary-oriented payment innovation, the BVA program, which is designed to steer beneficiaries to low-cost providers. Under the BVA program, insurers exert influence on beneficiaries' provider selection via recommendation effect. In this paper, we first investigate the effectiveness of recommendations under the BVA program and identify the optimal recommendation strategy. Additionally, we point out that the benefit of the BVA program also depends on procedure types and we found that the BVA program has least benefit for critically difficult procedures.

3 Growing the Vaccine Distribution Network During a Pandemic: Implications for Increasing Access

Sukrit Pal[1], Anand Nair[2], Jason Miller[3], [1]Iowa State University, Ames, IA, [2]Northeastern University, Boston, MA, [3]Michigan State University, East Lansing, MI

Hospitals implement different policies to better manage care capacity in environment of uncertain demand. In this study, we investigate one such policy - creation of access controlled

COVID isolation ward - to understand how hospitals exploit such policy to manage their protective equipment inventory and patient care.

4 Traffic Light Allocation Pathway System for Geriatric Patients

Abtin I. Maghsoodi[1], Valery Pavlov[2], Paul Rouse[3], Cameron Walker[4], Matthew Parsons[5], [1]Waikato Health District, Hamilton, New Zealand; [2]University of Auckland, Auckland, New Zealand; [3]University of Auckland, Auckland, New Zealand; [4]University of Aukland, Aukland, New Zealand; [5]University of Waikato, Hamilton, New Zealand. Contact: v.pavlov@auckland.ac.nz

For many geriatric patients access to the acute geriatric ward is critical for their health as their conditions and treatment are complex due to multiple comorbidities and general frailty of such patients. However, the acute geriatric ward purposefully designed and equipped to provide health care at the required level is unavailable for all geriatric patients due to its limited capacity. The complexity of such patients translates to a demanding, complex, and laborious triage process. Considering geriatric patients constitute about 34% of patients the triage process consumes time of some of the most highly qualified medical staff. A data-driven Traffic Light System has been developed that reduces the amount of required human decision-making by 95%.

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SE21

CC-North 128B

Leveraging Empirical Data to Improve Health IT and Healthcare Operations

Community Committee Choice Session

Session Chair: Seokjun Youn, University of Arizona, Tucson, AZ

1 Optimal Location of a Remote Dental Unit

Jong Youl Lee[1], Balaraman Rajan[2], Abraham Seidmann[3], [1]Florida International University, Miami, FL, [2]California State University East Bay, Pleasanton, CA, [3]Boston University, NEWTON, MA, MA, Contact: jongyoul.lee@simon.rochester.edu

We explore the economics of a major hospital operating a remote dental unit in a distant rural area. Specifically, we characterize the optimal location of the remote unit and examine the impact of operating a remote dental unit on the profit of a dental hospital. The ideal scenario, from a patient coverage perspective, is to put the remote unit location far enough away that patients accessing the remote unit are distinct from patients accessing the main hospital center to avoid redundancy (market cannibalization). However, we show that such a placement may not always be optimal for the hospital's profit and derive conditions under which the optimal patient coverage for the hospital and the remote unit overlaps. Our findings lead to policy implications for dental care reimbursement and service expansion.

2 Unintended Impact Of Initial Prescribing In Hypnotics Abuse

Manqi Li[1], Xiang Chen[1], Yan Huang[2], [1]Renmin University of China, Beijing, China; [2]Tepper School of Business, Carnegie Mellon University, Pittsburgh, PA, Contact: limanqi@rmbs.ruc.edu.cn

Hypnotics medication misuse is a severe global problem. In this study, we propose the bullwhip effect in chronic disease management, indicating the self-amplifying impact of an initial prescription of hypnotics medication on a patient's long-term outcome. Utilizing a unique prescription dataset, we identify causality between initial prescription dosage and long-term patient outcomes, uncovering the dynamics involved. Mechanism analysis shows that subsequent prescription in follow-up visits may refer to the dosage of the previous prescription, signifying a prominent impact of the initial decision. This study stresses the need for careful dosage decisions in the early stage of the treatment course.

3 Tracking Nosocomial Diseases at Individual Level with a Real-Time Indoor Positioning System

Yong-Hong Kuo[1], Chun Hung Cheng[2], Ziye Zhou[3], [1]The University of Hong Kong, Pokfulam Road, Hong Kong; [2]Logistics and Supply Chain MultiTech R&D Centre (LSCM), Hong Kong, Hong Kong; [3]The Chinese University of Hong Kong, Shatin, Hong Kong. Contact: yhkuo@hku.hk

Healthcare-associated infections (HAIs) pose a significant risk during infectious disease outbreaks like SARS, as they can spread through person-to-person contact or within healthcare facilities. To address this issue, we propose a novel methodology that models HAIs at an individual level and integrates real-time positioning technologies for effective outbreak control. We tested our approach using four months of human tracking data from a hospital that experienced a major SARS outbreak in 2003. Our evaluation results demonstrate that our framework outperforms existing models in characterizing macro-level phenomena such as the number of infected people and epidemic threshold. Our work highlights the importance of personalized modeling for controlling HAIs and provides a promising avenue for future research in this area.

4 From One Goal to Another: Understanding the Dynamic Mechanism of Goal Pursuitin Mobile Health Platforms

Chenxi Guo[1,2], Qiuju Yin[1], Zhijun Yan[1], Seokjun Youn[2], Wei Chen[2], [1]Beijing Institute of Technology, Beijing, China; [2]University of Arizona, Tucson, AZ, Contact: sarahguocx@hotmail.com

Goal pursuit are important for improving public health management. Existed literature reveals the change of user motivation in single and hierarchical goal pursuit. However, the change of user healthful activity in mHealth platforms is composed of multiple non-hierarchical goal-pursuing processes, which remains limited. This paper proposes a dynamic approach (hidden Markov model) to reveal 1) how user motivation change in the process of goal pursuit, especially moving to the next goal; 2) how previous goal (including the outcome and user feedback) affects the next goal pursuit. We identify three motivation states, and show that the characteristics of previous goal affect users' pursuit of the next goal differently across states. The findings offer implications for platform managers on how to encourage users to pursue goals and build sustainable online platforms.

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SE22

CC-North 129A

Emerging Applications of Machine Learning in Healthcare

Community Committee Choice Session

Session Chair: Caleb Bugg, Georgia Tech, Decatur, GA
Session Chair: Gian-Gabriel P. Garcia, Georgia Institute of Technology, Atlanta, GA

1 Clustered Multi-Task Learning for Prediction of Adverse Pregnancy Outcomes

Sun Ju Lee, Gian-Gabriel Garcia, Georgia Institute of Technology, Atlanta, GA, Contact: julee@gatech.edu

In clinical prediction models, combining individual indicators into a composite outcome can help overcome issues associated with single outcomes such as low predictability and low prevalence. However, this may obscure relationships between predictors and single outcomes, and may limit the clinical utility of the prediction model as diagnoses may have different etiologies addressed by different interventions. We aim to resolve this trade-off by developing an optimization framework to simultaneously cluster related outcomes and learn model parameters for each cluster. We apply our formulation to indicators comprising maternal and neonatal morbidity and demonstrate that our approach can aid interpretability by finding underlying groups of related tasks and deriving an interpretable set of predictors.

2 Studying and Fixing Machine Learning Racial Bias in Medical Appointment Scheduling

Michele Samorani, Santa Clara University, Santa Clara, CA

In an effort to increase clinic efficiency, state-of-the-art scheduling algorithms use patients' individual no-show predictions when scheduling medical appointments. By combining in such way machine learning and optimization, though, these algorithms inevitably result in undesirable racial disparities, because patients' race tend to be correlated with their no-show risk. Published and ongoing work shows, for example, that black patients are disproportionately placed in overbooked appointment slots, or that they are scheduled farther in the future than the rest of the patients. In this talk, I will give an overview of recent working and published papers that study and attempt to fix racial disparity in appointment scheduling.

3 Implementing Federal Food Service Guidelines In Federal And Private Worksite Cafeterias In The United States Improves Human And Planetary Health

Caleb Bugg[1], Gian-Gabriel P. Garcia[1], Yang Yang[1], Karen R. Siegel[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Emory University, Atlanta, GA, Contact: caleb.bugg@isye.gatech.edu

This modeling study estimates the potential impact of adherence to US Food Service Guidelines for Federal Facilities and further dietary substitutions on the carbon footprint and healthfulness of food menus offered by federal facilities in the United States. First, we built a food database that links food items with their greenhouse gas emissions (GHGEs), nutritional content, and healthfulness using multiple data sources. Next, we used this food database to parameterize a linear programming optimization model to estimate the impact on human and planetary health of (a) shifting from current adherence to FSGs to complete (100%) adherence and (b) shifting within food groups from less healthy to more healthy foods (for example, within the protein foods group, shifting from beef to chicken or from chicken to legumes).

4 On Time-dependent Workloads in Service Processes

Donald Lee[1], Hao Ding[2], Sokol Tushe[1], Diwas S. KC[1], [1]Emory University, Atlanta, GA, [2]Emory University, Decatur, GA

The empirical operations literature have shown that the service process of customers is state-dependent, with a primary focus on the relationship between patient length-of-stay and workload in emergency departments (ED). Traditionally, the state of the workload is either measured at the beginning of service, or the average workload over the course of the stay is used. Recognizing that the state of the workload is not time-static but actually varies over time, this paper provides empirical evidence from the ED setting that the patient service rate is both state- and time-dependent. Through two applications, we demonstrate that time-dependency is a first-order concern. First, we show how accounting for time-dependent workloads can potentially resolve an open question regarding the relationship between service speed and workload. Specifically, the literature has identified a number of seemingly contradictory findings. We show that this could be due to a statistical artefact of using static workloads in the estimation. Second, we use a naturalistic ED staffing simulation to demonstrate significant performance improvements gained from employing a state- and time-dependent service process model over one that only accounts for state-dependency.

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SE23

CC-North 129B

Emerging Topics in Logistics

Community Committee Choice Session

Session Chair: Sibel Alumur Alev, University of Waterloo, Waterloo, ON, Canada

1 The Value of the Multi-Period Solution Revisited: How to Model Time in Capacitated Location Problems

Hannah Bakker[1], Stefan Nickel[2], [1]Karlsruhe Institute of Technology, Karlsruhe, Germany; [2]Karlsruhe Insitute of Technology, Karlsruhe, Germany. Contact: stefan.nickel@kit.edu

Location decisions are often long-lasting and multi-period models have received considerable attention. The price to pay for the increased flexibility in decision-making is increased complexity. When facilities are capacitated, multi-period models impose additional restrictions regarding when to use resources. The value of the multi-period solution (VMPS) was introduced to quantify the benefit of shifting to a multi-period model by setting its objective value in relation to that of a static counterpart. We discuss how relaxing time-dependent constraints and deriving periods from the problem's data allows decision-makers to exploit the benefits of increased flexibility while limiting the drawbacks of multi-period modeling. We conclude that more does not necessarily translate to better when it comes to modeling time.

2 Multi-Period Hub Location with Shipment Consolidation and Time-Definite Transportation

Khaled M. Shah[1], Sibel A. Alumur[1], James H. Bookbinder[2], [1]University of Waterloo, Waterloo, ON, Canada; [2]University of Waterloo, Toronto, ON, Canada. Contact: jbookbinder@uwaterloo.ca

In this study, we jointly decide on locations of hubs, consolidation of shipments, and inventory holding. A fleet with different vehicle capacities and costs is used for inter-hub transportation. Inventory space at hubs is limited, demand between O-D pairs is distributed over a multi-period horizon, and there are promised times for delivery. We formulate a MIP model to decide the optimal hub locations, allocation of demand nodes to hubs, inventory to be held at hubs, and types and the number of vehicles to be dispatched on inter-hub links in different periods. We propose a solution methodology that incorporates a shipment consolidation subproblem embedded in a variable neighborhood search heuristic. We evaluate the performance of the model and algorithm by numerical experiments on a realistically prepared data set to derive managerial insights.

3 Sustainable Hub Location Under Uncertainty

Gita Taherkhani[1], Mojtaba Hosseini[2], Sibel Alumur[3], [1]Loyola University, Chicago, IL, [2]University of Iowa, Iowa City, IA, [3]University of Waterloo, Waterloo, ON, Canada. Contact: gtaherkhani@luc.edu

In this paper, we study the sustainable design of hub networks under uncertainty for truckload and less-than-truckload transportation. We develop a model in which, in addition to transportation and hub installation costs, the carbon tax is also explicitly included in the objective function. Moreover, to ensure that the total amount of greenhouse gas emissions emitted by trucks does not exceed the carbon cap, we incorporate an emission limit on the entire transportation network. To provide a more reliable solution framework for this problem, we take the demands as stochastic parameters and then develop a Benders-decomposition-based algorithm coupled with a sample average approximation scheme for solving our stochastic problem.

4 Data-Driven Hub Network Design for Ridesharing

Gita Taherkhani[1], Bissan Ghaddar[2], Sibel Alumur[3], [1]Loyola University, Chicago, IL, [2]Ivey Business School, London, ON, Canada; [3]University of Waterloo, Waterloo, ON, Canada. Contact: sibel.alumur@uwaterloo.ca

We study the design of ridesharing hub networks to promote shared transportation. Given a set of passenger trips in an urban area, the problem is to determine the origins and destinations of a fixed number of ridesharing connections to maximize the potential users of the system. The problem is formulated as a maximal covering hub arc location model and solved to optimality using Benders decomposition. Additionally, two data-driven clustering-based methodologies are adapted and implemented to compare with the solutions of the optimization model. All methodologies are tested using the New York City taxi trip data. Several computational experiments are conducted to compare optimization and data-driven approaches under key performance metrics.

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SE24

CC-North 130

Platform Economy and Socially Responsible Operations

Community Committee Choice Session

Session Chair: Yunlong Peng, Tsinghua University, Beijing, China

Session Chair: Chong Zhang, Tilburg University, Tilburg, Netherlands

1 The Impact of Image Quality in Review Platforms: Theory, Evidence, and Managerial Implications

Jiawei Chen[1], Yunke Mai[2], Chong Zhang[3], [1]Shanghai University of Finance and Economics, Shanghai, China; [2]University of Kentucky, Lexington, KY, [3]Tilburg University, Tilburg, Netherlands. Contact: c.zhang@tilburguniversity.edu

In this paper, we utilize a data-driven approach to study sellers' visual marketing decisions on service rating platforms. In particular, by applying image processing and machine learning techniques on a dataset collected on Yelp, we estimate the quality of photos posted by restaurants and establish its connection with the qualities of restaurants (reflected by ratings and reviews). We find that restaurants with higher ratings prefer to post photos, and more interestingly, the quality of photos is shown to have different impacts on customer reviews depending on restaurants' service qualities. Building upon this interesting data finding, we establish a quality disclose model that captures the key tradeoff behind the data observations in order to provide managerial insights and inform optimal visual marketing decisions for restaurants.

2 Reusable Packaging Program with Consumer Engagement

Yunlong Peng[1], fei gao[2], Jian Chen[3], [1]University of Warwick, Coventry, United Kingdom; [2]Indiana University Bloomington, Bloomington, IN, [3]Tsinghua University, Beijing, China. Contact: Yunlong.Peng@wbs.ac.uk

In this paper, we consider a firm selling in a market where some eco-conscious consumers start to use their own reusable containers to reduce the waste of single-use packaging. Two different strategies have been adopted by firms in practice to promote the use of reusable packaging: (i) offering incentives (including monetary and pro-environmental incentives) and providing their own reusable packaging to consumers. We develop a stylized model to study the effectiveness of such two strategies and examine their environmental implications.

3 Will Diversity Equity and Inclusion Commitment Improve Manufacturing Firms' Market Performance?

Chris Lo[1], Fei Li[2], Christopher S. Tang[3], Yi Zhou[4], [1]Hong Kong Polytechnic University, Hong Kong, China; [2]Hong Kong Polytechnic University, Hong Kong, China; [3]ucla, Los Angeles, CA, [4]Monash University, Caulfield East, Australia. Contact: kwan.yu.lo@polyu.edu.hk

As the U.S. faces changing demographics, Diversity, Equity, and Inclusion (DEI) becomes crucial for firms to meet regulations, attract talent, and enhance performance. However, limited research exists on DEI's implications, especially for manufacturing. We studied the effects of DEI commitment on 233 publicly traded manufacturing companies using Signaling Theory and event study methodology. Our analysis covered 311 DEI announcements from 2014-2022, revealing positive abnormal stock returns during the announcement period, particularly for strong DEI announcements or those through domestic media. We also compare U.S. and China results for a global DEI management perspective.

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SE25

CC-North 131A

Emergency Department Operations

Community Committee Choice Session

Session Chair: Lesley Meng, Yale School of Management, Yale University, New Haven, CT

1 Emergency Department Boarding: Quantifying the Impact of Inpatient Admission Delays on Patient Outcomes and Downstream Hospital Operations

Huifeng Su[1], Lesley Meng[1], Rohit Sangal[2], Edieal J. Pinker[1], [1]Yale School of Management, Yale University, New Haven, CT, [2]Yale School of Medicine, Yale University, New Haven, CT, Contact: huifeng.su@yale.edu

Emergency Department (ED) boarding refers to the delay in transfer experienced by admitted patients from ED to inpatient units. Using an instrumental variable design, we find that on average, longer boarding times lead to longer hospital stays and a higher chance of escalation in care. Our findings also reveal that the impact of boarding differs across patients, suggesting that considering such heterogeneity when assigning inpatient beds could improve the patient flow

2 Improving Emergency Department Flow: A Predictive Model for Ambulance Diversion

Chenhao Zhou[1], Temidayo Adepoju[2], David Dreyfus[3], Christine Ramdin[4], Erin Muckey[4], Anthony Rosania[4], Lewis Nelson[4], Akiva Dym[4], [1]Rutgers Business School, Newark, NJ, [2]Rutgers Business School, Newark, NJ, [3]Rutgers University, Newark, NJ, [4]Rutgers New Jersey Medical School, Newark, NJ, Contact: chenhao.zhou@rutgers.edu

This study delves into internal and external factors prompting ambulance diversion in Emergency Departments (EDs), an issue exacerbated by the rise in ED visits and uninsured patients. We extend the scope beyond prior research that largely focused on internal factors, utilizing patient-level longitudinal data for a holistic understanding. Leveraging artificial intelligence and machine learning, we analyze a wide spectrum of variables from our institution's health records while respecting privacy. Our objective is to establish a measurable pre-diversion threshold for proactive management of ambulance diversions, with implications for improving patient flow and overall healthcare efficiency.

3 Does Machine Learning Improve Operational Efficiency? Evidence from the Design of an Emergency Department Vertical Processing Unit

Agni Orfanoudaki, Oxford University, Oxford, United Kingdom

Many hospitals have been experimenting with innovative patient flow designs to address the emergency department (ED) overcrowding challenge. A promising approach is to separate patients who can be served vertically and route them to a different area, termed the Vertical Processing unit, also known as the Rapid Medical Assessment (RMA) unit. However, successful implementation of this design significantly depends on understanding which patients should be routed to the RMA unit. We develop and validate a machine learning model that accurately predicts when an arriving patient can be served in the RMA unit. Subsequently, we propose an analytical model to minimize the average patient length of stay in an RMA-based ED. Our results suggest that the proposed RMA design outperforms traditional patient flow approaches due to the dynamic and efficient use of ED resources.

4 The Cost of Task Switching: Evidence from Emergency Departments

Yiwen Jin[1], Yige Duan[2], Yichuan Ding[3], Mahesh Nagarajan[4], Garth Hunte[5], [1]University of British Columbia, Sauder School of Business, Vancouver, BC, Canada; [2]Vancouver School of Economics, UBC, Vancouver, BC, Canada; [3]McGill University, Montreal, QC, Canada; [4]University of British Columbia, Vancouver, BC, Canada; [5]University of British Columbia, Vancouver, BC, Canada. Contact: yiwen.jin@sauder.ubc.ca

Emergency department (ED) physicians treat patients of different symptoms and constantly switch between tasks. Using comprehensive data sets on patient visits and lab tests in two collaborating EDs, we examine the impact of task switching on physician productivity, quality of care, and patient routing. To address endogenous patient selection, we construct an instrumental variable using the exogenous composition of waiting patients. We find a 10% increase in physicians' switching frequency reduces the number of patients treated per hour by 8.65% -11.53%, with no significant influence on quality. By exploring the heterogeneous switch costs among different patient pairs, we propose a data-driven queue management method to best partition patients into two queues. In the simulation, we find implementing the proposed two-queue system reduces average waiting time by 38%.

5 Predicting Short-Stay Patients in the Emergency Department

A. Cecilia Zenteno, Massachusetts General Hospital, Boston, MA, Contact: azentenolangle@mgh.harvard.edu

Emergency Department overcrowding is a widespread concern amongst hospital leaders. A significant contributor to this congestion is created by patients who have been admitted, but who are waiting for an inpatient bed to become available. In this work, we propose to establish a different pathway for ED patients who are predicted to have a short length of stay upon admission (2 days maximum). Our goals are i) to minimize disruptions in care of this patient population, and ii) opening scarce ED and inpatient beds for more complex patients. Our predictive model, which uses patients' clinical, administrative, and demographic data, has been validated by a group of hospital physicians. It has a sensitivity of 65%, a positive predictive value of 62%, and is 79% accurate. This proposal is in the process of being implemented at Mass General Hospital.

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SE26

CC-North 131B

Emerging Topics in iFORM

Community Committee Choice Session

Session Chair: Yuqian Xu, UNC-Chapel Hill Kenan-Flagler Business School, Chapel Hill, NC

Session Chair: Youngsoo Kim, University of Alabama, Tuscaloosa, AL

1 Influence of Customer Financing Choices on Retail Demand and Pricing Decisions

Panos Kouvelis[1], Wenhui Zhao[2], [1]Washington University in St. Louis, St. Louis, MO, [2]Shanghai Jiao Tong University, Shanghai, China. Contact: zhaowenhui@sjtu.edu.cn

We study the pricing decision of a retailer selling a product to her customers, who can make the purchase with a credit card at a prespecified interest rate, or through a "buy now pay latter" (BNPL) service offered by a third-party provider at a zero interest rate but with a fixed amount of payment within a prespecified number of installments. If a customer cannot meet an installment requirement, the service provider has to stop his service till the time the customer can clear the outstanding balance. To offset such risks, the service provider will ask for a price discount from the retailer. We build demand models of the two customer financing modes, and analyze the optimal pricing decisions of the retailer. Interestingly, we show that the BNPL service may not necessarily attract more demands and generate more profits than the credit card financing mode.

2 Fintech Lending, Open Banking, And Consumer Manipulation

Yangguang Wang[1], Zhengping Wu[2], Fasheng Xu[3], [1]Syracuse University, Syracuse, NY, [2]Syracuse University, Syracuse, NY, [3]Syracuse University, Long Island City, NY, Contact: ywang784@syr.edu

Credit invisibles, consumers with limited (blank) credit histories and low credit scores, make up nearly 20 percent of the U.S. adult population. Long marginalized from mainstream credit services, they are more vulnerable to withstand financial shocks and face inconveniences in fundamental life aspects such as renting an apartment, not to mention encountering barriers to accessing to equitable financial opportunities. Open banking seems to provide a way to improve financial inclusion, especially for these credit invisibles. We study the impact of open banking on consumer behaviors regarding the manipulation of alternative data, and the consequential effects on lending decisions within the fintech sector. Additionally, we analyze its influence on the welfare of borrowers and lenders, as well as its role in reshaping competition within the lending market segment.

3 Towards Moderate Representation Balancing for Credit Policy Evaluation

Qi Wu, Yiyan Huang, City University of Hong Kong, Kowloon Tong, Hong Kong. Contact: qiwu55@cityu.edu.hk

Credit policy evaluation presents profitable opportunities for E-commerce platforms through improved decision-making. The core of policy evaluation is estimating the causal effects of the policy on the target outcome. However, selection bias presents a key challenge in estimating causal effects from real-world data. Some recent causal inference methods attempt to mitigate selection bias by leveraging covariate balancing in the representation space to obtain the domain-invariant features. However, over-balancing representations may result in the loss of domain-related information. This paper introduces a novel model to achieve moderate representation balancing to do policy evaluation. The extensive experimental results on benchmark datasets and a newly introduced credit dataset show a general outperformance of our method compared with existing methods.

4 Securing Payment from a Financially Distressed Buyer

Philipp J. Schneider[1], Isik Bicer[2], Thomas A. Weber[1], [1]EPFL, Lausanne, Switzerland; [2]York University Schulich School of Business, Toronto, ON, Canada. Contact: philipp.schneider@epfl.ch

When contracting with buyers that may become financially distressed, suppliers are exposed to an invoice-default risk. Based on Compustat data we identify a reduced-form model that relates salient operational and financial parameters to the default-risk premium. We derive the buyer's optimal ordering policy, as well as the effective risk premium paid by the otherwise risk-neutral supplier. Furthermore, we investigate the effects of the product's profit margin and of agency conflicts related to other debtors on the supplier's default-risk premium and the buyer's financial leverage.

Sunday, October 15, 4:00 PM - 5:15 PM

SE27

CC-North 131C

Recent Advancement of Stochastic Modeling for Service Systems

Community Committee Choice Session

Session Chair: Yue Hu, University of Chicago, Chicago, IL
Session Chair: Antonio Castellanos, Technion – Israel Institute of Technology, Nesher, Israel

1 Optimal Allocation of Resources to Reduce Risk of Fall in Hospital

Jared Chiu, Vahid Sarhangian, University of Toronto, Toronto, ON, Canada

Falls among inpatients are one of the most frequently reported safety incidents at hospitals. In this work, we investigate the optimal allocation of interventions (e.g., equipments or human resources) to reduce the risk of falls. We first use observational data from a large hospital to estimate the impact of various interventions on risk of falls. We then leverage these results to determine the optimal allocation of interventions under resource constraints.

2 Proactive Patient Treatment in Sepsis

Chia-Hao Chang[1], Vineet Goyal[1], Carri Chan[2], [1]Columbia University, New York, NY, [2]Columbia Business School, New York, NY, Contact: cc4626@columbia.edu

Sepsis is an emergent medical condition where body's immunological responses cause end-stage organ dysfunction and death. In a typical year, around three hundred and fifty thousand people died of sepsis in the United States. Its high mortality renders the timeliness of detection and treatment crucial. Some recent evidence has shown that providing early treatment to patients before they develop sepsis may lower their mortality. Due to the scarcity of the medical resources, such early treatment may cause congestion and block the urgent need from the patients developing sepsis. In this work, we consider a discrete-time Markov model where a policy maker decides the number of patients to treat proactively. Motivated by the structural insights from fluid approximation, we propose a state-dependent threshold policy. We justify our policy by showing its asymptotic optimality.

3 Analysis and Improvement for Eviction Enforcement

Baris Ata, Yuwei Zhou, University of Chicago, Chicago, IL, Contact: Yuwei.Zhou@chicagobooth.edu

Eviction proceedings are a critical component of the housing sector, and it is the legal responsibility of the Cook County Sheriff's Office (CCSO) to enforce them. The CCSO receives an average of 13,000 eviction requests annually. Besides the high volumes of requests, efficiently allocating resources such as labor and vehicles to fulfill these requests is an immense challenge. We model the eviction process using a Brownian Control Problem with dynamic control capability. However, solving the problem numerically to identify the optimal policy is still challenging, because the problem is high-dimensional due to its spatial nature. To overcome this challenge, we propose an approach that solves HJB equations using deep neural networks. Using this solution, we propose a policy for the queueing system and illustrate its effectiveness in a simulation study.

Sunday, October 15, 4:00 PM - 5:15 PM

SE28

CC-North 132A

Waste Reduction in Food Supply Chains

Community Committee Choice Session

Session Chair: Nicholas C. Petruzzi, University of Wisconsin-Madison, Madison, WI
Session Chair: Karthik Murali, Oregon State University, Corvallis, OR

1 The Impact of Online Sales on Perishable Product Waste in Grocery Retail

Parisa Shahsavand, Dorothee Honhon, The University of Texas at Dallas, Richardson, TX, Contact: parisa.shahsavand@utdallas.edu

We consider an omnichannel retailer satisfying demand from in-store and online consumers from the same in-store inventory. The retailer has to decide between FIFO and LIFO fulfilment methods for online orders up to an age-threshold. We study the impact on waste of an increase in the proportion of online consumers.

2 Strategic Sell-By Dates: Implications for Retail Food Waste

Karthik Murali[1], Aditya Vedantam[2], Nicholas C. Petruzzi[3], [1]Oregon State University, Corvallis, OR, [2]State University of New York at Buffalo, Williamsville, NY, [3]University of Wisconsin-Madison, Madison, WI, Contact: karthik.murali@oregonstate.edu

Grocery stores in the U.S. throw away 16 billion tons of food each year due to expiration. In this study, we develop a game-theoretic model to examine the strategic motivations behind a manufacturer's choice of sell-by dates and the corresponding implications for food waste at the retail level. We examine the role of supply chain structure as well as

inventory issuing policies on the sell-by date decision. Finally, we identify mechanisms that policy makers can implement to reduce food waste in the supply chain.

3 Multiplicity in Product Expiration Dates and Food Waste in Retail Stores

Nitish Jain[1], Ashish Kabra[2], Varun Karamshetty[3], [1]London Business School, London, United Kingdom; [2]University of Maryland-College Park, College Park, MD, [3]National University of Singapore, Singapore, Singapore. Contact: akabra@umd.edu

Perishable products with multiple expiration dates contribute to expiration waste (EW) in food retailers. Consumers tend to choose units with later expiration dates, resulting in waste of units with sooner expiration dates. Retailers use strategies like price markdowns and inventory rotation to reduce this waste, but lack awareness of its extent. This study presents the first large-scale evidence of the contribution of multiple-dates-led expiration waste (MDEW) to overall waste. The study introduces a novel methodology that calculates its lower and upper bounds. For a large dataset from a European retailer, the study finds that MDEW contributes 21-52% of the EW. This research provides a basis for academic investigation and offers a practical method for measuring MDEW in store operations.

4 Improving Smallholder Welfare And Productivity While Preserving Natural Capital

Dan Andrei Iancu, Erica Plambeck, Xavier Warnes, Stanford University, Stanford, CA, Contact: daniancu@stanford.edu

Smallholder farmers in developing economies produce more than 50% of the world's food calories and often live on the fringe of poverty. With agricultural supply chains acting as a prominent driver of tropical deforestation, increasing the welfare and productivity of smallholders can be a crucial driver for reducing worldwide poverty and hunger and preserving the natural environment. We study the optimal design of incentive schemes in agricultural supply chains to best balance these goals. We propose a detailed operational model of household decision-making that includes land clearing, production, and consumption decisions, as well as uncertainty and liquidity constraints. We characterize the optimal policies and analyze different incentive schemes that allow us to derive practical implications for public and private stakeholders.

Sunday, October 15, 4:00 PM - 5:15 PM

SE29

CC-North 132B

New Technologies in Operations Management

Community Committee Choice Session

Session Chair: Yao Cui, Cornell University, Ithaca, NY
Session Chair: Jingchen Liu, Nanjing University, Nanjing, China

1 Blockchain Adoption And Greenwashing

Yuze Li[1], Pnina Feldman[2], Gerry Tsoukalas[2], [1]Questrom School of Business, Boston University, Boston, MA, [2]Boston University, Boston, MA, Contact: yuzeli@bu.edu

Recently, some brands have started to adopt blockchain technology to certify the sustainability claims of their products. While blockchain technology has advantages such as tamper-resistance and transparency, it also suffers from weaknesses such as data input integrity issues. Given the advantages and weaknesses of blockchain, we examine the strategic aspects of blockchain adoption for certifying green products and examine its impact on greenwashing in practice. Using a stylized model, we demonstrate that, although blockchain certification can increase the environmental quality of products, it may also induce incentives for firms to engage in greenwashing. In addition, blockchain certification may lead to reduced profitability for the firm, reducing the incentives to adopt blockchain technology.

2 Invoice Tokenization for Deep-Tier Payables Finance

Jing Hou[1], Burak Kazaz[2], Fasheng Xu[2], [1]Nanjing University, Nanjing, China; [2]Syracuse University, Syracuse, NY

Invoices from tier-1 suppliers to the downstream anchor manufacturer can be tokenized onto a blockchain. The tier-1 suppliers are then able to split and transfer the tokens to their own (tier-2) suppliers, enabling deep-tier suppliers to sell tokens and access financing at more affordable rates based on the anchor manufacturer's credit rating. This paper investigates how invoice tokenization impacts the multitier supply chain's decisions and profits under different supply network configurations and contractual forms.

3 Predictive 3D Printing with IoT

Yue Zhang, Pennsylvania State University, University Park, PA

We consider a scenario where a 3D printer supplies a critical part to multiple machines that are embedded with sensors and connected through IoT. Our framework can help inform investment decisions regarding IoT/embedded sensors and support the development of scheduling tools for predictive 3D printing.

4 Resale with Non-Fungible Tokens
Yao Cui[1], Jingchen Liu[2], [1]Cornell University, Ithaca, NY, [2]Nanjing University, Nanjing, China
In this paper, we study NFTs as a novel means to facilitate resale. We characterize market conditions for NFTs to create value over traditional resale markets and prescribe how to design NFT features (such as the royalty fee) to maximize its value.

Sunday, October 15, 4:00 PM - 5:15 PM

SE30

CC-North 132C
Technology, Innovation and Entrepreneurship Panel
Panel Session

1 Technology, Innovation and Entrepreneurship Panel
Morvarid Rahmani, Georgia Institute of Technology, Atlanta, GA
We cordially invite you to join our engaging panel discussion on the new MSOM Special Interest Group: Technology, Innovation and Entrepreneurship (TIE). Our distinguished panelists, including journal editors and accomplished researchers, will discuss the profound significance of the TIE SIG for the research community and beyond.
Session Chair: Morvarid Rahmani, Georgia Institute of Technology, Atlanta, GA

2 Panelist
Serguei Netessine, The Wharton School

3 Panelist
Guillaume Roels, INSEAD, Fontainebleau, France

4 Panelist
Stylianos Kavadias, University of Cambridge, Cambrige, United Kingdom

5 **Panelist**
Hau Leung Lee, Stanford University, Stanford, CA

6 **Panelist**
Kamalini Ramdas, London Business School, London, United Kingdom

Sunday, October 15, 4:00 PM - 5:15 PM

SE31

CC-North 221A
OR/MS Applications in Practice - I
Community Committee Choice Session
Session Chair: Mustafa Can Camur, General Electric Research, New York, NY

1 Integrated Production and Buffer Planning Under Demand and Supply Uncertainty in the High-Tech Manufacturing Industry: A Case Study at ASML
Tijn Fleuren, Yasemin Merzifonluoglu, Maarten Hendriks, Renata Sotirov, Tilburg University, Tilburg, Netherlands
This paper proposes an integrated methodology to optimize tactical production planning and strategic buffer placement in high-tech manufacturing supply chains. Long production lead times, component commonality in the network, non-stationary and volatile demand, and supply uncertainty all complicate the decision-making. We introduce a framework that combines a mathematical programming-based rolling horizon procedure to optimize the production planning under uncertainty, and a heuristic approach to search for efficient buffer policies. In this way, we explicitly consider the interplay between optimal production planning and buffer allocation in capacitated systems. In a large-scale case study at our industry partner ASML, we overview current buffer planning practices and provide a comparison study to demonstrate the real-world benefit of our approach.

2 An Optimization Framework for Efficient and Sustainable Logistics Operations via Transportation Mode Optimization and Shipment Consolidation: A Case Study for GE Gas Power
Mustafa Can Camur, General Electric Research, New York, NY, Contact: can.camur@ge.com
GE Gas Power sources parts for its gas & steam turbines from multiple suppliers in Asia. These parts are transported to the USA using multiple modes of transportation including Full Container Load (FCL), Less than Container Load (LCL), and air-transport with varying lead times and costs. We present an optimization model backed by predictive modeling and a novel heuristic approach to develop a parts transportation plan to minimize cost while ensuring that the parts arrive at the destination within their respective deadlines.

3 An Empirical Investigation into the Prevalence and Impacts of Complicating Environmental Factors in Applied Analytical Modeling
Michael Gorman, University of Dayton, Dayton, OH

Previous research (Gorman, 2021) describes ten contextual complications that exist in the application of applying analytical models and how they impact the models and modeling approaches themselves. These complications are pervasive, and because the affect the constructs of the modeler, must be better understood by researchers in order to increase the robustness, appropriateness and usefulness of the models themselves. This research surveys the extent of the presence of these factors and the extent to which they affected modeling efforts in 70 different published applications via an author survey. It finds that the factors are pervasive and their importance to the appropriateness and success of the modeling efforts are high. Further, it finds a strong interaction factor between them. As a result, it would seem that a line of research geared towards identifying and overcoming these factors would aid in the application of analytical models.

4 An Overview of Research Programs to Drive Sustainability, Resiliency and Efficiency in GE Aerospace Enterprise Operations

Banu Gemici-Ozkan, Ph.D., General Electric, Niskayuna, NY

Our team of dedicated researchers brings together diverse expertise that combine physics-based first principals with domain specific business constraints and provide prescriptive decision support for enterprise challenges faced in design, manufacturing and service operations. Common to all these problems is digital twinning approach where structured and unstructured sensor data is fused to extract state information which in turn then integrated with model-based system representations to provide realistic representation of complex systems. Examples of data science, ORMS applications will be shared within three research pillars: 1) multi-tier sourcing for aircraft engine production, 2) engine maintenance and service operations and 3) minimizing climate impact of airline operations.

Sunday, October 15, 4:00 PM - 5:15 PM

SE32

CC-North 221B

Quadratic, Polynomial, and Semidefinite Optimization

Community Committee Choice Session

Session Chair: Boshi Yang, Clemson University, SC
Session Chair: Hao Hu, Clemson University, Clemson, SC

1 Facial Reduction for Semidefinite Relaxations of Combinatorial Optimization Problems

Hao Hu, Boshi Yang, Clemson University, Clemson, SC, Contact: hhu2@clemson.edu

We propose an efficient implementation of FR algorithms for SDP relaxations of combinatorial optimization problems. Our innovative approach is to leverage the combinatorial and the polyhedral structures behind its SDP relaxations. The key idea is that the feasible set of the semidefinite program is a relaxation for the lifted feasible set of the associated problem. Thus, it is possible to connect certain geometric properties between these feasible sets. Our strategy is to derive these relevant properties from the underlying CO problem directly. As a result, this allows us to facially reduce its semidefinite relaxation more efficiently and effectively.

2 Dual Nonnegativity Certificates in Polynomial Optimization

Dávid Papp, Maria M. Davis, North Carolina State University, Raleigh, NC, Contact: dpapp@ncsu.edu

We study the problem of computing optimal sum-of-squares (SOS) lower bounds for positive polynomials over a compact semialgebraic set, circumventing the conventional semidefinite programming reformulation. In the first part of the talk, we introduce the concept of *dual certificates*, which allows us to interpret vectors from the dual of the SOS cone as rigorous nonnegativity certificates. The second part of the talk will feature some algorithmic and theoretical applications, including a simple iterative method for computing the optimal SOS lower bound with a polynomial-time computational cost per iteration and linear rate of convergence, and which can also be turned into an efficient method in exact (rational) arithmetic.

3 Semidefinite Representable Reformulations for Two Variants of the Trust-Region Subproblem

Sarah Kelly, Clemson University, Central, SC

We consider two specific variants of the trust-region subproblem and provide exact semidefinite representable reformulations. The first is over the intersection of two balls; the second is over the intersection of a ball and a special second-order conic representable set. The reformulations obtained are based on partitions of the feasible regions into sub-regions with known lifted convex hulls.

Sunday, October 15, 4:00 PM - 5:15 PM

SE33

CC-North 221C

Advances in Mixed Integer Linear and Nonlinear Programming

Community Committee Choice Session

Session Chair: Jean-Philippe P. Richard, University of Minnesota, Minneapolis, MN

1 Robust Modeling Approach for Effective Multi-Period Fuel Treatment in South-East Australia

Tomas Lagos[1], Nam Ho-Nguyen[2], Dmytro Matsypura[2], Oleg A. Prokopyev[1], [1]University of Pittsburgh, Pittsburgh, PA, [2]The University of Sydney, Sydney, Australia

Wildfires pose grave risks to human life, health, and infrastructure. To address these challenges, proactive fuel treatment strategies are crucial before each fire season. However, managing fuel treatment resources in south-east Australia becomes problematic due to species protection and forest maturity considerations. We extend our previous work and introduce a robust modeling approach for devising multi-year treatment strategies. Our robust mixed-integer optimization model incorporates worst-case scenarios of fuel growth and treatment effects, offering adjustable uncertainty levels.

2 The Terminator: An Integration of Inner and Outer Approximations for Solving Regular and Ambiguous Chance Constrained Programs via Variable Fixing

Nan Jiang, Weijun Xie, Georgia Institute of Technology, Atlanta, GA, Contact: nanjiang@gatech.edu

We present a novel approach to enhance the effectiveness of solving regular and ambiguous chance constrained programs with empirical reference distributions. These programs can be, in general, reformulated as mixed-integer programs (MIPs) by introducing binary variables for each scenario, indicating whether a scenario should be satisfied. While existing methods have focused on either inner or outer approximations, this paper fills this gap by proposing a scheme that effectively combines these approximations via variable fixing. By probing the restricted outer approximations and comparing them with the inner approximations, we derive optimality cuts that significantly reduce the number of binary variables, fixing them to either one or zero. Our numerical results demonstrate the clear advantages of our approach in terms of computational time and solution quality.

3 Matrix Completion over Gf(2)

Akhilesh Soni, Jeffrey T. Linderoth, Jim R. Luedtke, Daniel Pimentel-Alarcon, University of Wisconsin-Madison, Madison, WI, Contact: linderoth@wisc.edu

We discuss integer-programming-based approaches to doing low-rank matrix completion over the finite field of two elements. We are able to derive an explicit description for the convex hull of an individual matrix element in the decomposition, using this as the basis of a new formulation. We also derive valid inequalities involving multiple matrix elements. Computational results showing the superiority of the new formulation over a natural formulation based on McCormick inequalities with integer-valued variables, and an extended disjunctive formulation arising from the parity polytope are given.

4 Variable Selection for Kernel Two-Sample Tests

Jie Wang[1], Santanu Dey[2], Yao Xie[1], [1]Georgia Institute of Technology, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA

We consider the variable selection problem for two-sample tests, aiming to select the most informative variables to distinguish samples from two groups. To solve this problem, we propose a framework based on the kernel maximum mean discrepancy (MMD). Our approach seeks a group of variables with a pre-specified size that maximizes the variance-regularized MMD statistics. This formulation also corresponds to the minimization of asymptotic type-II error while controlling type-I error, as studied in the literature. We present mixed-integer programming formulations and offer exact and approximation algorithms with performance guarantees for linear and quadratic types of kernel functions. Experimental results demonstrate the superior performance of our framework.

5 Convexification Techniques For Logical Implication Constraints Involving Cardinality Requirements

Jean-Philippe P. Richard[1], Mohit Tawarmalani[2], Jinhak Kim[3], [1]University of Minnesota, Minneapolis, MN, [2]Purdue University, West Lafayette, IN, [3]Northern Illinois University, Dekalb, IL

Cardinality requirements and implications between groups of distinct variables are pervasive in applications and are often modeled through the use of integer programming techniques. We describe a general constructive scheme that allows for the convex hull of sets involving logical implication constraints relating the cardinality of groups of variables to be derived in a higher dimensional space. We also discuss aspects of projecting the formulations. We provide simple illustrative applications of the scheme, which subsume existing results in the literature.

Sunday, October 15, 4:00 PM - 5:15 PM

SE34

CC-North 222A

Optimization of Networks' Design, Expansion, and Investment

Community Committee Choice Session

Session Chair: Zhaomiao Guo, University of Central Florida, Orlando, FL

1 Scheduling In Project Networks With Various Resource Types

Nicklas Klein, Mario Gnaegi, Norbert Trautmann, University of Bern, Bern, Switzerland. Contact: norbert.trautmann@unibe.ch

We consider scheduling in a project network, whose nodes correspond to activities which require two types of resources for execution: renewable resources representing, e.g., staff members or equipment; and production and consumption resources representing, e.g., the project budget. We present a mixed-integer linear programming formulation which significantly outperforms state-of-the-art models from the literature.

2 Correspondent Banking Network Optimization

NIMA Safaei, Scotiabank, Toronto, ON, Canada

Correspondent Banking (CB) Network refers to a network of financial institutions providing cross-border payment services for customers through different channels such as SWIFT, Fedwire, etc. We employ the mathematical programming approach in conjunction with the graph theory to optimize a CB network. Optimizing the network requires decisions to be made to onboard, terminate or restrict the bank relationships to optimize the size and overall risk of the network. This study provides theoretical foundation to detect the components, the removal of which does not affect some key properties of the network such as connectivity and diameter. We find that the correspondent banking networks have a feature we call k-accessibility, which helps to drastically reduce the computational burden required for finding the above mentioned components.

3 A Generalized Disjunctive Programming Formulation for Generation and Transmission Expansion Planning

Kyle Skolfield, John Siirola, Sandia National Laboratories, Albuquerque, NM, Contact: kyle.skolfield@asu.edu

Joint generation and transmission expansion planning (GTEP) is a challenging problem to solve, especially at the necessary scales, given its large number of discrete decision variables. The ongoing shift of the national energy system to inverter-based resources (IBRs) including renewables and storage amplifies the difficulty and necessity of solving this difficult problem. Furthermore, these resources are not properly valued in current GTEP formulations. This talk proposes a novel generalized disjunctive programming formulation using the unique capabilities of the Pyomo Python package to solve GTEP while appropriately valuing IBRs. SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525.

4 Information System Design in Transportation Network

Zhaomiao Guo[1], Weijun Xie[2], [1]University of Central Florida, Orlando, FL, [2]Georgia Institute of Technology, Atlanta, GA

Effective information sharing through vehicle-to-infrastructure technologies is a promising approach to improve traffic mobility. While studies have shown the benefits of information sharing, few have investigated the optimal design of information sharing locations over transportation network. To address this issue, we propose a bilevel mathematical model to optimally determine the information sharing locations in the upper level considering the drivers' decentralized routing behavior in response to the information received in the lower level. To solve this bilevel problem, we present a novel value-decomposition algorithm based on cutting plane methods. The proposed model can provide insights for transportation planners to strategically design information sharing locations to minimize network congestion and information infrastructure costs.

5 Convex Hull Pricing in Electricity Markets: Evidence from a Large Us Iso

Panagiotis Andrianesis[1], Dimitris Bertsimas[2], Michael C. Caramanis[1], William W. Hogan[3], [1]Boston University, Boston, MA, [2]Massachusetts Institute of Technology, Cambridge, MA, [3]Harvard University, Belmont, MA, Contact: panosa@bu.edu

We discuss the theory and application of convex hull pricing in non-convex electricity markets. In a recent work, we validated the proof-of-concept of a tractable, highly parallelizable, and exact method for convex hull price computation with guaranteed finite convergence, relying on Dantzig-Wolfe decomposition and Column Generation, and we illustrated how this approach provides intuition on the underlying price formation rationale. In this work, we provide evidence from the application of our method to a large US ISO, accounting for all applicable characteristics of the market participants and a fully granular network model, and we further elaborate on "cheap" performance-boosting techniques.

Sunday, October 15, 4:00 PM - 5:15 PM

SE35

CC-North 222B

First-order Methods for Stochastic Programming

Community Committee Choice Session

Session Chair: Jiaming Liang, Yale University, NEW HAVEN, CT

1 Inexact Bundle Method for Two-Stage Stochastic Programming

Baoyu Zhou[1], Haihao Lu[2], John R. Birge[3], [1]University of Michigan, Ann Arbor, MI, [2]University of Chicago Booth School of Business, Chicago, IL, [3]University of Chicago, Chicago, IL, Contact: zbaoyu@umich.edu

We propose an inexact bundle method for solving two-stage stochastic programming problems that arise from important application areas including revenue management and power system. We consider the setting that it is intractable to compute true objective function and gradient information, and instead only estimates of objective function and gradient values are available. Under common assumptions, the algorithm generates a sequence of iterates converging to a neighborhood of optimality, where the radius of neighborhood depends on the level of inexactness from stochastic objective function estimates. The numerical results demonstrate empirical performance of our proposed algorithm.

2 Asymptotic Normality and Optimality in Nonsmooth Stochastic Approximation

Liwei Jiang[1], Damek Davis[2], Dmitriy Drusvyatskiy[3], [1]Cornell University, Ithaca, NY, [2]Cornell University, ITHACA, NY, [3]University of Washington, Seattle, WA, Contact: lj282@cornell.edu

In their seminal work, Polyak and Juditsky showed that stochastic approximation algorithms enjoy a central limit theorem for solving smooth equations. Moreover, it has since been argued that the asymptotic covariance of the method is best possible among any estimation procedure in a local minimax sense of Hajek and Le Cam. A long-standing open question in this line of work is whether similar guarantees hold for important non-smooth problems, such as stochastic nonlinear programming or stochastic variational inequalities. In this talk, we show that this is indeed the case.

3 Variance Reduction and Low Sample Complexity in Stochastic Optimization via Proximal Point Methods

Jiaming Liang, Yale University, NEW HAVEN, CT

This paper studies novel variance reduction techniques in stochastic convex composite optimization via proximal point methods. It applies those techniques to obtain improved sample complexity in high probability results without assuming the standard light-tail conditions such as sub-Gaussian noise distributions. The paper develops both accelerated and unaccelerated proximal point methods based on the understanding that Nesterov's acceleration method can be regarded as an accelerated version of the proximal bundle method. Another interesting result of the paper is that it establishes the iteration complexity of Nesterov's acceleration method with the restart technique in the deterministic setting.

4 Optimal And Parameter Methods For Gradient Minimization In Convex Optimization

Jimmy Zhang[1,2], Yuyuan Ouyang[3], Guanghui Lan[4], [1]MIT, Boston, MA, [2]Northeastern University, Cambridge, MA, [3]Clemson University, Clemson, SC, [4]Georgia Institute of Technology, Atlanta, GA, Contact: jimmy_zhang@gatech.edu

We introduce novel algorithms for finding solutions with small gradient norms in convex smooth optimization. Our approach guarantees a solution with a small (projected) gradient norm using only $O(1)\sqrt{L/\epsilon}$ gradient evaluations. Our results match the state-of-the-art for unconstrained problems and are new for problems with simple feasible sets, composite functions, or nested functions. Notably, we resolve the open question of optimally solving smooth strongly convex problems in a parameter fashion, without knowing the strong convexity modulus.

Sunday, October 15, 4:00 PM - 5:15 PM

SE36

CC-North 222C

Optimization and Learning Models for Design and Operation of Microgrids

Community Committee Choice Session

Session Chair: Alexander Zolan, National Renewable Energy Laboratory, Austin, TX

1 Nash Bargaining Game for Cooperative and Operational Decisions for Microgrids with Hydrogen Integration Flexibility Options

Yolanda Matamala[1], Kevin Melendez[2], Hadi Charkhgard[3], Felipe A. Feijoo[4], [1]Pontifica Universidad Católica de Valparaíso, Valparaíso, Chile; [2]UNIVERSITY OF SOUTH

FLORIDA, TAMPA, FL, [3]University of South Florida, Tampa, FL, [4]Pontificia Universidad Católica de Valparaíso, Valparaiso, Chile. Contact: yolanda.matamala.a@mail.pucv.cl

Trading of electricity among connected microgrids has the potential to reduce the dependency on the independent system operator, which in turn reduces the use of fossil fuels. In this paper, we study the bargaining among microgrids solution for reducing the dependency on fossil fuels in periods with peak electricity demand. The bargaining game is modeled at the upper level of a Stackelberg model. We modeled an optimal power flow with endogenous prices in the lower level. The computational study on a 14-bus network shows that electricity trading between microgrids increases operational stability while minimizing operational costs. Finally, we showed that this kind of market achieves a fair distribution of the generated profit for all participating microgrids while reducing the network prices.

2 Assessing Fast Charging Station Requirements Under Varying EV Travel Demand and Weather Conditions with Integration of Distributed Energy Resources

Hamid Mozafari[1], Kunle Adeyemo[1], Mehrnaz Ghamami[2], Annick Anctil[1], Ali Zockaie[1], Jessica Crawford[3], [1]Michigan State University, East Lansing, MI, [2]Michigan State University, Okemos, MI, [3]Michigan Department of Environment, Great Lakes, and Energy, Lansing, MI, Contact: mozafar1@msu.edu

The rapid growth of the electric vehicle (EV) market share requires an extensive network of EV direct current fast charging (DCFC) stations and a responsive power distribution system. After simulating the future EV travel and energy demand of Michigan's intercity network, this study developed an optimization approach to find the optimum number and location of required DCFC stations throughout Michigan. Due to the varying travel demand and weather conditions over the seasons, the power demand of each charging station may unpredictably change, which causes problems for both the stations and utility providers. Applying the proposed optimization model, this study finds the optimum capacity of DERs, such as SLBs, in each charging station by integrating EV second-life batteries (SLBs) and other distributed energy resources (DERs) to respond to the uncertain energy demand.

3 Design and Dispatch of a Microgrid with Heterogeneous Heating Loads

Alexander Zolan, National Renewable Energy Laboratory, Austin, TX, Contact: alexander.zolan@nrel.gov

We introduce REOpt, an open-source web tool that obtains cost-minimizing distributed energy resource designs subject to meeting electrical, heating, and cooling loads with or without a utility connection for residential and commercial customers. We present an extension to include multiple heating loads of different quality and demonstrate the impact of this extension on design selection.

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SE37

CC-North 223

Recent Theory and Applications in DRO 1

Community Committee Choice Session

Session Chair: Yiling Zhang, University of Minnesota, Minneapolis, MN

Session Chair: Eojin Han, Southern Methodist University, Dallas, TX

1 Robust Contextual Portfolio Optimization with Gaussian Mixture Models

Yijie Wang[1], Grani Adiwena Hanasusanto[2], Chin Pang Ho[3], [1]The University of Texas at Austin, Austin, TX, [2]University of Illinois Urbana-Champaign, Urbana, IL, [3]City University of Hong Kong, London, United Kingdom

We consider the portfolio optimization problem with contextual information that is available to better quantify and predict the uncertain returns of assets. Motivated by the regime modeling techniques for the finance market, we consider the setting where both the uncertain returns and the contextual information follow a Gaussian mixture distribution. This problem is shown to be equivalent to a nominal portfolio optimization problem where the means and the covariance matrix are adjusted by the contextual information. We further propose the robust contextual portfolio optimization problem to alleviate the sensitivity of model parameters to the given data. Finally, we conduct a numerical experiment in the US equity markets to demonstrate the advantage of our proposed model against other benchmark methods.

2 Distributionally Ambiguous Multistage Stochastic Integer and Disjunctive Programs: Applications to Sequential Two-player Interdiction Games

Sumin Kang[1], Manish Bansal[2], [1]Virginia Tech, Blacksburg, VA, [2]Virginia Tech., Blacksburg, VA, Contact: suminkang@vt.edu

We study the generalizations of multistage stochastic mixed-integer programs (MSIPs) with distributional ambiguity, namely distributionally risk-receptive and risk-averse multistage stochastic mixed-integer programs (denoted by DRR- and DRA-MSIPs). These frameworks have applications in non-cooperative Stackelberg games involving two players, namely a leader and a follower, with uncertainty in the impact of the decisions made by the leader. We present cutting plane-based and reformulation-based approaches for solving DRR- and DRA-MSIPs to optimality. In addition, we introduce multistage stochastic disjunctive programs with(out) distributional ambiguity and present algorithms for solving them. To assess the performance of the algorithms for MSIPs, we consider instances of multistage maximum flow and facility location interdiction problems.

3 A Finitely Convergent Decomposition Algorithm for Distributionally Robust Two-Stage Convex Programming Problem

Fengqiao Luo[1], Shibshankar Dey[1], Sanjay Mehrotra[2], [1]Northwestern University, Evanston, IL, [2]Northwestern University, Evanston, IL, Contact: shibshankardey2025@u.northwestern.edu

We develop a finitely convergent decomposition algorithm for general mixed-integer convex problem applicable to distributionally robust two-stage convex program. This decomposition algorithm separates binary variables from integer and continuous variables, respectively acting as first and second stage variables. A finitely convergent branch-cut-union algorithm is first proposed for the second stage problem leveraging a parametric cut generation oracle. We then generate valid optimality cut using cut-generating-linear-program and show decomposition algorithm's finite convergence. Computational results with Wasserstein ambiguity set shows the superiority of branch-cut-union based decomposition approach compared to its no-cut counterpart, an extension to Luo and Mehrotra [Mathematical Programming 196:673-717, 2022] for convex program setting.

4 K-adaptability In Two-stage Distributionally Robust Optimization: A Primal Perspective For Explainability

Yiling Zhang[1], Eojin Han[2], [1]University of Minnesota, Minneapolis, MN, [2]Southern Methodist University, Dallas, TX, Contact: yiling@umn.edu

In this talk, we investigate the K-adaptability problem for two-stage distributionally robust optimization, which pre-selects K candidate second-stage decisions and then implements the best of them when the uncertainty is revealed. With given candidate policies, we provide an exact conic reformulation from a primal perspective building on characterizing conditional moments of second-order conic representable ambiguity sets. This conic reformulation enables to obtain K-adaptable policies with improved explainability in persistency and objective contribution of each candidate solution. Based on the conic reformulation, we derive an exact mixed-integer bilinear program for K-adaptability problems and a mixed-integer linear program when uncertainties are binary.

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CC-North 224A

Fair Learning and Optimization

Community Committee Choice Session

Session Chair: Qing Ye, Georgia Tech, Atlanta, GA

1 Multistage Fair Classification from Observational Data

Zhuangzhuang Jia[1], Grani Adiwena Hanasusanto[2], Phebe Vayanos[3], Weijun Xie[4], [1]University of Illinois Urbana-Champaign, Champaign, IL, [2]University of Illinois Urbana-Champaign, Urbana, IL, [3]University of Southern California, Los Angeles, CA, [4]Georgia Institute of Technology, Atlanta, GA

We focus on the multistage fair classification problem, which is a common scenario in many relevant applications where there is a predetermined limit or budget on the number of candidates that can be selected at each stage. We propose several optimization models with a fairness constraint that encourages the classifier to be fair in view of the equality of opportunity criterion. To remove the selection bias at each stage, we use the Inverse Probability Weighting method from causal inference. Finally, we provide numerical evidence demonstrating the effectiveness of our proposed approaches in mitigating unfairness on both synthetic and real datasets.

2 Fair Machine Learning in Healthcare

Na Zou, Qizhang Feng, Texas A&M University, College Station, TX

Due to the digitization of healthcare data and advancements in computing power, machine learning methods are increasingly being used in the healthcare domain. However, machine learning methods inherit and even amplify existing health disparity issues, leading to fairness issues such as unequal distribution of healthcare resources or disparity in diagnostic accuracy across demographic groups. In this talk, we bridge the gap between fair machine learning and healthcare disparities by defining the problem of fairness in healthcare, identifying its sources, and categorizing fair machine learning algorithms. Specifically, we provide a comprehensive classification of the fairness measures, introduce the various biases and algorithms. It is concluded by identifying additional challenges and outlining a number of promising new directions.

3 Dr-Fermi: A Stochastic Optimization Framework for Distributionally Robust Fair Empirical Risk Minimization

Sina Baharlouei, Meisam Razaviyayn, University of Southern California, Los Angeles, CA, Contact: baharlou@usc.edu

The majority of the developed fair machine learning algorithms rely on the assumption that the training and test data have similar distributions. In the presence of distribution shifts, fair models may behave unfairly on test data. Further, the proposed mitigation solutions are either designed based on the assumption of having access to the causal graph describing the interaction of different features or knowing the exact type of the distribution shift apriori. This work proposes the first distribution-shift-agnostic fairness framework with convergence guarantees for both full-batch and stochastic first-order optimization methods. The framework is based on a distributionally robust optimization problem under L_p norm uncertainty sets with respect to the Exponential Renyi Mutual Information (ERMI) as the measure of fairness violation.

4 Distributionally Fair Stochastic Optimization Using Wasserstein Distance

Qing Ye[1], Grani Adiwena Hanasusanto[2], Weijun Xie[1], [1]Georgia Institute of Technology, Atlanta, GA, [2]University of Illinois Urbana-Champaign, Urbana, IL

The conventional stochastic program under an empirical population treats each individual equally and optimizes an aggregated objective, which, unfortunately, can be rather unfair when the entire population consists of multiple groups. This paper generalizes the demographic parity fairness notion using Wasserstein distance and proposes a framework that searches for the fairest near-optimal decision. The proposed formulation is proven to be NP-hard in general and shown to be nonconvex. Fortunately, by exploring the properties of Wasserstein distance, we formulate the problem as a mixed-integer program and develop asymptotic optimal lower and upper bounds to generate fair and efficient decisions. The framework can be applied to a range of fair decision-making problems.

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SE39

CC-North 224B

Drone Delivery Operations

Community Committee Choice Session

Session Chair: James Campbell, University of Missouri - St. Louis, Saint Louis, MO

1 Facility Location Decisions for Drone Delivery: A Literature Review

Okan Dukkanci[1], James Campbell[2], Bahar Kara[3], [1]European University Viadrina, Frankfurt (Oder), Germany; [2]University of Missouri - St. Louis, Saint Louis, MO, [3]Ihsan Dogramaci Bilkent University, Ankara, Turkey

This study presents a comprehensive literature survey on facility location problems for drone delivery. The main goals of this review are to identify and categorize fundamental facility location problems associated with drone delivery and to provide a connection between the studies from different research fields that consider similar problems. We first discuss and classify the various types of facilities used for drone and hybrid vehicle-drone delivery systems, including drone bases, charging stations, rendezvous points, and riding points. The literature is then reviewed and categorized based on the types of facilities modeled, the drone operations and the location space. Each category is analyzed in terms of the modeling approach, decisions, objective functions, constraints and additional features. The talk will also present some future research directions.

2 National-Level Vaccine Distribution with Drones: Strategic Locations and Multi-Modal Network Design

Shakiba Enayati, James Campbell, Haitao Li, University of Missouri - Saint Louis, St Louis, MO, Contact: senayati@umsl.edu

This presentation addresses the use of drones to deliver vaccines to hard-to-reach populations using a novel optimization model to strategically design a multimodal vaccine distribution network. Our research incorporates multiple drone types, recharging of drones, a cold chain travel time limit, transshipment delays for switching transport modes, and practical limits on the vaccine paths and drone trips. The goal is to locate facilities (distribution centers, drone bases, and relay stations) and design vaccine paths to minimize transportation costs, including the fixed costs for facilities and transportation links and variable costs for transportation through the network. Results are shown for a case study of childhood vaccine delivery in Vanuatu, a South Pacific Island nation.

3 Local Vaccine Delivery with Drones: Multi-Modal and Hierarchical Network Design and Routing

Bahar Kara[1], Meltem Peker[2], Shakiba Enayati[3], James Campbell[4], Haitao Li[4], [1]Ihsan Dogramaci Bilkent University, Ankara, Turkey; [2]Bilkent University, Ankara, Turkey; [3]University of Missouri - Saint Louis, St Louis, MO, [4]University of Missouri - St. Louis, Saint Louis, MO, Contact: bkara@bilkent.edu.tr

This study addresses vaccine delivery within one health zone for hard-to-reach regions. This requires simultaneously determining the location of facilities (distribution centers, permanent clinics and drone bases) and hierarchical vaccine delivery routes from distribution centers to remote clinics. We consider drones as part of a multimodal transport system that must coordinate with the outreach trips of healthcare workers. The goal is to minimize the total transportation costs including the fixed costs and variable costs for transportation through the network. The model incorporates limits for the cold chain and drone ranges. We show results for a case study of distributing childhood vaccines in Vanuatu, a South Pacific Island nation.

4 Applications and Research Avenues for Drone-Based Models in Post-Disaster Response Logistics

Trilce Encarnacion[1], Diana Gineth Ramirez-Rios[2], [1]University of Missouri- St. Louis, Saint Louis, MO, [2]University at Buffalo, Buffalo, NY, Contact: tencarnacion@umsl.edu

Disaster response efforts operate under conditions characterized by significant disruptions to transportation infrastructure. The lack of ground transportation access to impacted areas presents a challenge that drones could address. In this research, we survey the literature to identify potential research directions of drone-based logistics that can address the challenges brought on by disasters, focusing on the critical emergency support functions that can benefit from these new technologies. This presentation provides a starting point for researchers interested in developing OR/MS models to address these challenges.

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CC-North 225A

Large-scale Data Analytics for Transportation Systems - Session I

Community Committee Choice Session

Session Chair: Sean Z. Qian, Carnegie Mellon University, Pittsburgh, PA

1 On Drivers' Routing Behavior Under Incidents: Fusing System-Level and Individual-Level Data in Networks

Haocheng Duan, Sean Z. Qian, Carnegie Mellon University, Pittsburgh, PA, Contact: haocheng@andrew.cmu.edu

Understanding drivers' re-routing behavior under incidents is crucial when predicting incident impacts on the large-scale network. This research proposes a data-driven approach leveraging data from roads, incidents, and GPS traces of probe vehicles. The route choice model under incidents is first validated and tested in a small synthesized network. It is then applied to learn drivers' re-routing choices in the real-world using data collected in the Washington DC region in 2020.

2 A Physics-regularized, Multi-task Gaussian Process With Multiple Kernel Learning To Uncover Mobile Data Generation Processes

Ekin Ugurel, Shuai Huang, Cynthia Chen, University of Washington, Seattle, WA, Contact: ugurel@uw.edu

Passively-generated mobile data has grown increasingly popular in the travel behavior (or human mobility) literature. We propose a novel generative machine learning framework to model individual mobile data using multi-task Gaussian processes (GP). Since data generation processes of such datasets are highly heterogeneous, we further propose a data-driven multiple kernel learning approach to determine the optimal composite kernel for each individual. Finally, we augment our approach using physics-based information such as average segment speeds and directions to reduce variance and bias in model estimation. Our numerical results demonstrate the potential of the proposed framework to uncover individual mobile data generation patterns.

3 Tfs-Dgan: Multi-View Temporal Factorizations-Based Dynamic Adaptive Generative Adversarial Networks for Hybrid Recovery of Missing Traffic Data

Zilin Huang[1], Jinlong Li[2], Lunhui Xu[2], Sikai Chen[1], [1]University of Wisconsin-Madison, Madison, WI, [2]South China University of Technology, Guangzhou, China. Contact: zilin.huang@wisc.edu

Recovering missing traffic data is crucial for intelligent transportation systems. However, current methods often fail to fully capture complex spatio-temporal correlations, which leads to suboptimal results. In this research, we introduce a novel hybrid framework, TFs-DGAN, that combines dynamic adaptive generative adversarial networks (DA-GAN) with multi-view temporal factorizations (TFs) to effectively impute missing data by modeling these correlations. The proposed

TFs-DGAN integrates all stage-optimized residuals through local feedback, ultimately yielding the best data repair results. By utilizing DA-GAN for data generation and TFs to refine temporal properties, our method significantly outperforms state-of-the-art baseline models in terms of accuracy, stability, and efficiency, based on tests with two publicly available traffic datasets.

4 Data-driven Quantification Of The Resilience Of Enforcement Policies On Transportation Systems: A Comparative Study Of Two Major Winter Storms In Buffalo, New York

Eren Kaval[1], Zilin Bian[2], Kaan Ozbay[2], [1]New York University, Brooklyn, NY, [2]New York University, Brooklyn, NY, Contact: ek3433@nyu.edu

Understanding traveler policy compliance is significant, especially in emergency disaster instances, where enforcement policies can impact the safety of the public. This study aims to investigate the regulation power policies retain during disruptive and deadly winter storms. A comparative study using the disruptive events of November and December 2022 blizzards in Buffalo is conducted. A novel concept in the field of policy research, LoR_p (Loss of Resilience of Policy) inspired by evacuation studies, is introduced to describe how the power of an enforcement policy evolves between the time it is issued and lifted. Results are analyzed using a change detection and spatial modeling framework on a neighborhood level to associate LoR_p with spatial and socioeconomic variables, understand their effects on LoR_p and study the factors affecting resilience of various policies.

5 Dynamic Routing Games for Connected and Autonomous Vehicles with Traffic Congestion: A Mean Field Game Approach

Eunhan Ka, Satish V. Ukkusuri, Purdue University, West Lafayette, IN, Contact: kae@purdue.edu

Large urban areas struggle with severe traffic congestion. Connected and Autonomous Vehicles (CAVs) can alleviate traffic congestion via road efficiency improvements. However, simulating traffic dynamics through dynamic routing games encounters scalability hurdles, warranting a Mean Field Game (MFG) approach. This study presents an MFG method for multi-player dynamic routing involving CAVs, addressing scalability issues and integrating game theory. We evaluate the proposed method on the Sioux Falls network and perform a sensitivity analysis for CAV penetration rates. The results show that CAVs effectively reduce network travel costs and impact routing decisions, resulting in alleviated congestion. Furthermore, as CAV penetration rates rise, the mean-field equilibrium policy converges toward the Nash equilibrium policy of the MFG.

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On-Demand Urban Logistics

Community Committee Choice Session

Session Chair: Zhengtian Xu, The George Washington University, Washington

Session Chair: Kenan Zhang, ETH Zurich, Zurich, Switzerland

1 Modeling and Managing an On-Demand Meal Delivery System

Anke Ye[1], Kenan Zhang[2], Xiqun Chen[1], Michael G.H. Bell[3], Simon Hu[1], [1]Zhejiang University, Hangzhou, China; [2]ETH Zurich, Zurich, Switzerland; [3]the University of Sydney, Sydney, Australia. Contact: ankeye@intl.zju.edu.cn

This paper proposes a theoretical framework to characterize an on-demand meal delivery (ODMD) system featured by bundling delivery and sharing couriers among restaurants. This framework makes the first attempt to allow bundling delivery for more than two orders among multiple restaurants in market analysis. It provides managerial insights for the stakeholders in the system. The developed model consists of a physical model describing the delivery process for bundled orders and an aggregated market model characterizing the demand and supply equilibrium. Analysis and numerical experiments are conducted to examine the market equilibrium characteristics and evaluate the performance of the ODMD system under the platform's maximum profit policy.

2 Exploiting Modularity in Co-Modal Passenger-Freight Transportation: A Market-Driven Approach

Hongyu Zheng[1], Jiayang Li[1], Jane Lin[2], Marco Nie[1], [1]Northwestern University, Evanston, IL, [2]University of Illinois-Chicago, Chicago, IL, Contact: hongyuzheng2024@u.northwestern.edu

Co-modal passenger-freight transportation refers to sharing infrastructure/capacity between passenger and freight transportation systems that may be independently owned and operated. This paper proposes a market-driven approach to co-modality that takes advantage of the autonomous modular vehicle (AMV) technology. As AMVs can easily join to form a train, transit operators can utilize them as buses with dynamically adjustable capacity. This flexibility allows the operator to efficiently address temporal demand variations using heterogeneous fleets. Meanwhile, the operator can gain revenue by renting spare AMVs to a freight carrier to supplement last-mile delivery operations during the off-peak period. Our goal is to understand the various trade-offs in such a system and analyze the optimal strategies for all participants under different market mechanisms.

3 Dynamic Order Fulfillment in Autonomous Last-Mile Delivery with Demand Uncertainty

Linxuan Shi, Zhengtian Xu, Miguel Lejeune, The George Washington University, Washington, DC, Contact: shilx@gwu.edu

The logistics industry has eyed on autonomous solutions, such as delivery robots and drones, as a promising future for last-mile delivery. For the problem we picture, a fleet of automated delivery vehicles is deployed for fulfilling the delivery requests that arrive with stochastic time, location, and urgency. Given an operational context with discrete delivery waves, we adopt a Model Predictive Control (MPC) framework to address the dynamic order fulfillment in a rolling horizon. A two-stage stochastic program is formulated to minimize the total expected delays and energy consumption, and an integer L-shaped method is adapted for efficient solutions.

4 Deep Reinforcement Learning to Assess the Potential Gains of Cooperating with Competitors in Meal Delivery Markets

Azadeh Gharibreza Yazdi, Vadim Sokolov, Elise Miller-Hooks, George Mason University, Fairfax, VA

This talk presents a job assignment algorithm using multi-agent deep reinforcement learning (MDRL) concepts for assessing the possible gains that can be obtained from a meal delivery company (MDC) from cooperating with competitors. The potential gains are assessed on numerical examples in a simulated environment built on data from real-world operations.

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CC-North 226A

Data Science and Machine Learning Applications

Community Committee Choice Session

Session Chair: Maryam Jafaripakzad, 1</sup

1 Enhancing Open-World Recognition: An Innovative Framework for Robust Detection of Unknown Instances

Mohammad Noroozi, Ankit Shah, University of South Florida, Tampa, FL, Contact: mnoroozi@usf.edu

Our talk focuses on open-world object recognition, examining in and out-of-distribution instances. We propose an innovative framework integrating image processing, generative adversarial network-based data augmentation techniques, and object detection models. Facilitating automated annotation and enhancing dataset diversity, our approach ensures reliable object detection performance. Rigorous experiments validate accurate detection, advancing the field and providing insights for diverse domains.

2 A Multi-Agent Reinforcement Learning Approach to Identify Optimal Intervention Options for 'Ending the HIV Epidemic'

Dinesh Sharma[1], Ankit Shah[1], Chaitra Gopalappa[2], [1]University of South Florida, Tampa, FL, [2]University of Massachusetts, Amherst, Amherst, MA

The U.S. government's 'Ending the HIV Epidemic' initiative aims to reduce HIV incidence by 90% by 2030. A significant challenge in identifying an optimal intervention policy to achieve this goal is that, because of disparities in infections across geography, one policy is not suitable for all, but because of geographical dynamics of infection spread, analyses to identify optimal policies cannot be conducted independent to each jurisdiction. To address this, we propose a multi-agent reinforcement learning framework that identifies jurisdiction-specific optimal policies, using an environment that simulates a national population as a composition of 96 interacting sub-jurisdictions. We evaluate alternative objective functions, minimizing costs and disease burden, and minimizing disease burden.

3 Predictive Models for ICU Admission Classification and Length of Stay Forecasting: Methodological Exploration and Feature Engineering in Healthcare Analytics

Maryam Jafaripakzad[1], Jorge Andrés Acuna[2], Jose L. Zayas-Castro[2], [1]University of South Florida, Tampa, FL, [2]University of South Florida, Tampa, FL, Contact: maryamjafaripakzad@usf.edu

This study follows a sequential prognostic approach to classify patients' hospital length of stay. For this purpose, we examine the impact of incorporating new features from two classifiers in two steps. We conducted a sensitivity analysis to determine the appropriate specifications for incorporating new features into each sequence classifier training, enhancing accuracy at each step. Moreover, we assessed the impact of diverse feature engineering and model training techniques to optimize our approach. These findings hold promising implications for refining patient management strategies and optimizing resource allocation in healthcare.

4 The Skill-Fit Model: Utilizing Skills to Advance Machine Learning Based Job Recommendation Systems

Alon Atzil[1], Hila Chalutz-Ben Gal[2], [1]Tel Aviv University, Tel Aviv, Israel; [2]Tel Aviv University, Tel Aviv, Israel

The growing practice of utilizing Machine Learning based Job recommendation systems (JRS) has become a major component in talent management. However, recent disruptions in the labor force (e.g. flexible work, freelancing, gig work) result in the need to adopt a Skill-Fit Model. For this purpose, we present an analysis of the ML based JRS literature and propose a synthesized approach to analyze and model skills. Our results indicate that some JRS features may benefit from the Skill-Fit Model thus may be adopted by ML-enabled JRS in order to achieve improved performance. This study contributes to the understanding and systematically developing skills - based JRS to support the new world of work.

5 Comparison Of Object Detection Methods Under Different Weather Conditions Using Multimodal Data

Mehrsa Mashhadi[1], Nicolas Bustos[2], Susana Lai-Yuen[1], Sudeep Sarkar[1], Tapas K. Das[1], [1]University of South Florida, Tampa, FL, [2]University of South Florida, TAMPA, FL, Contact: mehrsamashhadi@usf.edu

Thermal images are increasingly being used to complement visible images and to improve the performance of object detection models. While visible images provide detailed scene information, thermal images capture temperature information and are less affected by lighting conditions. However, adverse weather can affect object detection and current approaches lack uniform evaluation due to the use of different private datasets. In this work, we evaluate two object detection methods, YOLOv7 and Vision Transformers, on a publicly available multimodal dataset and under different weather conditions. The aim is to provide insights to assist in the design of more robust object detection methods under adverse weather conditions.

6 Wireless Signal Prediction Using Deep Learning Models

Abdullah Konak[1], Michael Bartolacci[2], Simon Delattre[3], [1]Penn State Berks, Reading, PA, [2]Penn State Berks, Bethlehem, PA, [3]Penn State, State College, PA, Contact: konak@psu.edu

Modeling wireless signal coverage in areas where measurements are difficult to record can be daunting. We utilized a deep autoregressive model and a convolutional neural network model trained on a synthetic floor plan dataset to accurately extrapolate signal coverage across such spaces without using specific information about antennae placements or floor plan designs.

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CC-North 226B

Data-driven Methods for Analyzing the Terminal Airspace

Community Committee Choice Session

Session Chair: Go Nam Lui, 1</sup

1 Vision-Based Decision Support for Improved Situational Awareness in General Aviation

Rahul Rathnakumar, Yongming Liu, Arizona State University, Tempe, AZ, Contact: rrathnak@asu.edu

Commercial aviation safety has seen remarkable progress thanks to improvements in Air Traffic Management technology and stringent regulations. These developments have resulted in safety standards that surpass those in General Aviation (GA) operations. In this work, we propose a novel data-driven decision support system to improve GA pilot situational awareness. Specifically, we leverage image data along with weather decriptors to build an uncertainty-aware neural network model to detect potential weather threats that can lead to a loss of situational awareness. The proposed model is compared against multiple baselines, showing some interesting benefits that adding additional contextual data brings to predictive performance. Finally, this work highlights some key challenges that models need to address to provide reliable decision support for GA pilots.

2 Data-Driven Environmental Assessment for Airport Operation Inside Terminal Airspace

Go Nam Lui[1], Dajung Kim[1], Kai Kwong Hon[2], Rhea Patricia Liem[1], [1]The Hong Kong University of Science and Technology, Sai Kung, Hong Kong; [2]Hong Kong Observatory, Tsim Sha Tsui, Hong Kong. Contact: gnlui@connect.ust.hk

This work proposes a data-driven approach to derive environmental assessment metrics for airport operations within terminal airspace. We incorporate flight information, flight trajectory, and weather data to quantify the fuel consumption status, noise pollution status, and adverse weather resilience for an individual airport. With the application of data-driven methodologies including Bayesian hierarchical model, we develop interpretable metrics to evaluate airport operations and identify opportunities for sustainable improvements. The proposed metrics can inform decision-making and promote a more advanced sustainable assessment of airport operations within terminal airspace.

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CC-North 226C

AI in Supply Chain Management

Community Committee Choice Session

Session Chair: Huihui Chi, EM Lyon, Écully, France
Session Chair: Haipeng Chen, William & Mary, Williamsburg, VA

1 Collective Learning: Resolving AI Explainability and Supply-Side Asymmetries in Airbnb Hosting

Rodreck David[1], Fatemeh Saadatmand[2], Shiyuan Liu[3], [1]EMLYON Business School, Lyon, France; [2]IT University of Copenhagen, Copenhagen, Denmark; [3]Stockholm School of Economics, Stockholm, Sweden. Contact: rdavid@em-lyon.com

As a digital platform that connects hosts and guests for short-term rental housing, Airbnb relies on AI algorithms to match various supply and demand parameters. This ‘matching’ process is highly driven by algorithms that are often opaque, making it challenging for hosts to navigate the asymmetries created by them. Using advanced text analyses, this study examined over 6 years of Airbnb hosts’ forum activity data with a temporal bracketing of key events. The analysis reveals that, through collective learning, hosts gain insights into the intricate mechanisms of Airbnb’s algorithms and fine-tune their listings to enhance their visibility, pricing, guest preferences, etc. The findings underscore the significance of collective learning in enhancing AI explainability and mitigating supply-side asymmetries associated with “black box” algorithms.

2 Models and Algorithms for a Dynamic Multi-Trip Vehicle Routing Problem with Time Windows

Xukun Qin[1], Hui Li[1], Zhiya Zuo[2], Xi Wang[1], [1]Central University of Finance and Economics, Beijing, China; [2]City University of Hong Kong, Kowloon Tong, China. Contact: 2022212400@email.cufe.edu.cn

Reinforcement learning (RL) has been studied in the field of information systems and proposed in public administration related to pandemic control. However, policymakers have been hesitant due to concerns such as reliability and ethical implications. Drawing on the AI trust theory, this study aims to address this dilemma by proposing a framework for designing a trustworthy RL-based policy support system. Through a design science approach, specific components, such as multi and guided rewards are introduced to enhance people’s trust in building the IT artifact. The findings will shed light on the complex interrelationships between public internal change, pandemic status, and government protest policy in the context of a public health crisis, which will contribute to greater transparency and accountability in the design of RL-based AI systems.

3 Recommendation System with Delay Option: Should Retailerrecommend Out-Of-Stock Products?

Huihui Chi[1], Wei Zhou[2], Howard Zhong[2], [1]EM Lyon, Écully, France; [2]ESCP Business School, Paris, France

When shortage happens, recommending out of stock products to consumers seems inappropriate and meaningless intuitively. However, the stockout message also reveals the products’ popularity and the customers’ strong desire in placing orders. Therefore, in this paper, we develop a newsvendor model for multi-products with different replenishment periods. A recommendation algorithm is embedded to adjust the demand in the model. First, we consider the option of substitution for out-of-stock products. Alternatively, as a second option, we add the substitution option as well as the waiting option for out-of-stock products. For evaluation, we test our model with by combining simulation and a dataset collected from a British store. Our preliminary results demonstrate that the addition of waiting option in recommendation strategy yields higher profits and is favored.

4 Dynamic Feature-Based Newsvendor

Zexing Xu[1], Ziyi Chen[2], Xin Chen[3], [1]University of Illinois Urbana-Champaign, Champaign, IL, [2]University of Utah, Salt Lake City, UT, [3]Georgia Institute of Technology, Atlanta, GA, Contact: zexingx2@illinois.edu

In this paper, we investigate the dynamic feature-based newsvendor problem within a multi-period inventory control setting featuring backlogged demands. Highlighting the significance of feature information and a multi-stage decision-making framework, we introduce novel algorithms and techniques to tackle the problem’s challenges. The proposed Contextual Value Iteration (CVI) algorithm exhibits efficacy across diverse scenarios, supported by performance analysis, including generalization bounds and sample complexity, as well as numerical experiments.

5 Complex Contagion Influence Maximization: A Reinforcement Learning Approach

Haipeng Chen[1], Bryan Wilder[2], Wei Qiu[3], Bo An[3], Eric Rice[4], Milind Tambe[5], [1]William & Mary, Williamsburg, VA, [2]Harvard University, Los Angeles, CA, [3]Nanyang Technological University, Singapore, Singapore; [4]University of Southern California, Los Angeles, CA, [5]Harvard University, Cambridge, MA, Contact: hchen23@wm.edu

Influence maximization (IM) aims to find a set of seed nodes in a social network that maximizes the influence spread. While most IM problems focus on classical influence cascades which assume that individual influence cascade probability is independent of the number of neighbors, recent studies show that many influence cascades follow a pattern called complex contagion (CC), where cascade probability is much higher when more neighbors are influenced. Nonetheless, there are very limited studies on complex contagion influence maximization (CCIM). This is partly because CC is non-submodular, the solution of which has been an open challenge. We propose the first reinforcement learning (RL) approach to CCIM that uses the CCIM problem structure. Empirical results show that our approach achieves state-of-the-art performance on 9 real-world networks.

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CC-North 227A

Machine Learning and Optimization in Power Systems

Community Committee Choice Session

Session Chair: Tanneau Mathieu, Georgia Tech

Session Chair: Pascal Van Hentenryck, ISyE Georgia Tech, Atlanta, GA

1 End-To-End Feasible Optimization Proxies for Large-Scale Economic Dispatch

Wenbo Chen[1], Mathieu Tanneau[1], Pascal Van Hentenryck[2], [1]Georgia Tech, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA, Contact: wchen616@gatech.edu

The paper proposes a novel End-to-End Learning and Repair (E2ELR) architecture for training optimization proxies for economic dispatch problems. E2ELR combines deep neural networks with closed-form, differentiable repair layers, thereby integrating learning and feasibility in an end-to-end fashion. E2ELR is also trained with self-supervised learning, removing the need for labeled data and the solving of numerous optimization problems offline. E2ELR is evaluated on industry-size power grids with tens of thousands of buses using an economic dispatch that co-optimizes energy and reserves. The results demonstrate that the self-supervised E2ELR achieves state-of-the-art performance, with optimality gaps that outperform other baselines by at least an order of magnitude.

2 Multiperiod Stochastic Security-Constrained Economic Dispatch: A Systematic Study

Haoruo Zhao, Mathieu Tanneau, Pascal Van Hentenryck, Georgia Institute of Technology, Atlanta, GA, Contact: hzhao306@gatech.edu

US Independent System Operators co-optimize energy and reserve dispatches every five minutes to minimize operating costs while meeting physical and regulatory constraints. However, due to the growing penetration of renewable energy generation, the current single-period, deterministic, security-constrained economic dispatch (SCED) formulations struggle to manage operational uncertainty effectively. This project proposes a multi-period stochastic look-ahead (SLAD) formulation to explicitly consider uncertainty in real-time markets. An accelerated Benders' decomposition is utilized to solve the formulation efficiently. The approach is evaluated on an industry-size transmission grid, and the numerical results demonstrate that SLAD significantly improves reliability and reduces costs, saving approximately 2% on high net load days compared to SCED.

3 Bucketized Active Sampling for Acopf Optimization Proxies

Michael Klamkin, Georgia Tech, Atlanta, GA, Contact: klam@isye.gatech.edu

This paper considers optimization proxies for Optimal Power Flow (OPF), i.e., machine-learning models that approximate the input/output relationship of OPF. Their training requires significant data, each instance necessitating the (offline) solving of an OPF. To meet market-clearing requirements, this paper proposes Bucketized Active Sampling (BAS), a novel active learning framework that aims at training the best OPF proxy within a time limit. BAS partitions the input distribution and uses an acquisition function to determine where to sample. Numerical experiments are conducted on large power grids, benchmarking different BAS strategies against classical approaches wherein training data is generated offline. Overall, BAS achieves the same or better accuracy but does so in half the compute time.

4 Online Risk Assessment with Optimization Proxies

Mathieu Tanneau[1], Pascal Van Hentenryck[2], [1]Georgia Tech, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA

The increased penetration of renewable energy and distributed energy resources is fueling an increase in operational uncertainty in modern power grids.To manage this uncertainty, grid operators must continuously monitor and manage risk. This, in turn, requires tools that can quantify risk in a real-time fashion.

This talk presents how optimization proxies, i.e., machine learning models that approximate the input-output mapping of an optimization problem, offer a scalable tool for real-time risk assessment. Numerical results on an industry-size system will be presented.

Sunday, October 15, 4:00 PM - 5:15 PM

SE46

CC-North 227B

Data-Driven Innovations in OR Education

Community Committee Choice Session

Session Chair: Jeroen Belien, KU Leuven, Brussel, Belgium

Session Chair: Thomas A. Grossman, University of San Francisco, San Francisco, CA

1 Prescriptive Analytics in the Data Analysis Pipeline

Alice Paul, Brown University, Providence, RI

Practical Data Analysis is a required course for Biostatistics Masters and PhD students. Last year, the course focused around a semester-long project on foodborne illness in collaboration with a Co-Chair of the Healthy People 2030 Foodborne Illness Reduction Committee. The project goal was to use insights from a national foodborne pathogens database to help drive action on foodborne illness prevention. A key challenge of this project was shifting the student perspective to a prescriptive one: needing to frame their analyses to help make data-driven decisions. I'll talk about how using large, messy data helped to drive home the course concepts and give lessons learned in integrating project-based learning and prescriptive analytics into a data science course.

2 Using an Excel Error as a Teaching Tool

Eric Logan Huggins[1], Ivan G. Guardiola[2], [1]Fort Lewis College, Durango, CO, [2]Fort Lewis College, Durango, CO, Contact: huggins_e@fortlewis.edu

Performing linear regression in Microsoft Excel is relatively easy and fast. The software calculates the slope, y-intercept and coefficient of determination (r^2) and creates a graph of the data and best-fitting line automatically. An option exists to force the y-intercept to zero, which makes sense in some cases, but the resulting output is glaringly wrong - the r^2 value is incorrect, tending to increase even though the line is a worse fit! One of our students discovered this in class, boldly questioning the accuracy of MS Excel output. We discuss what the error is, how to fix it, and how to use this error as a teaching tool in two ways: first, that students should always double check results from any software and second, as a means to better explain what correlation is and how to calculate it.

3 Gilp: An Interactive Tool for Visualizing the Simplex Algorithm

Henry W. Robbins[1], David B. Shmoys[2], Samuel Gutekunst[3], David P. Williamson[2], [1]Uber, New York, NY, [2]Cornell University, Ithaca, NY, [3]Bucknell University, Weston, CT, Contact: hwr26@cornell.edu

The Simplex algorithm is a fundamental topic in many Operations Research courses. While it relies on intuitive geometric ideas, the computationally-involved mechanics of the algorithm can obfuscate a geometric understanding. Here, we present gilp, an easy-to-use Simplex algorithm visualization tool designed to explicitly connect the mechanical steps of the algorithm with their geometric interpretation. We provide an extensive library with example visualizations, and our tool allows an instructor to quickly produce custom interactive HTML files for students to experiment with the algorithm (without requiring students to install anything!). The tool can also be used for interactive assignments in Jupyter notebooks, and has been incorporated into a forthcoming Data Science and Decision Making interactive textbook.

4 The Flair Game: Teaching Newsvendor and Inventory Pooling in One Classroom Session

Jeroen Beliën[1], Stefan Creemers[2], [1]KU Leuven, Brussel, Belgium; [2]IESEG, Aarschot, Belgium. Contact: jeroen.belien@kuleuven.be

We present the Flair game: an Excel-driven classroom game for teaching the concepts of newsvendor and inventory pooling in one 2-hour class. The game stimulates active participation and peer learning through a competitive setting with a dynamic team size formation. Since 2016, the game has been used successfully for a wide range of education: from undergraduate to executive teaching.

5 Moneyball for Murderball: A Teaching Case on Using Analytics to Construct Lineups in Wheelchair Rugby

Timothy Chan[1], Craig Fernandes[1], Albert Loa[1], Nate Sandholtz[2], [1]University of Toronto, Toronto, ON, Canada; [2]Brigham Young University, Provo, UT, Contact: nsandholtz@stat.byu.edu

Motivated by the problem of lineup optimization in wheelchair rugby (WCR), this case covers descriptive, predictive and prescriptive analytics. The case is presented from the perspective of a new assistant coach of Canada's national WCR team, who has been tasked by the head coach to use analytics to improve their lineups. While the data and actors are fictitious, they are based on real data and discussions with the national team coach and sport scientists. To solve the case, students must conduct data wrangling, regression modeling, and optimization modeling. These three steps are tightly linked, as the data wrangling is needed to prepare the data for regression, and the regression outputs are used as parameters in the optimization. As such, students build proficiency in developing an end-to-end solution approach for a complex real-world problem.

Sunday, October 15, 4:00 PM - 5:15 PM

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CC-North 227C

Computational Methods for Uncertainty Quantification I/II

Community Committee Choice Session

Session Chair: Moses Chan, Northwestern University, Evanston, IL

1 Bayesian Model Mixing Of Computer Simulators

John Yannotty[1], Thomas Santner[2], Richard Furnstahl[1], Matthew Pratola[3], [1]The Ohio State University, Columbus, OH, [2]Ohio State University, Columbus, OH, [3]The Ohio State University, New Albany, OH, Contact: yannotty.1@buckeyemail.osu.edu

Multiple computer simulators are often used to study complex physical systems. Each simulator may have varying accuracy across the input domain. One strategy is to mix the predictions from the simulators using a linear combination with input-dependent weights. Recent work focused on mixing EFT Nuclear Physics models using weight functions modeled by Bayesian Additive Regression Trees (BART). In this work, we propose a tree-based model for mixing arbitrary simulators. One limitation of the BART-based weight functions was their piecewise constant form. We incorporate probabilistic path assignments which leads to smooth predictions of the weight functions and physical system, while also achieving more appropriate uncertainty quantification, all in a matrix-free formulation. The methodology is demonstrated on motivating Nuclear Physics and Climate problems.

2 Online Nonparametric Surrogate Models for Scientific Computation

Hengrui Luo, Lawrence Berkeley National Laboratory, Berkeley, CA

Online surrogate modeling, where the observed dataset keeps accumulating, is becoming an increasingly important topic in statistics, mathematics, and data science research. In this seminar talk, we will introduce the Gaussian process (GP) regression, and how we can use it as a Bayes online nonparametric surrogate to approximate the "black-box performance function" arising in scientific computation. Using the Gaussian process model, we will illustrate several novel research projects inspired by related scientific computation applications. In particular, we will discuss extensions of surrogate models when there exists discontinuous responses (motivated by exascale computing) and structured variables (motivated by functional data simulation). We will also point out several ongoing theoretical and applied challenges when working with online surrogates.

3 Uncertainty Quantification for Bayesian Optimization

Rui Tuo[1], Wenjia Wang[2], [1]Texas A & M University, College Station, TX, [2]Hong Kong University of Science and Technology (Guangzhou), GuangZhou, China

Bayesian optimization is a class of global optimization techniques. It regards the underlying objective function as a realization of a Gaussian process. Although the outputs of Bayesian optimization are random according to the Gaussian process assumption, quantification of this uncertainty is rarely studied in the literature. In this work, we propose a novel approach to assess the output uncertainty of Bayesian optimization algorithms, in terms of constructing confidence regions of the maximum point or value of the objective function. These regions can be computed efficiently, and their confidence levels are guaranteed by newly developed uniform error bounds for sequential Gaussian process regression. Our theory provides a unified uncertainty quantification framework for all existing sequential sampling policies and stopping criteria.

4 Simulation Surrogate for Stochastic High-Dimensional Outputs with Heterogeneous Error

Moses Chan, Matthew Plumlee, Northwestern University,

Evanston, IL, Contact: mosesyhc@u.northwestern.edu
Gaussian processes are a popular surrogate choice in place of an expensive simulation model. Many modern simulation models are stochastic, for example agent-based models, meaning that a different output is returned each time (even) at the same input. In the case of a simulation output that is high-dimensional with potentially heterogeneous error structure, approximations are often the method researchers resort to, due to the exploding computational cost associated with the large covariance matrix. We propose a novel Gaussian process model that allows a rich representation of the covariance matrix and offers exact while efficient inference.

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CC-North 228A

Structured Data Analysis in Healthcare Applications

Community Committee Choice Session

Session Chair: Xin Zan, University of Florida, GAINESVILLE, FL
Session Chair: Xiaochen Xian, University of Florida, GAINESVILLE, FL

1 Scalable Dependent Dirichlet Process Mixture Model via Parallel Mcmc

Ning Dong, Dongping Du, Texas Tech University, Lubbock, TX, Contact: ndong@ttu.edu
Bayesian nonparametric methods such as the Dirichlet Process Mixture Model (DPMM) have been widely used in survival analysis. A compelling challenge for solving Bayesian nonparametric models is the high computational cost, especially when dealing with large datasets and high-dimensional parameter spaces. Parallel MCMC algorithms have been developed to speed up the computation. However, none of them applies to the posterior inference in DPMM. This study develops a scalable DPMM via parallel MCMC, which divides the massive data set into small subsets and aggregates the subsets' posteriors to approximate the true posterior. The DPMM generates discrete posteriors that allow aggregation without sampling to minimize information loss. The model is validated by simulation studies and a medical dataset, which shows good computational efficiency and accuracy.

2 Concurrent Data Assimilation for Model-Guided Learning of Cardiac Potassium Channel Activities

Haedong Kim, The Pennsylvania State University, University Park, PA, Contact: huk344@psu.edu
Potassium channels (K_v) play critical roles in the cardiac conduction system. Although there are various K_v isoforms, only the sum of their activities can be measured in the form of currents (I_{Ksum}). Most existing studies estimate K_v kinetics via curve-fitting procedures, but are limited because: 1) curve-fitting decomposition only relies on the shape of current traces, which does not discern the underlying kinetics and interactions of K_v isoforms; 2) I_{Ksum} traces only be fitted for one clamp voltage at each time. Here, we develop a novel concurrent data assimilation method that calibrates computer models to decompose and delineate kinetics of K_v isoforms with multiple voltage-clamp responses simultaneously. Experimental results show that the proposed method effectively handles cellular dynamics in multiple responses.

3 Weakly Supervised Deep Learning for Monitoring Sleep Apnea Severity Using Coarse-Grained Labels

Xin Zan[1], Di Wang[2], Changyue Song[3], Feng Liu[4], Xiaochen Xian[5], Richard Berry[5], [1]University of Florida, GAINESVILLE, FL, [2]Shanghai Jiaotong University, Shanghai, China; [3]Stevens Institute of Technology, Cedar Grove, NJ, [4]Stevens Institute of Technology, Hoboken, NJ, [5]University of Florida, Gainesville, FL, Contact: xxian@ufl.edu
Sleep apnea is a common sleep disorder suffered by a large population. Current automatic apnea detection methods relying on supervised learning require massive well-labeled training data, which is usually unavailable due to the high labeling cost. This work establishes a weakly supervised deep learning framework using only coarse-grained labels indicating apnea presence to automatically derive fine-grained labels representing the latent apnea severity. A novel knowledge-enhanced dual-granularity consistency loss, which simultaneously considers the consistency between coarse- and fine-granularity and the incorporation of clinical knowledge, is designed to allow the proposed method to accurately estimate fine-grained apnea severity in real time with significantly reduced labeling costs, extending the reach of sleep apnea monitoring to larger population.

4 Multi-Branching Temporal Convolutional Network with Tensor Data Completion for Diabetic Retinopathy Prediction

Zekai Wang[1], Suhao Chen[2], Tieming Liu[3], Bing Yao[4], [1]The University of Tennessee. Knoxville, Knoxville, TN, [2]South Dakota School of Mines and Technology, Rapid City, SD, [3]Oklahoma State University, Stillwater, OK, [4]The University of Tennessee Knoxville, Knoxville, TN, Contact: zwang142@vols.utk.edu

Diabetic retinopathy (DR) is a microvascular complication of diabetes, and it is the leading cause of vision loss among working-aged adults. Due to the low compliance rate of DR screening and expensive medical devices for ophthalmic exams, many DR patients fails to seek medical attention until DR develops to irreversible stages. The systematically collected electronic health record (EHR) data provide an great opportunity to develop inexpensive tools for DR detection. This paper proposes a Multi-branching Temporal Convolutional Network with Tensor Data Completion (MB-TCN-TC) to model the multivariate longitudinal EHRs for DR prediction. Experimental results show that MB-TCN-TC effectively captures complicated variable interactions in the longitudinal clinical data by accounting for missing value and imbalanced data issues and outperforms existing methods.

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CC-North 228B

Data Science in Manufacturing and Work Environment

Community Committee Choice Session

Session Chair: Hongyue Sun, University at Buffalo, Buffalo, NY

Session Chair: Fadel Mounir Megahed, Miami University, Oxford, OH

1 Explaining The Variability In The Profiles Of Ratings Of Perceived Exertion For A Dynamic Upper Extremity Task: A Functional Regression Approach

Setareh Kazemi Kheiri, State University of New York at Buffalo, Buffalo, NY

Musculoskeletal disorders (MSDs) are prevalent among warehouse order-pickers due to repetitive tasks impacting the upper extremities. Our study delves into fatigue dynamics of these extremities to aid intervention strategies. Using data from 14 participants, we created models based on varied tasks, and exertion levels reported via Borg's scale as the functional response variable. Muscular activity was tracked using wearable sensors. Through a functional regression approach, our analysis indicated that models integrating sensor data outperformed others. Additionally, extracting sensor data features using functional principal component analysis excelled in explaining the model variability compared to statistical features from signals.

2 Analytical Study On Direct Ink Writing Process

Wuyang Chen[1], Chenyu Xu[1], Chi Zhou[2], Hongyue Sun[1], [1]University of Georgia, Athens, GA, [2]University at Buffalo, Buffalo, NY, Contact: wuyang.chen@uga.edu

Direct Ink Writing (DIW) boasts numerous advantages over other additive manufacturing techniques, including porous structure, material versatility, and multi-material printing. Despite these benefits, the complexity of the process presents significant challenges and limitations. This study aims to systematically investigate the DIW process including setup building, experimental design, and data analysis, and to find the optimal system control solution for the process in the future.

3 Development of a Hybrid-Sampling Method for Wafer Test Data Considering Spatial Characteristics of Wafer: A Case Study on Latent Defect Detection Model Development

Young-Mok Bae, Kwang-Jae Kim, POSTECH, Pohang, Kyungbuk, Korea, Republic of. Contact: ymbae@postech.ac.kr

The complexity and diversity of defect mechanisms challenge latent defect detection after the wafer test. Recent studies have focused on machine learning models for latent defect classification using wafer test data, but the need for high-speed, accurate classification may limit their industrial application. This study proposes a hybrid sampling method considering spatial attributes on the wafer. Under-sampling employs a one-dimensional convolutional neural network autoencoder for spatial learning, while over-sampling uses the Synthetic Minority Over-sampling Technique on inadequately learned samples. Case studies show that this hybrid approach, paired with traditional machine learning, enhances latent defect detection and reduces training time, and thus potentially aiding in actual cost-effective wafer testing.

4 An Integrated Offline and Online Optimization Framework for Large Scale Additive Manufacturing

Lu Liu[1], Feng Ju[1], Seokpum Kim[2], [1]Arizona State University, Tempe, AZ, [2]Oak Ridge National Lab, Oak Ridge, TN

In the large-scale additive manufacturing process, applying an optimization model to ensure proper layer temperature plays an important role in producing high-quality products. Currently, there are two major studies available, but both have drawbacks when practiced solely. Therefore, an integrated approach by taking advantage of two methods is proposed. When printing based on the optimal layer time

suggested by an offline design, the real-time information captured by the IR camera is considered in the online control to make further adjustments to the layer time.

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CC-North 229A

Enhancing Climate Resilience of Renewable-Dominated Power Grids

Community Committee Choice Session

Session Chair: Yunhe Hou, The University of Hong Kong, Hong Kong, Hong Kong
Session Chair: Feng Liu, Tsinghua University, Beijing
Session Chair: Yujia Li, The University of Hong Kong, Hong Kong, China

1 Risk-Informed Resilience Enhancement of Transmission Grids Against Ice Storms

Chenxi Hu, The University of Hong Kong, Hong Kong, China

This work proposes a resilient-oriented planning model for transmission systems against ice storms. The model integrates the predictive information to enhance system resilience through a more informed allocation of resources in anticipation of extreme events. Considering the operation strategies changes under normal and extreme conditions, the model adopts a dual-objective approach to achieve trade-offs during different stages. The model is formulated as a stochastic mixed-integer linear problem. The first stage makes line hardening decisions, as well as the optimal sitting and sizing of energy storage. The second stage evaluates the risk-informed operation costs by taking into account both the normal and the emergent operation stages, respectively. Case studies demonstrate the effectiveness of the proposed model.

2 The Impacts of Uncertainties from Renewables on Dyanmic Response of Power Systems

Chengxi Liu, China

This presentation proposes a novel method based on arbitrary Polynomial Chaos (aPC) to evaluate how parameter and variable uncertainties, like climate or weather, impact the dynamic response of power systems. The method defines a set of orthogonal polynomials that approximate the relationship between the sources of uncertainties, such as the power generation of renewable energy resources determined by climate or weather, and the system dynamic response. Measurement data can be directly utilized to construct the aPC model without any prior knowledge of the probability distribution of the uncertainty. A whitening transformation method is also integrated to decouple the correlated data sets and thus avoid errors caused by distribution fitting. Finally, to avoid numerical issues common to polynomial chaos methods, the k-means++ clustering is embedded in the aPC.

3 Multi-Stage Stochastic-Robust Power System Generation Expansion Planning Under Heterogeneous Uncertainties

Rongpeng Liu, McGill University, Montreal, QC, Canada. Contact: rpliu@eee.hku.hk

This work addresses wind power generation expansion planning (WPGEP) problems with heterogeneous uncertainties. First, we divide the heterogeneous uncertainties into long-term (climate change-induced) wind resource evolution uncertainties and short-term decision-dependent wind power output uncertainties. A multi-stage stochastic-robust optimization model is proposed to handle WPGEP problems and derive optimal expansion decisions. In this model, the long-term uncertainties and short-term decision-dependent uncertainties are depicted by weighted scenarios and decision-dependent ellipsoidal uncertainty sets, respectively. In order to solve the proposed model, we develop a modified parametric C&CG algorithm and analyze its convergence. Testing results verify the effectiveness of the proposed model and solution method.

4 Enhancing the Grid's Resilience by Optimal Hardening and Maintenance

Bo Zeng[1], Zhengsong Lu[2], [1]University of Pittsburgh, Pittsburgh, PA, [2]University of Pittsburgh, Pittsburgh, PA, Contact: bzeng@pitt.edu

A Grid's resilience can be improved by employing costly hardening decisions or implementing frequent but less costly maintenance operations.

5 Climate-Adaptive Transmission Network Expansion Planning Considering Evolutions of Resources

Yixuan Chen, The University of Hong Kong, Pok Fu Lam, Hong Kong

The unpredictable climate change introduces ambiguity into the system, since the weather-sensitive resources would evolve with the climate and gradually exhibit a different distribution from the past in an uncertain manner. Lack of considering this climate-induced ambiguity in transmission network expansion planning (TNEP) may cause misunderstanding of future operational scenarios. Aiming at a higher security operation level under climate change yet

less line investment, this paper proposes a climate-adaptive TNEP, which is a robust TNEP equipped with a climate-adaptive uncertainty set (CUS).
Determination of the CUS involves three steps. First, model future unknown distribution under climate change. Specifically, the climate-driven evolution is quantified by an evolutionary distance between historical and future true distributions, while the future unknown distribution is then modeled by a distance-based ambiguity set; Second, determine the CUS which has a minimal volume yet a desired confidence level by a parametric Wasserstein distance-based distributionally robust optimization (p-WDRO); Third, solve the p-WDRO by a data-clustering-incorporated reformulation. After the CUS is determined, the overall climate-adaptive TNEP is solved by a modified C&CG method. Simulations are conducted on three test systems with practical data, which demonstrate that the climate-adaptive TNEP can improve operational security under climate change while reducing investment costs.

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SE51

CC-North 229B

Advancing Energy Systems Optimization Modeling and Analysis: Tackling Key Challenges for Planning, Operations, and Implementation

Community Committee Choice Session

Session Chair: Anderson de Queiroz, North Carolina State University

Session Chair: Andeson Queiroz, 1</sup

1 Exploring Illustrative Decarbonization Pathways Under near Cost-Optimal Futures for the United States

Aditya Sinha, NC State University, Raleigh, NC

Real-world energy system pathways deviate greatly from deterministic least-cost scenarios. Modeling to generate alternatives can identify a diverse set of near-cost-optimal net-zero CO_2 futures for the United States energy system. We find that nearly all future net-zero pathways result in the rapid expansion of solar and wind power generation, substantial reductions in petroleum use, and near elimination of coal combustion. In contrast, nuclear power and coal with carbon capture and sequestration are highly adopted in a small subset of pathways. Exploring correlations of technology adoption across pathways, allow us to identify coupled technologies, as well as counterintuitive relationships resulting from energy system interactions. Our results demonstrate that significantly varied pathways are available for deep decarbonization at comparable system costs.

2 Scenario Analysis for Energy Storage Technologies in Energy System Optimization Models Adopting Different Time Scales and Cost Projections

Matteo Nicoli, Politecnico of Torino / NC State University, Torino, Italy. Contact: matteo.nicoli@polito.it

This work focuses on the assessment of the possible role of storage technologies in the future energy system. Its goal is to capture the dynamics of short-term operation within hourly discretization and connect this into long-term capacity expansion decision-making. Storage technologies can play a role in enforcing the reliability and flexibility of energy systems with high shares of intermittent sources. We integrate techno-economic data for storage processes in Energy System Optimization Models and present the methodology adopted to represent the infra-annual dynamics. Results present storage penetration within supply and demand sectors under alternative conditions: policy scenarios, model time scale refinement, and cost projections.

3 Nuclear-Renewable-Storage Systems: Enhancing Planning and Operations of Integrated Energy Systems

Binghui Li, Jianqiao Huang, Idaho National Laboratory, Idaho Falls, ID, Contact: binghui.li@inl.gov

Nuclear-renewable-storage integrated energy systems (IES) are multi-carrier energy systems that include not only electricity but also other forms of demands. Because individual IES components must observe their thermo-physical limits, including ramp rates, start-up, and shut-down time, we formulate operations of the IES as an optimization model by minimizing the total operations costs subject to physical limits of all constituent components. In addition, we develop a data-driven approach to improve the computational performance of the economic dispatch model by using reinforcement learning, where an agent is rewarded by meeting demands and penalized otherwise when shifting to the next state.

4 Energy Systems Capacity Expansion Planning Under the Risk of Hurricane Damage

Victor Faria[1], Anderson Rodrigo de de Queiroz[2], [1]North Carolina State University, Raleigh, NC, [2]North Carolina Central University, Raleigh, NC, Contact: vaduraes@ncsu.edu

Capacity expansion planning in energy systems aims to identify the most cost-effective combination of resources to meet future energy demand, considering various factors like policies, fuel prices, and technology expenses. Despite the substantial damages caused by extreme weather events to power and energy systems, these are rarely incorporated into the scenarios of capacity expansion studies. This project aims to reduce this gap by using stochastic programming to better understand the changes in electricity cost and system planning infrastructure, given the incorporation of hurricane scenarios in an energy system optimization model for the North Carolina energy system.

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SE52

CC-North 230

Transmission, Generation and Storage Long-Term Expansion Planning

Community Committee Choice Session

Session Chair: Enzo E. Sauma, Pontificia Universidad Catolica de Chile, Santiago, Chile

1 Green Ammonia Production in Chile: An Optimization-Based Model for Computing the LCOA

David Pozo[1], Enzo E. Sauma[2], [1]European Commission, Joint Research Centre (JRC), Petten, Netherlands; [2]Pontificia Universidad Catolica de Chile, Santiago, Chile

Green ammonia, a potential game-changer in the global effort to combat climate change, is a carbon-free chemical compound made by combining hydrogen and nitrogen. This sustainable alternative to traditional ammonia production has garnered significant attention due to its potential to serve as both an energy carrier and a key component in various industrial processes.

We introduce a methodology for calculating the Levelized Cost of Ammonia (LCOA) and assess the techno-economic feasibility of green ammonia production in Chile, identifying optimal locations for facilities based on renewable energy availability. Our numerical experiments demonstrate that the LCOA for green ammonia production in various locations positioning Chile as a competitive player in the global market.

2 Adaptive Two/Multi-Stage Stochastic Energy Infrastructure Expansion Planning

Yuang Chen[1], Beste Basciftci[2], [1]Georgia Tech Shenzhen Institute, Shenzhen, China; [2]University of Iowa, Iowa City, IA, Contact: yuang.chen@gatech.edu

Two-stage and multi-stage stochastic optimization are commonly used for energy infrastructure expansion planning when future demand is uncertain. The two-stage model has a strict static investment policy that is predetermined at the outset, whereas the multi-stage model has a flexible fully adaptive policy but must be adapted for each time period. To address the limitations of both models, this talk introduces a new stochastic expansion planning model called adaptive two/multi-stage stochastic programming, which lies between a two-stage and a multi-stage stochastic model. The number of adaption times for investment decisions to adapt to underlying uncertainty is fixed. The model determines the optimal adaption times while keeping the investment policy static otherwise. Results from a case study in Rwanda demonstrate the effectiveness of the proposed models.

3 Transmission Benefits and Cost Allocation Under Ambiguity

Han Shu, Jacob Mays, Cornell University, Ithaca, NY, Contact: hs2226@cornell.edu

Large-scale expansion transmission infrastructure would bring economic, reliability, and environment benefits. However, it is challenging to allocate costs for such shared infrastructure investments roughly in proportion to benefits, particularly when faced with uncertainty. To address this challenge, the article proposes a multistage stochastic mixed-integer transmission and generation co-optimization model with binary decisions for transmission expansion. Our mathematical analysis reveals that load is the only long-term beneficiary of transmission expansion. Benefit assessment for a transmission expansion project is carried out by comparing the optimal surplus with a counterfactual scenario where that specific project is constrained. The transmission expansion cost is then allocated in proportion to the expected benefits in a long-term horizon.

4 Long-Term Power Expansion Considering Hydrogen Production

Enzo E. Sauma[1], Javier Jorquera-Copier[1], Álvaro Lorca[2], Stefan Lorenczik[1], Matias Negrete[1], [1]Pontificia Universidad Catolica de Chile, Santiago, Chile; [2]Pontificia Universidad Catolica de Chile, Atlanta, GA, Contact: esauma@ing.puc.cl

We formulate and implement a model that co-optimizes, from a system-wide perspective, the expansion of the H_2 industry and the expansion of the associate power system, when considering the main technical features of both the power system operation and the H_2 production, and use such a model to adequately asses the economic and environmental impacts of green H_2 production on the Chilean power system infrastructure investments. In doing that, we formulated a model that co-optimizes the expansion of the H_2 industry and the expansion of the associate power system, considering the main technical features of both the power system operation and the H_2 production. We used the proposed model to analyze the interactions between the main Chilean power system and H_2 industry, assessing the economic and environmental impacts of green H_2 production on the Chilean power system.

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CC-North 231A

New Algorithms for Power System Operation

Community Committee Choice Session

Session Chair: Daniel Bienstock, Columbia University, New York, NY

1 GravitySDP: A Solver for Sparse Mixed-Integer SDPs

Hassan Lionel Hijazi, Los Alamos National Laboratory, Los Alamos, NM

In this talk, we will introduce GravitySDP, a new solver for sparse mixed-integer semidefinite programming. Experiments on academic benchmarks and energy applications will be presented.

2 Advances in Solving Large-Scale Grid Optimization Problems

Andy Sun, MIT, Cambridge, MA

Operation of large-scale electric power grids imposes challenging optimization problems. In this talk, we will review some of these challenges and new advances in computational methods for dealing with nonconvex constraints, discrete variables, and multiple decision periods. We will demonstrate that large-scale grid optimization problems of real-world sizes can now be solved to obtain high-quality solutions.

3 Recursive Restoration Refinement: A Fast Heuristic for Near-Optimal Restoration Prioritization in Power Systems

Line Roald[1], Noah Rhodes[1], Carleton Coffrin[2], [1]University of Wisconsin - Madison, Madison, WI, [2]Los Alamos National Laboratory, Los Alamos, NM, Contact: roald@wisc.edu

The prioritization of restoration actions after large power system outages impacts how quickly power can be restored. Fast and intuitive heuristics for restoration prioritization most often result in low-quality restoration plans, while mathematical optimization tools that find high-quality restoration plans are too slow to be applied to restoration planning problems of practical interest. To close this quality vs compute time gap we propose the Recursive Restoration Refinement heuristic for power system restoration. This heuristic produces near-optimal restoration plans up to 1,000 times faster than other state-of-the-art methods on a range of test cases with up to 500 buses and 700 damaged components. The recursive restoration refinement algorithm is available as part of the open-source software package, PowerModelsRestoration.

4 Linear Formulations for AC-OPF

Matias Villagra, Columbia University, NYC, NY, Contact: mjv2153@columbia.edu

In this talk, we present a pure LP-based approach for quickly proving lower bounds of challenging AC-OPF instances. Our cutting-plane algorithm leveraged cuts generated from structural properties of the network.

5 Physics-Informed Machine Learning for Electricity Markets

Robert Ferrando[1], Laurent Pagnier[2], Robert Mieth[3], Zhirui Liang[4], Yury Dvorkin[5], Daniel Bienstock[6], Michael Chertkov[1], [1]University of Arizona, Tucson, AZ, [2]University of Arizona, Tucson, AZ, [3]Princeton University, Princeton, NJ, [4]Johns Hopkins University, Baltimore, MD, [5]Johns Hopkins University, Baltimore, MD, [6]Columbia University, New York, NY, Contact: rferrando@math.arizona.edu

We present a physics-informed, market-aware machine learning-driven algorithm to solve the DC optimal power flow problem. Namely, we employ active set learning to construct a system of linear equations whose solution is equivalent to the primal and dual solution of DC-OPF. The scheme, which we refer to as physics-informed, market-aware, active-set OPF (PIMA-AS-OPF), is validated on the New York ISO 1814-bus system, with results shown for different unit commitment, levels of wind penetration, and levels of noise. In addition, we demonstrate that the LMPs and dispatches adhere to established principles of market design, including revenue adequacy and cost recovery. Finally, we discuss how similar ML-driven schemes may be developed for unit commitment, which is mixed-integer and thus inherently more challenging in nature than DC-OPF.

Sunday, October 15, 4:00 PM - 5:15 PM

SE54

CC-North 231B

Data-Driven Optimization and Explainability II

Community Committee Choice Session

Session Chair: Alexandre Forel, Polytechnique Montreal, Montreal, QC, Canada

1 Adversarially Robust Decision Tree Retraining

Benoit Duval, Claudia Bongiovanni, Thibaut Vidal, MAGI, Polytechnique Montreal, Montréal, QC, Canada. Contact: claudia.bongiovanni@polymtl.ca

Decision trees are widely used for creating transparent, explainable, and interpretable models. However, their effectiveness is limited when faced with noisy data and uncertainty due to their inflexible partitioning scheme. To address this, we propose a post-learning procedure for re-training robust decision trees. This procedure incorporates data re-labeling, node re-splitting, and node pruning, formulated as a mixed integer program. We evaluate its efficiency on benchmark instances from the literature and compare it to full enumeration and established adversarially-robust methodologies.

2 Applications and Limitations of Reinforcement Learning in Operations Management

Magnus Josef Maichle[1], Nikolai Stein[2], [1]University of Würzburg, Würzburg, Germany; [2]University of Wuerzburg, Wuerzburg, Germany. Contact: magnus.maichle@uni-wuerzburg.de

We propose a versatile reinforcement-learning-based approach that can effectively solve multiple inventory management problems. Our approach extends existing research in two ways: First, we show that our approach not only works in univariate, but also in multivariate settings with many co-variates (features). Second, we demonstrate the approach's applicability to a larger problem class, including problems with fixed ordering costs that have not been considered previously. Based on numerical experiments we show that this generic approach yields very good results, even when compared to previous data-driven approaches that are engineered towards each individual data and problem instance.

3 A Flexible Framework for Data-Driven Optimization Using Level-Set Kernel Weights

Kai Guender, Felix Schmidt, Julius-Maximilians-University Wuerzburg, Wuerzburg, Germany. Contact: kai.guender@uni-wuerzburg.de

We propose a framework for solving various classes of data-driven optimization tasks using a re-weighting of data samples based on point estimation similarity under contextual features. Our approach can utilize any state-of-the-art machine learning model for point estimation, scales efficiently with the number of samples, and can be applied to both univariate and multivariate problems. We can prove asymptotically optimal behavior under mild assumptions; the results of extensive numerical experiments with real world data suggest strong performance.

Sunday, October 15, 4:00 PM - 5:15 PM

SE55

CC-North 231C

On-Demand Transportation Services with Innovative Technology

Community Committee Choice Session

Session Chair: Xiaotang Yang, University of Minnesota, Minneapolis, MN

1 General Coupled Morning-Evening Traffic Equilibria with Rideshare and Ride-Hailing Services

Wei Gu[1], Michael Zhang[2], Maged M. Dessouky[3], Jong-Shi Pang[1], [1]University of Southern California, LOS ANGELES, CA, [2]University of California-Davis, Davis, CA, [3]University of Southern California, Los Angeles, CA, Contact: weig@usc.edu

We develop general equilibrium models to capture the influence of the emerging rideshare and ride-hailing services on traffic congestion and travelers' choice behavior in a coupled morning-evening commute framework. The models are formulated as variational inequalities. Then the existence of an equilibrium solution is investigated, and we provide the conditions on the model parameters under which the equilibrium will be unique. Furthermore, we prove that the travelers' disutility of our coupled models will not be worse than that of decoupled modeling approaches. The proposed models are validated with numerical experiments on the Sioux-Falls network.

2 Distance-Based Fee Design of On-Demand Delivery

Manlu Chen[1], Mingliu Chen[2], Ming Hu[3], Jianfu Wang[4], [1]Renmin University of China, Beijing, China; [2]Columbia University, New York, NY, [3]University of Toronto, Minneapolis, MN, [4]College of Business, City University of Hong Kong, Kowloon, Hong Kong. Contact: chenmanlu@

rmbs.ruc.edu.cn

The rapid growth of e-commerce has fostered booming instant delivery services. To examine the impact of the pricing scheme of on-demand delivery services, we consider a vendor that serves customers' online requests and charges a two-part delivery fee, consisting of a uniform base fee and a variable fee that depends on delivery distance. Compared to optimal flat delivery fee, the vendor can serve a broader region and increase profit and social welfare by charging more distant customers a lower delivery fee. When considering customer valuation heterogeneity, the delivery price design becomes more complex and depends on customer density. We also explore the effect of a self-pickup option implemented by the vendor and find that introducing the self-pickup option can enhance system throughput and lead to a win-win for vendor and customers compared to delivery-only operations.

3 Flying High with Improved Data: How an Instructor Training Workshop Boosting Pilot Competency Assessment

Qingyin GE[1], Jussi KEPPO[1], Chuan Hoo TAN[2], Hong Ming TAN[1], [1]National University of Singapore, Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore. Contact: qingyin.g@u.nus.edu

Data informativeness is crucial for effective data-driven decision-making. In the context of evaluating pilots' competencies within an international airline, we identify a tendency for evaluators to attribute extremity to both ends of the scale, leaving the scores congregating at the mid-point, particularly for skills that are non-technical. To address this challenge, we conducted workshops to educate instructors on grading criteria and the current unvaried grading scale. Utilizing a difference-in-differences approach with a multi-period synthetic control, we find a 29% improvement in the grading variation after the workshops, resulting in a more informative reflection of the pilots' competence. Our findings highlight the efficacy of instructor training in the pilot programs and provide policy implications for enhancing data informativeness.

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SE56

CC-North 232A

Network Models in Optimization and Their Applications

Community Committee Choice Session

Session Chair: Yajun Lu, Jacksonville State University, Jacksonville, AL

1 Welfare-Oriented and Public Health-Aware Disaster Sheltering Network Design

Mohamed R. Salama, Min Kyung Lee, Yuehwern Yih, Purdue University, West Lafayette, IN, Contact: salamam@purdue.edu

The inferior conditions that disaster victims commonly experience at public shelters may drive them to refuse evacuation. Moreover, the possible spread of infectious diseases inhibits them further from using such shelters. Therefore, in this study, a four-echelon network design is developed to allow for small-capacity shelters that can enhance both the welfare and public health of evacuees. A two-stage stochastic mixed-integer linear programming model is formulated to select opening nodes in each of the four network echelons under different disaster scenarios, in addition to determining the logistical operations. The national network of shelters in the United States is used as a case study to demonstrate the proposed network design and solution approach.

2 Identifying High Mortality Rate Disease Clusters In Comorbidity Graphs

Parisa Vaghfi Mohebbi[1], Baski Balasundaram[2], Yajun Lu[3], Zhuqi Miao[4], Ramesh Sharda[2], Pankush Kalgotra[5], [1]Oklahoma State University, Stillwater, OK, [2]Oklahoma State University, Stillwater, OK, [3]Jacksonville State University, Jacksonville, AL, [4]SUNY-New Paltz, New Paltz, NY, [5]Auburn University, Auburn, AL, Contact: parisa.vaghfi_mohebbi@okstate.edu

Mortality rate is the fraction of expired patients who had a particular group of diseases. The knowledge of high mortality rate disease clusters can enable healthcare providers to develop tailored interventions that improve patient outcomes and overall quality of care. This talk will discuss our ongoing work on finding cliques of comorbid diseases that correspond to high mortality rates among a given patient population. To tackle this, we explore two approaches: (i) a mixed-integer programming formulation that maximizes a single fractional objective subject to linear constraints, and (ii) an extension of the classical Bron-Kerbosch (BK) enumerative algorithm. We will report results from our experiments with both approaches on large-scale datasets derived from patient electronic healthcare records.

3 Combining Heuristics and Optimization in Kinaxis RapidResponse Supply Chain Planning

Carsten D. Jordan[1], Dan Vlasie[2], Ingrid Bongartz[3], Sergei Krutelevich[3], Yankai Zhang[3], [1]Kinaxis, San Diego, CA, [2]Kinaxis, Boston, MA, [3]Kinaxis, Ottawa, ON, Canada.

Contact: cjordan@kinaxis.com
Some supply chains involve expensive production on the lower BillOfMaterial levels and distribution on higher levels, across many sites and SKUs. We present an approach where we use heuristic planning on the higher levels and optimization on the lower BillOfMaterial levels. We show the advantages of this approach in a life science supply chain in the Kinaxis RapidResponse software.

4 On Atomic Cliques in Temporal Graphs
Yajun Lu[1], Zhuqi Miao[2], Parisa Sahraeian[3], Baski Balasundaram[3], [1]Jacksonville State University, Jacksonville, AL, [2]SUNY-New Paltz, New Paltz, NY, [3]Oklahoma State University, Stillwater, OK, Contact: ylu@jsu.edu
Atomic cliques were introduced recently to analyze disease progression in temporal comorbidity graphs. Informally, an atomic clique is a clique that is unsplittable over time---the clique is either present or absent entirely and no parts of it appears in the temporal graph unless the entire clique is present. We consider the atomic counterpart of the classical maximum clique problem in this paper. Our main contribution is a polynomial-time algorithm that transforms the maximum atomic clique problem to the maximum clique problem on an auxiliary graph. We report results from our computational studies that demonstrate the effectiveness of this transformation in solving the maximum atomic clique problem in comparison to direct integer programming based approaches.

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SE57

CC-North 232B

Quantum Computing and Optimization II

Community Committee Choice Session

Session Chair: Brandon Augustino, Lehigh University, Landing, NJ

1 Graph Decomposition Technique for Solving Combinatorial Optimization Problems with Variational Quantum Algorithms
Moises Ponce[1], Rebekah Herrman[1], Phillip Lotshaw[2], Sarah Powers[2], George Siopsis[1], Travis Humble[2], James Ostrowski[1], [1]University of Tennessee Knoxville, Knoxville, TN, [2]Oak Ridge National Laboratory, Oak Ridge, TN, Contact: rherrma2@utk.edu
The quantum approximate optimization algorithm (QAOA) has the potential to approximately solve complex combinatorial optimization problems in polynomial time. However, current noisy quantum devices cannot solve large problems due to hardware constraints. In this talk, we introduce an algorithm that decomposes MaxCut graphs into reduced problems and solves them using QAOA. We discuss algorithm performance on a collection of test graphs. On average, the algorithm requires approximately 88% fewer qubits than QAOA requires to solve the original MaxCut instances. Furthermore, solving the reduced problems improves the approximation ratio by approximately 125% compared to directly solving the original problems.

2 Quantum Approximate Optimization for Constrained Combinatorial Problems
Phil Lotshaw, ORNL, Oak Ridge, TN
Quantum alternating operator ansätze (QAOA) are being explored as potential approaches to obtain quantum computational advantages in approximately solving combinatorial optimization problems. QAOA typically addresses unconstrained optimization problems, while constrained optimization is relatively less explored. Here we analyze two QAOA approaches to handle constraints in simple instances of binary integer linear programming problems. The first approach uses penalty terms to transform the problem into an unconstrained version; the second approach enforces constraints within the circuit, with auxiliary variables and a smaller number of penalty constraints. We assess the benefits and tradeoffs inherent to these approaches and quantify their performance and scaling.

3 Quantum Approximate Optimization Algorithm Applied to a Classically Intractable Problem
Ruslan Shaydulin, JPMorgan Chase, New York, NY
The Quantum Approximate Optimization Algorithm (QAOA) has attracted a lot of interest as a promising algorithm for solving combinatorial optimization problems on quantum computers. We numerically evaluate the performance of QAOA on a classically intractable problem. We discuss the implications of our findings to the problem of understanding the potential of quantum computers to assist in solving hard optimization problem.

Sunday, October 15, 4:00 PM - 5:15 PM

SE59

CC-West 101A

New Perspectives in Multiple Criteria Decision Making

Community Committee Choice Session

Session Chair: Mohammad Ghaderi, Pompeu Fabra

University, Barcelona, Spain
Session Chair: Salvatore Greco, University of Catania, Catania, Italy

1 Selection of a Representative Sorting Model in a Preference Disaggregation Setting: Existing Procedures, New Proposals, and Experimental Comparison

Milosz Kadzinski, Michal Wojcik, Krzysztof Ciomek, Poznan University of Technology, Poznan, Poland. Contact: milosz.kadzinski@cs.put.poznan.pl

We consider preference disaggregation in the context of multiple criteria sorting. Given the multiplicity of sorting models compatible with indirect preferences, selecting a single, representative one can be conducted differently. We review several procedures for this purpose, aiming to identify the most discriminant, average, central, parsimonious, or robust models. Also, we present three novel procedures that implement the robust assignment rule in practice. The performance of fourteen procedures is verified on problem instances with different complexities. The results of an experimental study indicate the most efficient procedures in classification accuracy, reproducing the DM's model, and delivering the most robust assignments.

2 A New Ordinal Regression Procedure for Multiple Criteria Decision Aiding

Salvatore Greco[1], Maria Barbati[2], Isabella Lami[3], [1]University of Catania, Catania, Italy; [2]Università Ca' Foscari Venezia, Venezia, Italy; [3]Politecnico di Torino, Torino, Italy. Contact: salgreco@unict.it

We define a new elicitation procedure to handle Decision Makers (DMs) preferences. The preferences are elicited by conjugating the deck of cards method with the ordinal regression approach allowing the DM to provide preference information in terms of ranking and pairwise comparison of some reference alternatives in terms of intensity of preference. Then, the score ofthe reference solutions obtained through the deck of the cards method is used as a basis for an ordinal regression procedure. We show how this methdology can be usefully applied to different forms of a value function such as weighted sum, Choquet integra, additive value function.

3 XIMEA-DRSA: A New Interactive and Explainable Evolutionary Multiobjective Optimization Method

Roman Slowinski[1], Salvatore Corrente[2], Salvatore Greco[2], Benedetto Matarazzo[2], [1]Poznan University of Technology, Poznan, Poland; [2]Department of Economics and Business, University of Catania, Catania, Italy. Contact: roman.slowinski@cs.put.poznan.pl

XIMEA-DRSA is a new interactive evolutionary multiobjective optimization method guided by preferences of the user modeled in terms of "if ..., then ..." decision rules. Besides guiding the search process, the decision rules can be read as arguments explaining the user's preferences. In this way, the user has a chance to understand how their assessment of a small sample of solutions in the preference elicitation phase is translated into guidelines for the algorithm in the optimization phase. This is a distinctive aspect of an eXplainable Interactive Multiobjective Evolutionary optimization Approach (XIMEA). Decision rules are induced from the preference information using the Dominance-based Rough Set Approach (DRSA). XIMEA-DRSA was tested on benchmark problems, both continuous and combinatorial ones, showing a very good performance.

4 Preference Disaggregation: A Probabilistic View

Moha Ghaderi[1], Milosz Kadzinski[2], [1]Pompeu Fabra University, Barcelona, Spain; [2]Poznan University of Technology, Poznan, Poland. Contact: mohammad.ghaderi@upf.edu

The preference disaggregation paradigm concerns the construction of utility or value functions from the preference information supplied by a decision maker, typically in the form of qualitative judgments and holistic pairwise comparisons of decision alternatives. The extant literature often starts with a utility function, involving various specification and distribution assumptions, and takes the form of mapping utility vectors to choice probabilities. We argue that defining preferences in terms of choices can be problematic for generating insights into the underlying choice process and it assumes away various boundedly rational behavioral patterns such as context-dependency since it arrives at a preference relation endogenously. We provide an alternative approach where utilities are merely quantification mediums that facilitate handling preferences.

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SE60

CC-West 101B

MIF Paper Competition 2023

Community Committee Choice Session

Session Chair: Michelle M. Alvarado, University of Florida, Gainesville, FL

1 Joint Client Selection and Contract Design for A Risk-Averse Commodity Broker in a Two-Echelon Supply Chain

Belleh Fontem, University of Massachusetts Lowell, Lowell, MA
We study an expected payoff maximization problem for a risk-sensitive broker aiming to evaluate the merits of designing and underwriting an option contract on a traded commodity with geometric Brownian motion spot price trajectories. The broker's objective is jointly to (i) choose a so-called trigger price function that will fundamentally define the option contract, and (ii) select a value-maximizing set of client firms to whom the broker will offer the contract. We reformulate the problem as a bilevel program whose continuous relaxation we transform into a single-level, univariate problem. Then, we use real-world data to study the implications of violating a certain constraint that implicitly bounds the optimal trigger price.

2 Learning Product Rankings Robust to Fake Users
Negin Golrezaei, Massachusetts Institute of Technology, Cambridge, MA
Online platforms heavily rely on product rankings to influence customers, who often focus on top items. Platforms use customer data for ranking learning. However, this can incentivize some sellers to manipulate rankings. We address this, studying platforms with indistinguishable real and fake data points. Our effective algorithms work for platforms aware or unaware of the number of fake data points, ensuring optimal robust rankings and surpassing existing methods. Our approach includes novel strategies like product-ordering graphs and multi-level learning.

3 Monitoring Policy in the Context of Preventive Treatment of Cardiovascular Disease
Daniel Felipe Otero Leon, Harvard Medical School, Boston, MA
Preventing chronic diseases is an essential aspect of medical care. Physicians focus on monitoring risk factors and prescribing necessary medication. Monitoring too frequently may be unnecessary and costly; on the other hand, monitoring the patient infrequently means the patient may forgo needed treatment and experience adverse events. We propose a Markov decision process to define monitoring policies. To build our model, we use EHR longitudinal observational data from patients seen in the U.S. Veterans Affairs health system. We use our model to study policies for whether or when to assess the need for cholesterol-lowering medications. We further use our model to investigate the role of sex and race in optimal monitoring policies.

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SE61

CC-West 101C

How OR Scholars Successfully Collaborate with Public Institutions? A Panel Discussion

Panel Session

Session Chair: Gemma Berenguer, Universidad Carlos III de Madrid, Getafe, Spain

1 How OR Scholars Successfully Collaborate with Public Institutions? A Panel Discussion
Gemma Berenguer, Universidad Carlos III de Madrid, Getafe, Spain
This session will describe different public sector OR collaborations between academics and public sector institutions.

2 Panelist
Yuehwern Yih, School of Industrial Engineering, Purdue University, W Lafayette, IN

3 Panelist
Mahyar Eftekhar, Arizona State University, Tempe, AZ

4 Panelist
Ravi Anupindi, University of Michigan, Ann Arbor, MI

5 Panelist
Jessica Heier Stamm, Kansas State University, Manhattan, KS

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SE62

CC-West 102A

Analytics for Railway Operations

Contributed Session

Session Chair: Md Gulam Kibria, Georgia Institute of Technology, Clarkston, GA

1 Planning Service Protocols for Extra-Long Trains
Jesus Osorio[1], Shiyu Shen[2], Yanfeng Ouyang[3], [1]University of Illinois Urbana-Champaign, Urbana, IL, [2]University of Illinois at Urbana-Champaign, Urbana, IL, [3]U of Illinois at Urbana-Champaign, Urbana, IL
Metro systems are becoming overly saturated by the ever-increasing travel demand in many megacities, which results in overcrowded stations, excessive delays, and unsafe rider

anxieties. The concept of extra-long trains (i.e., trains longer than station platforms) was recently proposed in the literature as a promising way to increase metro line capacity without additional infrastructure construction. This talk presents a general modeling and solution framework to optimize train block configuration and operation protocols for extra-long trains under arbitrary demand distributions and platform settings. Numerical experiments, including both hypothetical and real-world cases, are conducted to demonstrate the applicability and effectiveness of the proposed framework. In addition, a set of sensitivity analyses are performed to draw managerial insights.

2 Real-Time Decision Support for Human-Machine Interaction in Digital Railway Control Rooms

Léon Sobrie[1], Marijn Verschelde[2], [1]Ghent University, Ghent, Belgium; [2]IÉSEG School of Management, Lille, France. Contact: leon.sobrie@ugent.be

In digital railway control rooms, traffic operators can on-the-spot choose to use automation. As these choices are frequently suboptimal, we propose a real-time decision support tool to improve human-machine interaction (HMI) at Infrabel, Belgium's railway infrastructure company. The tool provides descriptive, predictive and prescriptive analytics on both expected and desirable HMI at the 15-minute level for each workstation. We benchmark clustering-based approaches for the descriptives, and machine and deep learning approaches for the predictions. To obtain prescriptions, we compare the predictions of HMI with their desirable counterparts. SHAPley values are deployed to foster model explainability and we document a generational difference in the distance between expected and desirable HMI.

3 Explainable Real-Time Predictive Analytics on Employee Workload in Digital Railway Control Rooms

Léon Sobrie[1], Marijn Verschelde[2], Bart Roets[3], [1]Ghent University, Ghent, Belgium; [2]IÉSEG School of Management, Lille, France; [3]Infrabel, Brussels, Belgium. Contact: m.verschelde@ieseg.fr

Workload peaks/lows impact employee well-being. We propose real-time predictive employee workload analytics as decision support for management in an environment with variable and imbalanced workload: the digital railway control rooms of Infrabel. The granularity of the data facilitates an analysis of the multiple dimensions of workload at the 15-minute level. We perform an extensive benchmark between well-known Machine Learning and Deep Learning models to predict the presence and magnitude of various workload dimensions. We leverage SHAPley values to obtain both local and global explainability. Further, we show the value for adequate explainability of disentangling the presence and magnitude of workload. The proposed model is implemented as a proof of concept for explainable decision support within the company of focus.

4 Incentive Design to Shift Car Users to Transit Under TNC-Transit Partnerships

Md Gulam Kibria[1], Srinivas Peeta[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA

Qualitative studies suggest that transportation network companies (TNCs) can increase transit catchment area through partnerships with transit agencies by addressing the first-and-last mile problem. This study explores monetary and non-monetary incentive designs to shift car users to transit by utilizing the increased transit catchment area under TNC-transit partnerships. We propose mathematical models to maximize societal benefit and the associated user-level incentive designs in an integrated system in which TNCs provide first-and-last mile connections to transit stops.

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SE63

CC-West 102B

Diversity, Equity, Inclusion, and Justice in Services

Community Committee Choice Session

Session Chair: Muge Yayla Kullu, University of Central Florida, Orlando, FL

1 Promising Tomorrow: Students' Well-Being Focused Transformative Bottoms-Up Approach for Inclusive Stem Higher Education

Mihir Mehta, Penn State University, State College, PA

OR/MS equitable and inclusive higher education learning experiences are vital for realizing sustainable diversity in OR/MS fields. The "Promising Tomorrow" theme takes a student-focused bottoms-up approach. With three strategic panel discussions, it promotes students' well-being through positivity, productivity, and prosperity goals. The mental health session discusses practices for creating a positive learning environment through pedagogy. The neurodiversity session leverages executive functioning to promote productivity with informative and compassionate mentoring guidelines. The student DEI participation sessions outline future collaborative student DEI efforts for the prospering sense of belonging in OR/MS communities.

2 Redrawing Attendance Boundaries to Foster More Racially and Socioeconomically Diverse Schools

Nabeel Gillani, Northeastern University, Boston, MA, Contact: n.gillani@northeastern.edu

Most U.S. school districts draw “attendance boundaries” to define catchment areas that assign students to schools near their homes, often recapitulating neighborhood segregation by race and socioeconomic status in schools. This talk describes applications of combinatorial optimization to redraw school attendance boundaries in ways that foster more racially, ethnically, and socioeconomically integrated schools. We highlight findings from both country-wide simulations and school district outreach, as well as close collaborations with school district partners, to discuss both challenges and opportunities in using operations research methods to foster more diverse, integrated, and equitable educational environments.

3 Exploring Equity in Social Media Communication for Crisis Management by Water Utilities

Khalid K. Osman[1], Rohit Valecha[2], Arkajyoti Roy[3], Kasey M. Faust[4], [1]Stanford University, Stanford, CA, [2]UTSA, San Antonio, TX, [3]The University of Texas at San Antonio, San Antonio, TX, [4]University of Texas at Austin, Austin, TX, Contact: osmank@stanford.edu

This study investigates whether water utility communications in the US during a crisis are accessible by historically disenfranchised populations. Specifically we explored user engagement with utilities’ messages in non-dominant languages for information regarding utilities’ resources in the form of financial assistance. We examined water utility social media communications during the COVID-19 pandemic using 180,000 tweets from 338 water utilities nationwide. Using a dynamic panel data model, we found that tweets written in Spanish led to positive engagement for financial assistance-related information in Hispanic counties. This finding highlights that in vulnerable communities, social media can be considered as a trusted source for seeking financial assistance information from official organizations when it incorporates non-dominant languages.

4 Dynamic Exception Points for Fair Liver Allocation

Mustafa Akan, Musa Celdir, Sridhar Tayur, Carnegie Mellon University, Pittsburgh, PA

There are disparities in access to livers based on transplant patients’ height - which disproportionately affects women across ethnicities, in addition to Hispanics and Asians broadly - because they can receive transplants from a smaller pool of available deceased donors for medical reasons. We analyze fairness within the current US liver allocation system. We propose a simple adjustment - providing additional (exception) points based on height and MELD score - that can be easily implemented in practice, which materially reduces the disparity without sacrificing overall efficiency.

5 Impact Of Power Distance On Gender Gap In Economic Participation: The Moderating Effects Of Educational Attainment And Masculinity

Muge Yayla Kullu[1], A. Melih Kullu[2], [1]University of Central Florida, Orlando, FL, [2]Florida Southern College, Lakeland, FL, Contact: muge@ucf.edu

Gender diversity in the workforce has proven its benefits. While there has been considerable progress over the last century regarding the women’s status in society, the gender gap in the business world has endured. Women hold jobs that are inferior and pay less and occupy less seats up in the hierarchy. In this paper, we aim to understand the impact of national culture on gender gap in the workforce. We focus on the power distance dimension that studies inequalities in a society. In addition, we also examine how increased education and reduced masculinity helps with reducing the observed gender gap.

Sunday, October 15, 4:00 PM - 5:15 PM

SE65

CC-West 103A

Product and Process Innovation in Healthcare

Community Committee Choice Session

Session Chair: zhili Tian, Univ. of Houston, Myrtle Beach, SC

Session Chair: Anh Tuan Ninh, College of William and Mary, Department of Mathematics, Williamsburg, VA

1 Optimal Enrollment in Late Stage New Drug Development with Learningof Drug’s Efficacy for Group Sequential Clinical Trials

zhili Tian[1], Gordon B. Hazen[2], Hong Li[3], [1]Univ. of Houston, Houston, TX, [2]Northwestern University, Evanston, IL, [3]Univ. of California, David, CA, Contact: zhili.a.tian@gmail.com

The cost for developing a new drug is close to $2.6 billion in early 2010’s. The efficacy of a candidate drug, patient enrollment, and the market exclusivity period (MEP) are uncertain. Slow enrollment leads to increased costs, canceled trials, and lost potential revenue. Firms hope to detect efficacy vs. futility of the candidate drug early to save development costs in group-sequential-design trials. We developed a dynamic program with learning of a drug’s efficacy and MEP. We update a drug's efficacy by Bayes' rules. Our optimal policies can assist firms effectively conduct clinical trials considering competition from other drugs in the marketplace. Firms can use the properties of the value function to select late-stage trials for their drug-development project portfolios and use our model in simulation to select their trial design parameters.

2 Modeling Patient Recruitment In Clinical Trials
Anh Tuan Ninh, William and Mary, Department of Mathematics, Williamsburg, VA, Contact: atninh@wm.edu
Forecasting patient enrollment is of paramount importance in trial monitoring, as it provides decision-makers with crucial information about the anticipated number of recruits and the expected recruitment timeline. In this study, we present both an exact and an approximated formula for calculating the number of recruits at a given time and the recruitment time in a multi-center trial.

3 Analysis Of Compensation Contracts For Providers Inclinical Studies
Xueze Song[1], Mili Mehrotra[2], Tharanga Kumudini Rajapakshe[3], [1]University of Illinois at Urbana-Champaign, Urbana, IL, [2]University Of Illinois Urbana Champaign, Champaign, IL, [3]University of Florida, Gainesville, FL, Contact: xuezes2@illinois.edu
To improve participant retention, the clinical study sponsors often provide monetary payments to participants and compensate providers (investigators and coordinators) for their efforts. In this work, our goal is to examine the cost performance of three widely adopted compensation contracts—fixed (FC), linear (LC), and condition linear (CLC) in improving participant retention. To this end, we analyze a sponsor's decisions regarding monetary payments and providers' efforts under a centralized model, and identify the optimal contracts for the providers under the two decentralized team structures: (i) the sponsor-investigator (SI) model and (ii) the outsourcing (OM) model.

4 Food Safety And Sustainable Practices In Hunger Relief Organizations: Analysis Of Current And Potential Partnerships
Naimur Rahman Chowdhury[1], Rashik Intisar Siddiquee[2], Abdullah Al Nadim[3], Naurin Zoha[2], Ricky Owusu[4], Motunrayo Ogunmola[5], Julie Simmons Ivy[6], Shona D. Morgan[7], Lauren Berrings Davis[5], [1]North Carolina State Universoty, Raleigh, NC, [2]North Carolina State University, Raleigh, NC, [3]North Carolina State University, Raleigh, NC, [4]North Carolina A&T State Universoty, Greensboro, NC, [5]North Carolina A&T State University, Greensboro, NC, [6]University of Michigan, Ann Arbor, MI, [7]North Carolina A&T State University, Greensboro, NC, Contact: nchowdh2@ncsu.edu
Under the United Nation's Sustainable Development Goals, increasing concern for sustainability has motivated many hunger relief organizations to focus on environmental responsibilities as well as maintain food safety for holistic well-being. The aim of this paper is to analyze critical attributes in the domains of sustainable practices and food safety and create a predictive framework for hunger-relief companies to make critical decisions on collaboration and partnership with other hunger-relief organizations. First, we train a machine learning model with rating of different sustainability attributes of existing collaborators. The trained model is then used to measure relative ranking of potential partners for future collaborations.

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SE66

CC-West 103B

Innovation and Technology Management in Supply Chains

Community Committee Choice Session

Session Chair: Shubhobrata Palit, Georgia Institute of Technology, Rochester, NY

1 Effects of Responsive Pricing on Product Quality and Profitability in a Decentralized Channel
Chongguang Liu[1], Baojun Jiang[2], Yannan Jin[1], Hang Wei[1], [1]Shanghai University of Finance and Economics, Shanghai, China; [2]Washington University in St. Louis, St. Louis, MO, Contact: chongguang@wustl.edu
We build an analytical model to study how the retailer's responsive pricing affects the manufacturer's quality-investment decision and firms' profitability. We find that if the consumers' valuation for quality is sufficiently homogeneous, the retailer's responsive pricing will dampen the manufacturer's quality investment; otherwise, the retailer's responsive pricing will induce the manufacturer to increase its quality investment. We find that if the consumers in the market are sufficiently but not extremely homogeneous, the retailer's responsive pricing will force the manufacturer to set a higher wholesale price, which results in a lose-lose outcome. However, if the consumers in the market are very heterogeneous, the retailer's responsive pricing will induce the manufacturer to set a lower wholesale price, which results in a win-win outcome.

2 Innovation and Technological Knowledge Utilization in Supply Networks

Shubhobrata Palit[1], Manpreet Singh Hora[2], Soumen Ghosh[2], [1]Esade Business School, Barcelona, Spain; [2]Georgia Institute of Technology, Atlanta, GA, Contact: shubhobrata.palit@esade.edu

We focus on a buyer as a source of technological knowledge for a supplier and examine factors that make a supplier utilize technological knowledge from the buyer. Specifically, we study buyer innovation, technological similarity between a supplier and a buyer, a supplier's dependence on a buyer, and buyer-supplier size asymmetry, and how these factors interrelate in influencing the extent of the knowledge utilization from the buyer by the supplier.

Sunday, October 15, 4:00 PM - 5:15 PM

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CC-West 104A

Platform Data Mining for Consumer and Social Good

Community Committee Choice Session

Session Chair: Mariia Petryk, George Mason University, Gainesville, FL

1 Twitter Word-of-Mouth and NFT Sales

Katsiaryna Siamionava, Pei-yu Chen, Arizona State University, Tempe, AZ

In the recent years, non-fungible token (NFT) marketplace has rapidly expanded. Despite the public interest for NFTs, predicting success of NFT campaigns or specific digital assets remains a complex task. Prior research indicates the importance of non-financial factors in the NFT valuation prediction (Kapoor et al. 2022; Vasan, Janosov, and Barabási, 2022). We contribute to this research domain by examining the link between the social media word-of-mouth (WOM) on Twitter and NFT sales on OpenSea, one of the largest NFT platforms worldwide. We leverage Koat.ai analytics to extract valuable Twitter WOM dimensions. The outcomes of the study will contribute to the understanding of social influence on NFT sales and will inform NFT campaign strategies.

2 The Efficacy of Need-Based Attentional Interventions in Educational Crowdfunding

Amin Sabzehzar[1], Gordon Burtch[2], Yili Kevin Hong[3], Raghu Santanam[4], [1]Tulane University, New Orleans, LA, [2]Boston University, Boston, MA, [3]University of Miami, Pinecrest, FL, [4]Arizona State University, Tempe, AZ, Contact: asabzehzar@tulane.edu

The ability of the platforms to direct donors' attention toward disadvantaged student groups is predicated on the assumption that donor audiences hold no stereotypes toward underrepresented students. We explore the consequences of attentional interventions from the platform to support disadvantaged student groups. Leveraging data from DonorsChoose.org, we first report evidence that fundraisers benefiting lower-income and minority students receive systematically lesser funding, conditional on project characteristics and amounts requested. Subsequently, we examine the causal effect of a platform-implemented intervention to draw attention to student beneficiaries' poverty and minority status in the form of an 'equity-focus' project label.

3 Consumer Complaints Analysis

Reihane Boghrati[1], Amir Sepehri[2], Pei-yu Chen[1], [1]Arizona State University, Tempe, AZ, [2]ESSEC, Paris, France

Theory suggests when customers voice their complaints to businesses, they seek either psychological recompense (e.g., apology) and/or financial compensation (e.g., refund). We used the Safer Products Database (SPDB), a dataset of consumer complaints and corresponding company responses, to train a classifier for predicting financial and psychological labels. We then ran an experiment to measure the effect of match/mismatch between what consumers seek and what companies offer.Together, the field study and experiment have significant implications for companies. Although consumers are happy with financial compensation, companies cannot provide financial compensation to every customer due to limited resources. By utilizing the machine learning model, companies can classify consumer complaints and allocate their resources more effectively.

4 Designing NFT Collections: An Exploration of Trait Distribution and Diversity

Ehsan Valavi[1], Harang Ju[1], Madhav Kumar[2], Sinan Aral[1], [1]Massachusetts Institute of Technology, Boston, MA, [2]MIT, Cambridge, MA

The meteoric rise of non-fungible tokens (NFTs) has opened up a new frontier for digital art and collectibles. This paper focuses on the design of NFT collections, specifically exploring the distribution of traits and their impact on the perceived value and attractiveness of a collection. Through a comprehensive analysis of existing NFT collections and an examination of the principles of rarity and diversity, we offer insights and guidelines for artists and creators to design appealing and valuable NFT collections.

5 How E-Wom Influences Blockchain-Based Fundraising: The Role of Linguistic Elements

Wei Xiong[1], Siwei Zhu[2], [1]Mercer University, Atlanta, GA, [2]Minnesota State University Moorhead, Moorhead, MN
Prior literature has investigated the impact of eWOM on fundraising. However, there is a lack of discussion on how linguistic elements in eWOM may affect the fundraising performance. Different linguistic elements may trigger different types of eWOM and therefore show heterogeneous influence. Distinguishing between emotional eWOM and informational eWOM, we examine 4 linguistic elements of tweet posts with conservatism and ambivalence related to emotional eWOM while lexical uniqueness and readability related to informational eWOM. Drawing on the context of blockchain-based fundraising, our empirical analysis indicates that conservatism, ambivalence and lexical uniqueness negatively affect fundraising outcomes, while readability positively affects fundraising outcomes. The findings offer valuable insights for entrepreneurs to take advantage of eWOM.

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CC-West 104B

Data Analytics in Digital Platforms

Community Committee Choice Session

Session Chair: Onur Seref, Virginia Tech, Blacksburg, VA

Session Chair: Derya Ipek Eroglu, 1</sup

1 Examining the Impact of Tailoring on Perceived Social Support of a Conversational Agent

Sagar Mahesh Badve, Alan Gang Wang, Wenqi Shen, Virginia Tech, Blacksburg, VA
Advancement in conversational artificial intelligence (AI) has created opportunities for using conversational technologies such as chatbots in various domains. A recent development is the sophisticated conversational agent ChatGPT which has found widespread applications since its launch. Researchers have argued its usefulness and ethical implications in the healthcare domain, specifically mental healthcare. Based on anthropomorphism and communication literature, this research examines the effects of tailoring a conversational agent's cues that use ChatGPT as its underlying mechanism. Particularly, we examine the effect of tailoring responses and avatars of the conversational agent on the user's perceived social support in mental healthcare. Our research also provides guidelines on ethically using ChatGPT to assist in mental healthcare.

2 When the Views Change: Design-Motivated Persuasive Communication on a Reddit Community

Derya Ipek Eroglu[1], Onur Seref[2], Michelle Seref[2], [1]SUNY Brockport, Brockport, NY, [2]Virginia Tech, Blacksburg, VA
Digital spaces allow more people to be connected while paradoxically leading to more polarization. Online environments fostering good faith discussions and diverse opinions could mitigate this problem, a good example of which is the ChangeMyView community of the Reddit platform. If a redditor is successful in persuasion, they receive Delta, a reward system with a specific purpose. We seek answers to two phenomena in the CMV community: challenger strategies to persuade the OP and the way the OP processes the comments and changes her view. With a mixed-methods research design, we explore challengers' persuasion strategies and incorporate these strategies into our theoretical model. We utilize content analysis in the qualitative analysis to find themes of persuasion, and we incorporate these themes into our theoretical model and quantitative analysis.

3 Temporal Context Tracking

Onur Seref, Michelle MH Seref, Christopher W. Zobel, Virginia Tech, Blacksburg, VA, Contact: seref@vt.edu
We present a visualization framework for observing changes in context over time in a time stamped text corpus. We introduce different methods to keep track of the local maxima of a three dimensional surface induced by two dimensional points that represent small units of text from the corpus using a kernel function. We use several combinations of popular methods for vectorization and dimensionality reduction to produce the representative points. We apply our framework to a corpus of 311 calls around the onset of the COVID pandemic to study the drastic shift in the reports.

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CC-West 105A

Novel Policy Applications of Natural Language Processing (NLP)

Community Committee Choice Session

Session Chair: Kwan-Yuet Ho, Leidos, Columbia, MD

Session Chair: Weifeng Zhong, Mercatus Center at George Mason University, Arlington, VA

1 Propaganda and Foreign Policy Change in China: Text Analysis of People'S Daily Content During International Crises

Weifeng Zhong, Mercatus Center at George Mason University, Arlington, VA

The People's Daily is at the nerve center of China's propaganda system, and existing research has shown that propaganda changes often precede domestic policy changes. This paper extends this insight to the realm of foreign policy. We collect data on official foreign coverage in the People's Daily before, during, and after international crises involving Chinese military or economic coercion from 1990 to 2022. Using a set of natural language processing techniques, we analyze the text to detect changes in how China's state media prioritize their foreign coverage. We hypothesize that the desire to shape public opinion through propaganda and to tie hands during international bargaining will allow us to detect changes in foreign coverage corresponding to escalation and de-escalation of international crises. The analysis will reveal the extent to which the Chinese government (i) preemptively shapes public attitudes towards a target state before the initiation of military conflicts or economic sanctions or (ii) retroactively spins foreign coverage to manage public opinion during the crisis.

2 Calibration in Categorizing Scientific Documents

Kwan-Yuet Ho, Ledos, Columbia, MD

Model calibration in natural language processing (NLP) supervised learning problem is necessary when a probability of the classification result is important for downstream analysis. These probabilities can be estimated using the model output scores directly. In this talk, the example of Assisted Referral Tool (ART), a tool to categorize scientific grant proposals, is demonstrated to see how the model results are calibrated and the quality of the calibration be measured.

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SE70

CC-West 105B

Networks, Org Structure, and Media for Business Decisions

Community Committee Choice Session

Session Chair: Yuan Yuan, Purdue University, West Lafayette, IN

1 Network Interventions to Reduce Hate Speech on Twitter

Eaman Jahani[1,2], [1]UC Berkeley, Berkeley, CA, [2]University of Maryland, College Park, MD, Contact: eaman@umd.edu

There are growing concerns about the prevalence of hate content on online social media platforms. Several companies have embarked on content moderation as a way to combat online hate speech. The evidence on the effectiveness of these punitive measures is mixed. In contrast, community-driven interventions rely on the existing social capital in networks and can potentially be more long-lasting. This randomized control study evaluates and compares the effectiveness of network-based interventions aimed at reducing hate speech on Nigerian Twitter. We view online hate content as an ecosystem with supply and demand, and test whether an intervention targeting hate producers is more effective than targeting their consumers. The experiment enables us to compare the effectiveness of producer-only and consumer-only campaigns while taking spillovers into consideration.

2 Workers' Propensity to Return to Office: A National Survey

Y. Jessica Cheng, Y. Jasmine Wu, Noshir Contractor, Northwestern University, Evanston, IL, Contact: jasminewu@u.northwestern.edu

The COVID-19 pandemic prompted a major shift to remote and hybrid work, and many organizations are eager to bring workers back to in-person work. While past research has examined gender, commute time, and geographic factors as predictors of worker propensity to telecommute, this study examines worker propensity to return to the office in the post-pandemic world. Through a national survey distributed in the US and China between December 2020 and March 2021, we collected data on workers' willingness to return to the office and their work relations networks. Results of random forest and logistic regression models show that outdegrees of advice and friendships relations in their work teams are important predictors of their propensity to work in person. This research informs organizational policies and practices promoting collaborative hybrid workplaces.

3 Examining Co-Attendance Patterns in Hybrid Work Environments

Marie-Laure Charpignon[1], Yuan Yuan[2], Dehao Zhang[3], Longqi Yang[3], Fereshteh Amini[3], Sonia Jaffe[3], Sid Suri[3], [1]MIT, Cambridge, MA, [2]Purdue University, West Lafayette, IN, [3]Microsoft, Redmond, WA, Contact: mcharpig@mit.edu

Hybrid work introduces new challenges regarding the synchronization of in-office workdays. We quantified co-attendance patterns among employees at a large US

technology company using anonymized building access data. We employed a two-way fixed effects model to investigate the association between an employee's presence in the office and that of their manager and teammates. Employee in-person attendance was 29% higher (7.7pp) when managers were present. Similarly, a one standard deviation increase in the share of an employee's teammates being present boosted their attendance by 16% (4.2pp). Our findings were consistent across multiple countries, emphasizing the importance of peers in driving employee attendance across different geographical and socio-cultural contexts. These empirical results provide evidence of partial coordination in hybrid work settings.

4 Ai-Enhanced Collective Intelligence: A Transactive Systems Framework

Pranav Gupta, University of Illinois, Urbana-Champaign, Champaign, IL, Contact: pranavgu@illinois.edu

AI-powered machines increasingly mediate our collective managerial, economic, and cultural actions. How do we know that such a socio-technical system as a whole, a complex web of hundreds of human-machine interactions, is performing to its potential? I discuss a holistic approach to designing and studying the dynamics of such socio-technical systems. Drawing a parallel to cognitive architectures that describe the key components and processes of an individual agent's decision-making, we describe and extend a candidate socio-cognitive architecture, the Transactive Systems Model of Collective Intelligence, that articulates the key components and processes underlying collaboration in human-AI systems.

5 Habits In Social Media Use: Entropy As A Habit Measure

Amir Tohidi[1], Dean Eckles[2], Ali Jadbabaie[3], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]MIT, Cambridge, MA, [3]University of Pennsylvania, Philadelphia, PA, Contact: atohidi@mit.edu

This talk introduces an innovative methodology for quantifying habitual behavior in the context of social media usage. By leveraging entropy as an implicit measure of regularity, this study aims to uncover the intricate relationship between habit formation and digital routines. Through empirical analyses, we establish the validity of the entropy metric, demonstrating its effectiveness in capturing distinct behavioral patterns beyond mere frequency. Our results highlight the nuanced connection between entropy and future app engagement, indicating a positive association for lower entropy values and a significant decline for excessively irregular patterns. These offer practical insights for managing digital habits and advances our comprehension of how habits manifest in the digital realm and provides a robust tool for predicting long-term user behavior.

Sunday, October 15, 4:00 PM - 5:15 PM

SE71

CC-West 105C

Data Science and Design Science in Information Systems

Flash Session

Session Chair: Hongyi Zhu, UT San Antonio, San Antonio, TX

Session Chair: Victor Benjamin, [1]</sup

1 Using Computational Design Science and Contrastive Self-Supervised Learning to Link Vulnerabilities and Their Remediations

Steven Ullman, University of Arizona, Tucson, AZ, Contact: stevenullman@arizona.edu

Advanced cyberinfrastructure has received millions of dollars in funding to support high-impact organizational and scientific applications. However, open-source software supporting cyberinfrastructure can contain thousands of vulnerabilities and expose cyberinfrastructure to attacks from malicious hackers. Moreover, cybersecurity analysts often struggle remediating vulnerabilities since vulnerability data is often unlabeled and incomplete. This research adopts the computational design science paradigm to develop a novel contrastive self-supervised learning-based artifact to link unlabeled vulnerabilities with their remediations. Experiment results indicate that operating in a self-supervised manner and capturing contextual text features and vulnerability metadata enhances vulnerability remediation linking.

2 Early Detection of Healthcare Misinformation

Minjia Mao, University of Delaware

The growth of the internet greatly influences the spread of misinformation in public, including healthcare misinformation. During the COVID-19 infodemic, a large amount of fake news pieces has caused social panic and weakened the effect of pandemic countermeasures. Existing automatic learning-based detection methods require manual fact-checking for labeling news instances for both true and fake. However, labeled information in healthcare in the early stage is not sufficient due to lacking labor force and expert knowledge. Consequently, our research aims to find an early detection model of healthcare misinformation by leveraging knowledge from other domains.

3 Leverage "Future Information" in Finance Market Prediction with Multi-Task Learning

Yu Zhu, University of Utah, Midvale, UT

When predicting the finance market (e.g., stock price), the predictors must come from the past, i.e., to predict the price on day *t*, we can only use data before *t*, otherwise the model will cheat. In this talk we show that it is possible to leverage "future information"—information that has predictive power on the outcome but is generated *after* time *t*—while *avoiding* cheating. For example, to predict the stock price after the release of quarterly earnings, we can use the *post*-earnings-release stock demand, since demand is strongly associated with price. To achieve that, we adopt the multi-task learning framework and use such future information as model outputs instead of inputs.

4 How Machine-Generated Ratings and Social Exposure Affect Human Reviewers: Evidence from Initial Coin Offerings

Yingxin Zhou[1], Keongtae Kim[2], Ling Xue[1], [1]Georgia State University, Atlanta, GA, [2]The Chinese University of Hong Kong, Shatin, Hong Kong. Contact: yzhou46@gsu.edu

While machine-generated information is prevalent, its impact on human ratings remains understudied. This study exams the influence of increased social exposure and different experiences on human experts' ratings relative to machine-generated ratings (MGRs) in the context of online professional ratings of initial coin offerings (ICOs). Leveraging an ICO rating platform's interface design change, we find that increased social exposure leads experts with advisor experiences to lower ratings and rate below and closer to MGRs. Besides, increased social exposure leads human experts with team member experiences to rate closer to MGRs, without significantly affecting their rating levels. Overall, increased social exposure drives human experts to conform to MGRs, possibly correcting humans' rating biases.

5 Systemic Fairness

Arindam Ray[1], Balaji Padmanabhan[1], Lina Bouayad[2], [1]University of South Florida, Tampa, FL, [2]Florida International University, Miami, FL, Contact: arindamray@usf.edu

Machine learning algorithms are increasingly used to make or support decisions in a wide range of settings. With such expansive use there is also growing concern about the fairness of such methods. Prior literature on algorithmic fairness has extensively addressed risks and in many cases presented approaches to manage some of them. However, most studies have focused on fairness issues that arise from actions taken by a (single) focal decision-maker or agent. In contrast, most real-world systems have many agents that work collectively as part of a larger ecosystem. This paper develops formalisms for firm versus systemic fairness and calls for a greater focus in the algorithmic fairness literature on ecosystem-wide fairness - or more simply systemic fairness - in real-world contexts.

6 Empirical Investigation of Software Security Vulnerabilities Present in Human and Machine Generated Code

Agrim Sachdeva, Indiana University, Bloomington, IN

Our study conducts an empirical analysis that examines potential vulnerabilities in human-generated versus machine-generated code. Using open-source machine-generated code datasets, and vulnerability scanners, we provide insights into the relative security strengths and weaknesses of machine and human generated code. Our research aims to inform safer software development practices and enhance the robustness of AI-generated code.

7 Multi-Modal Retrieval-Based Chest X-Ray Report Summarization

Xingmeng Zhao, Tongnian Wang, Anthony Rios, The University of Texas at San Antonio, San Antonio, TX, Contact: xingmeng.zhao@utsa.edu

Radiology report summarization aims to automatically provide concise summaries of radiology findings, reducing time and errors in manual summaries. However, current methods solely summarize the text, which overlooks critical details in the images. Unfortunately, directly using the images in a multimodal model is difficult. Multimodal models are susceptible to overfitting due to their increased capacity, and modalities tend to overfit and generalize at different rates. Thus, we propose a novel retrieval-based approach that uses image similarities to generate additional text features. We further employ few-shot with chain-of-thought and ensemble techniques to boost performance. Overall, our method achieves state-of-the-art performance across multiple metrics.

8 How Online Reviews Create Distortion: Uncovering the Real Demand

Wenya Shen, Arizona State University, AZ

Online shopping remains a growing market in the retail industry; however, customers face uncertainty about product attributes without the opportunity to evaluate them physically when purchasing. The uncertainty often leads to demand distortion, a scenario when customers purchase products that do not meet their expectations or fulfill their needs. Despite the severe problems caused by demand distortion, there has been a limited understanding of the formation of demand distortion and how to mitigate it. This motivates us to develop a framework that can integrate both purchase and return information to understand the source of demand distortion and the associated market outcomes. This study not only provides practical implications for adjusting firm strategies but also examines the societal impact on the environment from the counterfactual analysis.

9 Social Context Behind Visual Content - a Multimodal Approach

Shuang Gao, Victor Benjamin, Pei-yu Chen, Arizona State University, Tempe, AZ

In recent years, the trend of social media analytics has moved from text format to visual format. For visual analytics, most machine vision models are set up to recognize objects, but usually not able to understand the social context behind it. However, human readers can understand the intention and react with their likes and comments, which may contain their understanding. Therefore, we proposed to leverage the crowd wisdom from selected comments to help the machine in intention classification. The model enables practitioners to detect image threads with specific intentions. Organizations can collect product feedback and brand perceptions concerning themselves and their competitors from large volumes of data, and across vast lengths of time.

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CC-West 106A

Using Data for Socially Responsible Operations

Community Committee Choice Session

Session Chair: Rakesh Reddy Mallipeddi, Th Ohio State University, Columbus, OH

Session Chair: Subodha Kumar, Fox School of Business, Temple University, Philadelphia, PA

1 Modeling Single-Donor Organ Chain Exchange: Optimization Framework for Analyzing Transplant Success

Rakesh Reddy Mallipeddi[1], Chelliah Sriskandarajah[2], Jon M. Stauffer[2], Yunxia Zhu[3], [1]Th Ohio State University, Columbus, OH, [2]Texas A&M University, College Station, TX, [3]University of Nebraska-Lincoln, Lincoln, NE, Contact: yunxia.zhu@unl.edu

An optimal matching problem to maximize transplant success rate is investigated in the context of single donor organ exchange, where one living donor's organ is transplanted to a single patient. In such exchanges, multiple medical compatibility criteria pose a serious challenge for matching a patient with compatible donor. The objective of these exchanges is to increase matching donors with patients requiring organs with maximum transplant success rate. In order to facilitate this organ matching, we use chain mechanism to increase the number of patient-donor matches with maximum success rate for patients receiving transplants. We formulate a general optimization framework for obtaining the chain that maximizes the success rate of patients receiving transplants taking into account multiple compatibility criteria.

2 AI-Powered Personalized Grocery Service

Jingchen Cao[1], Xiaowei Bao[2], Antoine Atallah[3], [1]Hungryroot, San Francisco, CA, [2]Hungryroot, Portland, OR, [3]Hungryroot, Seattle, WA, Contact: xiaowei.bao@hungryroot.com

When shopping for groceries, composing a diverse weekly shopping cart can be challenging. Here we introduce the innovative approach of Hungryroot in revolutionizing the grocery shopping experience using artificial intelligence and machine learning techniques. Our comprehensive solution encompasses a robust data collection framework, advanced statistic analysis and modeling, and a multi-objective mix-integer programming model, which adeptly balances essential objectives like taste, convenience, nutrition, cost, and suitability. In addition, this solution generates personalized offerings for groceries and recipes that cater to each customer's distinct preferences and goals, making shopping for and planning healthy food easier than ever.

3 Online Harassment Toward Transgender Across Social Media Platforms: An Examination of Victim Mental Health Using Deep Learning Methods

Siying Guo[1], Edwin (Yuchen) Wang[2], [1]Wayne State University, Detroit, MI, [2]Kean University, Union, NJ

This research aims to address the prevalent issue of online harassment (OH) towards transgender individuals by utilizing deep learning techniques to automatically identify and analyze harmful images on social media platforms. The proposed deep convolutional neural network model is developed to detect and classify various forms of OH. By examining the typologies, factors, mental health consequences, and coping strategies associated with OH, this study provides valuable insights into the experience of the transgender community. The constructed dynamic decision support system (DDSS) enables effective detection of OH while ensuring user privacy, and can inform the development of interventions, policies, and technologies.

Sunday, October 15, 4:00 PM - 5:15 PM

SE73

CC-West 106B

Machine Learning in Finance

Community Committee Choice Session

Session Chair: Markus Pelger, Stanford University, Stanford, CA

1 Agent-Based Market Simulators: Mean-Field Games and Generative Adversarial Networks

Renyuan Xu, University of Southern California, Los Angeles, CA, Contact: renyuanx@usc.edu

Deep-learning-based market simulators have garnered significant attention for generating realistic financial scenarios, yet they often overlook interactions among market participants. This can lead to issues such as unrealistic back-testing performance when market impacts are ignored. In contrast, multi-agent simulation (MAS) allows for incorporating vital interactions among agents, shedding light on how the dynamics arise from traits of individuals and the underlying environment. However, the performance of existing MAS methods is limited when dealing with a large number of agents.
In this talk, we tackle the scalability challenge by applying mean-field approximations. Additionally, we employ generative adversarial networks to construct market simulators. The talk will cover both theoretical developments and empirical performance.

2 Inference for Large Panel Data with Many Covariates

Markus Pelger, Jiacheng Zou, Stanford University, Stanford, CA, Contact: jiachengzou@stanford.edu

This paper proposes a novel testing procedure for selecting a sparse set of covariates that explains a large dimensional panel. Our method provides correct false detection control while having higher power than existing approaches.
We develop inferential theory for large panels with many covariates by combining post-selection inference with a novel multiple testing adjustment. Our data-driven hypotheses are conditional on the sparse covariate selection. As an easy-to-use and practically relevant procedure, we propose Panel-PoSI, which combines the data-driven adjustment for panel multiple testing with valid post-selection p-values of LASSO. In an empirical study, we select a small number of asset pricing factors that explain a large cross-section of investment strategies. Our method dominates the benchmarks out-of-sample due to its better size and power.

3 Asset-Pricing Factors with Economic Targets

Svetlana Bryzgalova[1], Victor DeMiguel[1], Sicong Li[1], Markus Pelger[2], [1]London Business School, London, United Kingdom; [2]Stanford University, Stanford, CA, Contact: ali@london.edu

We propose a method to estimate latent asset-pricing factors that incorporates economically motivated targets for both cross-sectional and time-series properties of the factors. Cross-sectional targets may capture the shape of loadings (monotonicity of expected returns across characteristic-sorted portfolios) or the pricing span of exogenous state variables (macroeconomic innovations or intermediary-based risk factors). Time-series targets may capture overall expected returns or mispricing relative to a benchmark reduced-form model. Using a large-scale set of assets, we show that these targets nudge risk factors to better span the pricing kernel, leading to substantially higher Sharpe ratios and lower pricing errors than conventional approaches.

4 Estimating Market Liquidity from Daily Data: Marrying Microstructure Models and Machine Learning

Yuehao Dai, Ruixun Zhang, Peking University, Beijing, China. Contact: 2201110080@pku.edu.cn

We apply machine learning to estimate market liquidity by combining human-engineered liquidity proxies based on microstructure models and widely available low-frequency (daily) data. Nonlinear machine learning models can effectively estimate high-frequency spread from the raw low-frequency data alone, achieving better performances than human-engineered proxies. In addition, combining these proxies and the raw low-frequency data further improves performance. The machine learning models can be interpreted using feature importance scores, partial dependence plots, and Shapley values. The latter two show nonlinear relationships otherwise not captured by prior approaches. Our results suggest that significant improvements in liquidity estimation can be achieved by combining human knowledge and machine.

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CC-West 106C

Michael H. Rothkopf Junior Researcher Paper Prize

Award Session

Session Chair: Martin Bichler, Technical University of Munich, Garching B. München, Germany

1 Contextual Standard Auctions with Budgets: Revenue Equivalence and Efficiency Guarantees

Rachitesh Kumar, Santiago Balseiro, Christian Kroer, Columbia University, New York, NY

2 Dynamic Pricing Provides Robust Equilibria in Stochastic Ride-Sharing Networks

J Massey Cashore, Peter Frazier, Eva Tardos, Cornell University, Ithaca, NY

3 Batching and Optimal Multi-stage Bipartite Allocations

Yiding Feng, Rad Niazadeh, University of Chicago Booth School of Business, Chicago, IL

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SE75

Session.Location:CC-West 208A

Operations Planning for Autonomous Entities

Contributed Session

Session Chair: Yiduo Huang, University of California-Berkeley, Berkeley, CA

1 A Machine Learning Enhanced Multi-Robot Path Planning Protocol for AMR Intralogistics

Zekun Liu, Seokcheon Lee, Purdue University, West Lafayette, IN, Contact: louiszekunliu@gmail.com

Multi-Robot Path Planning (MRPP) plays a critical role in the fleet management of Autonomous Mobile Robots (AMR) Intralogistics, influencing conflict incidence and informing task allocation through travel time predictions. However, traditional methods use deterministic Multiagent Pathfinding (MAPF) algorithms or assume arbitrary delay probabilities in static planning scenarios, failing to address real-world uncertainties. We propose a real-time, reservation-based MRPP protocol coupled with a machine learning-based time estimator. This innovative approach reduces replanning and timeouts, enhancing task scheduling accuracy and ensuring that AMRs execute tasks as planned.

2 Truck-Heterogeneous Sidekicks Cooperative Traveling Salesman Problem with Battery Swapping and Parcel Handover Between Delivery Robots and Unmanned Aerial Vehicles

Joohang Kang, Byoungil Choi, Joonyup Eun, Korea University, Seoul, Korea, Republic of

In the aftermath of the economic crisis following COVID-19, the unmanned delivery is still attractive due to its relatively cheap operational costs. This study proposes a model that employs a truck and heterogeneous sidekicks (i.e., delivery robots and unmanned aerial vehicles) cooperatively. The distinction of the model from the existing models is that an unmanned aerial vehicle can swap batteries and receive parcels from delivery robots as well as the truck to perform additional deliveries. In this talk, the concept and mathematical formulation are presented. In addition, a tailored heuristic to solve large number of customer cases within a reasonable computation time are proposed. The effectiveness of the model and managerial implications are demonstrated based on numerical experiments.

3 Drone-Truck Arc Routing Problem: A Single-Drone-Single-Truck Case

Sung Hoon Chung, Emad Alenany, Binghamton University, Binghamton, NY, Contact: schung@binghamton.edu

We address a Drone-Truck Arc Routing Problem (DT-ARP) for which an integer programming model is proposed. To solve the model, a heuristic method is used following the route-first, cluster-second approach in which the best combination of launch and recover nodes for each edge associated with best savings is selected. We use multiple initial truck tours and use local search (LS) and Simulated Annealing (SA) for the selection of the initial truck solution. Numerical examples are presented to discuss the effectiveness of the proposed model and heuristic for DT-ARP.

4 Flow-Based Integrated Assignment and Path-Finding for Mobile Robot Sorting Systems

Yiduo Huang[1], Zuo-Jun Max Shen[2], [1]University of California-Berkeley, Berkeley, CA, [2]University of California Berkeley, Berkeley, CA, Contact: yiduo_huang@berkeley.edu

In robotic sorting systems, mobile robots are used to sort incoming parcels by destination. In this study, we propose an integrated assignment and path-finding method for robots in such sorting systems. The method has two parts: offline and online. In the offline part, we represent the system as a traffic flow network, develop an approximate delay function using stochastic models, and solve the min-cost network flow problem. In the online part, robots are guided through the system according to the calculated optimal flow split probability. The online calculation of the method is decentralized and has linear complexity. Our method gives the approximated system-optimal traffic assignment rather than an equilibrium flow assignment. According to our simulations, our method can achieve 10%-20% higher throughput than zoning or random assignment.

Sunday, October 15, 4:00 PM - 5:15 PM

SE76

Session.Location:CC-West 208B

Optimization of Autonomous Transportation Systems

Contributed Session

Session Chair: Sina Bahrami, University of Michigan, Ann Arbor, MI

1 Bi-Objective Optimization for Scheduling of Connected and Autonomous Vehicles at a Reservation-Based Intersection Considering Efficiency and Safety

Muting Ma[1], Zhixia Li[2], Matthew Hudnall[3], Mesut Yavuz[3], [1]The University of Alabama, Tuscaloosa, AL, [2]University of Cincinnati, Cincinnati, OH, [3]University of Alabama, Tuscaloosa, AL

Efficiency and safety at a reservation-based intersection are two conflicting objectives with respect to scheduling the connected and autonomous vehicles (CAVs). When CAVs cross the intersection as a platoon, the efficiency of the intersection improves, whereas the collision risk increases. In terms of balancing these two conflicting objectives, a bi-objective optimization model is proposed by obtaining an optimal platoon size of CAVs. An efficient frontier approach is exploited where the simultaneous maximization of efficiency and minimization of collision risk is desired. The efficient frontier is constructed via an exact dynamic programming algorithm. The optimal platoon size is obtained under different thresholds of efficiency and safety. Scheduling and trajectory planning insights for CAVs are provided in terms of grouping vehicles into a platoon.

2 Coordinated Platooning and Adaptive Routing with Reinforcement Learning

Xi Xiong[1], Maonan Wang[2], Dengfeng Sun[3], Li Jin[4], [1]Tongji University, Shanghai, China; [2]The Chinese University of Hong Kong, Shenzhen, China; [3]Purdue University, West Lafayette, IN, [4]Shanghai Jiao Tong University UM Joint Institute, Shanghai, China. Contact: xi_xiong@tongji.edu.cn

Platooning connected and autonomous vehicles has the potential to reduce both congestion and fuel consumption. While previous work has extensively examined platooning in static networks, this project delves into the interaction among vehicles and presents a reinforcement learning framework specially designed for platooning in dynamical networks. We explore coordinated platooning in conjunction with adaptive routing within networks. To achieve this, we decouple the action space and use reinforcement learning to estimate travel times for routing purposes. This estimation can subsequently be utilized in the threshold-based policy for coordinated platooning. The results obtained demonstrate the superiority of our approach compared to traditional methods, especially in dynamically changing networks.

3 Lane-Change Behavior of Human-Driven Vehicles in Mixed-Flow Traffic: A Driving Simulator Study

Yongyang Liu[1], Srinivas Peeta[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA, Contact: liuyongyang@gatech.edu

Connected and autonomous vehicles (CAVs) and human-driven vehicles (HDVs) will coexist on roads in the future, creating mixed-flow traffic. The heterogeneity of HDVs' lane-change (LC) behavior can significantly impact CAV operations and degrade CAV control performance. This driving simulator-based study investigates HDVs' LC behavior in mixed-flow traffic and analyzes differences in their lane change behaviors involving HDVs and CAVs. Behavior evolution is also factored as HDVs' LC behavior may evolve after human drivers gain more experience in driving alongside CAVs.

4 Optimal Investment in Driving Automation: Onboard vs. Roadside Sensors

Mohammadamir Ahmadian[1], Sina Bahrami[2], Mehdi Nourinejad[1], Yafeng Yin[2], [1]York University, North York, ON, Canada; [2]University of Michigan, Ann Arbor, MI, Contact: sinab@umich.edu

Connected automated vehicles are a rapidly advancing technology that has the potential to revolutionize traffic. CAVs use information collected by their sensors to make motion decisions. Each CAV sensor information can be complemented by information shared by other CAVs through vehicle-to-vehicle (V2V) or roadside sensors through vehicle-to-infrastructure (V2I). Exploiting the setting of a CAV-exclusive corridor, we investigate optimal investment in roadside sensors or connectivity to minimize travel time. Our analysis shows that roadside unit investment is beneficial for low traffic flow, and when the traffic flow is over some threshold, connectivity investment to enable V2V can be more effective than roadside units.

Sunday, October 15, 4:00 PM - 5:15 PM

SE77

Session.Location:CC-West Lecture Hall

Analytics and AI

Contributed Session

Session Chair: Aida Khosh Raftar Nouri, Memorial university, St Johns, NL, Canada

1 Advancing Root Cause Analysis with Causal Inference Using Boosting Trees and Topological Data Analysis

Janhavi Giri[1], Attila Lengyel[1], Edward Kibardin[2], [1]Intel Corporation, Folsom, CA, [2]DataRefiner, London, United Kingdom. Contact: janhavi.giri@intel.com

Causal inference is vital across many fields, but it's challenging due to confounding effects, selection bias, and other factors. Machine learning techniques, such as boosting trees, is helpful because it handles high-dimensional data and nonlinear relationships. Topological Data Analysis (TDA) is also promising, as it uncovers complex structures and patterns in data. We propose a novel framework for causal inference that combines boosting trees and TDA. We use boosting trees to estimate causal effects and TDA to identify potential causal pathways and mechanisms. Our approach provides accurate causal inference and deeper insights into the data.

2 Using Decision Trees to Explain Machine Learning Models

Tom Grant, SAS Global Academic Program, Cary, NC, Contact: tom.grant@sas.com

Machine Learning Algorithms can be powerful tools in complex analytic models. However, using a Machine Learning Model is considered "Black Box" technique, where the relationships between inputs and target cannot be directly communicated for explanatory purposes. The appeal of using traditional statistical models (such as Regression) because the magnitude and directional impact (positive or negative) of each model input can be determined, often over-rules the use of Machine Learning models (particularly in observational studies).Using Decision Trees after a Machine Learning model is built, can help remove most of the ambiguity that comes with these "Black Box" algorithms.The combination of Machine Learning and Decision Trees allows the modeler to take advantage of the flexibility and strength of the algorithms without losing the interpretability.

3 Evaluation Imputation in a Two-Way Table of Means for Training Data Construction

Atousa Arzanipour[1], Sigurdur Olafsson[2], [1]Iowa state university, ames, IA, [2]Iowa State University, Ames, IA, Contact: arzani@iastate.edu

The process of predictive machine learning starts with a training dataset. For each of two predictor variables and a response variable, the training dataset can be converted into a two-way table where the rows and columns are each of the predictor variables and the values of each cell are the value of the response variable corresponding to those predictor variables. This two-way table can be highly sparse with a lot of missing values where each missing value represents an observation that could have been possibly made but hasn't. The values for missing observations can be constructed using imputation methods. This research study imputation methods in two-way tables to investigate how they can be used for constructing new data points when the two-way table is converted back to the training dataset then analyze how well such data construction improve quality of predictive models.

4 Optimal Feature Split in Classification Models with Dependency

Daniel B. D. Abib[1], Cristian Bravo[1], Raffaella Calabrese[2], Maria Oskarsdottir[3], [1]University of Western Ontario, London, ON, Canada; [2]University of Edinburgh, Edinburgh, United Kingdom; [3]University of Reykjavik, Reykjavik, Iceland. Contact: dbarboza@uwo.ca

In this work, we estimate a model with more than one source of dependency in the form of a multilayer graph, then develop a two-step method to split the features of a dataset into two blocks for subsequent modeling, which is necessary to avoid endogeneity. Examples of such sources of dependency could be geographical distance and money transfer between companies.We show that including multiple sources of dependency between individuals might improve the performance of classification models. For this, we combine Generalized Method of Moments estimation of spatial models with a branch and bound algorithm that searches for the best feature split, and test our methodology to measure the correlated credit risk of a set of small businesses.

5 Enhancing Machine Learning Performance with Instance-Based Data Collection

Aida Khosh Raftar Nouri, Memorial university, St Johns, NL, Canada. Contact: akhoshraftar@mun.ca

Advancements in machine learning (ML) performance are increasingly reliant on data diversity. Traditional class-based data collection methods, however, can limit this diversity due to their predefined categories and attributes, potentially leading to an inadequate representation of complex subjects. In contrast, instance-based data collection captures a more comprehensive attributes, thereby enhancing the accuracy and reliability of ML models. By identifying the most relevant attributes and potential confounders, and avoiding

overfitting, instance-based methods offer a richer data source for feature selection. Emphasizing the potential of instance-based data collection, this study highlights its role in improving ML performance across various applications, providing a more accurate, diverse, and effective approach for data gathering in the ML field.

Sunday, October 15, 4:00 PM - 5:15 PM

SE78

Session.Location:CC-West 211A

spORts I

Community Committee Choice Session

Session Chair: Liz Wanless, Ohio University, Athens, OH

1 Does Draft Currency Promote Competitive Balance? an Empirical Investigation of the National Football League 2002-2021

Michael A. Lapre[1], Elizabeth M. Palazzolo[2], [1]Vanderbilt University, Nashville, TN, [2]Lazard, New York, NY, Contact: m.lapre@vanderbilt.edu

In the NFL draft, teams take turns selecting entering players. The draft is a market mechanism designed to promote competitive balance as the NFL assigns draft positions to teams in reverse order relative to last season's performance. Teams frequently trade draft picks. We use several market valuations of draft picks to define original draft currency as the total value of draft picks available before any trades and final draft currency as the total value of picks used after all trades. For the 2002-2021 period, counter to the intent of the draft, we find that original draft currency does not affect the probability of reaching the playoffs, but final draft currency does. Usage of outdated market valuations by most teams can help explain how the best team has used draft-pick trades to remain among the strongest teams over two decades thereby perpetuating competitive imbalance.

2 Advances by Female Athletes from the Ancient Olympics to the Present and Fairness in Gender Inclusiveness

Raymond Stefani, California State University, Long Beach, Lake Forest, CA

In the ancient Olympics and early modern Olympics, emphasis was on men. By the 1970s, the female/male velocity ratio of Olympic champions in running and swimming reached the lean-to-weight ratio for women, indicative of reaching equal training and efficiency. Born with testosterone creating testes (which influence lean-to-weight ratio) instead of ovaries, testosterone restrictions are required of Castor Semenya and other intersex female athletes who were simply born that way. Conversely, it is quite fair to place no restrictions on muscular weight throwers and African distance runners with high lean-to weight ratios and oxygen capacity who also were born that way. It is fair to place testosterone restrictions on men transitioning to become female athletes. They are probably already undergoing hormone therapy, but it is important to make such restriction age sensitive.

3 Moving the Needle from Confusing to Consequential: Making the Most of Sports Examples in the Classroom

Keith A. Willoughby[1], Kent J. Kostuk[2], [1]University of Saskatchewan, Saskatoon, SK, Canada; [2]Engcomp, Saskatoon, SK, Canada

We enjoy deploying sports examples in the classroom. These examples enable us to discuss a key concept, enhance classroom understanding, or nurture student curiosity about the applicability of analytical approaches. Despite some students who feverishly dive into these classroom examples, we have observed challenges. For instance, a sports-based example may present a completely unknown environment to some students. We describe strategies for conveying curriculum content, while ensuring that a focus on sports examples does not deter student learning.

4 Sports Betting Markets and the Football Power Index

Thomas Robbins, East Carolina University, Greenville, NC

Major analytics organizations have developed and promoted a predictive model known as a Football Power Index. In this talk we examine 2 models, the ESPN FPI, and the 538.com ELO model. We discuss how they work, how accurate they are, and how they fare relative to sport betting markets. We investigate what they tell us about semi-strong efficiency in sports betting markets.

Sunday, October 15, 4:00 PM - 5:15 PM

SE79

Session.Location:CC-West 211B

George B. Dantzig Dissertation Prize

Award Session

Session Chair: Daniela Saban, Stanford University, Palo Alto, CA

1 Revenue Management in Video Games and with Fairness

Xiao Lei, University of Hong Kong, New York, NY

Video games are the largest and fastest-growing segment of the entertainment industry, yet have received limited attention from the operations community. This thesis explores revenue management and matchmaking problems in video games, focusing on loot boxes, player engagement, and fairness issues. We consider optimal pricing and design of loot boxes, aiming to maximize revenue while providing customer protection. We also explore managing player engagement through optimal matchmaking policies and AI bots, using optimization and real data. Finally, we address the inequality induced by price discrimination in e-commerce platforms, considering fairness regulations and their impact on social welfare.

2 Social Choice for Social Good: Proposals for Democratic Innovation from Computer Science

Paul Gölz, Cornell University, Ithaca, NY

Driven by shortcomings of current democratic systems, practitioners and political scientists are exploring democratic innovations, i.e., institutions for decision-making that more directly involve constituents. In this thesis, we support this exploration via three approaches: we design practical algorithms for use in democratic innovations, we mathematically analyze the fairness properties of proposed decision-making processes, and we identify extensions of such processes that satisfy desirable properties

3 Uncertainty in Service Systems: Performance Measure Estimation and Optimization Methods for Contact Centers with Information Uncertainty

Antonio Castellanos, Israel Institution of Technology, Haifa, Israel

In the quest to improve services, companies offer customers the opportunity to interact with their agents using texting. This has become a favorite channel of communication for customers with companies. However, text-based contact centers face operational challenges. Via data analysis of two North American contact centers, we find that the usual ways of analyzing and measuring quality in call centers give biased estimations of performance levels. The reason for this is the way customers and employees behave in these systems, which creates various types of information uncertainty. In this thesis we identify the main sources of such uncertainty and develop methods to cope with them. We do this by combining statistical and optimization methods.

4 Experimental Design and Decision-Making in Marketplace Platforms

Hannah Li, Columbia, New York, NY

Online platforms rely on experiments to aid decision-making. However, in marketplace platforms, prior work shows that treatment effect estimates can be biased due to interference, or users interacting with each other. This dissertation develops a structural modeling method to study interference in marketplace experiments. The work finds two main results that are helpful for practitioners: (1) Supply and demand imbalance balance is a primary factor determining which side of the market (supply or demand) should be randomized to minimize bias. (2) The work introduces a novel experimental design using Two-Sided Randomization and associated estimators that achieve relatively low bias in a wide range of supply and demand imbalance regimes.

5 Adaptivity, Structure, and Objectives in Sequential Decision-Making

Sean Sinclair, Massachusetts Institute of Technology, Cambridge, MA

We will consider designing methods for sequential decision-making (bandits, reinforcement learning) that leverage auxiliary data sources (imitation learning, exogenous datasets, geometric assumptions) based on the themes of adaptivity, structures, and objectives. We will specialize this framework in areas including memory management, fair resource allocation, and cloud computing. Central to this, we will additionally discuss our open-source code instrumentation and methodology to analyze the multi-criteria performance of algorithms on these problems.

Sunday, October 15, 4:00 PM - 5:15 PM

SE80

Session.Location:CC-West 212A

INFORMS JFIG Best Paper Competition I

Award Session

Session Chair: Albert Solomon Berahas, University of Michigan, Ann Arbor, MI

1 The Power of Simple Menus in Robust Selling Mechanisms

Shixin Wang, The Chinese University of Hong Kong, Hong Kong, China

We study the robust screening problem with a finite menu size. Our framework characterizes the optimal selling mechanisms and the corresponding competitive ratio across various menu sizes and ambiguity sets of the buyer's valuation distributions, such as support, mean, and quantile ambiguity sets. We show that a selling mechanism with a small menu already yields a competitive ratio comparable to the optimal robust mechanism with infinite options in the menu. Remarkably, a menu size of merely two can significantly enhance the competitive ratio compared to deterministic pricing, which establishes a favorable trade-off between theoretical performance and implementation simplicity.

2 Compact Formulations for Low-rank Functions with Indicator Variables

Andres Gomez, University of Southern California, Los Angeles, CA

We study the mixed-integer epigraph of a special class of convex functions with nonconvex indicator constraints, which are often used to impose logical constraints on the support of the solutions. The class of functions we consider are defined as compositions of low-dimensional nonlinear functions with affine functions. Extended formulations describing the convex hull of such sets can easily be constructed via disjunctive programming, although a direct application of this method often yields prohibitively large formulations, whose size is exponential in the number of variables. In this paper, we propose a new disjunctive representation of the sets under study, which leads to compact formulations with size exponential in the dimension of the nonlinear function, but polynomial in the number of variables. Moreover, we show how to project out the additional variables for the case of dimension one, recovering or generalizing known results for the convex hulls of such sets (in the original space of variables). Our computational results indicate that the proposed approach can significantly improve the performance of solvers in structured problems.

3 Quantifying Spatial Under-reporting Disparities in Resident Crowdsourcing

Nikhal Garg, Cornell Tech, New York, NY

Modern city governance relies heavily on crowdsourcing to identify problems such as downed trees and power-lines. A major concern is that residents do not report problems at the same rates, with heterogeneous reporting delays directly translating to downstream disparities in how quickly incidents can be addressed. Measuring such under-reporting is a difficult statistical task, as, by definition, we do not observe incidents that are not reported or when reported incidents first occurred. Thus, low reporting rates and low ground-truth incident rates cannot be naively distinguished, and reporting delays are unobserved. We develop a method to identify (heterogeneous) reporting delays, without using external ground truth data. Our insight is that rates on duplicate reports about the same incident can be leveraged to disambiguate whether an incident has occurred with its reporting rate once it has occurred. Using this idea, we reduce the question to a standard Poisson rate estimation task -- even though the full incident reporting interval is also unobserved. We apply our method to over 100,000 resident reports made in New York City and to over 900,000 reports made in Chicago, finding that there are substantial spatial disparities in how quickly incidents are reported, even after controlling for incident characteristics -- some neighborhoods report three times as quickly as do others. These spatial disparities correspond to socio-economic characteristics: in NYC, higher population density, fraction of people with college degrees, income, and fraction of population that is White all positively correlate with reporting rates. Finally, leveraging a collaboration with the NYC Department of Parks and Recreation, we demonstrate how estimating reporting delays leads to practical insights and interventions for more equitable, efficient government service.

Sunday, October 15, 4:00 PM - 5:15 PM

SE81

Session.Location:CC-West 212B

Undergraduate Outreach through Case Competitions: Benefits and Challenges

Panel Session

Session Chair: Steve E. Moss, Georgia Southern University, Statesboro, GA

1 Undergraduate Outreach through Case Competitions: Benefits and Challenges

Steve E. Moss, Georgia Southern University, Statesboro, GA

This session is being provided by the Informs Undergraduate Outreach Committee. The session will be a panel discussion on various types of student competitions. Topics discussed may include the benefits to you students and program, how to organize competitions and differences between graduate and undergraduate student competitions. Panelists are Matthew Lanham, Purdue University, Carrie Beam, University of California at Berkeley and Cody Baldwin, University of Wisconsin-Madison. The moderator will be Steve Moss, Georgia Southern University.

2 Panelist

Cody Baldwin, University of Wisconsin-Madison, Madison, WI

3 Panelist

Matthew A. Lanham, Purdue University, Lafayette, IN

4 Panelist
Carrie Beam, University of California Davis

Sunday, October 15, 4:00 PM - 5:15 PM

SE82

Session.Location:CC-West 212C

Innovative Healthcare Service Delivery Models

Contributed Session

Session Chair: Marco Bijvank, University of Calgary, Calgary, AB, Canada

1 Insurance Coverage for Telehealth Services and Analysis of Appointment Scheduling Metrics for Selected Healthcare Specialties

Aysenur Betul Cengil, Burak Eksioglu, Sandra D. Eksioglu, University of Arkansas, Fayetteville, AR

The COVID-19 pandemic triggered policy changes in 2020, allowing insurance companies to reimburse telehealth services, which led to increased telehealth use. However, with many emergency rules ending in 2022, there is a concern about a potential decrease in telehealth services. This study examines telehealth use in Arkansas from 2020 to 2022. We employed statistical tools to compare the number of telehealth and in-person visits for specific specialties and investigated insurance coverage trends for each. Our evaluation also included a procedure to calculate appointment performance metrics such as waiting time and appointment length. We presented our results for specific specialties to highlight the potential benefits of telehealth.

2 Telemedicine: Not Just If, But How It Bridge Healthcare Equity

Saif Benjaafar[1], Xiaonan Li[2], Hai Wang[3], Xiaotang Yang[1], [1]University of Minnesota, Minneapolis, MN, [2]Tongji University, Shanghai, China; [3]Singapore Management University, Singapore, Singapore. Contact: 1830336@tongji.edu.cn

Disparities in the distribution of healthcare resources have long created a chasm between urban and rural hospitals. Urban hospitals suffer from overcrowding, while their rural counterparts face underutilization. In this study, we leverage a queueing game model to delve into patients' choices, considering factors such as the hospital's critical care capability, travel costs, waiting durations, and patients' health perceptions. Our findings underscore the potential of telemedicine to re-balance this inequity. By channelling a portion of the urban hospital's capacity to serve rural patients via telemedicine, urban congestion can significantly decrease. Our research further elucidates the conditions required for this rebalance and offers actionable insights for optimizing telemedicine integration, ensuring both societal benefit and healthcare equity.

3 Managing Capacity Reservation for Low-Priority Strategic Patients

Guanlian Xiao[1], Marco Bijvank[2], [1]Vrije Universiteit Amsterdam, Amsterdam, Netherlands; [2]University of Calgary, Calgary, AB, Canada. Contact: marco.bijvank@haskayne.ucalgary.ca

We study a healthcare system that operates two parallel tracks, i.e., a shared track and a dedicated track, to serve two priority classes of patients. High-priority patients are assigned to the dedicated track for prompt service following a FCFS principle. When the dedicated track is relatively busy, high-priority patients are diverted to the shared track with a non-preemptive priority over low-priority patients. Low-priority patients are strategic, and they choose to join the waiting queue on the shared track, or to balk from the system. Their join-or-balk decision is made based on the utility of joining after obtaining delay information. In our study, we consider two types of expected waiting time information to be revealed to low-priority patients: long-term expected waiting time, and real-time expected waiting time.

Sunday, October 15, 4:00 PM - 5:15 PM

SE83

Session.Location:CC-West 213A

Machine Learning and Optimization Applications II

Contributed Session

Session Chair: Ashish Chandra, Illinois State University, Bloomington, IL

1 Enhancing State-Level Unemployment Rate Forecasts Using Google Trends Data

Levent Bulut[1], Islam Rizvanoghlu[2], [1]University of North Texas, Frisco, TX, [2]NRG Energy, Houston, TX

In this study, we incorporate the generalized additive model (GAM) into the time-series models to forecast and nowcast the monthly state-level unemployment rate statistics in the U.S. from January 2004 to April 2023. Our focus is on utilizing Google Trends data, which provides real-time, high-frequency, and state-specific information. As job search is a requirement for eligibility to receive unemployment insurance benefits in 49 out of the 50 states, we explore whether Google Trends data can enhance the accuracy of state-level unemployment rate forecasts compared to data on initial claims and other factors. Our findings indicate a significant correlation between searches for unemployment-related phrases and state-level unemployment rates

2 A Study on Distributionally Robust Optimization with Changeable Ambiguity Sets

Zhengsong Lu[1], Bo Zeng[2], [1]University of Pittsburgh, Pittsburgh, PA, [2]University of Pittsburgh, Pittsburgh, PA, Contact: zs.lu@pitt.edu

We study DRO (Distributionally Robust Optimization) models with complex ambiguity sets that can be modified, including those defined by moment inequities and the Wasserstein metric.

3 Bayesian Kernelized Tensor Factorization as Surrogate for Bayesian Optimization

Lijun Sun, McGill University, Montreal, QC, Canada. Contact: lijun.sun@mcgill.ca

4 A Generative Neural Network Based Surrogate Model for Displacement Estimation for Topology Optimization in B-Spline Space

Congfang Huang, UW Madison, Madison, WI, Contact: chuang286@wisc.edu

This work establishes a generative neural network-based surrogate model for estimating displacements in topology optimization within the B-spline space. The model aims to improve the efficiency of the optimization process by providing accurate displacement predictions.

5 Risk Minimization for Network Traffic Engineering

Ashish Chandra[1], Mohit Tawarmalani[2], [1]Illinois State University, Bloomington, IL, [2]Purdue University, West Lafayette, IN, Contact: achand6@ilstu.edu

We introduce a new two-stage model for integrated quantile functions. This framework leads to a bilinear optimization problem (P), a special case of which reveals a new model for the VaR minimization problem. We discuss various techniques to under- and over-estimate the optimal value of (P), in turn developing new lower and upper-estimators for VaR. We also consider chance-constraint programs (CCP). Utilizing the overestimates we construct for (P), we develop convex inner approximations for the CCP.

Sunday, October 15, 4:00 PM - 5:15 PM

SE84

Session.Location:CC-West 213B

MSOM Service Operations II

Contributed Session

Session Chair: Yao Li, Kellogg, Northwestern University, Evanston, IL

1 Estimating Demand for Crowdsourcing the Last-Mile Delivery in Rural Areas (North Dakota) Using Optimization Techniques for Commuters from Urban Areas

Sumadhur Shakya[1], Joseph Gerard Szmerekovsky[2], [1]California State University Monterey Bay, Seaside, CA, [2]North Dakota State University, Fargo, ND, Contact: sshakya@csumb.edu

We estimate the feasibility of crowdsourcing commuters from urban areas for making deliveries to rural areas of North Dakota. Origins are consolidated pickup points from the nearest urban center while a set of rural areas where a certain percentage of the population receives frequent deliveries, as the destinations. Demand is estimated with random assignment of drivers, origins, destinations, etc. Commuter attributes such as compensation, and increased travel time/distance, are used to predict the number of potential drivers that can be crowdsourced to make deliveries. Finally, we propose a matching process to pair the willing commuters with packages for delivery, aiming to optimize a cost or profit function and/or maximize the number of packages delivered. This matching strategy is likely to minimize costs and increase overall efficiency in the delivery process.

2 Enabling Electric Cooking Supply Chain Using Digital Twin

Sanket Mishra, Jayendran Venkateswaran, Indian Institute of Technology Bombay, Mumbai, India. Contact: jayendran@iitb.ac.in

Digital twin is used to help activate a sustainable supply chain (SC) for electric cooking in rural India. A system dynamics simulation model was initially developed incorporating material, information & cash flows of a local SME & its distribution network. The SC network provides IoT-based electric induction stoves with cookware to rural households and help their transition from biomass cooking to e-cooking. Simulation based risk analysis of demand-side & supply-side interventions (behavior nudging, consumer finance, awareness, service network, carbon credits) was done to develop a 2-year business plan. The digital twin then monitors SC network performance & aids in rapid plan-do-check-act cycles to maximize profit & household adoptions. Digital twinning process, along with learnings from the implementation will be discussed.

3 Appointment Interval Sizing at a Pediatric Dentistry

Yao Li[1], Jan A. Van Mieghem[2], Itai Gurvich[3], [1]Kellogg, Northwestern University, Evanston, IL, [2]Northwestern University, Evanston, IL, [3]Northwestern University, Kellogg School of Management, Evanston, IL, Contact: yao.li@kellogg.northwestern.edu

We look for the best appointment length to minimize patient waiting time and care provider idleness and overtime in slot-based appointment systems. As a benchmark, we consider the stationary problem utilizing the limiting distribution in a D/G/1 queue. In practice, professional offices (such as dental clinics) start the day empty and exhibit substantial transient behavior. (In fact, in the pediatric dental clinic we studied, steady state is never approached.) Therefore we focus on transient analysis, derive analytically the optimal appointment length in a recursive form and shows the optimal length grows as patient number in the system increases. Real-world data from a pediatric dentistry clinic is used, extending results to multiple patient classes.

Sunday, October 15, 5:25 PM - 6:15 PM

SK01

CC-North 120BC

The Model Made Me Do It - Ethical ORMS in a Data-Driven World

Keynote Session

1 The Model Made Me Do It - Ethical ORMS in a Data-Driven World

Julie Simmons Ivy, University of Michigan, Ann Arbor, MI

ORMS has the power to help the world but with great power comes great responsibility. How are we considering the impact of our models and using that information to create better models?

Sunday, October 15, 5:25 PM - 6:15 PM

SK02

CC-West 301ABC

The Electric Grid in Evolution: Data, Optimization, and Risk-Taking

Keynote Session

1 The Electric Grid in Evolution: Data, Optimization, and Risk-Taking

Daniel Bienstock, Columbia University, New York, NY

Power systems i.e., power grids around the world are now in the midst of an accelerating change that will deliver far more knowledge- and data-aware operations in the coming decade. This evolution is spurred by a need for more investment as equipment ages, by increased consumption of power around the world, and, principally, by increased volatility in real-time behavior due to ramped-up renewable penetration and to participation in power systems by prosumers, i.e., entities that can both generate and consume power. The latter two factors contribute correlation patterns that may be opaque to traditional power systems operators. In this talk we will discuss the state-of-the-art of a number of critical technical areas in this domain, including the computation of power flow patterns (a nonlinear, nonconvex optimization problem), financial engineering aspects already seen today, and appropriate data science that can be harnessed to effectively stress test power system operations.

Sunday, October 15, 5:25 PM - 6:15 PM

SK03

CC-North 120D

Making Good Decisions with Wrong Models

Keynote Session

1 Making Good Decisions with Wrong Models

Jose Blanchet, Stanford University, Stanford, CA

Our capacity to access massive data sets and computing resources at scale has enabled the application of OR/MS methods in data driven decision making. But what is the impact of decisions that are made when the data is corrupted or possibly contains anomalies? Or when the deployment/prescription environment is different from the training/learning environment? These situations appear similar in the sense that direct data driven OR/MS approaches lead to making decisions based on wrong models, but, as we shall discuss, they are fundamentally different conceptually. In this talk, we will discuss the differences and provide a disciplined yet practical approach to dealing with these types of problems.

Sunday, October 15, 5:25 PM - 6:15 PM

SK04

CC-North 120A

2023 Edelman Award Winner Reprise

Keynote Session

1 Optimizing Walmart's Outbound Supply Chain from Strategy to Execution - A Grocery Case Study

Mingang Fu[1], Tiantian Nie[2], Xiaojie Wang[2], Jing Huang[2], Prakhar Mehrotra[2], [1]Walmart, Palo Alto, CA, [2]Walmart, Sunnyvale, CA

As the largest retail distribution operation in the US, Walmart has always been at the forefront of building optimization capabilities to empower its supply chain from strategy to execution. A set of scalable optimization models have been adopted to determine the optimal network and transformational roadmap for the next decade. For daily operations, a truck routing and load planning optimization system was built. With grocery network alone, the strategy work impacts at least $10 billion investment in transformation, and the system contributes $60 million direct savings in year 2022.

Monday, October 16, 8:00 AM - 9:15 AM

MA01

CC-North 120A

Sensitivity Analysis

Tutorial Session

Session Chair: Douglas R. Shier, Clemson University, Pittsboro, NC

1 Sensitivity Analysis

Emanuele Borgonovo, Bocconi University, Milano, Italy

A primary activity in operations research and the management sciences is the creation of quantitative models to support decision making. The presence of complex architectures, makes tools for explainability and interpretability essential to reinforce stakeholders' trust in the model forecasts and increase transparency. This tutorial reviews the role of sensitivity analysis as a toolset for interpreting and communicating model results. We examine the evolution of sensitivity analysis in the management sciences and analyze available methods through the lens of four primary analysis goals: factor prioritization (or feature importance), trend determination, interaction quantification, and stability (robustness). We present a variety of techniques, starting with local methods and moving on to global methods.

Monday, October 16, 8:00 AM - 9:15 AM

MA03

CC-North 120D

Provalis Research

Technology Tutorial

1 Machine Learning in Text Analytics: Do We Really Need Deep Learning?

Normand Peladeau, Provalis Research, Montreal, QC, Canada. Contact: npeladeau@provalisresearch.com

The renewed enthusiasm for artificial intelligence (A.I.) and, more particularly, for techniques based on deep learning and other forms of neural networks, means that we are trying to apply these latest techniques to all problems requiring a supervised or unsupervised form of learning. But this unprecedented wave of interest often makes us forget there are other forms of machine learning that have proven themselves over time. During this presentation we will compare certain forms of machine learning with and without the contribution of neural network techniques in order to assess the importance and the nature of a possible contribution (if any). To do this, we will examine different tasks in the field of automatic language processing, namely topic modeling, automatic word disambiguation, and the development of semantic lexicons. We will also try to identify in which context an approach based on neural networks or deep learning deserves consideration.

Monday, October 16, 8:00 AM - 9:15 AM

MA04

CC-North 121A

Frontiers of Adaptive Learning and Approximations for Sequential Experiments

Community Committee Choice Session

Session Chair: Anand Kalvit, Columbia Business School, New York, NY

1 Experimenting Under Stochastic Congestion

Xu Kuang[1], Shuangning Li[2], Ramesh Johari[3], Stefan Wager[4], [1]Stanford Graduate School of Business, Stanford, CA, [2]Harvard, Cambridge, MA, [3]Stanford University, Stanford, CA, [4]Stanford GSB, Stanford, CA

While randomized experiments have been effective in gaining causal insights and prescribing policy improvements in many domains, using them to study stochastic congestion has proven challenging. In this work, taking a standard queueing system as a benchmark model of congestion, we study how to conduct randomized experiments in a service system that has a single queue with an outside option. We study switchback experiments and a local perturbation experiment, and demonstrate that the estimator from the local perturbation experiment is asymptotically more accurate than the estimators from the switchback experiments by taking advantage of the structure of the queueing system.

2 Diffusion Approximations for Online Content Moderation

Amir A. Alwan, Rene A. Caldentey, Amy R. Ward, Tingrui Shi, The University of Chicago Booth School of Business, Chicago, IL, Contact: amir.alwan@chicagobooth.edu

The surge in user-generated content on social media platforms has made online content moderation an increasingly challenging problem. To effectively moderate online content, most platforms rely on both artificial intelligence (AI) and human moderators. The AI system is trained using labels assigned by human moderators in order to improve its content classification accuracy. We adopt a Bayesian learning and queueing framework to model the online content moderation problem. In a regime of high frequency and low informativeness, we derive a diffusion approximation for our model and investigate the trade-off between the speed of learning of different content types and the operations of managing a human moderation system.

3 Optimal Policies in Bandit Experiments

Karun Adusumilli, University of Pennsylvania, Heidelberg

We provide a decision theoretic analysis of bandit experiments. Using diffusion asymptotics, we define suitable notions of asymptotic Bayes and minimax risk. For normally distributed rewards, the minimal Bayes risk can be written as the solution to a 2nd-order partial differential equation (PDE). Using a limit of experiments approach, we show that this PDE characterization also holds asymptotically under both parametric and non-parametric distributions of the rewards. In doing so, we describe the state variables it is asymptotically sufficient to restrict attention to, and thereby suggest a strategy for dimension reduction. The PDEs characterizing minimal Bayes risk can be solved efficiently using sparse matrix routines. The optimal Bayes and minimax policies substantially dominate existing methods such as Thompson sampling and UCB, often by a factor of two.

4 Improved Asymptotics for Multi-Armed Bandit Experiments Under Optimism-Based Policies

Anand Kalvit[1], Assaf Zeevi[2], [1]Stanford University, Stanford, CA, [2]Columbia University, New York, NY

This work provides new asymptotic results for UCB-based multi-armed bandit algorithms, leading to several important insights. Among these, it is shown that arm-sampling rates under classical UCB are asymptotically deterministic, regardless of the problem complexity. This discovery facilitates the first complete characterization of the worst-case regret of UCB, as well its “diffusion limit” performance. Among other things, these findings reveal profound distinctions between UCB and Thompson Sampling such as an “incomplete learning” phenomenon characteristic of the latter.

Monday, October 16, 8:00 AM - 9:15 AM

MA05

CC-North 121B

Learning against Uncertainty in Revenue Management

Community Committee Choice Session

Session Chair: Mingxi Zhu, Stanford University, Stanford, CA

1 Bayesian Demand Learning and Revenue Management Under Limited Capacity

Mihalis Markakis[1], Marcos Serrano-Mayor[2], [1]IESE Business School, Barcelona, Spain; [2]Stanford University, Stanford, CA, Contact: marcossm@stanford.edu

Under limited capacity, the optimal price and quantity decision is primarily driven by the total demand rate during the sales season. When demand is unknown, the seller may need adjust its revenue management policy over time as it learns the arrival rate. We formulate the dynamic optimization problem under Bayesian learning. We solve it analytically when there is one unit of capacity for sale, and develop effective heuristics for the multi-unit case. Surprisingly, we find that lack of information pushes the seller to opt for a low-volume, high-margin position for a longer time, and only reduce margins close to the end of the season, as opposed to earlier which would accelerate learning.

2 Sequential Search with Acquisition Uncertainty

David Brown, Cagin Uru, Duke University, Durham, NC, Contact: cagin.uru@duke.edu

We study a variation of the classical Pandora's problem in which a decision-maker (DM) sequentially explores alternatives from a given set and learns their values while trying to acquire the best alternative. The variations in the model we study are (i) alternatives randomly become unavailable during exploration and (ii) the DM's ability to acquire a remaining alternative is uncertain and depends on a chosen offer price. Such acquisition uncertainties arise in many applications, including housing search, hiring problems, and e-commerce, but greatly complicate the search problem. We develop simple greedy policies based on static sequencing and a single threshold value. We show that our policies (a) are asymptotically optimal in high multiplicity regimes with many alternatives and (b) obtain at least 1-1/e ≈ 63.2% of the optimal value under a broad set of conditions.

3 Robust Mean Field Control in Revenue Management

Sirui Lin, Stanford University, Stanford, CA, Contact: siruilin@stanford.edu

Our method provides a robust strategy with mean field control and applies to the revenue management of a large number of objects.

4 Data Sharing Under Competition

Mingxi Zhu, Stanford University, Stanford, CA

The advent of the digital era has brought about an exponential growth in data generation, leading to a significant rise in the value and importance of data for firms across industries. With the increasing recognition of data as a strategic asset, firms are confronted with the decision of whether to share their data with competitors, thereby potentially compromising their competitive advantage, or withhold it to maintain exclusivity at the expense of potential collaborative benefits. This paper proposes a novel model that investigates how market competition influences firms' data sharing incentives and decisions, and provides equilibrium data sharing and contingent competition strategies for firms competing in the same market. The results presented in this paper provide insights for firms seeking to optimize their data sharing decisions in competitive markets.

Monday, October 16, 8:00 AM - 9:15 AM

MA06

CC-North 121C

Recent Advances in Online Learning and Data-Driven Decision Making

Community Committee Choice Session

Session Chair: Divya Singhvi, New York University, New York, NY

1 The Multi-Armed Bandit Problem with K Types

Anand Kalvit[1], Assaf Zeevi[2], [1]Stanford University, Stanford, CA, [2]Columbia University, New York, NY, Contact: ak4076@columbia.edu

We consider a stochastic multi-armed bandit (MAB) problem endowed with a "large" collection of arms containing exactly K arm-types. Each type is characterized by a distinct mean reward and occurs with an unknown probability in the universe. Furthermore, the type of an arm remains unobservable throughout the game. Oblivious to statistical properties of realized rewards (other than [0,1]-boundedness), the decision maker must maximize her cumulative expected payoffs over n rounds of play. While the description suggests a great degree of similarity to the classical MAB problem, properties of performance bounds and salient aspects of algorithm design are quite distinct from the latter, as are key primitives that determine complexity along with the analysis tools needed to study them. We propose adaptive algorithms for this setting achieving rate-optimal "regret" w.r.t. n.

2 The Product Replacement Problem in Fashion: Addressing Manager Behavior and Demand Uncertainty

Manuel Manuel Moran-Pelaez[1], Tamar Cohen-Hillel[2], Georgia Perakis[3], [1]MIT Operations Research Center, Cambridge, MA, [2]UBC Sauder School of Business, Vancouver, BC, Canada; [3]Massachusetts Institute of Technology, Cambridge, MA, Contact: georgiap@mit.edu

Fast fashion retailers offer a wide range of trendy options that are updated frequently. The quick turnover translates into the need to make swift and frequent assortment and inventory decisions to optimize profit. We refer to this as the product replacement problem. The problem involves two decision-makers, with headquarters introducing new items and store managers deciding which current items to remove. We develop optimal and interpretable policies for both decision-makers by accounting for different incentives and uncertainties around the other party's behavior and demand. We show an improvement of 6%-8% in profit when incentives are aligned and of 2%-4% when headquarters adopt a pessimistic policy in terms of manager's behavior.

3 Temporal Fairness in Learning and Earning: Price Protection Guarantee and Phase Transitions

Qing Feng, Cornell University, Ithaca, NY, Contact: qf48@cornell.edu
Motivated by the prevalence of "price protection guarantee", which allows a customer who purchased a product in the past to receive a refund from the seller during the price protection period, we study the impact of such policy on algorithm design for dynamic pricing with initially unknown demand. We consider a setting where a firm sells a product over a horizon of T time steps. For this setting, we characterize how the value of M, the length of price protection period, can affect the optimal regret of the learning process. We first establish the optimal regret by first establishing a fundamental impossible regime with novel regret lower bound instances, then propose an algorithm LEAP to match this lower bound up to logarithmic or even doubly logarithmic factors (under the two-price case). Our results reveal the surprising phase transitions of the optimal regret with respect to M.

4 The Effects of Organic Waste Bans: An Analysis of U.S. Waste Disposal from 2005-2020

Fiori Anglou[1], Robert E. Sanders[2], Ioannis Stamatopoulos[3], [1]University of Texas Austin, Austin, TX, [2]UC, San Diego, Los Angeles, CA, [3]The University of Texas at Austin, McCombs School of Business, Austin, TX, Contact: fiori.anglou@mccombs.utexas.edu
We estimate the effects of organic waste bans on waste diversion from landfills using annual county- and state-level waste-disposal and composting data from 36 U.S. states from 2005 to 2020. This is the first study that empirically studies the effect of organic waste bans. We use a synthetic controls design and placebo inference to estimate the statistical power of the dataset. Using synthetic controls we estimate the treatment effects and compare them against the expected regulatory effect. Contrary to policymakers' expectations, we find evidence of a null effect of the bans on total waste diverted from landfills. Our findings suggest that current organic waste bans may not effectively reduce waste disposal as expected or promote waste diversion, namely composting, indicating a need for further research on alternative policy mechanisms.

Monday, October 16, 8:00 AM - 9:15 AM

MA07

CC-North 122A

New Frontiers in Online Ad Auctions

Community Committee Choice Session

Session Chair: Yeganeh Alimohammadi, Stanford University, Stanford, CA

1 Multi-Channel Autobidding with Budget and Roi Constraints

Yuan Deng[1], Negin Golrezaei[2], Patrick Jaillet[3], Jason Cheuk Nam Liang[4], Vahab Mirrokni[5], [1]Google, NYC, NY, [2]MIT, Cambridge, MA, [3]M.I.T., Cambridge, MA, [4]MIT Operations Research Center, Cambridge, MA, [5]Google Research, New York, NY
In online advertising, advertisers procure ad impressions on multiple platforms, or so-called channels, such as Google Ads, Meta Ads Manager, etc., each of which consists of numerous auctions. We study how an advertiser maximizes total conversion while satisfying aggregate return-on-investment (ROI) and budget constraints across all channels. In practice, an advertiser authorizes a channel to procure impressions on her behalf: the advertiser can only utilize two levers on each channel, namely setting a per-channel budget and per-channel target ROI. In this work, we first analyze the effectiveness of each of these levers for solving the advertiser's global multi-channel problem. We then present an efficient learning algorithm that produces per-channel budgets and target ROI whose resulting conversion approximates that of the global optimal problem.

2 Auction Design in the Auto-Bidding World

Andres Perlroth, Google Research
Over the past few years, more and more Internet advertisers have started using automated bidding to optimize their advertising campaigns. This enables advertisers to simply provide high-level constraints and goals to an automated agent (a.k.a auto-bidder), which optimizes their auction bids on their behalf. The auto-bidders objective is to maximize value instead of profits which makes classic results in auction design no longer applicable to this context. In this talk, we focus on important results of auction design in the auto-bidding world. We discuss how bidding is related to the truthfulness property of the auctions; how different auctions might affect advertisers' incentives in reporting their constraint to the auto-bidders. We also discuss how the presence of auto-bidders affects optimal auction design in the multi-channel setting.

3 Modeling Pricing Strategies for Subscriptions in Service-Based Industries

Rojin Rezvan, University of Texas at Austin, Austin, TX
Subscription-based selling models are popular in many service-based industries, providing the customers with different options to access services such as streaming, delivery, etc. In this work, we explore how customers behave

when they have options to buy subscriptions over a period of time, or pay per use. We analyze how the sellers should optimally price these options, and examine the distribution of customer purchases between these two sources. We propose ways to model buyer behavior, regarding utility and willingness to pay for services by considering factors such as value of service, usage patterns, budget constraints and past purchases. Furthermore, we address the seller's perspective and discuss how the seller should set the prices for pay-per-use and subscription, and whether it is best to provide each or both of them when the objective is maximizing revenue.

4 Improved Online Contention Resolution For Matchings And Applications To The Gig Economy

Mohammad Roghani[1], Tristan Pollner[1], Amin Saberi[1], David Wajc[2], [1]Stanford University, Stanford, CA, [2]Google Research, Mountain View, CA, Contact: roghani@stanford.edu

Motivated by applications in the gig economy, we study approximation algorithms for a sequential pricing problem. Given a bipartite graph of workers and jobs, the platform offers prices to workers for job matches. Our aim is to maximize revenue or social welfare. We propose an efficient Random-Order Online Contention Resolution Scheme (RO-OCRS) approximation algorithm for matching. This yields a 0.456-approximation for the sequential pricing problem. We further extend our results to settings where workers can only be contacted a limited number of times and show how to achieve improved results for this problem.

Monday, October 16, 8:00 AM - 9:15 AM

MA08

CC-North 122B

Experimentation in Industry

Community Committee Choice Session

Session Chair: Andrew T. Zheng, Massachusetts Institute of Technology, Boston, MA

Session Chair: Tianyi Peng, Massachusetts Institute of Technology, Cambridge, MA

1 Optimizing Audio Recommendations for the Long-Term

Daniel Russo, Columbia University, New York, NY

We study the problem of optimizing a recommender system for outcomes that occur over several weeks or months. We begin by drawing on reinforcement learning to formulate a comprehensive model of users' recurring relationships with a recommender system. Measurement, attribution, and coordination challenges complicate algorithm design. We describe careful modeling -- including a new representation of user state and key conditional independence assumptions -- which overcomes these challenges and leads to simple, testable recommender system prototypes. We apply our approach to a podcast recommender system that makes personalized recommendations to hundreds of millions of listeners. A/B tests demonstrate that purposefully optimizing for long-term outcomes leads to large performance gains over conventional approaches that optimize for short-term proxies.

2 Experimentation and Beyond at ByteDance

Xinyuyang Ren, Huang Yang, ByteDance Inc., San Jose, CA

At ByteDance, its in-house experimentation platform has successfully leveraged the power of null-hypothesis significance testing to prompt data-driven decision making that fostered products like TikTok, Lemon8, Douyin and etc. to reach their popularity as of today. In the meantime, the platform is also facing growing challenges of conducting experiments in complex environments with interference, high-dimensional bandits, and infeasibility of randomization. ByteDance has been searching for dynamic, automatic, and observation-friendly solutions with a few that have been in production and demonstrated business values.

3 Correcting for Interference in Experiments: A Case Study at Douyin

Tianyi Peng, Massachusetts Institute of Technology, Cambridge, MA

Interference is a common issue in experiments on two-sided content marketplaces like Douyin (China's TikTok equivalent). We address this problem by formulating interference inference as policy evaluation. We propose a novel Monte-Carlo estimator, utilizing "Differences-in-Qs" (DQ) techniques. Our estimator achieves second-order bias in treatment effect while being sample-efficient. Theoretical contributions include a generalized Taylor expansion theory extending DQ to major MDP formulations. On the practical side, we implement our estimator on Douyin's platform, creating a plug-and-play solution for real-world interference. It offers robust, low-bias, low-variance treatment effect estimates, computationally cheap uncertainty quantification, and reduces MSE by 99% compared to existing alternatives.

Monday, October 16, 8:00 AM - 9:15 AM

MA09

CC-North 122C

Learning and Optimization in Nonstationary Environments

Community Committee Choice Session

Session Chair: Daniel Russo, Columbia University, New York, NY

Session Chair: Seungki Min, KAIST, Yuseong-gu, Korea, Republic of

1 An Information-Theoretic Analysis of Nonstationary Bandit Learning

Seungki Min[1], Daniel Russo[2], [1]KAIST, Daejeon, Korea, Republic of; [2]Columbia University, New York, NY, Contact: skmin@kaist.ac.kr

In nonstationary bandit learning problems, the decision-maker must continually gather information and adapt their action selection as the latent state of the environment evolves. In each time period, some latent optimal action maximizes expected reward under the environment state. We view the optimal action sequence as a stochastic process, and take an information-theoretic approach to analyze attainable performance. We bound limiting per-period regret in terms of the entropy rate of the optimal action process. The bound applies to a wide array of problems studied in the literature and reflects the problem's information structure through its information-ratio.

2 Non-Stationary Bandit Learning via Predictive Sampling

Benjamin Van Roy[1], Yueyang Liu[1], Kuang Xu[2], [1]Stanford University, Stanford, CA, [2]Stanford Graduate School of Business, Stanford, CA

Thompson sampling has proven effective across a wide range of stationary bandits. However, we demonstrate that it may not perform well when applied to non-stationary bandits. We attribute such failures to the fact that the algorithm does not account for how quickly acquired information loses its usefulness due to non-stationarity. Based on this insight, we propose methods to create algorithms that prioritize the acquisition of durable information and deprioritize information that quickly loses its usefulness. Predictive sampling is one example of such an algorithm. We establish a Bayesian regret bound that applies to any agent, and subsequently apply it to predictive sampling. Notably, the regret bound depends on a concept we call predictive information, which measures the cumulative amount of durable information.

3 Multi-Armed Bandit Meets Time Series Forecasting

Djallel Bouneffouf[1], Qinyi Chen[2], Negin Golrezaei[3], [1]IBM Research, New York, NY, [2]MIT, Cambridge, MA, [3]Massachusetts Institute of Technology, Lexington, MA, Contact: djallel.bouneffouf@ibm.com

Multi-armed bandit (MAB) problems are mainly studied under two extreme settings known as stochastic and adversarial. These two settings, however, do not capture realistic environments such as search engines and marketing, in which rewards stochastically change in time. Motivated by that, we introduce a dynamic MAB problem with stochastic temporal structure, where the expected reward of each arm is governed by an auto-regressive (AR) model. Due to the dynamic nature of the rewards, simple "explore and commit" policies fail, as all arms have to be explored continuously over time. We formalize this by characterizing a per-round regret lower bound. We present an algorithm whose per-round regret almost matches our regret lower bound. Our algorithm relies on two mechanisms: (i) alternating between recently pulled arms and unpulled arms with potential, and (ii) restarting.

4 Non-Stationary A/B Tests

Yuhang Wu[1], Zeyu Zheng[1], Guangyu Zhang[2], Zuohua Zhang[2], Chu Wang[2], [1]University of California, Berkeley, Berkeley, CA, [2]Amazon, Seattle, WA, Contact: wuyh@berkeley.edu

A/B tests, also known as online randomized controlled experiments, have been used at scale by data-driven enterprises to guide decisions and test innovative ideas to improve core business metrics.Meanwhile, non-stationarities, such as the time-of-day effect and the day-of-week effect, can often arise nonparametrically in key business metrics involving purchases, revenue, conversions, customer experiences, etc. We discuss in this presentation the impact and challenges of non-stationarities on A/B tests. We then discuss some scenarios where such impact and challenges can be appropriately addressed.

Monday, October 16, 8:00 AM - 9:15 AM

MA10

CC-North 123

Decision Making Under Uncertainty

Community Committee Choice Session

Session Chair: Yilun Chen, CUHK Shenzhen, West New York, NJ

1 Contextual Linear Optimization with Bandit Feedback

Yichun Hu[1], Nathan Kallus[2], Xiaojie Mao[3], [1]Cornell University, Ithaca, NY, [2]Cornell University, Long Island City, NY, [3]Cornell University, New York, NY, Contact: yh767@cornell.edu

Contextual linear optimization (CLO) uses predictive observations to reduce uncertainty in random cost coefficients and improve performance. An example is stochastic shortest path with random edge costs. Existing work on CLO focuses on data with fully observed cost coefficients, but in many applications we can only see the realized cost of a historical decision, that is, just one projection of the random cost coefficient vector. We study two classes of algorithms for CLO with this so-called bandit feedback: estimate then optimize, where we learn a predictive model and plug predictions into the linear optimization; and induced empirical risk minimization, where we fit the predictive model to directly optimize downstream performance of the policy it induces. We relate the new regret bounds to the full feedback case and demonstrate the dependence on a coverage condition.

2 Allocating Emission Permits Efficiently via Uniform Linear Mechanisms

Xingyu Lin[1], Jiaqi Lu[2], [1]the Chinese University of Hong Kong (Shenzhen), Shenzhen, China; [2]the Chinese University of Hong Kong (Shenzhen), Shenzhen, China. Contact: thulujq@gmail.com

We study the problem of allocating emission permits in an emissions trading system and provide efficiency guarantee of simple uniform linear allocation mechanisms in the broad class of component-wise concave mechanisms. It was well accepted in the literature that the equilibrium consumer surplus and social welfare are not affected by the initial lump-sum allocation of emission permits in a deterministic system without trading fractions. We show that this is no longer the case under more general allocation mechanisms. In particular, for N firms operating under Cournot competition that differs in their abatement abilities, uniform linear permit allocation mechanisms are the most efficient, i.e., achieve the maximum consumer surplus and emission reduction. Numerical experiments show that the benefit of uniform linear mechanisms compared to constant ones can be large.

3 Restless Bandits with Average Reward: Breaking the Uniform Global Attractor Assumption

Weina Wang, Carnegie Mellon University, Pittsburgh, PA, Contact: weinaw@cs.cmu.edu

We study the infinite-horizon Restless Bandit problem with average reward. Prior work on asymptotic optimality relies on the complicated uniform global attractor property (UGAP). In this paper, we propose Follow-the-Virtual-Advice, a simulation-based framework that produces a policy with an $O(1/\sqrt{N})$ optimality gap. In discrete time, we assume a simpler synchronization assumption, covering non-UGAP problem instances. More notably, in continuous time, our result only requires the standard unichain condition. Our work gives the first asymptotic optimality result without UGAP.

4 Decision-Making with Side Information: A Causal Transport Robust Approach

Luhao Zhang, 1</sup

We consider stochastic optimization with side information where, prior to decision-making, covariate data are available to inform better decisions. We propose to consider a distributionally robust formulation based on causal transport distance. Compared with Wasserstein metric, the causal transport distance is better at capturing the information structure revealed from the conditional distribution of random problem parameters given the covariate values. We derive a dual reformulation for evaluating the worst-case expected cost and show that the worst-case distribution in a causal transport distance ball has a similar conditional information structure as the nominal distribution. When optimizing over all decision rules, we identify a new class of robust optimal decision rules when the cost function is convex with respect to a one-dimensional decision variable.

Monday, October 16, 8:00 AM - 9:15 AM

MA11

CC-North 124A

Digital Twin Revolution: Advancing the Frontiers of Large-Scale and High-Fidelity Simulation

Community Committee Choice Session

Session Chair: Tianyi Peng, Massachusetts Institute of Technology, Cambridge, MA

Session Chair: Andrew T. Zheng, Massachusetts Institute of Technology, Boston, MA

1 Efficient Algorithm for Large-Scale Online Fulfilment Simulation

Joren Gijsbrechts[1], Tianyi Peng[2], [1]Portuguese Catholic University, Lisbon, Portugal; [2]Massachusetts Institute of Technology, Cambridge, MA

We develop a parallel simulator that evaluates fulfillment policies of large-scale online retailers. The fulfillment problem consists of deciding from which fulfillment center to supply incoming orders in an online fashion. Fulfillment centers carry inventory of many items but have a maximum daily available processing capacity, which is shared across items. We develop an efficient simulator that paralellizes the evaluation of fulfillment policies across items, which may naturally violate the joint processing capacity constraint. We iteratively solve these violations and show that our algorithm converges in a small amount of iterations. We obtain bounds on the expected running time of our parallel algorithm, as well as a sequential benchmark, and validate our findings in an extensive numerical experiment. By adopting our algorithm, firms may significantly reduce their computational effort to optimize their fulfillment decisions.

2 Improving Supply Chain Resiliency Using a Digital Twin

David Simchi-Levi, Massachusetts Institute of Technology, Cambridge, MA, Contact: dslevi@mit.edu

We report the impact of leveraging a Digital Twin on improving supply chain resiliency. This includes quantifying the level of resiliency, identifying hidden risk and developing mitigation strategies.

3 Optimizing Supply Chain Inventory Management Through Large-Scale Simulation: Challenges and Lessons Learned

Zhuojie Huang, Nike Inc, Beaverton, OR

This research explores the opportunities to develop large-scale simulation system for inventory management and presents challenges and lessons learned. Key challenges are discussed, including decision granularity, system interactions and dynamics, demand forecasting, replenishment policies, and optimization algorithms. Lessons learned from practical implementations provide insights into the trade-offs between model complexity and outcome precisions. The research emphasizes the importance of addressing challenges related to data accuracy and computational efficiency to achieve effective simulation outcomes. Additionally, we explore collaborative frameworks between the analytics team and the business team to facilitate the effective utilization of simulation model outcomes in informing and guiding business strategy.

Monday, October 16, 8:00 AM - 9:15 AM

MA12

CC-North 124B

Sequential Learning in Simulation

Community Committee Choice Session

Session Chair: Eunhye Song, Georgia Institute of Technology, Atlanta, GA

1 Optimizing Input Data Collection for Ranking and Selection

Taeho Kim, Eunhye Song, Georgia Institute of Technology, Atlanta, GA, Contact: esong32@gatech.edu

We consider a Bayesian ranking and selection problem under input uncertainty when all solutions share the common input models. We assume that there are multiple independent input data sources from which data can be collected at a cost to reduce input uncertainty. To optimize the data collection, we first show that the most probable best (MPB)—the solution with the largest posterior probability of being optimal (posterior preference)—is a strongly consistent estimator for the true optimum. We investigate the optimal asymptotic static sampling ratios from the input data sources that maximize the exponential convergence rate of the MPB's posterior preference. A sequential sampling rule that balances the simulation and input data collection effort is created and demonstrated. The proposed algorithm stops with posterior confidence in the solution quality.

2 Approximate Gaussian Process Regression with Pairwise Comparison Data

Efe Sertkaya[1], Ilya O. Ryzhov[2], [1]University of Maryland, College Park, MD, [2]University of Maryland, College Park, MD, Contact: sertkaya@umd.edu

We use approximate Bayesian inference, together with Gaussian process regression, to create a new estimator for an unknown function in a situation where we can only observe pairwise comparisons of function values at different inputs. Preliminary experimental results suggest that, although information is heavily censored in this setting, it may still be possible to learn the local and global minima of the underlying function. We discuss possible sampling criteria, and explore the performance of the "probability of improvement" strategy numerically.

3 Data-Driven Optimal Allocation via Balancing Empirical Large Deviations in Sequential Selection

Ye Chen, Virginia Commonwealth University, Richmond, VA, Contact: ychen24@vcu.edu

The ranking and selection problem is a classic mathematical framework about identifying the best alternative from multiple alternatives through sampling them. However, the uncertainty about sampling distributions in the ranking and selection problem has been relatively overlooked and related research is just starting to gain momentum recently. We for the first time propose an efficient data-driven nonparametric tuning-free sequential budget allocation strategy under completely unknown sampling distributions. Furthermore, we theoretically prove that our methodology achieves the optimal allocation specified by large deviation analysis. Especially, we propose a new efficient point estimation approach for estimating the optimal large deviation rates and theoretically demonstrate its validity.

Monday, October 16, 8:00 AM - 9:15 AM

MA13

CC-North 125A

Implications of Generative AI for Decision Analysis

Panel Session

Session Chair: Jeffrey M. Keisler, University of Massachusetts-Boston, Boston, MA

1 Implications of Generative AI for Decision Analysis

Gregory S. Parnell, University of Arkansas, Fayetteville, AR

Decision Analysis pulls together a mix of creativity, expert judgment. sentiment and logical reasoning to guide action. We explore the implications of generative AI for this field.

2 Panelist

Yael Grushka-Cockayne, University of Virginia, Charlottesville VA, VA

3 Panelist

Max Henrion, Lumina, Campbell, CA

4 Panelist

K. Nadia Papamichail, The University of Manchester, Manchester, United Kingdom

Monday, October 16, 8:00 AM - 9:15 AM

MA14

CC-North 125B

Healthcare Analytics for Social Good

Community Committee Choice Session

Session Chair: Zhaowei She, Singapore Management University, Singapore, Singapore

Session Chair: Leon Xu, [1]</sup

1 First Dose or Second Dose? A Study of Vaccination Policy with Supply and Capacity Constraints

Miao Bai[1], Qi (George) Chen[2], Cuihong Li[1], [1]University of Connecticut, Storrs, CT, [2]London Business School, London, United Kingdom. Contact: miao.bai@uconn.edu

We study the problem of allocating limited vaccine supply over time between first-dose and second-dose usage with vaccine administration capacity constraints. Based on the stylized SIR model, our analytical and numerical results establish the value of strategically delaying the vaccination campaign and prioritizing second-dose usage before switching to prioritizing first-dose usage.

2 The Impact of Changing Queue Ranks on Patient Processing in the Emergency Department

Lu Wang[1], Mazhar Arikan[2], Suman Mallik[2], [1]Ball State University, Muncie, IN, [2]University of Kansas, Lawrence, KS, Contact: wang@bsu.edu

We examine the impacts of changing queue rank on patient processing in the ED using empirical investigation. We demonstrate that the additional arrivals of patients that occur close to the end of waiting time contribute to the queue rank changes. Such additional arrivals and changing queue ranks affect the patient waiting time significantly.

3 Medical Inequality: Helping Vulnerable Hospitals

Wei Gu[1], Meng Li[2], Qiang Li[3], [1]University of Science and Technology Beijing, Beijing, China; [2]University of Houston, Houston, TX, [3]Wilfrid Laurier University, Waterloo, ON, Canada. Contact: qli@wlu.ca

In this study, we take advantage of an exogenous event--the introduction of outside experts and examine the impact of the program on service efficiency and service quality for the hospital and physicians. We find that the program has significantly improved the efficiency and quality of medical services provided by them.

4 Beyond Words: Unveiling The Effect Of Physician'S Use Of Audio Communication In Online Healthcare Communities

Xunyu Chen[1], Yeongin Kim[2], Seokjun Youn[1], [1]University of Arizona, Tucson, AZ, [2]Virginia Commonwealth University, Richmond, VA, Contact: syoun@arizona.edu

The digital transformation has made online healthcare communities (OHCs) a vital hub for exchanging healthcare information. Many OHCs now implement multimodal channels (e.g., voice, visual) to enhance physician-patient communication. Despite this evolution, we lack a systematic understanding of how these new communication mediums could influence the interactants involved. We leverage social support theory, social exchange theory, and communication theories, to empirically examine the potential implications of audio communication for OHC physicians and patients. We offer insights for OHC design by revealing the potential of audio communication to enhance user utility. We also advise physicians on the benefits of audio communication in online practice.

Monday, October 16, 8:00 AM - 9:15 AM

MA15

CC-North 126A

Enabling Data-Centric Operations for Decision Dominance

Community Committee Choice Session

Session Chair: David Bierbrauer, Army Cyber Institute, U.S. Military Academy, West Point, NY

1 Data-Driven Assessment of Information Environments: Unveiling Bias Without Human Expertise

Iain Cruickshank, Army Cyber Institute, West Point, NY

The significant role of online information in shaping outcomes is evident in recent events like U.S. National Elections and the COVID-19 Pandemic. Efforts to understand the online information environment have been extensive, but critical gaps persist. Media bias still relies on subjective human assessments, while existing methods are often limited to English or Western media. Computational techniques focus on sentiment and network interactions, neglecting conversations and bias. This presentation introduces novel techniques leveraging advancements in natural language processing, network science, and graph convolutional neural networks. These techniques analyze bias using actual data, eliminating subjective expertise and regional assumptions, providing a fresh approach to understanding the online information environment.

2 Data-Efficient Federated Learning for Edge Network Intrusion Detection

David A. Bierbrauer[1], Mikal Willeke[2], Nathaniel D. Bastian[3], [1]Army Cyber Institute, U.S. Military Academy, West Point, NY, [2]U.S. Military Academy, West Point, NY, [3]United States Military Academy, West Point, NY, Contact: david.bierbrauer@westpoint.edu

Advancements in the use of deep learning using raw network traffic payloads for network intrusion detection systems enable cybersecurity professionals to maintain an advantage over adversaries. However, the evolution of the modern battlefield towards the Internet of Battlefield Things (IoBT) consisting of many interconnected networks, sensors, and devices necessitates more distributed paradigms capable of handling heterogeneous distributions of data. To ensure decision dominance for the IoBT, we propose a data-efficient federated learning (FL) framework that updates and distributes a global intrusion detection model. Initial results using resource-limited devices achieved over 93\% accuracy with the global model. We expand on this by implementing FL strategies on more realistic IoBT network configurations while exploring asynchronous learning methods.

3 Measuring Classification Certainty for Safety-Critical Applications

Alexander Berenbeim[1], Nathaniel D. Bastian[2], Iain Cruickshank[3], Susmit Jha[4], Robert Thomson[3], [1]Army Cyber Institute, USMA, Highland Falls, NY, [2]United States Military Academy, West Point, NY, [3]Army Cyber Institute, West Point, NY, [4]SRI International, Menlo Park, CA, Contact: alexander.berenbeim@westpoint.edu

Quantitative characterizations and estimations of uncertainty are of fundamental importance in optimization and decision-making processes, particularly in safety-critical settings. We propose intuitive scores, which we call *certainty* and *doubt*, that can be used in both a Bayesian and frequentist machine learning framework to assess and compare the quality and uncertainty of predictions of classification models across different modalities and model architectures. Further, using certainty scores, we can assess a model's *competence* in addition to accuracy to assess model reliability, as well as perform out-of-distribution detection.

4 Cyber Creative Generative Adversarial Network for Novel Malicious Packets

John A. Pavlik[1], Nathaniel D. Bastian[2], [1]Army Cyber Institute, West Point, NY, [2]United States Military Academy, West Point, NY, Contact: john.pavlik@westpoint.edu

Benign network traffic and malicious cyber attacks are always evolving and changing, meaning that the existing datasets for training a Network Intrusion Detection System (NIDS) quickly become obsolete. We investigate generative ML modeling for network packet synthetic data augmentation to improve NIDS detection of novel, but similar, cyber attacks. We develop a Cyber Creative Generative Adversarial Network (CCGAN), inspired by previous generative modeling to create new art styles from existing art images. The goal is to create network packet payloads that appear malicious but from novel distributions of cyber attack classes. CCGAN can increase a NIDS baseline accuracy on a novel malicious class from 79% to 97% with a minimal degradation in accuracy on benign classes (98.9% to 98.7%).

Monday, October 16, 8:00 AM - 9:15 AM

MA16

CC-North 126B

Emeriging Topics in Artificial Intelligence: Methods and Applications

Flash Session

Session Chair: Christopher M. Rump, Bowling Green State University, Bowling Green, OH

1 Should I Trust ChatGPT to Review My Program?

Mark Sherman, Carnegie Mellon University, Pittsburgh, PA, Contact: mssherman@sei.cmu.edu

ChatGPT is one of hottest new machine-learning based systems to appear on the Internet. ChatGPT can both create and analyze computer source code. The CERT program at the Software Engineering Institute has an extensive collection of insecure programs. We have used some of these assets to learn how ChatGPT would analyze vulnerable programs. In this talk, we share what we observed about the capabilities of ChatGPT in recognizing and fixing security problems in computer source code.

2 Internet Disrupted Journalism's Rendezvous with AI

Deepti Singh[1], Rohit Nishant[2], Vivek Singh[3], Robert D. Austin[4], [1]California State University - Long Beach, Long Beach, CA, [2]Université Laval, Quebec, QC, Canada; [3]University of Missouri–St. Louis, St. Louis, MO, [4]Ivey Business School, London, ON, Canada. Contact: deepti.singh@csulb.edu

The widespread availability of high-speed Internet and content dissemination through social networks have disrupted traditional journalism and its norms. Competition for clicks and the rush to publish have plagued online news outlets. These outlets are experimenting with generative AI-based tools like ChatGPT for content creation as these tools become more prevalent. We empirically analyze elements of the structural components of the articles written by AI and contrast them with articles written by humans within the same categories. Analyzing the corpus of web-published articles with human and AI authors and we conduct an empirical analysis to explore the differences and shortcomings in the creative processes of journalism in the new world order in progress under the influence of AI.

3 Value-Oriented Loss Function Tuning for Timeseries Forecasting in Energy Markets

Ruben Smets[1], Jean-François Toubeau[1], Mihaly Dolanyi[2], Kenneth Bruninx[3], Erik Delarue[1], [1]Katholieke Universiteit Leuven, Leuven, Belgium; [2]Université de Mons, Mons, Belgium; [3]TU Delft, Delft, Netherlands. Contact: ruben.smets1@kuleuven.be

In complex markets with a high amount of uncertainty, such as balancing markets, significant forecast errors are inevitable. Recently, the paradigm of value-oriented forecasting is gaining traction. While these techniques typically require a specific implementation dependent on the application, we propose a generally applicable value-oriented methodology for training time series forecasters. We achieve this by introducing a generalized loss function with a continuous exponent and variability component, and leveraging the maximum downstream value as the selection criterion in the hyperparameter tuning step. The proposed methodology is tested on the optimal control of different types of energy storage systems in the Belgian balancing market. We show that our methodology outperforms traditional benchmarks with 13% to 106% in terms of out-of-sample profit.

4 A Deep Learning Approach for High-Dimensional Time Series Forecasting

Ali Sarabi, Arizona State University, tempe, AZ, Contact: asarabi1@asu.edu

Time series forecasting is a challenging problem in various academic fields, particularly as model predictions become less accurate over longer periods. In many real-world applications, hierarchical structures exist between different time series that cannot be ignored. Graph Neural Network (GNN) models have shown great potential in addressing these relational dependencies. In this study, we present a deep neural network that utilizes graph convolution to capture inter-series dependencies and employs a Transformer to capture intra-series temporal relationships. This framework enables accurate short and long-term predictions, offering potential benefits in various domains.

5 Mining a Lottery for a Favorable Jackpot

Christopher M. Rump, Bowling Green State University, Bowling Green, OH, Contact: cmrump@bgsu.edu

A lottery offers rare opportunities for a favorable wager with a positive expected ticket value. We test various data mining methods for predicting when such opportunities may arise. Two parsimonious models - a logistic regression and a classification decision tree - are shown to make very good predictions for favorability of a wager on the next lottery drawing. These models are practical for a bettor in that they only utilize easily estimated ticket sales for the previous rolled-over jackpot and the size of that cash jackpot prize.

Monday, October 16, 8:00 AM - 9:15 AM

MA17

CC-North 127A

Frontiers in Behavioral Operations Management

Community Committee Choice Session

Session Chair: Anyan Qi, The University of Texas at Dallas, Richardson, TX

1 Human-Centric AI for Sequential Decision-Making

Park Sinchaisri, University of California, Berkeley, Berkeley, CA

Algorithmic recommendation systems are becoming increasingly crucial in supporting decisions in several domains, but there remains a gap between what is technically possible and what is utilized. Human biases are difficult to override, and people often erroneously mistrust effective recommendations after experiencing failure or when facing uncertainties. Recommendation content is also highly crucial, as bridging the gap between intuitive and ideal behavior is necessary to create the most powerful recommendation systems. We study how to best design a recommendation system that acknowledges human biases in the face of uncertainties to induce efficient behavior in complex sequential decision tasks. Our experimental studies also offer insights into the dynamics of human compliance with machine-generated recommendations.

2 Increasing Food Access Through Scheduled Grocery Delivery

Yeonjoo Lee, Karen L. Donohue, University of Minnesota, Minneapolis, MN, Contact: yjlee@umn.edu

The ability to access food is a significant concern for many low-income urban households in the United States. While online grocery delivery has the potential to improve food access, the high delivery fees and markup pricing typical of most instant delivery models pose critical cost barriers for the low-income population. This study examines how a scheduled delivery model, which consolidates nearby grocery orders and delivers on a weekly schedule, can better support the food access for under-served customers. Scheduled delivery may lower the shipping fee through increased operational efficiency, and improve customer grocery consumption behaviors, such as healthy food consumption, by creating an environment for planning. Using field data and experiments, we study the potential operational and customer well-being benefits of this new grocery delivery model.

3 Team Building and Incentive Design in Collaborative Projects

Ruth Beer[1], Anyan Qi[2], Ignacio Rios[2], [1]Baruch College, CUNY, New York, NY, [2]The University of Texas at Dallas, Richardson, TX

We explore factors affecting worker productivity in collaborative projects and what incentives promote the highest worker performance. We also explore another widely used managerial practice utilized by firms seeking to improve workers' performance in collaborative projects: team-building activities. We first derive predictions with an analytical model, and we then test these predictions with a behavioral experiment.

Monday, October 16, 8:00 AM - 9:15 AM

MA18

CC-North 127B

Cancer Modeling Within the CISNET Consortium ? The OR experience

Community Committee Choice Session

Session Chair: Iakovos Toumazis, The University of Texas MD Anderson Cancer Center, Houston, TX

1 The Engage Framework for Personalizing Lung Cancer Screening

Iakovos Toumazis, The University of Texas MD Anderson Cancer Center, Houston, TX, Contact: itoumazis@mdanderson.org

Lung cancer screening guidelines, such as the US Preventive Services Task Force (USPSTF), determine eligibility based on categorical age and smoking history. Selecting individuals for screening using a risk prediction model have been shown to be more effective and more cost-effective than the USPSTF guidelines. Using validated models developed within the Cancer Intervention and Surveillance Modeling network (CISNET), we developed the individualized lung cancer screening decisions (ENGAGE) framework, a partially observable Markov decision process (POMDP), that optimizes screening at the individual-level. We present the ENGAGE framework and compare the optimal policy against existing guidelines.

2 Using Collaborative Simulation Modeling to Develop Health Policy: A Case Study of Breast Cancer Screening Guidelines for Women with Down Syndrome

Oguzhan Alagoz, University of Wisconsin-Madison, Madison, WI, Contact: alagoz@engr.wisc.edu

Although randomized controlled trials (RCTs) are the most reliable form of evidence for health policy decisions, they may not be practical when making decisions that affect a small number of patients. In such cases, simulation modeling can be used to fill in the gaps in evidence. In this presentation, we explain how two established models from the National Cancer Institute's Cancer Intervention and Surveillance Modeling Network (CISNET) were used to develop mammography screening guidelines for women with Down syndrome. These women have a lower risk of breast cancer and significantly shorter life expectancies compared to women without Down syndrome. Our findings indicate that the traditional mammography screening guidelines recommended for average-risk women are not optimal for women with Down syndrome.

3 Dynamic Designs for Calibration of Mathematical Models: Application in Bladder Cancer Population Modeling

Thomas Trikalinos, Brown University, Providence, RI, Contact: thomas_trikalinos@brown.edu

The Cancer Intervention and Surveillance modeling Network (CISNET) Bladder Cancer Site uses two independently developed population-level mathematical models to address important questions in bladder cancer detection and control. Calibration of such models to data from cancer registries and individual- and aggregate-level datasets is a computationally expensive task. I will describe active learning explore-exploit algorithms to efficiently generate experimental designs for model calibration and their comparison with state-of-science approaches.

4 Robustness Analysis of Colorectal Cancer Colonoscopy Screening Strategies

Pedro Nascimento de Lima[1], Carolyn M. Rutter[2], Christopher Maerzluft[2], Jonathan Ozik[3], Nicholson Collier[3], [1]RAND Corporation, Arlington, VA, [2]Fred Hutchinson Cancer Center, Seattle, WA, [3]Argonne National Laboratory, Lemont, IL, Contact: plima@rand.org

This study uses the CRC-SPIN microsimulation model to perform a stress test of currently-recommended colorectal cancer (CRC) screening strategies. First, we extend CRC-SPIN to include birth-cohort effects allowing adenoma incidence to increase in later birth-cohorts and to estimate natural history parameters. We then conduct a large-scale experiment evaluating 26 screening strategies while accounting for uncertainty stemming from natural history, colonoscopy sensitivity, and the youngest age of adenoma occurrence. Finally, we identify non-dominated screening strategies and report posterior credible intervals for LYG, the number of colonoscopies needed, and incremental effectiveness ratios. We find that existing CRC screening policy recommendations are robust to the uncertainties considered in this study.

Monday, October 16, 8:00 AM - 9:15 AM

MA19

CC-North 127C

Healthcare Data: So Much Data, So Many Questions to Answer!

Panel Session

1 Panel Moderator

Wesley Javier Marrero, Thayer School of Engineering at Dartmouth, Hanover, NH

The Healthcare data: so much data, so many questions to answer! panel features speakers with vast experience working with large datasets. They will discuss some of the challenges/opportunities of working with healthcare data.

Session Chair: Wesley Javier Marrero, Thayer School of Engineering at Dartmouth, Hanover, NH

2 Panelist

Oguzhan Alagoz, University of Wisconsin-Madison, Madison, WI

3 Panelist

Nicoleta Serban, ISyE Georgia Tech, Atlanta, GA

4 Panelist

Vedat Verter, Queen's University, Kingston, ON, Canada

Monday, October 16, 8:00 AM - 9:15 AM

MA20

CC-North 128A

Practice-driven Healthcare Research in Collaboration with Hospitals and Clinicians

Flash Session

Session Chair: Pooyan Kazemian, Case Western Reserve University, Cleveland, OH

1 Personalized Treatment Decisions for Type 2 Diabetes: Balancing Health Benefits and Costs

Pooyan Kazemian, Case Western Reserve University, Cleveland, OH

Type 2 diabetes is a chronic disorder characterized by insulin resistance and high blood glucose levels, leading to complications in various organs. Type 2 diabetes affects 30 million Americans, with rapidly increasing prevalence projected for the future. While metformin is commonly used as a first-line treatment, many patients require additional medications. Traditional and newer classes of medications offer varying efficacy and side effects, with newer options showing superior benefits but at higher costs. The optimal treatment plan for each patient remains uncertain, as clinical guidelines often provide generalized recommendations. In this context, we developed mathematical and simulation models to help inform personalized treatment decisions based on patient-specific factors, aiming to maximize health benefits while considering costs.

2 Provider Scheduling in a Urology Clinic to Maximize Patient Access

Jennifer Mason Lobo[1], Ayca Erdogan[2], Bjorn Berg[3], Hyojung Kang[4], Matthew Clements[5], Stephen Culp[1], Tracey Krupski[1], [1]University of Virginia, Charlottesville, VA, [2]San Jose State University, San Jose, CA, [3]University of Minnesota, Minneapolis, MN, [4]University of Illinois Urbana-Champaign, Champaign, IL, [5]Lahey Health, Burlington, MA, Contact: jem4yb@virginia.edu

Assigning clinic days to urology providers in academic and large group practices is challenging given numerous scheduling constraints: evaluation and management visits, office or operating room procedures/surgeries, teaching, trainee mentorship, committee work, and outreach activities. We present an integer programming model for scheduling providers for clinic shifts in order to maximize patient access to appointments. We present results for a case study with an academic urology clinic, lessons learned from implementing the model generated schedule, and trends in the number of encounters and relative value units (RVUs, a measure that informs reimbursement for physician services) before and after the change in scheduling.

3 Impact Of Hospitalist Compliance With Providing Medically-Ready-for-Discharge Date

Keely Dwyer-Matzky[1], Dessislava Pachamanova[2], Vera Tilson[3], [1]University of Rochester Medical Center, Rochester, NY, [2]Babson College, Wellesley, MA, [3]University of Rochester, Rochester, NY, Contact: dpachamanova@babson.edu

We report on the impact of a program implemented in a large hospital system where health care providers were requested to estimate and record the Medically-Ready-for-Discharge Date in the electronic health records for hospitalized patients to facilitate efficient hospital stays.

4 Modeling Liver Acceptance Decision Making in Transplantation Using Continuous-Time Markov Decision Processes

Jiahui Luo[1], Wesley Javier Marrero[1], Mariel Sofia Lavieri[2], David W. Hutton[2], Neehar D. Parikh[2], [1]Dartmouth College, Hanover, NH, [2]University of Michigan, Ann Arbor, MI, Contact: jiahui.luo.th@dartmouth.edu

Markov Decision Processes (MDPs) are a collection of mathematical models designed to offer optimal solutions for sequential decision-making problems under uncertainties. The process of decision-making in organ transplantation typically involves uncertainty in the timing and qualities of the organ offers, and the health conditions of patients. To represent the decision-making process of accepting or declining organ offers tailored to an individual candidate on the liver transplantation waiting list, we develop a continuous-time finite-horizon Markov decision process (MDP) model. In this work, we solve the model using data from the Organ Procurement and Transplantation Network (OPTN) to maximize the expected total survival of the candidate in the liver transplantation waiting list.

5 Infection Aware Nurse Staffing

Buyun Li[1], Jonathan Eugene Helm[2], Pengyi Shi[3], Kurt M. Bretthauer[2], [1]Kelley School of Business; Indiana University, Bloomington, IN, [2]Indiana University, Bloomington, IN, [3]Purdue University, West Lafayette, IN, Contact: libu@iu.edu

We study the nurse staffing problem with the awareness of nurse absenteeism caused by the transmission of infectious diseases. In collaboration with Indiana University Health (one of the largest healthcare providers in the Midwest), we find empirical evidence for factors that are contributing or preventing nurses' absenteeism caused by in-hospital infection. Using these factors, we construct a random graph model to capture the transmissions from all sources. The random graph model is able to capture the interaction between operation decisions and disease transmission.

This allows us to perform counterfactual analysis to identify effective operational strategies for protecting nurses and providing patient care. We also offer a novel estimation method for the random graph model which accounts for the unobservable number of nurses in the incubation and infection time.

6 To Open or Not to Open: Efficient Scheduling and Capacity Management for Diagnostic Services

Maureen Canellas[1], Joyce Luo[2], Dessislava Pachamanova[3], Georgia Perakis[2], [1]University of Massachusetts Medical School, Worcester, MA, [2]Massachusetts Institute of Technology, Cambridge, MA, [3]Babson College, Wellesley, MA

The management of diagnostic services is a challenging task for hospital systems. Unmet demand is often carried over and pushed into the weekend, which is inefficient for the hospital and increases patient waiting times. In collaboration with a large Level I Trauma hospital, we use robust machine learning (ML) and optimization methods to provide more efficient policies for satisfying demand for diagnostic services (i.e. MRI scans, echocardiograms) among competing patient classes. We address uncertainty in demand and appointment lengths using data-driven uncertainty sets based on predictions from ML models. We also consider capacity adjustments like modifying the hospital's scan opening schedule or staffing distribution. Our work draws analogies to traditional inventory theory, as we aim to minimize daily patient demand carryover.

Monday, October 16, 8:00 AM - 9:15 AM

MA21

CC-North 128B

Healthcare OM: Nonprofit and Public Sector Perspectives

Community Committee Choice Session

Session Chair: Can Zhang, Duke University, Durham, NC

1 Indication-Based Pricing for Multi-Indication Drugs

Elodie Adida, University of California - Riverside, Riverside, CA, Contact: elodie.goodman@ucr.edu

Many pharmaceutical drugs have multiple indications, for which they offer a varying degree of benefit for patients. Yet, in the current US pricing system, the price of the drug is the same regardless of the indication for which it is prescribed. We use a modeling approach to analyze how indication-based pricing compares to uniform pricing for the manufacturer's profit and investment incentives, the patients' access to the drug and benefit, and the payer's coverage incentives and objective. We find that under indication-based pricing, the drug manufacturer earns higher profits and has stronger incentives to invest in a new indication, while the payer has stronger incentives to cover the drug, compared to uniform pricing. However, indication-based pricing may hurt the patient demand, patient utility and the payer's objective.

2 Impacts of a Non-Profit Intermediary on Reliability of Drug Supply

Hyoduk Shin[1], Junghee Lee[2], Jennifer K. Ryan[3], Daewon Sun[2], [1]UC-San Diego, La Jolla, CA, [2]University of Notre Dame, Notre Dame, IN, [3]University of Nebraska - Lincoln, Lincoln, NE, Contact: hdshin@ucsd.edu

Drug shortages have become increasingly common and costly in the U.S., particularly for generic drugs. In recent years, non-profit organizations dedicated to enhancing the reliability of the drug supply have begun to enter the pharmaceutical supply chain, alongside traditional for-profit intermediaries, such as group purchasing organizations. We study the impact of a non-profit intermediary on the market structure, health care providers' surplus, and reliability of supply in the context of a single drug that is vulnerable to shortages. We find that the introduction of a non-profit intermediary will not necessarily improve the surplus of health care providers. We also investigate the impact of the reimbursement rate as a lever to improve the reliability of supply and find that a non-profit intermediary is a more cost-effective mechanism to achieve the same result.

3 The Role of Market Interventions to Increase Access of Health Commodity in LMIC: A Case of the IPAQT

Parshuram Hotkar[1], Sarang Deo[2], Mohammed A. Rahman[1], [1]Indian School of Business, Hyderabad, India; [2]Indian School of Business, Hyderabad, India. Contact: parshuram_hotkar@isb.edu

Low and medium income countries (LMICs) face challenges to provide access to health commodities. This paper examines the role of market interventions like IPAQT in India, which was established to lower the price of TB diagnostic tests by negotiating with manufacturer and coordinating with private labs. We use a game-theoretic model to investigate the feasibility and sustainability of such market-transforming interventions. We show that internal price control mechanisms like the IPAQT will increase consumption more than external price control mechanisms like regulatory set price caps when there is heterogeneity in the private labs market. The research aims to generalize the economics of market-transforming interventions and provide guidelines for intervention designs to increase access to health commodities in LMICs.

4 Strengthen Blood Transfusion System in Africa: Inspire and Enhance Blood Donation Willingness by Utility-Based Blood Drive Planning

Yiqi Tian[1], Bo Zeng[2], Jayant Rajgopal[1], Bopaya Bidanda[1], Pratap Kumar[3], Juan Puyana[4], [1]University of Pittsburgh, Pittsburgh, PA, [2]University of Pittsburgh, Pittsburgh, PA, [3]Strathmore University Business School, Nairobi, Kenya; [4]University of Pittsburgh Medical School, Pittsburgh, PA, Contact: yit30@pitt.edu

Blood transfusion is a critical medical intervention that saves millions of lives every year. However, in many parts of Africa, blood transfusion services are under-resourced and face a range of logistical and operational challenges. This presentation proposes a two-stage blood drive planning approach that utilizes decisions to improve the blood transfusion system in Africa. By integrating decision-dependent uncertainty sets into the planning process, the proposed approach can influence the behavior of donors in the system. The presentation provides a detailed overview of the approach, highlighting its key features and advantages, and presents examples of how it can be applied in practice.

Monday, October 16, 8:00 AM - 9:15 AM

MA22

CC-North 129A

Statistical and Machine Learning Methods in Healthcare

Community Committee Choice Session

Session Chair: Raaz Dwivedi, Harvard and MIT, CAMBRIDGE, MA

Session Chair: Kyra Gan, Harvard University, Cambridge, MA

1 Non-Dominated Designs for Adaptive Clinical Trials

Eric Laber, Duke University, Durham, NC

Sequential experiments are often designed to ensure a balance between exper-iments that efficiently generate information and experiments that generate utility.A sequential experimental design that maximizes long-term cumulative utility mustexplore, i.e., forgo immediate utility in favor of information, only if and when thevalue of information generated by exploration outweighs the short-term loss in utility. Unfortunately, it is not possible to construct such designs in general. Instead,researchers must rely on heuristics that force exploration through randomization orby adding an exploration `bonus' to the utility function. We show that experimentsselected by commonly used heuristics frequently generate less information and lessutility than alternatives. Such experiments are said to be dominated in terms of utilityand information. We show that if one removes from consideration experiments thatare estimated to be dominated at each time point and then applies standard heuris-tics for forced exploration it is still possible to obtain consistency and asymptoticnormality. Furthermore, in a suite of simulation experiments, these non-dominatedheuristics generate more utility and more information (i.e., are more efficient) thantheir standard counterparts.

2 Adaptive Sequential Design For Long Time-series

Ivana Malenica, Harvard University, Cambridge, MA

This work is motivated by the need for robust personalized medicine, introducing a sequential, adaptive design for a single individual in a nonparametric model. We aim to learn an optimal choice of the controlled components of the design and continue to adapt randomization for future experiments. First, we define a class of conditional causal parameters suited for time-series data. We present a study of the data-adaptive inference for the mean under the optimal policy, where the target parameter adapts over time in response to the observed context. Out proposed estimator is double-robust, with favorable statistical properties for the mean under both true and estimated optimal rule. Secondly, we explore a setting where short-term rewards are not available, and the experimenter only has access to the final outcome at the end of a long time-series.

3 Identifying Synthetic Lethality Pairs with Recursive Feature Machines

Adityanarayanan Radhakrishnan, Cathy Cai, Caroline Uhler, MIT, Cambridge, MA, Contact: aradha@mit.edu

Synthetic lethality, i.e., the idea that simultaneous inactivation of pairs of genes can lead to cell death but individual inactivation does not, provides an avenue for identifying drug targets for cancer. The recent rise of large scale gene perturbation screens offers the opportunity to identify such pairs automatically using machine learning. In this work, we present a pipeline for unsupervised synthetic lethality screening based on feature learning kernel machines known as Recursive Feature Machines (RFMs). We demonstrate that RFMs more accurately recover synthetic lethality pairs and are orders of magnitude faster than prior methods for screening based on random forests or univariate statistical methodology. Moreover, we show that feature matrices from RFMs are useful for characterizing candidate pathways for treatment.

4 Tell Me Something Interesting: Clinical Utility of Machine Learning Prediction Models in the Icu

Bar Eini, Danny Eytan, Ofra Amir, Uri Shalit, Technion, Haifa, Israel. Contact: beini@campus.technion.ac.il

Machine learning (ML) prediction models for the intensive care unit (ICU) often prioritize overall precision, but is that aligned with clinicians' priorities? We believe that patient care is at its core a joint human-AI task, and that models should be optimized for this collaboration. In this talk, I will present our work aiming to understand and address clinicians' needs when designing ML models predicting vital signs for patients in the ICU. This includes prediction targets and timescales stemming from actionability requirements, and concerns regarding evaluation and trust in prediction algorithms. Based on our findings, we suggest new ways to measure model performance that go beyond the usual mean squared error. We show how these new utility functions can in turn be used as loss functions for training models that focus their predictive power on these more useful measures.

Monday, October 16, 8:00 AM - 9:15 AM

MA23

CC-North 129B

Analytics for Risk, Resilience and Safety in Supply Chains

Community Committee Choice Session

Session Chair: Retsef Levi, MIT, Cambridge, MA

1 A Discretization Framework for Robust Contextual Stochastic Optimization

Rares Cristian[1], Georgia Perakis[2], [1]Massachusetts Institute of Technology, Cambridge, GA, [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: raresc@mit.edu

Many real-world optimization problems depend on uncertain parameters that must be predicted from historical data. For example, in inventory allocation problems, demand distributions can vary based on observed features like location or season. We consider the class of contextual stochastic optimization problems and present a novel method to combine the learning and optimization steps in order to produce decisions that can minimize cost but also be robust and safeguard against worst-case scenarios. Our experimental results demonstrate that our approach is competitive in terms of average regret and yields more robust solutions than other methods proposed in the literature. Specifically, when the objective function is nonlinear, our method outperforms other methods by up to 50% in terms of 95th quantile costs.

2 Digital Supply Chain Analytics to Predict Cyber Risk

Kevin Hu, Retsef Levi, Raphael (Rafi) Yahalom, El Ghali Zerhouni, MIT, Cambridge, MA

The presentation provides the first empirical evidence that certain supply-chain attributes are significant predictors of cyber risk for enterprises, in addition to their internal characteristics and level of cybersecurity management. It leverages outside-in cyber risk scores that represent quality of cyber security management, and augment these with supply chain features that are inspired by network science research, to develop a more comprehensive risk assessment. The main result is to develop a model that shows that supply chain network features add significant detection power relative to merely internal enterprise attributes in predicting risk of cyber data breach incidents. Additionally, the model highlights several cybersecurity risk insights related to third party data breach mechanisms that have seen significant increase over the last several years.

3 Transmission Interaction Persistence (TIP): A Supply Chain and Epidemiological Model for Zoonotic Diseases Outbreaks

El Ghali Zerhouni[1], Retsef Levi[2], [1]MIT, Cambridge, MA, [2]MIT, Cambridge, MA, Contact: egaz@mit.edu

Zoonotic diseases that jump from animals to humans, such as avian influenza, swine flu, or SARS, have been responsible for major pandemics in the last several decades. Meanwhile farms could be a source of such diseases, most of the outbreaks have been linked to live animal markets in China. This talk presents a supply chain motivated transmission, interaction, and persistence (TIP) stochastic epidemiology model that seeks to explain the mechanism of disease amplification in markets, with a case study on avian influenza. It shows how even low infection rates among animals flowing from farms to markets and staying there less than one day can lead to large outbreaks. The study identifies the environment as a critical transmission host and vector of the disease. The results also stress and quantify the importance of sanitation practices to mitigate the risk of future pandemics.

4 Surveillance of Adverse Event Variability Across the Manufacturing Supply Chain of Biologic Drugs

Josh Wilde, Jacqueline Wolfrum, Stacy Springs, Retsef Levi, MIT, Cambridge, MA

In this talk we describe an innovative data-driven methodology to detect post marketing safety signal in biologic drugs that potentially emerge from variability in the manufacturing and supply chain conditions. Hidden Markov Chain modeling is used to detect safety signals based on the adverse reporting rate per lot.Real data is used to illustrate the applicability of the approach.

Monday, October 16, 8:00 AM - 9:15 AM

MA24

CC-North 130

Digital Platforms

Community Committee Choice Session

Session Chair: Dmitry Mitrofanov, Boston College, Chestnut Hill, MA

1 Deep Learning for Policy Targeting with Continuous Treatment

Zhiqi Zhang[1], Zhiyu Zeng[2], Ruohan Zhan[3], Dennis Zhang[4], [1]Washington University in St. Louis, St. Louis, MO, [2]Tsinghua University, Beijing, China; [3]Hong Kong University of Science and Technology, Clear Water Bay, China; [4]Washington University in St Louis, ST LOUIS, MO, Contact: z.zhiqi@wustl.edu

Optimizing continuous monetary treatments in marketing and operations, including wages, pricing, incentives, and discounts, is a complex task. Current approaches utilize discrete experiments to assess people's responses and return on investment (ROI) at specific treatment levels. We propose a double-machine-learning framework that leverages personal characteristics to determine the optimal treatment level for each customer. Unlike traditional discrete experiments, our approach provides theoretical guarantees on revenue and enables the identification of the optimal treatment level without relying on discrete levels. We validate our approach using a random field experiment on a large-scale video-sharing platform.

2 Optimal Mix of Dedicated and Flexible Supply in Digital Marketplaces

Chiara Farronato[1], Yejia Xu[2], [1]Harvard Business School, Brookline, MA, [2]Harvard Business School, Boston, MA, Contact: rxu@hbs.edu

We study the optimal mix of dedicated and flexible supply in digital marketplaces. We define dedicated supply as the set of service providers who are expected to be working with a planned schedule ex ante, while flexible supply as those who freely decide when and where to operate. Using data from a food-delivery platform operating in South America, we explore how the optimal supply mix changes across different geographic locations and hours of the day, and examine how it has changed over time as the platform has grown. Our results have implications on driver scheduling for both nascent and established platforms.

3 Disclosing Low Product Availability: An Online Retailer's Strategy for Mitigating Stockout Risk

Dmitry Mitrofanov[1], Benjamin Knight[2], [1]Boston College, Chestnut Hill, MA, [2]Instacart, San Francisco, CA

Ensuring product availability and the successful fulfillment of orders are key priorities for any company operating in the retail industry. In this paper, we investigate the impact of sharing information about low item availability on customer purchase decisions in the retail industry. It is hard to predict the net impact of sharing item availability information on business metrics ex-ante because there are multiple effects that might act in opposite directions. Through a field experiment with over 840K customers on Instacart, the study reveals that customers are 25% less likely to purchase low-stock items when informed about their availability. In addition, this disclosure also leads to higher customer satisfaction and positively affects revenue and order frequency, with a 5.33% increase in revenue per customer and a 4.9% increase in order frequency.

4 Customers' Multihoming Behavior in Ride-Hailing: Empirical Evidence Using a Structural Model

Sandeep Chitla[1], Maxime Cohen[2], Srikanth Jagabathula[1], Dmitry Mitrofanov[3], [1]NYU Stern School of Business, New York, NY, [2]McGill University, Kirkland, QC, Canada; [3]Boston College, Chestnut Hill, MA, Contact: chitlasandeep@gmail.com

We examine customer multihoming using a large ride-hailing panel dataset that observes repeated Uber and Lyft choices of 1.4 million rides completed by 160k NYC riders in NYC in 2018. To explain riders' choices, we develop a structural model that incorporates customers' search behavior and consideration set formation. We find that operational factors do not fully explain riders' choices, suggesting customers view platforms as differentiated service providers. In 2018, 45% of users used only Uber and 20% only Lyft, and only

43% of the remaining 35% of Uber and Lyft users considered both platforms. Targeting customers earlier in their lifecycle increases the platform's market share by 77.56% more than their current promotional strategy. Targeting customers with low search friction increases market share by 24.78% more than targeting customers with high search friction.

Monday, October 16, 8:00 AM - 9:15 AM

MA25

CC-North 131A

Health IT and Analytics

Community Committee Choice Session

Session Chair: Tan (Suparerk) Lekwijit, W. P. Carey School of Business, Arizona State University, Tempe, AZ

1 Impact of Telehealth on Appointment Adherence in Ambulatory Care

Masoud Kamalahmadi, Christos Zacharias, Howard Gitlow, University of Miami, Coral Gables, FL, Contact: mkamalahmadi@miami.edu

We study the effect of telehealth on patients' adherence to medical appointments. Using data from a large medical system, we find that no-show and late-arrival probabilities decrease over telehealth. We discuss the underlying mechanisms of these improvements and their implications for managers and policy makers.

2 People Talking and AI Listening: How Stigmatizing Language in EHR Notes Affects AI Fairness

Yizhi Liu[1], Weiguang Wang[2], Gordon Gao[3], Ritu Agarwal[4], [1]University of Maryland, College Park, College Park, MD, [2]University of Rochester, Rochester, NY, [3]Johns Hopkins University, Baltimore, MD, [4]Johns Hopkins Carey Business School, Baltimore, MD, Contact: yizhiliu@umd.edu

Electronic healthcare records (EHRs) are a critical data source for the artificial intelligence (AI)-driven transformation in healthcare. However, clinician biases reflected in EHR notes can lead to AI models inheriting these biases and perpetuating health disparities. This study focuses on the impact of stigmatizing language (SL) in EHR notes on mortality prediction using a deep learning model. We find that SL written by clinicians impedes AI performance, especially for black patients, highlighting SL as a source of racial disparity in AI development. Further, we investigate the generation of SL and find that removing SL written by central clinicians in their collaborative network is an efficient bias reduction strategy. This study provides actionable insights for responsible AI development and contributes to understanding clinician behavior in EHR note writing.

3 Toward Equitable Care Access: The Impact of Telehealth Adoption in Safety-Net Health Centers

Kyuyeon (Jenny) Rhee[1], Xiao Liu[2], Tan Lekwijit[1], Pei-yu Chen[2], [1]W. P. Carey School of Business, Arizona State University, Tempe, AZ, [2]Arizona State University, Tempe, AZ, Contact: krhee1@asu.edu

This research examines the effectiveness of telehealth in safety-net community health centers (CHCs) in the U.S., specifically targeting underserved populations and mental health services. Focusing on barriers like specialist access and distance to care, it analyzes how mental telehealth implementation varies across locations and delivery models. Key findings indicate an increase in mental health patients and visits, particularly in lower-income areas. The study also differentiates between specialist-facilitated and remote telehealth models, highlighting the nuanced implications for quality and access. The research emphasizes that telehealth's deployment must consider various socioeconomic factors and calls for context-specific strategies, offering critical insights into healthcare disparities.

4 Impact Of Health Information Exchanges On Continuity Of Care

Saeede Eftekhari[1], Ramaswamy Ramesh[2], [1]Tulane University, NEW ORLEANS, LA, [2]SUNY Buffalo, East Amherst, NY

Patient movement between service providers is an important phenomenon in the continuum of healthcare. In this research, we focus on primary care settings, and we investigate how Health Information Exchanges (HIEs) affect patients' return to the primary care physicians (PCPs) for follow-up care. More specifically, we study whether HIEs can speed up the return of patients to the primary care physicians after specialist care is given. Our findings have important managerial and policy implications for both healthcare markets and HIE platforms.

Monday, October 16, 8:00 AM - 9:15 AM

MA26

CC-North 131B

FinTech and Blockchain

Community Committee Choice Session

Session Chair: Fasheng Xu, Syracuse University, Long

Island City, NY

1 The Paradox of Just-In-Time Liquidity in Decentralized Exchanges: More Can Sometimes Mean Less

RUIZHE Jia, Agostino Capponi, Brian Zhu, Columbia University, New York, NY, Contact: rj2536@columbia.edu

This study scrutinizes the intricacies of Just-in-Time (JIT) liquidity in blockchain-based decentralized exchanges. While JIT liquidity providers, acting as high-frequency market makers, ostensibly enhance the liquidity pool, our findings reveal they inadvertently crowd out passive liquidity providers. This surprising paradox, where 'more leads to less', occurs due to the unchanged adverse selection costs and reduced fee earnings for passive providers. This can diminish overall equilibrium liquidity and increase execution risk for traders, since JIT liquidity, unlike passive liquidity, is unobservable pre-trade.

2 What Drives the (In)stability of a Stablecoin?

Yujin Kwon[1], Kornrapat Pongmala[1], Kaihua Qin[2], Ariah Klages-Mundt[3], Philipp Jovanovic[4], Christine Parlour[5], Arthur Gervais[4], Dawn Song[1], [1]UC Berkeley, Berkeley, CA, [2]Imperial College London, London, United Kingdom; [3]Cornell University, Winona, MN, [4]UCL, London, United Kingdom; [5]University of California - Berkeley, Berkeley, CA, Contact: yujinyujin9393@berkeley.edu

In May 2022, an apparent speculative attack, followed by market panic, led to the precipitous downfall of UST, one of the most popular stablecoins at that time. However, UST is not the only stablecoin to have been depegged in the past. Designing resilient and long-term stable coins, thus, appears to present a hard challenge.
To further scrutinize existing stablecoin designs and ultimately lead to more robust systems, we need to understand where volatility emerges. Our work provides a game-theoretical model aiming to help identify why stablecoins suffer from a depeg. This game-theoretical model reveals that stablecoins have different price equilibria depending on the coin's architecture and mechanism to minimize volatility. Moreover, our theory is supported by extensive empirical data consisting of daily prices for 22 stablecoins and on-chain data from five blockchains.

3 Web3 Reputation: Introducing Dynamic Incentives into Distributed Networks

Lin William Cong[1], Luofeng Zhou[2], [1]Cornell University, Ithaca, NY, [2]NYU Stern School of Business, New York, NY, Contact: lz2198@nyu.edu

In this paper, we introduce dynamic incentives to distributed systems via incorporating suppliers' reputation. Reputation aligns suppliers' incentive to platform welfare and allows myopic suppliers to consider long-term interests. Using Proof-of-Stake (PoS) protocol as an example, we show that the platform can support more throughput with same amount of staking, and the transaction fee is immune to shocks to suppliers. Furthermore, we analyze how dynamic incentives mitigate moral hazard in decentralized reporting game, and how decentralization solves wealth concentration caused by dynamic incentives. These analyses propose adding reputation to Web3 applications in support of sustainable and robust long-run prospect.

4 The Value of Information on Trade Credit Platforms

Jiding Zhang[1], Song Yang[2], Xiangfeng Chen[3], Xinyue Cheng[4], [1]Arizona State University, Tempe, AZ, [2]London Business School, London, United Kingdom; [3]Fudan University, Shanghai, China; [4]Shanghai Jiao Tong University, Shanghai, China

We examine the role of information transparency on a trade credit platform. We first build a structural model to study the cost and benefit associated with different actions upon receivcing bills (account receivables) for each agent on the supply chain. We then run counterfactual experiments to examine how different levels of information transparency affect the efficiency of the supply chain finance.

Monday, October 16, 8:00 AM - 9:15 AM

MA27

CC-North 131C

Digital Marketplace: Operational Challenges and Opportunities

Community Committee Choice Session

Session Chair: Guangwen (Crystal) Kong, Temple University, Philadelphia, PA
Session Chair: Hao Jiang, temple university, PHILADELPHIA, PA

1 Food-Delivery Platforms: Near-Optimal Policies for Capacity Sizing, Order-Batching and Routing

Yang Bo[1], Milind Dawande[2], Ganesh Janakiraman[3], [1]The Chinese University of Hong Kong, Shatin, N.T., Hong Kong; [2]The University of Texas at Dallas, Richardson, TX, [3]University of Texas- Dallas, Richardson, TX, Contact: yangbo@cuhk.edu.hk

We study the one-time capacity sizing and infinite-horizon real-time orders' batching and routing problem for a food delivery platform. The objective is to minimize the long-run average cost incurred per unit time, where the cost includes wages to servers plus the delay penalty cost. We characterize the fundamental trade-off between spatial economies of scale and orders' waiting time before entering delivery service in this setting through a lower bound on the cost under any policy within a general class of policies. We then identify a simple, near optimal algorithm whose performance gap with respect to this lower bound vanishes in a meaningful asymptotic regime.

2 Wage Fairness in Two-Sided Markets

Jingyuan Wan, University of Minnesota, Minneapolis, MN

Wage discrimination is a pervasive issue in labor markets. But will imposing wage fairness regulation be the solution? In this work, we develop a model of a two-sided market to study the impact of fairness constraint on outcomes for workers, consumers, and the firm. The model captures the heterogeneity of workers by dividing them into distinct groups based on their salient characteristics. We show that conditions exist under which imposing fairness constraints may not lead to better outcomes, including for the target group.

3 Strategic Delay In Grocery Delivery Platform

Hao Jiang[1], Guangwen (Crystal) Kong[2], [1]temple university, PHILADELPHIA, PA, [2]Temple University, Philadelphia, PA, Contact: tul13843@temple.edu

Inspired by the interactions between customer's online shopping experience and the grocery delivery platform's service strategies, we study whether the platform should strategically delay the service when considering the store's inventory. We find the platform's strategic delay may be higher than the delay determined by the queueing system.

4 The Impact of Automation on Workers when Workers are Strategic: The Case of Ride-Hailing

Zicheng Wang, University of Minnesota, Minneapolis, MN

Technological advances in robotics, machine learning, and artificial intelligence have raised concerns about the displacement of human workers by automation. We study the impact of automation on worker welfare when workers have discretion in how they carry out the work and may act strategically. We ground our analysis in the setting of a ride-hailing service that operates a mixed fleet with human drivers and autonomous vehicles (AVs). We show that the introduction of AVs, by inducing a more favorable equilibrium, can lead to outcomes that improve both efficiency and worker welfare.

Monday, October 16, 8:00 AM - 9:15 AM

MA28

CC-North 132A

Procurement and Market Design

Community Committee Choice Session

Session Chair: Mehdi Farahani, University of Miami, Miami, FL

1 Asymmetric Cost of Quality, Sourcing, and Vertical Differentiation

Jie Ning[1], Zhibin (Ben) Yang[2], [1]Case Western Reserve University, Cleveland, OH, [2]Universtiy of Oregon, Eugene, OR, Contact: zyang@uoregon.edu

Should firms differentiate quality to soften competition, or equalize it by sourcing? We study sourcing by inefficient firm 2 from efficient firm 1. We show firm 2 prefers sourcing, if it well improves quality. Otherwise, firm 2 may not source even for free. Firm 1 averts sourcing if it enjoys large quality leadership under no-sourcing and low horizontal product differentiation. While sourcing pools resource for innovation to firm 1, it may lead to lower quality than no-sourcing if firm 1 has small efficiency advantage.

2 Price Subsidies with or Without Physical Procurement: Impact on Quality, Profits, and Welfare

Omkar D. Palsule-Desai[1], Aysajan Eziz[2], Srinagesh Gavirneni[3], [1]IIM Indore, Indore, India; [2]Ivey Business School, Western University, London, ON, Canada; [3]Cornell University, Montreal, Canada. Contact: omkardpd@iimidr.ac.in

Newly introduced price subsidy programs without physical procurement have resulted in an increased (vis-\`{a}-vis the subsidy programs with physical procurement) preponderance of deliberate quality degradation for certain crops by Indian farmers. The physical procurement of the crop from farmers provides an alternate sales channel to farmers. The farmers' deliberate quality degradation may moderate the benefits of the altered competitive structure. Using a multi-stage incomplete information-based (Bayesian) game-theoretic model, we characterize the farmers' strategic production and selling decisions. We demonstrate that to eliminate farmers' deliberate crop quality degradation, when MSP is moderate, if not lower, the government should (should not) procure the crop physically if the high-quality crop price premium in the open market is higher (lower).

3 A Prior-Free Asymptotically Efficient Mechanism for Two-Sided Platforms with Dynamic Arrivals

Arun Kumar Rout[1], Milind Dawande[1], Ganesh Janakiraman[2], [1]The University of Texas at Dallas, Richardson, TX, [2]University of Texas- Dallas, Richardson, TX, Contact: arun.rout@utdallas.edu

We consider a platform that operates a two-sided market in which unit-demand buyers with private valuations and unit-supply sellers with private costs arrive dynamically over time — the arrival processes of these agents and their value/cost distributions are Markov-modulated. The platform incurs a waiting cost per agent per unit time for agents waiting in the market. The platform seeks to design a mechanism that maximizes its efficiency, which is the difference of the aggregate valuation of the matched buyers and the aggregate cost of the matched sellers, less the waiting cost. For this problem, we develop a prior-free asymptotically efficient mechanism. More generally, we provide a framework that takes as input a static mechanism with some desirable properties and outputs a dynamic mechanism that retains these properties and is prior-free and asymptotically efficient.

4 Pay with Your Data: Designing Optimal Data-Sharing Mechanisms for Artificial Intelligence Services

Chandrasekhar Manchiraju[1], Sameer Mehta[2], Milind Dawande[3], Ganesh Janakiraman[4], [1]Michigan State University, East Lansing, MI, [2]Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands; [3]The University of Texas at Dallas, Richardson, TX, [4]University of Texas- Dallas, Richardson, TX, Contact: chandumanchi@gmail.com

The rapid advances in the field of Machine Learning (ML) have led to the proliferation of Artificial Intelligence (AI) services offered by firms. To develop a valuable AI service, a firm must build an accurate ML model which requires a large amount of training data. Present-day firms usually obtain this data by offering incentives to consumers to share their data during the initial development phase of the AI service, and then use that data to re-train the ML models to improve the quality of the AI service. In this paper, we analyze two popular data-sharing mechanisms employed by firms: manual data-sharing and algorithmic data-sharing. For both approaches, we obtain revenue-maximizing mechanisms for the firm and analyze the fundamental differences between the two approaches in terms of the revenue accrued by the firm, the consumer surplus, and the volume of data collected.

Monday, October 16, 8:00 AM - 9:15 AM

MA29

CC-North 132B

Optimizing Supply Chain Operations

Community Committee Choice Session

Session Chair: Shivam Gupta, University of Nebraska Lincoln, Lincoln, NE

1 Cloud Cost Optimization: Model, Bounds, and Asymptotics

Zihao Qu[1], Milind Dawande[1], Ganesh Janakiraman[2], [1]The University of Texas at Dallas, Richardson, TX, [2]University of Texas- Dallas, Richardson, TX, Contact: zihao.qu@utdallas.edu

Motivated by the rapid growth of the cloud computing industry, we study an infinite-horizon, stochastic optimization problem from the viewpoint of a firm that employs cloud resources to process incoming orders (or jobs) over time. There are several types of resources that differ in their costs, performance attributes, reserved prices and on-demand prices. Orders of several types arrive stochastically through time -- orders differ in their deadlines and in their resource-specific processing-time distributions. The firm's goal is to minimize the long-run average expected cost per period, considering reserved-capacity costs, on-demand capacity costs, and order-delay costs. We show that our proposed policy is asymptotically optimal. We also report results of a comprehensive numerical study -- on a testbed informed by capacity and pricing data from Amazon Web Services.

2 Ordering of Perishable Products Where Order Value is Constrained by Revenue

Jyotishka Ray, Miami University, Oxford, OH

We consider a spare-parts dealer who is authorized by a firm to purchase OEM parts and sell it in the local market at regulated price. The parts are purchased on credit and needs to be paid at the beginning of the next period when the order arrives. The unsold parts are carried forward in the next period and perceived to be perishable after the arrival of the new parts. We consider the dealer's problem of finding optimum order policy so that the revenue generated in a period is sufficient enough to repay the credit for the next period order after incurring holding and maintenance costs. We use uniform demand distributions of a single old-and new parts to find a simple steady state ordering policy. We formulate a multi-part finite horizon dynamic program which is separable in parts. A fast converging, efficient, and scalable heuristic is developed which is free of any optimization steps.

3 Procurement for Assembly Systems Under Disruption Risk: Optimal Mechanisms

Like Bu, Milind Dawande, Ganesh Janakiraman, The University of Texas at Dallas, Richardson, TX, Contact: lxb190003@utdallas.edu

Motivated by the recent surge in supply chain disruptions, we study a mechanism design problem faced by a firm assembling a product from multiple components. For each component, the firm has access to an unreliable supplier whose production cost information is private and whose production could be disrupted with some publicly known probability. In addition, for each component, the firm has access to a more expensive but reliable supply source upon whom it can fall back in the event of a disruption. The goal is to design a procurement mechanism for the firm. Our research presents a practically appealing optimal mechanism, and we provide optimal mechanisms for two extensions in which supply uncertainty is modeled as general discrete random variables and continuous random variables. With an eye on practice, we offer screening implementations of all our mechanisms.

4 Data-Driven Condition-Based Maintenance for Perpetual Systems

Sandun Perera, College of Business, University of Nevada, Reno, NV

We consider an IOT-based smart system where the past performance of the system is monitored in real-time and is used to derive the operational control bands to optimize its performance over time. In particular, we show that the optimal maintenance policy for this smart system is to follow a "two-band control" on the current performance level. The smart system autonomously switches to a prearranged backup system when its performance is detected to be unacceptable (not in control) and immediately transmits an IoT-enabled Kanban signal to the maintenance crew. When the maintenance order is completed, the backup system switches back to the original system. This paper not only proves the optimal policy is a two-band control policy but also provides efficient ways to approximate the optimal policy as well as the underlying performance of the system.

5 Product Line Design in Distribution Channels with Demand-Learning Considerations

Yulia Vorotyntseva, Saint Louis University, St Louis, MO, Contact: yulia.vorotyntseva@slu.edu

This paper proposes an analytical framework for optimizing the product line of a distributor who sells to small retailers. The distributor has better information about consumer demand but does not share it with the retailer, who uses her own sales data to decide which, if any, product to pick from the distributor's assortment. Upon offering a product, the retailer receives a noisy signal about its performance and updates her beliefs about the market demand in a Bayesian fashion. The proposed model captures the distributor's tradeoff between the risk of losing a retailer to another distributor if none of the products in the assortment appeal to her and the risk of the retailer substituting a higher margin product for a lower margin one.

Monday, October 16, 8:00 AM - 9:15 AM

MA30

CC-North 132C

Science, Technology, and Operations

Community Committee Choice Session

Session Chair: Junghee Lee, University of Notre Dame, Notre Dame, IN

1 Learning by Failing: The (Unintended) Consequence of Test Reporting on Autonomous Vehicle Training

Zhi Chen[1], Wenjie Xue[2], [1]National University of Singapore, Singapore, Singapore; [2]Cornerstone Research, Inc., Menlo Park, CA, Contact: zhi.chen@nus.edu.sg

Autonomous vehicles (AVs) have great potentials to revolutionize the transportation industry. The success of AVs depends on its access to various real-world driving scenarios. To improve AVs' algorithms, firms send testing vehicles onto public roads to discover those rare complex driving scenarios ("edge cases"). While these edge cases are valuable for AVs' future improvements, they trigger failure of testing vehicles (called disengagement) each time an edge case is discovered. Using a game-theoretic model, we study how disengagement reporting requirements by regulators affects the testing strategies of AV firms.

2 Advising Entrepreneurs: Optimal Recommendation of Alternatives

Zeya Wang[1], Morvarid Rahmani[2], Karthik Ramachandran[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA

Facing emergent business challenges, entrepreneurs often seek guidance from experienced advisors. When multiple alternatives could potentially solve the entrepreneur's problem, advisors can lead the entrepreneur's exploration by choosing which alternative(s) to suggest and in what sequence. We develop a dynamic game-theoretic model that captures the sequential interaction between an advisor and an entrepreneur. Our analysis reveals that, following a failed trial, the advisor should readily offer a new alternative if the entrepreneur's capability is either very high or low. Otherwise, the advisor should encourage the entrepreneur to try the same solution multiple times. In situations where alternative solutions are interdependent, our analysis reveals that the advisor might find it optimal to present them simultaneously and early in the horizon.

3 Access to Science in the Town Square:Social Media Democratize Science Communication

Yang Yang[1], Tanya Tian[2], Brian Uzzi[3], Benjamin Jones[3], [1]University of Notre Dame, Notre Dame, IN, [2]New York University, New York, NY, [3]Northwestern University, Evanston, IL

Science is increasingly communicated to the public through social media, raising significant questions about the role that social media serve in how scientific knowledge is consumed in public domains. Here, we engage in systematic investigation combining several large-scale datasets. There are several important findings. First, our results demonstrate that social media use high-quality science consistent with what is impactful within science. Second, while mainstream media coverage is concentrated in a handful of fields, social media usage of science draws broadly and equitably from different fields. Further, while eminent institutions tend to dominate mainstream media coverage, social media gives voice more equally. Finally, our analyses on scientists active on social media reveal a remarkable alignment between social media impact and eminence in science.

4 Slow Hunch to Vision. the Interaction Between Entrepreneurial Vision Making and Pivoting

Monique Boddington, Stylianos Kavadias, University of Cambridge, Cambridge, United Kingdom. Contact: mib25@cam.ac.uk

This paper focusses on the micro-foundations of strategy, explaining how entrepreneurial vision making influences pivoting and persevering, in early stage ventures. The success of a venture is dependent both on the quality of the idea and strategy. What is less clear is how entrepreneurs balance their own vision of an entrepreneurial opportunity, with external feedback gained through a 'scientific' approach to entrepreneurship. This paper proposes that entrepreneurs engage in an interplay, between vision making and learning, through experimentation and external feedback. We document, how vision, rather than being a single epiphany, comes into being as a 'slow hunch' that develops over time, influenced by multiple events. Through testing and iteration, entrepreneurs strengthen their own vision, which increasingly acts as a guiding light for future decisions.

Monday, October 16, 8:00 AM - 9:15 AM

MA31

CC-North 221A

Edelman Finalist Reprise

Community Committee Choice Session

Session Chair: Rajeev Namboothiri, GE Research, Bangalore, India

1 Supercharged by Advanced Analytics, JD.com attains Agility, Resilience, and Shared Value Across its Supply Chain

Yongzhi Qi, JD.com, Beijing, China

Despite challenges in the sophisticated retail supply chain, JD.com has strengthened its supply chain agility, and attained shared value by focusing on supply chain efficiency, supply chain resilience, and customer-demand intelligence. Specifically, JD.com implemented an end-to-end inventory management system based on a dynamic programming model and a neural network model, leading to a reduction in costs and enhancements in operational efficiency. To be able to provide guaranteed service levels for consumers during supply chain disruptions, JD.com utilized intelligent techniques, including an emergency classification mechanism and a simulation model, to strengthen critical partnership collaboration, to attain resilience, and to benefit the society as a whole. For the upstream manufacturers, JD.com implemented the consumer-to-manufacturer (C2M) system by incorporating state-of-the-art artificial intelligence algorithms, and enabled manufacturers to accurately sense customer demand and produce more popular products, hence creating value for the entire ecosystem. Billions of dollars in increased revenue and tens of millions of dollars in cost savings have been achieved since the implementation of aforementioned techniques to date, and customer welfare and partner manufacturers' benefits have been significantly enhanced.

2 A Better Match for Everyone, Reinforcement Learning at Lyft

Sebastien Martin[1], Tony Qin[2], [1]Kellogg School of Management, Northwestern University, Evanston, IL, [2]Lyft, San Francisco, CA

To better match drivers to riders in our ridesharing application, we revised Lyft's core matching algorithm using a novel reinforcement learning approach. This innovation enabled our drivers to serve millions of additional rides each year, leading to more than $30 million per year in incremental revenue.This change was the first documented real-world implementation of a ridesharing matching algorithm that can learn and improve in real time. Our experiments showed that this approach benefits drivers, riders, and the platform.

3 Innovative Integer Programming Software and Methods for Large-Scale Routing at DHL Supply Chain

Jon Cox[1], Manjeet Singh[1], Yibo Dang[2], Theodore Allen[2], [1]DHL Supply Chain, Westerville, OH, [2]Ohio State University, Columbus, OH

We utilize innovative integer programming approaches in the TNO software, including a new type of two-color ant colony search, leading to over $117 million in estimated savings to DHL Supply Chain and its customers and increasing the win rate from approximately 15% to approximately 60%.

Monday, October 16, 8:00 AM - 9:15 AM

MA32

CC-North 221B

Convex Relaxations for Polynomial Optimization

Community Committee Choice Session

Session Chair: Jie Wang, Chinese Academy of Sciences, China

1 A Correlative Sparse Lagrange Multiplier Expression Relaxation for Polynomial Optimization

Zheng Qu[1], Xindong Tang[2], [1]The University of Hong Kong, Pokfulam, Hong Kong; [2]The Hong Kong Polytechnic University, Hung Hom, Hong Kong

We consider polynomial optimization with correlative sparsity. We construct correlative sparse Lagrange multiplier expressions (CS-LMEs) and propose CS-LME reformulations for polynomial optimization using the KKT optimality conditions, and solve these reformulations by correlative sparse sum-of-squares (CS-SOS) relaxations. We show that the CS-LME reformulation inherits the original correlative sparsity pattern, and the CS-SOS relaxation provides sharper lower bounds when applied to the CS-LME reformulation, compared with when it is applied to the original problem. The convergence is guaranteed under mild conditions. In numerical experiments, our new approach usually finds the global optimum with a low relaxation order. Also, by exploiting the correlative sparsity, our CS-LME approach requires less computational time than the original LME approach.

2 Sum-Of-Squares Chordal Decomposition of Polynomial Matrix Inequalities

Yang Zheng[1], Giovanni Fantuzzi[2], [1]University of California San Diego, San Diego, CA, [2]Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany. Contact: zhengy@eng.ucsd.edu

Sum-of-squares (SOS) optimization has found many applications in control theory, fluid dynamics, and power systems. In theory, SOS optimization can be solved in polynomial time using interior-point methods, but these methods are only practical for small- to medium-sized problems. In this work, we introduce decomposition methods for SOS optimization with chordal sparsity, which scale more favorably to large-scale instances. Chordal decomposition allows one to decompose a positive semidefinite cone into a set of smaller and coupled cones. This work extends the classical chordal decomposition to the case of sparse polynomial matrices that are positive (semi)definite globally or locally on a semi-algebraic set. The extended results can be viewed as sparsity-exploiting versions of the Hilbert-Artin, Reznick, Putinar, and Putinar-Vasilescu Positivstellensätze.

3 Community/Committee'S Choice Submission

Ngoc Hoang Anh Mai, Konstanz, Denmark

4 Risk Analysis for Stochastic Processes Using Polynomial Optimization

Jared F. Miller, Northeastern University, Boston, MA

This work formulates algorithms to upper-bound the maximum Value-at-Risk (VaR) of a state function along trajectories of stochastic processes. The VaR is upper bounded by concentration tail-bounds (Cantelli, Vysochanskij-Petunin). Concentration bounds lead to a infinite-dimensional Second Order Cone Program (SOCP) in occupation measures. Under compactness and regularity conditions, there is no relaxation gap between the infinite-dimensional convex program and their nonconvex optimal-stopping stochastic problems. Upper-bounds on the SOCP are obtained by a sequence of semidefinite programs through the moment-Sum-of-Squares hierarchy. The VaR-upper-bounds are demonstrated on example polynomial Stochastic Differential Equations.

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CC-North 221C

Algorithms for Discrete Optimization

Community Committee Choice Session

Session Chair: Swati Gupta, ISyE Georgia Tech, Atlanta, GA

Session Chair: Jai Moondra, Georgia Institute of Technology, Atlanta, GA

1 Online Demand Scheduling with Failovers

Rudy Zhou[1], Konstantina Mellou[2], Marco Molinaro[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Microsoft Research, Redmond, WA

Motivated by cloud computing applications, we study the problem of how to deploy new hardware subject to power and robustness constraints. We have identical devices with capacity constraints. Demands come one-by-one and, to be robust against a device failure, need to be assigned to a pair of devices. When a device fails (in a failover scenario), each demand assigned to it is rerouted to its paired device (which may now run at increased capacity). The goal is to assign demands to the devices to maximize the total utilization subject to both the normal capacity constraints as well as these novel failover constraints. These latter constraints introduce new decision tradeoffs not present in classic assignment problems such as Multiple Knapsack and AdWords. We present algorithms for both the worst case and stochastic model, where demands come i.i.d. from an unknown distribution.

2 Determinant Maximization via Matroid Intersection

Adam Brown[1], Aditi Laddha[1], Madhusudhan Pittu[2], Mohit Singh[1], Prasad Tetali[2], [1]Georgia Tech, Atlanta, GA, [2]Carnegie Mellon University, Pittsburgh, PA

Determinant maximization provides a general framework for problems from statistics, convex geometry, fair allocation and network design. In an instance of the determinant maximization problem we are given a collection of vectors and the goal is to select a small subset where the sum of the rank-1 matrices formed by the chosen vectors has large determinant. In general we may have additional combinatorial constraints on which subsets can be selected, such as a matroid base constraint. In this work, we adapt the classical weighted matroid intersection algorithm and apply it to approximate determinant maximization. Instead of the traditional vertex weights, we use edge weights which measure the change in determinant after an individual swap, and iteratively search for improving cycles. Joint work with Aditi Laddha, Madhusudhan Pittu, Mohit Singh, and Prasad Tetali.

3 Online Covering in Stochastic and Random-Order Settings

Anupam Gupta[1], Gregory Kehne[2], Roie Levin[3], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Harvard University, Cambridge, MA, [3]Tel Aviv University, Tel Aviv, Israel

We present a framework for solving a broad class of online integer covering problems---including set cover, covering integer programs, and non-metric facility location---in a number of beyond-worst-case settings. We obtain simple and efficient O(log mn)-competitve algorithms for these {problems}×{settings} which are asymptotically optimal and essentially match offline complexity-theoretic lower bounds. We address models when constraints arrive (1) in random order, (2) from a partially observed adversarial input sequence, (3) drawn from distinct prior distributions, and (4) in a hybrid two-stage/online stochastic model. We derive algorithms for (2)-(4) via simple black-box reductions to the random-order setting (1).

4 Maintaining Matroid Intersections Online

Sherry Sarkar[1], Daniel Hathcock[1], Anupam Gupta[1], Niv Buchbinder[2], Anna Karlin[3], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Tel Aviv University, Tel Aviv, Israel; [3]University of Washington, Seattle, WA, Contact: sherrys@andrew.cmu.edu

Maintaining a maximum bipartite matching online while minimizing recourse/augmentations is a well studied problem, motivated by content delivery, job scheduling, and hashing. A breakthrough result of Bernstein, Holm, and Rotenberg resolved this problem up to a logarithmic factors. However, we may need a richer class of combinatorial constraints (e.g., matroid constraints) to model other problems in scheduling and resource allocation. We consider the problem of maintaining a maximum independent set of an arbitrary matroid M and a partition matroid P in the online setting. Our main result is an O(n log ^2 n)-competitive algorithm, where n is the rank of the largest common base. A key contribution of our work is to make connections to market equilibria and prices, and our use of properties of these equilibria in submodular utility allocation markets.

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CC-North 222A

Network Design and Optimization

Community Committee Choice Session

Session Chair: Zeyad Kassem, Arizona State University, Tempe, AZ

1 Using Hexagonal Grid Topology for Wireless Sensor Networks Optimization

Ceca Mijatovic, The George Washington University, Washington, D.C., DC, Contact: cecamijatovic@gwmail.gwu.edu

Distribution of Internet-of-Things sensors often leads to transmission conflicts and inefficiency of energy utilization, resulting in decreased sensor communication and incomplete data for decision making. Even 5% to 20% of missing data makes the performance of recognition sensors decrease to 84% and 45% respectively, rendering the data unusable. In common deployments, sensors are placed randomly, causing limited coverage and poor monitoring quality. The use of hexagonal grid topology in broad wireless sensor networks deployments (for monitoring of wind power plants, water surface pollution, and deep space) can optimize network coverage, reduce energy consumption, and enhance network reliability. Optimization objective is to maximize sensor spacing while minimizing the total energy consumption of the network by leveraging unique hexagonal grid properties.

2 Where to Invest in Resilience in a Facility Network?

Kedong Chen[1], Ankur Mani[2], Kevin W. Linderman[3], [1]Old Dominion University, Norfolk, VA, [2]University of Minnesota - Twin Cities, Minneapolis, MN, [3]University of Minnesota, Minneapolis, MN, Contact: kchen@odu.edu

This study examines an underexplored question of where to invest in resilience in a facility network. Prior studies offered insights into this issue, with some scholars recommending a focus on critical nodes, while others emphasize the importance of critical paths. Yet the node and path perspectives have not been fully integrated and optimized for facility networks. This study reconciles the debate over node vs. path and proposes the optimal strategy of resilience investment that maximizes expected max-flow through the network. The analysis reveals that investing in high-capacity nodes is optimal under rare disruptions, whereas investing in entire paths is best under frequent disruptions. The problem is generally NP-hard, but we propose greedy algorithms inspired by both the node and path perspectives to provide approximate solutions with performance guarantees.

3 Minimum Feedback Arc Set over Bidirectional Graphs with an Application to Faculty Hiring Network

Adolfo Raphael Escobedo, Sina Akbari, Arizona State University, Tempe, AZ

This work introduces a novel graph theory problem that includes the minimum feedback arc set as a special case, specifically, it expands from this classic problem by allowing bidirectional arcs in the input graph and output arc set. Multiple integer programming formulations for solving it are derived and compared. The proposed framework is implemented to study faculty hiring networks to identify the prestige (rank) of different departments within specific disciplines.

4 The Edge-Based Contiguous P-Median Problem with Connections to Territorial Districting

Zeyad Kassem, Adolfo Raphael Escobedo, Arizona State University, Tempe, AZ, Contact: zekassem@asu.edu

We introduce the edge-based contiguous p-median (ECpM) problem to partition a road network into a given number of compact and contiguous territories. Two binary programming models are introduced. The first model requires an exponential number of cut set-based constraints to model contiguity; it is paired with an iterative branch and bound algorithm with a cut generation scheme (B&B&Cut). The second model utilizes a polynomial number of shortest-path constraints to model contiguity and can be solved with off-the-shelf solvers. The two solution approaches associated with the proposed models are tested on road networks with up to 2,018 nodes and 2,655 edges. The shortest path-based formulation attains speed ups in computational time up to almost 4x relative to the computational time of solving the first optimization model via B&B&Cut.

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CC-North 222B

The Interplay between Learning, Optimization, and Statistics

Community Committee Choice Session

Session Chair: Lijun Ding, University of Wisconsin -- Madison, Seattle, WA

Session Chair: Alex L. Wang, [1</sup]

1 Self-Calibration and Biconvex Compressed Sensing with Applications in MRI

Yuan Ni[1], Thomas Strohmer[1,2], [1]University of California Davis, Davis, CA, [2]Center for Data Science and Artificial Intelligence Research (CeDAR), Davis, CA, Contact: yuani@ucdavis.edu

Self-calibrated parallel imaging strategies provide a robust mechanism for accelerating MRI acquisitions. However, most such strategies result in reconstruction that corresponds to solving a challenging biconvex optimization problem. In this work, we bring together the concepts of Self-Calibration, Compressive Sensing, and Biconvex Optimization. We show how self-calibrated parallel imaging can be treated as a convex optimization problem using the idea of 'Lifting'. By exploiting block sparsity in the signal model, we derive explicit theoretical guarantees for robust and stable recovery.

2 Score Approximation, Estimation and Distribution Recovery of Diffusion Models on Low-Dimensional Data

Minshuo Chen[1], Mengdi Wang[2], [1]Princeton University, Princeton, NJ, [2]Princeton University, Princeton, NJ

Diffusion models achieve state-of-the-art performance in various generation tasks. However, their theoretical foundations fall far behind. This paper studies score approximation, estimation, and distribution recovery of diffusion models. Our result provides sample complexity bounds for distribution estimation using diffusion models. We show that with a properly chosen neural network architecture, the score function can be both accurately approximated and efficiently estimated. Furthermore, the generated distribution based on the estimated score function captures the data geometric structures and converges to a close vicinity of the data distribution. The convergence rate depends on the data intrinsic dimension, indicating that diffusion models can circumvent the curse of data ambient dimensionality.

3 Sharp Exact Penalty Formulations in Signal Recovery

Lijun Ding[1], Alex L. Wang[2], [1]University of Wisconsin -- Madison, Seattle, WA, [2]Purdue University, West Lafayette, IN, Contact: wang5984@purdue.edu

 We study a sample complexity vs. conditioning tradeoff in modern signal recovery problems where convex optimization problems are built from sampled observations. We begin by introducing a set of condition numbers related to sharpness for a general class of convex optimization problems covering sparse recovery, low-rank matrix sensing, and (abstract) phase retrieval. Then, we show that these condition numbers improve with the number of samples in each of the three signal recovery problems. Finally, we introduce a new first-order method based on mirror descent that is able to converge linearly on these problems. This new algorithm has a convergence rate explicitly depending on our condition numbers.

4 Benign Overfitting And Grokking In Two-layer Neural Networks

Zhiwei Xu[1], Yutong Wang[1], Spencer Frei[2], Gal Vardi[3], Wei Hu[1], [1]University of Michigan, Ann Arbor, MI, [2]UC Davis, Davis, CA, [3]TTI-Chicago, Chicago, IL, Contact: yutongw@umich.edu

Grokking refers to the phenomenon in which a model near-perfectly fits the training data, while the test accuracy stagnates before eventually rising. For non-linearly separable data generated by a noisy XOR function, we prove that two-layer neural networks trained by gradient descent exhibit a grokking-like behavior under suitable assumptions. More precisely, we show that after one training iteration, the model perfectly fits the training data, while the expected test accuracy is close to 1/2. Moreover, after two training iterations, the model generalizes to the test data.

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Special Topics in Derivative-free Optimization

Community Committee Choice Session

Session Chair: Sara Shashaani, North Carolina State University, Raleigh, NC

Session Chair: Yunsoo Ha, NC State, Raleigh, NC

1 Consistency and Complexity of Adaptive Sampling Based Trust-Region Optimization

Yunsoo Ha[1], Sara Shashaani[2], [1]NC State, Raleigh, NC, [2]North Carolina State University, Raleigh, NC

We present complexity results of a class of stochastic noncovex optimization problems with trust-region methods and adaptive sampling schemes devised for zeroth order (ASTRO-DF) and first order (ASTRO) stochastic oracles. We present two metrics for measuring efficiency; the classical iteration complexity and work or sampling complexity. The latter is more appropriate for adaptive sampling procedures where the total number of queries to the stochastic oracle varies per iteration.

2 Deepzero: Scaling up Zeroth-Order Optimization for Deep Model Training

Aochuan Chen[1], Yimeng Zhang[1], James Diffenderfer[2], Bhavya Kailkhura[2], Sijia Liu[1], [1]Michigan State University, East Lansing, MI, [2]Lawrence Livermore National Laboratory, Livermore, CA

Zeroth-order (ZO) optimization has become a popular technique for solving machine learning (ML) problems when first-order (FO) information is difficult or impossible to obtain. However, the scalability of ZO optimization remains an open problem: its use has primarily been limited to relatively small-scale ML problems. To overcome this roadblock, this paper proposes DeepZero, a principled and practical ZO deep learning (DL) framework that scales ZO optimization to DNN training through three primary innovations. We show that DeepZero achieves state-of-the-art (SOTA) accuracy on ResNet-20 trained on CIFAR-10, approaching FO training performance for the first time. Furthermore, we demonstrate the practical utility of DeepZero in two real-world use cases, certified adversarial defense and physics-coupled DL.

3 Sample Sizing for Function Estimation in Stochastic Derivative-Free Optimization

Luis Nunes Vicente, Lehigh University, Bethlehem, PA

We introduce a new tail bound condition for function estimation which allows for an improvement in the required sample sizing for derivative-free optimization of the order delta^{-2q} (non-correlated errors) and delta^{2-2q} (correlated errors), where delta is the step size or trust-region radius and the error is assumed to have a momentum of order q/(1-q). We also introduce simple stochastic non-smooth direct-search and trust-region methods, sharing the following principles: generate a direction; generate the new iterate by either search along the direction or by solving a trust-region subproblem (where the linear term is the direction); use a sufficient decrease acceptance test to decide if the trial point can be accepted or not. The methods are shown to globally converge almost surely under the new tail bound condition. Joint work with F. Rinaldi and D. Zeffiro.

4 The Limitation of Neural Nets for Approximation and Optimization

Tommaso Giovannelli, Griffin Kent, Luis Nunes Vicente, Lehigh University, Bethlehem, PA, Contact: tog220@lehigh.edu

We are interested in assessing the use of neural networks to approximate and minimize objective functions in optimization problems. While neural networks are widely used for machine learning tasks such as classification and regression, their application in solving optimization problems has been limited. Our study begins by determining the best activation function for approximating objective functions of popular nonlinear optimization test problems. We then show that the composition of an activation function with the natural basis can lead to benefits for polynomial interpolation or regression. Lastly, we provide insights into the limitation of using neural networks to enhance the performance of optimization methods that do not use derivatives.

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Recent Theory and Applications in DRO 2

Community Committee Choice Session

Session Chair: Yiling Zhang, University of Minnesota, Minneapolis, MN

Session Chair: Eojin Han, Southern Methodist University, Dallas, TX

1 Robust Satisficing MDPs

Haolin Ruan[1], Siyu Zhou[2], Zhi Chen[3], Chin Pang Ho[1], [1]School of Data Science, City University of Hong Kong, Hong Kong, China; [2]The City University of Hong Kong Shenzhen Research Institute, Shenzhen, China; [3]CUHK Business School, The Chinese University of Hong Kong, Hong Kong, China. Contact: haolin.ruan@my.cityu.edu.hk

Robust MDPs are proposed to overcome parameter ambiguity in MDPs by optimizing the worst-case performance under ambiguity. While robust MDPs can provide reliable policies with limited data, their worst-case performances are often overly conservative. This paper proposes robust satisficing MDPs (RSMDPs), where the expected returns of feasible policies are softly-constrained to achieve a user-specified target under ambiguity. We derive a tractable reformulation for RSMDPs and develop a first-order method for solving large instances. Experimental results showcase the strong target-oriented feature of RSMDPs. Moreover, the average and percentile performances of our model are competitive among other models. We also demonstrate the scalability of the proposed algorithm compared with a state-of-the-art commercial solver.

2 A General Approach to Solve Shape-Constrained Distributional Optimization via Importance-Weighted Sample Average Approximation

Zhenyuan Liu[1], Henry Lam[1], Devaushi Singham[2], [1]Columbia University, New York, NY, [2]Naval Postgraduate School, Monterey, CA

Shape-constrained optimization arises in a wide range of problems including distributionally robust optimization (DRO) that has surging popularity recently. In the DRO literature, these problems are usually solved via reduction into moment-constrained problems using the Choquet representation or its variants, whose tractability is determined case by case. In this work, we develop a general method to solve shape-constrained DRO by integrating sample average approximation with importance sampling, which reduces these infinite-dimensional problems into linear programs. Our approach handles shape-constrained DRO that are beyond the reach of previous Choquet-based reformulation. Our theoretical underpinning builds on empirical process theory and reveals how shape constraints play an important role to guarantee desirable consistency and convergence rates.

3 A Distributionally Robust Stochastic Clearing Policy

Sila Cetinkaya[1], Eojin Han[2], [1]SMU, Dallas, TX, [2]Southern Methodist University, Dallas, TX

We propose a distributionally robust optimization framework for operating of a stochastic clearing system consisting of an input process (orders) and a clearing mechanism that instantaneously serves them. We show that distributionally robust optimal clearing cycles can be found efficiently when distributional ambiguity is described with mean, support and mean-absolute deviation. The proposed method allows analytical solutions in special cases which offer multiple managerial insights. Our framework is general, and, thus, can incorporate temporally correlated arrivals and convex cost structure. Extensive simulation results are provided to obtain additional practical insights on the proposed method.

4 Distributionally Robust Discrete Choice Model and Assortment Optimization

Bin Hu[1], Qingwei Jin[2], Daniel Zhuoyu Long[1], Yu Sun[1], [1]The Chinese University of Hong Kong, Shatin, Hong Kong; [2]Zhejiang University, Hangzhou, China. Contact: sun-yu@link.cuhk.edu.hk

We introduce two distributionally robust assortment formulations, robust assortment revenue optimization and robust assortment revenue satisficing. By using the multinomial logit model as the reference choice model for both formulations, we show that the optimal assortments exhibit a revenue-ordered property, derive the closed-form worst-case distribution, construct a discrete choice model based on the worst-case distribution and conduct corresponding analysis. Moreover, we generalize the analysis to the distributionally robust assortment under the nested logit model. We next compare the two approaches and find that the revenue satisficing approach can achieve the target revenue with a higher probability and a lower computational complexity. In computational studies, we show that our approaches outperform both robust and stochastic approaches.

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Stochastic Programming with Discrete Decisions and/or Decision-Dependent Uncertainty

Community Committee Choice Session

Session Chair: Zhichao Ma, University of Wisconsin Madison, Madison, WI

1 Data-Driven Facility Location Problem with Multimodal Decision-Dependent Demand Ambiguity

Beste Basciftci, University of Iowa, Iowa City, IA

We propose a distributionally robust facility location problem under demand uncertainty where customer demand is multimodal and its distribution depends on the location decisions. We present a moment-based ambiguity set, where the first and second moment information of multimodal demand distribution depend on the open facilities. We derive a monolithic reformulation of the proposed problem under this set, which can be a mixed-integer linear program depending on the form of decision-dependency. We propose a cutting-plane based solution algorithm that leverages separation problems and derive valid inequalities to strengthen the formulation. Our computational studies demonstrate the value of integrating multimodality and decision dependency into this problem by having better performance in terms of profit and quality of service, compared to existing approaches.

2 Scaled Cuts for Stochastic Mixed-Integer Programming

Ward Romeijnders, Niels van der Laan, University of Groningen, Groningen, Netherlands. Contact: w.romeijnders@rug.nl

We develop a new type of Benders' decomposition for two-stage stochastic mixed-integer programs with general mixed-integer variables in both time stages. In this algorithm we iteratively construct tighter lower bounds of the expected second-stage cost function using a new family of so-called scaled optimality cuts. We derive these cuts by parametrically solving extended formulations of the second-stage problems using deterministic mixed-integer programming techniques. The advantage of these scaled cuts is that they allow for parametric non-linear feasibility cuts in the second stage, but that the optimality cuts in the master problem remain linear. We establish convergence by proving that the optimality cuts recover the convex envelope of the expected second-stage cost function.

3 A Risk-Averse Multistage Stochastic Model Utilizing Scenario Dominance Cuts for Optimal Control of a Forest Invasive Insect

Sabah Bushaj[1], Esra Buyuktahtakin Toy[2], Robert G. Haight[3], [1]State University of New York at Plattsburgh, Plattsburgh, NY, [2]Virginia Tech, Blacksburgh, VA, [3]USDA Forest Service, Saint Paul, MN, Contact: sbush010@plattsburgh.edu

In this study, we formulate a risk-averse multistage, stochastic, mixed-integer programming (RA-MSS-MIP) model. We then present a cutting plane algorithm based on scenario ordering to tackle decision-dependent uncertainty for an invasive species management problem. We aim to assist decision-makers in allocating resources for the surveillance of the ash population for Emerald Ash Borer (EAB) infestation and subsequent treatment and removal of infested trees over space and time in the State of New Jersey.

4 A Model and Method for Optimization Problems with Decision-Dependent Uncertainty

Zhichao Ma[1], Jeffrey T. Linderoth[2], Jim R. Luedtke[2], [1]University of Wisconsin Madison, Madison, WI, [2]University of Wisconsin-Madison, Madison, WI, Contact: zma59@wisc.edu

Traditional stochastic programming models assume exogenous uncertainties, where decision-makers have no control over the realization of uncertain parameters. However, in many real-world situations, uncertainties are endogenous, influenced by the decision-maker's actions or policies. We focus on stochastic programs with endogenous uncertainty in which decisions can affect the time of realization of uncertainty. We provide a three-stage stochastic program with binary decision variables in the first stage that can determine the realization time of uncertainty, whether in the second stage or in the third stage. We develop methods to estimate the upper and lower bounds of this problem. Additionally, we present a branch and bound algorithm to efficiently solve the problem, which can significantly reduce computation time compared to the extensive form.

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Facility Location and Logistics for Disaster Operations Management

Community Committee Choice Session

Session Chair: Vedat Bayram, Kent, United Kingdom
Session Chair: Ali Kemal Dogru, University of Southern Mississippi, Hattiesburg, MS

1 Multimodal Social Aid Distribution in Urban Areas

Baris Yildiz[1], Vedat Bayram[2], Vahid Akbarighadikolaei[3], Ali Kemal Dogru[4], Pinar Keskinocak[5], [1]Koc University, Sariyer, Turkey; [2]University of Kent, Kent Business School, Canterbury, United Kingdom; [3]University of Nottingham, Nottingham, United Kingdom; [4]University of Southern Mississippi, Hattiesburg, MS, [5]ISyE Georgia Tech, Atlanta, GA

The lack of an infrastructure to facilitate the fast and economical distribution of social aid is one of the main obstacles to enhancing the scope and the quality of social aid efforts. Difficulties related to last-mile delivery operations result in spending a significant part of the aid resources on delivery expenditures or blocking a substantial in-kind donation potential. To address this issue, for the first time in the literature, we propose to use existing public transit (PT) systems to constitute a backbone network to transfer in-kind donations in an urban area and place collection/transshipment centers in the selected PT stations to facilitate transportation of goods between origins/destination points of the donations and the public transit system by the volunteer couriers.

2 Mixed-Integer Programming for Team Sizing and Vehicle Assignment in Unstructured Off-Road Environments

Sachet Khatiwada[1], Pamela Murray-Tuite[2], [1]Clemson University, Clemson, SC, [2]Clemson University, Clemson, SC, Contact: sachetk@g.clemson.edu

Off-road vehicle operations are common in post-disaster relief and evacuation scenarios. Moving in an unstructured off-road environment requires consideration of many variables, for mission completion and safety. This presentation proposes a mixed integer linear programming-based approach to assign vehicles from a heterogeneous vehicle fleet into different teams along different paths while considering vehicle properties and path characteristics. Preliminary results from experiments for team assignment along two different paths in unstructured environments, from a 17-vehicle fleet of 3 different vehicle types show that this approach successfully assigns teams along the planned paths. OPSEC #7490 DISTRIBUTION A. Approved for public release; distribution unlimited.

3 Capacity Pre-Allocation for Multi-Period Mobile Facility Location with Spatial Coverage

Jessa Rhea, University of Iowa, Iowa City, IA

In covering mobile facility location, the task is to route a fleet of *M* mobile facilities with capacity *Q* over *T* discrete time periods to maximize the difference between the total demand served of customers within the mobile facilities' coverage radii and the transportation costs of the mobile facilities. Our model captures the situation where customers ultimately decide when and which mobile facility to visit and treats the resource provided by the mobile facility as a fixed amount rather than a rate per unit time. We focus on the behavior of the model as various capacity pre-allocation strategies are considered with the goal of providing equitable service to customers in each period while still maximizing served demand.

4 Preparedness Network Design for Relief Supplies in Response to Foreseen Disasters

Vala Rahmati, Halit Uster, Southern Methodist University (SMU), Dallas, TX, Contact: vrahmati@smu.edu

A well-designed relief network can be crucial in saving lives and helping people recover after a disaster. However, designing such a network involves considering various factors such as cost and time constraints. To address this, we proposed a mixed integer model that minimizes costs and satisfies evacuee demand by determining the supply locations and delivery in a time-efficient manner. For the model solution, we examine several enhancement techniques within a Benders Decomposition framework. We report results based on randomly generated instances for the algorithmic efficiencies and also results of a real case study with real data from the state of Texas using GIS.

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Large-scale Data Analytics for Transportation Systems - Session II

Community Committee Choice Session

Session Chair: Sean Z. Qian, Carnegie Mellon University, Pittsburgh, PA

1 Pathways for Harnessing Open-Specification and Multi-Resolution Network Analysis Tools for Advanced Transportation Systems Analysis

Mustafa Gadah[1], Xuesong Zhou[2], [1]Arizona State University, tempe, AZ, [2]Arizona State University, Tempe, AZ, Contact: mgadah1@asu.edu

Expanding the open-specification GMNS-based ecosystem and harnessing the power of Geographic Information Systems (GIS) and Python are the primary objectives in enhancing transportation systems analysis. This talk presents the extensive use of these tools for large-scale data analytics in smart city transportation planning. Topics covered include fundamental aspects of GIS, advanced network modeling techniques, and the mapping of linear reference systems. Additionally, a case study conducted in the Town of Gilbert showcases a streamlined workflow for transportation analysis modeling and simulation, demonstrating the practicality of utilizing open-source and multi-resolution network analysis tools.

2 A-Team: Advanced Traffic Event Analysis and Management Platform for Enhanced Transportation Decision-Making

Zilin Bian, New York University, New York, NY, Contact: zb536@nyu.edu

With the surge in transportation data availability, integrating emerging AI/ML methods into decision support systems is both promising and challenging. A full-fledged decision support system requires not only well developed and calibrated models, but also efficient connections with back-end infrastructure and front-end utilities. This paper introduces the A-TEAM, a large-scale data analytics platform designed to streamline the decision-making process. It can incorporate user-defined AI/ML models, providing versatile visualization and interactive front-end functionalities to generate various case scenario results. The A-TEAM demonstrated three real-world applications tested on NY City datasets: work zone management, traffic forecasting, and crash analysis, providing valuable decision-making support to both traffic researchers and practitioners.

3 Applying Data-Driven Research to Real-World Traffic Operations Issues

Yao-Jan Wu, Pramesh Pudasaini, University of Arizona, Tuscon, AZ

Transportation agencies have invested a great deal amount of funding in intelligent transportation systems, especially traffic sensor technologies, to better manage traffic and reduce congestion. However, not all agencies have fully utilized the capacities of advanced technologies. This presentation aims at providing data-driven solutions to enhancing traffic data usability for performance measurement for responsive traffic management and operations.

4 Optimizing Universal Basic Mobility Programs in Multimodal Networks

Lindsay Graff, Carnegie Mellon University, PITTSBURGH, PA, Contact: lgraff@andrew.cmu.edu

Several American cities have recently piloted Universal Basic Mobility (UBM) programs aimed at removing transportation barriers. UBM programs offer community members a fixed monthly credit to be used on shared mobility services, such as public transit, car share, e-scooter, and bike share. However, the relationship between UBM's social impact and the monetary value of the fixed credit in multimodal systems is unclear. Owing to open data policies that have made new types of transportation-related data available, this analysis is now possible. Building upon previous work where we design a routable multimodal network model, we propose a method that uses this model to optimize the value of the fixed credit to maximize social benefit. Social benefit in this context is defined in terms of accessibility to opportunities.

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CC-North 225B

Data Intelligence and Travel Behaviors

Community Committee Choice Session

Session Chair: Yili Tang, University of Regina, Regina, SK, Canada

1 Evaluating Impacts of the Joint Price-Resource Strategy in Transport Markets Under Equity Constraints Using Hong Kong Travel Data

Yanyan Ding, Xiaoshu Ding, Sisi Jian, Liu Jianing, The Hong Kong University of Science and Technology, Hong Kong, Hong Kong

Recent advances in information technology have enriched the data that mobility service providers (MSPs) can collect from travelers, such as trip records and individual characteristics. MSPs can adopt a discriminatory mobility resource allocation and pricing strategy to maximize their profits according to traveler clusters derived from customer data. Nonetheless, such inequitable treatment of travelers has sparked widespread social concerns. To ensure that mobility services are accessible and affordable to all social groups, we develop a framework to investigate MSPs' joint pricing and mobility resource allocation strategies under equity constraints and use Hong Kong travel data to quantify the corresponding impacts. Results show that there exists an equity level threshold, above which the MSP will cease operation to avoid a deficit.

2 Spatial-Queue Based Mesoscopic Traffic Model and Its Application in Wildfire Evacuation Simulations

Pengshun Li[1], Bingyu Zhao[2], Kenichi Soga[1], [1]University of California, Berkeley, Berkeley, CA, [2]Vienna University of Technology, Vienna, Austria. Contact: pengshun@berkeley.edu

To capture highly dynamic traffic situations, efficient mesoscopic models can deliver comprehensive yet fast results. This paper presents a spatial-queue based mesoscopic simulation model, with each vehicle represented as an autonomous agent with origin, destination, route choice, and other properties. Vehicles on a road are assumed to run at free-flow speed until joining a queue of vehicles at the downstream end. The length of the queue increases until no more vehicles can enter, creating the spillback effect often seen in congestion and disaster evacuation situations. Case studies are presented to demonstrate the applications in wildfire evacuations. The detailed disaggregated results are used to quantitatively evaluate intervention options and understand the challenges for evacuees in reaching safe destinations due to traffic bottlenecks and congestion.

3 A Framework for Enhanced EV Adoption: Optimizing Long-Distance Electric Vehicle Infrastructure in Canadian Sparsely Populated Areas

Majid Emami Javanmard, Yili Tang, University of Regina, Regina, SK, Canada. Contact: emami@uregina.ca

The research offers a novel approach for locating crucial route segments and tailoring long-distance EV infrastructure in order to increase the comfort of EV travel. It investigates current vehicle traffic patterns, including origins, destinations, trip lengths, and seasonal fluctuations, by analyzing intercity highway records, traffic statistics from Regina, and the provincial traffic database of Saskatchewan. Sensitivity studies examine the viability of transforming petrol stations into EV charging stations, taking into account variables like station number, locations, and vehicle types. The study gives helpful suggestions for enhancing long-distance EV travel in sparsely populated Canadian locations, improving EV charging infrastructure, and resolving concerns about limited range.

4 Users' Charging Behavior and Power Level Preferences of Electric Vehicle on Urban Areas

Jesús Adrián Martínez Hernández, University of Regina, Regina, SK, Canada

In 2020 road transportation accounted for around 19% of total greenhouse gas emissions in Canada. According to estimates, by 2030 at least 95% of light duty vehicles sales should be EVs to meet decarbonisation goals and keep global average temperature increase below 1.5 °C. Yet many challenges remain for the in-mass adoption, being the absence of a fully deployed charging infrastructure one of the main concerns for prospect users. This research seeks to employ discrete choice modelling based on revealed preference data to analyze users' charging behavior and power level preferences. The proposed approach can help to develop an integrated framework with the purpose to optimally deploy infrastructure according to actual EV users' behavior and needs, achieving a better allocation of resources in the short term, and a more efficient and reliable infrastructure for users.

5 Spatial-Temporal Impacts of On-Demand Transit Service on Neighborhood Ridership and Economic Growth

Yili Tang, Zaima Tasneem, University of Regina, Regina, SK, Canada. Contact: ytangap@gmail.com

On-demand transit (ODT) services is being rapidly adopted by many transit agencies given its advantages in flexibility and potential cost reduction. This paper analyzed and evaluated the impacts of on-demand transit services on neighbourhood with a case study in the City of Regina, Canada. The analysis suggests a growth in the ridership for each individual neighborhood that implemented the ODT service. The study also specifically investigates the effects of location endowment characteristics of a neighborhood (evaluated by accessibility and connectivity) to understand these impacts. Results indicated the potential of on-demand transit services not only improve ridership but also the economy of a neighborhood. Moreover, the accessibility and connectivity of neighboring areas also impact the economic growth of one another.

Monday, October 16, 8:00 AM - 9:15 AM

MA42

CC-North 226A

Advanced Control, Command and Optimization for Transportation Networks

Community Committee Choice Session

Session Chair: Xuewu Dai, 1</sup

Session Chair: Meng Zhao, 1</sup

1 Pricing for Shared Charging Parking Spaces in Urban Mixed Parking Lots

Yi Zhang, Minfang Huang, North China Electric Power University, Beijing, China. Contact: yizoe@foxmail.com

In view of the increasing market penetration of electric vehicles, mixed parking has emerged as an operational paradigm that allows for shared parking and charging spaces for both fuel-powered and electric vehicles. However, in urban areas where parking spaces are generally limited, conflicts arise between user demands, such as fuel-powered or fully charged vehicles occupying charging spaces. This study examines the coordinated management of mixed parking lots, and develops a two-tier game model that produces the Pareto-Nash equilibrium that maximizes social welfare. The proposed theoretical methods of pricing for shared charging and parking spaces may contribute to optimizing urban static traffic environment, increasing the efficiency of charging and parking resources, and promoting sustainable development in the electric vehicle industry.

2 Integrated Optimization of Rolling Stock Allocation and Train Timetables for Urban Rail Transit Networks: A Benders Decomposition Approach

Fan Pu, Texas A&M University, College Station, TX

We investigate integrated optimization of rolling stock allocation and train timetables (RATT) in an urban rail transit network with multiple lines and depots. Our model aims to optimize investment cost and passenger service quality by generating rolling stock allocation plans and train schedules. To handle computational complexity, we develop a Benders decomposition-based solution algorithm, decomposing the problem into a rolling stock assignment problem and train scheduling subproblems. We test our approach on real-world instances from the Beijing rail transit network, showing significant improvements in service quality compared to existing plans. Our RATT approach achieves a 17.6% average improvement in service quality using the same fleet size.

Monday, October 16, 8:00 AM - 9:15 AM

MA43

CC-North 226B

Forecasts and Machine Learning in Air Transportation

Community Committee Choice Session

Session Chair: Xufang Zheng, American Airlines,

Fort Worth, TX
Session Chair: shulu Chen, George Washington University, Arlington, VA

1 Integrated Conflict Management for Uam with Strategic Demand Capacity Balancing and Learning-Based Tactical Deconfliction

Shulu Chen[1], Antony Evans[2], Marc Brittain[3], Peng Wei[1], [1]George Washington University, Washington, DC, [2]Airbus UTM at Acubed, Sunnyvale, CA, [3]MIT Lincoln Laboratory, Lexington, MA, Contact: shulu@gwu.edu

Before the commercialization and adoption of Urban air mobility (UAM), aviation safety must be guaranteed. Reinforcement learning has demonstrated effectiveness in the tactical deconfliction of en route commercial air traffic in simulation. However, its performance is found to be dependent on the traffic density. In this project, we propose a novel framework that combines demand capacity balancing (DCB) for strategic conflict management and reinforcement learning for tactical separation. By using DCB to precondition traffic to proper density levels, we show that reinforcement learning can achieve much better performance for tactical safety separation. In addition, combining strategic DCB with reinforcement learning for tactical separation can meet these safety levels while achieving greater operational efficiency than alternative solutions.

2 Air Transportation Local Share Analysis and Forecast

Xufang Zheng, American Airlines, Fort Worth, TX

Air transportation local share is a crucial metric that quantifies the disparity between original passengers and connecting passengers at airports. It serves as an indicator of an airport's role within the intricate air transportation network system, reflecting the network strategies employed by competing airlines at that airport. In the wake of the pandemic, airports are undergoing significant transformations due to changes in demand and network dynamics. Understanding which airports will regain their pre-pandemic status and which will assume new roles is a compelling research topic for the Federal Aviation Administration (FAA). This study focuses on analyzing and forecasting the local share at domestic airports across the United States to identify distinct changes and future behaviors of local share .

3 Identifying Similar Thunderstorms via the Optimal Transport Theory

Binshuai Wang, The George Washington University, Washington, DC, Contact: derekwang@gwu.edu

Thunderstorms are one of the important uncertainties in air traffic control. We propose a new approach to identify temporal-spatial similar thunderstorms with respect to aviation operational considerations via the optimal transport theory. Different from existing geometric methods, we represent each thunderstorm with a probability distribution, and similarity is measured by the Wasserstein distance of their distributions. By setting different kernel functions, we can also redefine the similarity of thunderstorms, so that multiple factors can be expressed in the same framework. In addition, we also develop an unsupervised learning method to cluster thunderstorms and generate similar thunderstorm data based on clustering. Experimental results show our approach is robust and efficient.

4 Machine Learning-Based Approach Towards Dynamic Airspace Network Generation for Regional Air Mobility Operations in South Korea

Junghyun Kim[1], Seulki Kim[2], [1]Handong Global University, Pohang, Korea, Democratic People's Republic of; [2]Georgia Institute of Technology, Atlanta, GA

This research focuses on establishing airspace infrastructure for upcoming Regional Air Mobility (RAM) operations in South Korea. The proposed methodology leverages three different algorithms: 1) a partitioning-based clustering algorithm for placing vertiport locations, 2) a density-based clustering algorithm for predicting areas of convective weather, and 3) the Latin Hypercube Sampling-based Probabilistic Roadmap (LHS-based PRM) algorithm for generating an adaptive airspace network. The resulting airspace takes into account airspace restriction areas such as prohibited areas or military operation areas. The main contribution of this research is to employ a data-driven approach using machine learning and LHS-based PRM algorithms to dynamically establish airspace infrastructure potentially utilized for upcoming RAM operations in South Korea.

5 Machine Learning for Anomaly Detection and Precursor Identification in Commercial Aviation

Nikunj C. Oza, NASA, Moffett Field, CA

The National Airspace is a very safe system. We must keep it safe through expected changes such as increasing variety of traffic (e.g., UAVs). The system is currently monitored using exceedances---rules describing known safety issues. By definition, these rules cannot identify previously unknown safety issues. Also, they do not identify precursors to safety issues—states that may not represent safety issues themselves, but are conditions under which safety issues are more likely to occur. In this talk, I describe machine learning-based methods that we have developed for anomaly detection and precursor identification and the aviation safety results that we have obtained. I also describe the active learning algorithm that we have developed to mitigate the false alarm problem that is common to data-driven anomaly detection methods.

Monday, October 16, 8:00 AM - 9:15 AM

MA44

CC-North 226C

Adaptive Learning for Platform Operations

Community Committee Choice Session

Session Chair: Ruohan Zhan, Hong Kong University of Science and Technology, Clear Water Bay

Session Chair: Zhengyuan Zhou, Stern School of Business, New York University

1 Treatment Effects in Market Equilibrium

Evan Munro[1], Stefan Wager[2], Kuang Xu[3], [1]Stanford University, Stanford, CA, [2]Stanford GSB, Stanford, CA, [3]Stanford Graduate School of Business, Stanford, CA, Contact: munro@stanford.edu

When randomized trials are run in a marketplace equilibriated by prices, interference arises. To analyze this, we build a stochastic model of treatment effects in equilibrium. We characterize the average direct (ADE) and indirect treatment effect (AIE) asymptotically. A standard RCT can consistently estimate the ADE, but confidence intervals and AIE estimation require price elasticity estimates, which we provide using a novel experimental design. We define heterogeneous treatment effects and derive an optimal targeting rule that meets an equilibrium stability condition. We illustrate our results using a freelance labor market simulation and data from a cash transfer experiment.

2 Adaptively Learning to Rank Unstructured Items in Online Platforms

Ying Jin, Department of Statistics, Stanford University, Stanford, CA

We study learning to adaptively rank a list of unstructured items to optimize cumulative user engagement in online platforms. We formulate this problem via a contextual-bandit approach, with actions being rankings that account for user characteristics and position effects. For each item ranked at any position, we construct an upper confidence bound for the engagement score to balance exploration and exploitation. Our algorithm then chooses the ranking action by solving a maximum weight matching problem. Our algorithm achieves the regret of O(Kd\sqrt{T}) when ranking K items in a d-dimensional feature space over T rounds, under the generalized linear model assumption on user engagement scores. This regret relieves the dependence on the total action space of K! different rankings. Experiments demonstrate improved user engagement of our algorithm compared to baselines.

3 Synthetic Combinations: A Causal Framework for Combinatorial Interventions

Abhineet Agarwal, University of California, Berkeley, Berkeley, CA, Contact: aa3797@berkeley.edu

Consider the problem of learning unit-specific potential outcomes for N heterogenous units under any combination of p interventions. Running N x 2^p experiments to estimate all parameters is infeasible. Further, with observational data there is confounding. We study this problem under a novel model that imposes latent structure across both units and combinations. That is, we assume the matrix of potential outcomes, and the coefficients in the Fourier expansion of potential outcomes have rank r, and sparsity s respectively. We establish identification, and propose a estimation procedure, Synthetic Combinations, for all parameters despite unobserved confounding. Our approach requires far fewer observations to achieve consistency as compared to previous methods. We use Synthetic Combination to propose a experimental design mechanism for combinatorial inference.

4 Risk-Sensitive Reinforcement Learning

Zhengqi Wu, Renyuan Xu, University of Southern California, Los Angeles, CA, Contact: zhengqiw@usc.edu

Reinforcement learning (RL) methods have garnered significant attention in Operations Research, particularly in applications such as portfolio management, traffic planning, and clinical trial recommendations. There is a pressing need to mitigate the risk of the decision maker (DM). Problem-dependent criteria have been proposed, such as safety constraints and exponential utility functions. However, Risk-sensitive RL with general utility functions remains an open question.

In this talk, we consider a scenario where the DM optimizes a general utility function of the cumulative reward. We extend the state space with an extra dimension for the cumulative reward. We then propose a modified value iteration algorithm that employs an epsilon-covering over the extended state space. Under mild assumptions, our algorithm efficiently identifies the near-optimal policy.

5 Revisiting the Role of Competitor Information in Airline Pricing: Insights from a Field Experiment

Gang Guo, Changchun Liu, Chung Piaw Teo, National

University of Singapore, Singapre, Singapore. Contact: gangg@u.nus.edu

The determination of airfares is a crucial aspect of revenue management in the airline industry. While it is common for airlines to consider competitors' price ladders when designing their own, we argue that this approach may be suboptimal in volatile and uncertain competitive environments. We propose the integration of demand prediction into ladder pricing. We test our hypothesis by partnering with a leading airline company, consisting of 16 routes over two months. Our results show that embedding demand prediction into ladder pricing leads to increased revenue. Our findings suggest that in volatile competitive environments, greater weight should be given to self-demand when setting prices, and less weight should be allocated to competitors' information.

Monday, October 16, 8:00 AM - 9:15 AM

MA45

CC-North 227A

Learning in Games

Community Committee Choice Session

Session Chair: Christian Kroer, Columbia University, New York, NY

Session Chair: Gabriele Farina, 1</sup

1 Near-Optimal Learning of Extensive-Form Games with Imperfect Information

Yu Bai, Salesforce AI Research, Palo Alto, CA, Contact: yu.bai@salesforce.com

Imperfect Information Games, where players can only make decisions based on partial information about the true underlying state of the game, constitute an important challenge for modern artificial intelligence. This talk presents several recent advances on learning Imperfect-Information Extensive-Form Games (EFGs) from bandit feedback. We present the first line of near-optimal algorithms for learning various equilibria, such as Nash Equilibria in two-player zero-sum games, Coarse Correlated Equilibria in multi-player zero-sum games, and various notions Correlated Equilibria such as the Extensive-Form Correlated Equilibria and its several generalizations. The number of episodes scale only linearly in the number of information sets in the game tree, building on new *balancing* techniques.

2 Zero-sum Polymatrix Markov Games: Equilibrium Collapse and Efficient Computation of Nash Equilibria

Ioannis Panageas, Fivos Kalogiannis, UC Irvine, Irvine, CA

The works of (Daskalakis et al., 2009, 2022; Jin et al., 2022; Deng et al., 2023) indicate that computing Nash equilibria in Markov games is a computationally hard task. This fact raises the question of whether or not computational intractability can be circumvented if one focuses on specific classes of Markov games. Inspired by zero-sum polymatrix normal-form games (Cai et al., 2016), we define a class of zero-sum multi-agent Markov games in which there are only pairwise interactions described by a graph. For this class of Markov games, we show that an □-approximate Nash equilibrium can be found efficiently. To do so, we show that the set of coarse-correlated equilibria collapses to the set of Nash equilibria. Afterwards, it is possible to use any algorithm that computes approximate Markovian coarse-correlated equilibria policies to get an approximate Nash equilibrium.

3 Block-Coordinate Methods and Restarting for Solving Extensive-Form Games

Darshan Chakrabarti, Columbia University

Coordinate methods are popular for their simple updates and excellent practical performance. Extending them to sequential games is difficult because the strategy spaces do not satisfy the separable block structure exploited by these methods. We present the first cyclic coordinate-descent-like method for computing a Nash equilibrium in two-player zero-sum extensive-form games. We show our method enjoys a O(1/T) convergence rate, while avoiding polynomial scaling in the number of blocks. Our method exploits the recursive structure of the proximal update induced by dilated regularizers in order to perform pseudo-block updates. Empirically, our algorithm usually performs better than mirror prox and sometimes beats CFR+. We also introduce a restarting heuristic for EFG solving that can often lead to speedups for our cyclic method and existing methods.

4 Learning to Bid in Adversarial First-Price Auctions

Zhengyuan Zhou, NYU Stern, New York, NY

First-price auctions have very recently swept the online advertising industry, replacing second-price auctions as the predominant auction mechanism on many platforms. This shift has brought forth important challenges for a bidder: how should one bid in a first-price auction, where unlike in second-price auctions, it is no longer optimal to bid one's private value truthfully and hard to know the others' bidding behaviors? In this paper, we take an online learning angle and address the fundamental problem of learning to bid in repeated first-price auctions, where both the bidder's private valuations and other bidders' bids can be arbitrary.

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Modeling for Equity and Sustainability

Community Committee Choice Session

Session Chair: Destenie S. Nock, Carnegie Mellon University, Pittsburgh, PA

Session Chair: Zana Cranmer, Bentley University, Waltham, MA

1 Municipal Climate Action Planning

Zana Cranmer, Bentley University, Waltham, MA

National climate targets are made up of climate actions taken at a local level. Larger and more well-resourced municipalities can draw on expertise to craft and implement plans. Smaller and under-resourced municipalities have greater difficulty in accessing the same opportunities. This work develops an open-source tool to support local stakeholders with varying levels of expertise to tap into data and modeling resources.

2 The Role of Carbon Capture in a Power System's Just Decarbonization

Paola Furlanetto[1], Erin Baker[2], [1]UMass Amherst, Amherst, MA, [2]Univ of Massachusetts-Amherst, Amherst, MA, Contact: ppimentelfur@umass.edu

We evaluate how adding Carbon Capture to fossil fuel power plants influences the stock and distribution of heath-harming airborne pollutants (local pollutants) considering technological uncertainties and policy design. The objective of this exercise is to identify scenarios where a climate policy - one that focuses on CO2 limits - leads to more local pollution or to an unequal pollution burden to vulnerable communities. Our results indicate Carbon Capture leads to higher local pollution when the corresponding emission controls are not enforced. Including additional air pollution controls translates into more costs for an already expensive technology. In short, for Carbon Capture to be part of a route to net zero that is also equitable, baseline costs and emission requirements must go beyond greenhouse gases.

3 Exploring Equity of Ridehailing for Essential Travel During Disrupting Weather Conditions

Carlos Mateo Samudio Lezcano, Destenie Nock, Corey Harper, Jeremy Michalek, Gregory Lowry, Carnegie Mellon University, Pittsburgh, PA, Contact: csamudio@andrew.cmu.edu

The dependence on ridehailing as a widespread means of transportation has increased significantly in recent years. As a result, the shifts in market prices can significantly impact the population of essential riders who rely solely on ridehailing for their transportation needs. This study aims to estimate the effects of disruptive weather events, such as rain, snow, and heat waves, on ridehailing market prices. Using this estimation, we analyze the impact of these weather events on the essential rider population. The study provides insights into the challenges faced by essential riders and highlights the need for policies to ensure equitable access to affordable ridehailing services during disruptive weather events.

4 Comparing Electric Vehicle Charging Station Long-Distance Coverage

Lily Hanig[1], Catherine Ledna[2], Destenie S. Nock[3], Corey D. Harper[4], Arthur Yip[2], Eric Wood[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]National Renewable Energy Laboratory, Golden, CO, [3]Carnegie Mellon University, Pittsburgh, PA, [4]Carnegie Mellon University, Pittsburgh, PA, Contact: lhanig@andrew.cmu.edu

Passenger vehicles are the largest sector of greenhouse gas emissions in the US. Electric vehicles (EVs) present a lower-emissions option; however, many consumers hesitate to purchase an EV because of 'range anxiety'. The Bipartisan Infrastructure Law (BIL) allocates $5 billion for fast chargers along interstates to spur EV adoption and the National Electric Vehicle Infrastructure (NEVI) Program designated highway corridors to place fast chargers on first. We use a breadth-first search to compute a novel consecutive coverage metric to find: 1) What is the consecutive EV charging coverage from each county? 2) What is the increase in coverage by state from the NEVI program? In 2023, only 10% of counties have minimum viable coverage above 75%. The NEVI-program will improve fast charger coverage the least for California (21% increase) and the most for Maine (94% increase).

Monday, October 16, 8:00 AM - 9:15 AM

MA47

CC-North 227C

High-Dimensional Data Analytics for Manufacturing

Community Committee Choice Session

Session Chair: Fenglian Pan, University of Arizona, Tucson, AZ
Session Chair: Jian Liu, University of Arizona, Tucson, AZ

1 Layer-Wise Process Parameters Optimization for Metal Additive Manufacturing

Chaoran Dou, Rongxuan Wang, Zhenyu James Kong, Virginia Tech, Blacksburg, VA

Metal parts produced by Additive Manufacturing (AM) suffer from many quality issues due to suboptimal process parameters setting. Traditional approaches used fixed process parameters for the entire part. Such methods do not consider the layer-wise difference during printing. Nevertheless, if considering the layer-wise effect, the number of process parameters to be optimized brings tremendous challenges for process optimization. Therefore, we proposed a novel methodology, which formulates process parameters along the layer-wise direction as a parametric function. Such a function is a linear combination of several pre-determined base functions. Then, the weights of each base function can be optimized to achieve the best final quality. In case studies, the proposed method significantly improved the overall printing quality compared to traditional approaches.

2 Multimodal Probabilistic Modeling and Characterization of Melt Pools

Runsang Liu, Hui Yang, Penn State University, State College, PA, Contact: rzl275@psu.edu

The variations of melt pool geometry are closely pertinent to mechanical and functional properties of final AM builds. Most of previous works are concerned about the extraction of melt pool features (e.g., geometric statistics, size, shape descriptors) for AM process monitoring. However, very little has been done to investigate the emission physics of photons that leads to the generation of melt pool images. This work presents a novel approach to simulate the emission of photons for statistical estimation and modeling of the multimodal probability distribution function (PDF) of a melt pool. In addition, we investigate how process conditions influence the geometric variations of melt pools. Experimental results show that the proposed methodology effectively builds the multimodal distribution model of melt pool geometric variations.

3 Adaptive Sampling and Monitoring for Image Data

Jinwei Yao[1], Chao Wang[2], [1]The University of Iowa, Iowa City, IA, [2]University of Iowa, Iowa City, IA, Contact: jinwei-yao@uiowa.edu

Image-based monitoring techniques have achieved great success in many engineering applications. However, most existing image monitoring methods require fully observed images to implement modeling/monitoring. This requirement limits the application of these techniques for images with large sizes and/or cameras with limited scanning area. In this paper, we propose to solve this issue by splitting the large image into multiple sub-images and using partially observed sub-images to implement monitoring of the whole large image. More specifically, the two-dimensional multivariate functional principal analysis (2D-MFPCA) is proposed to model the cross-and-within correlation among sub-images, which facilitates the information augmentation from partially observed sub-images.

4 Probabilistic Framework for Modeling Internal Defects in Additive Manufacturing

Shehzaib Irfan, Jia Liu, Auburn University, Auburn, AL, Contact: szi0016@auburn.edu

Additive manufacturing (AM) offers many advantages, but AM parts are prone to forming internal defects that adversely affect the fatigue life of these parts. These defects are of different types, each impacting the fatigue differently due to its distinct geometry. Also, the spatial distribution of these defects in the manufactured part plays a key role in the fatigue behavior of that part. Therefore, accurate spatial modeling of these defects is paramount and can contribute to a better understanding of the fatigue behavior of additively manufactured parts. We will develop a probabilistic framework using spatial statistics to model the distribution of different defects inside the part. This will provide insights into process physics beyond the mere parameters and enable researchers to incorporate the impact of defects' location in modeling AM parts' fatigue behavior.

Monday, October 16, 8:00 AM - 9:15 AM

MA48

CC-North 228A

High-dimensional Data Modeling for Quality and Reliability Improvements

Community Committee Choice Session

Session Chair: Meng Zhao, University OF Florida, Gainesville, FL
Session Chair: Mostafa Reisi, University of Florida, Gainesville, FL

1 Personalized Tucker Decomposition: Modelling Commonality and Peculiarity on Tensor Data

Jiuyun Hu[1], Naichen Shi[2], Raed Al Kontar[2], Hao Yan[1], [1]Arizona State University, Tempe, AZ, [2]University of Michigan, Ann Arbor, MI, Contact: jiuyunhu@asu.edu

We propose a personalized Tucker decomposition (perTucker) to address the limitations of traditional tensor decomposition methods in capturing the heterogeneity in distributed systems. PerTucker decomposes tensor data into shared global components and personalized local components. We introduce a mode orthogonality assumption and develop a proximal gradient regularized Block Coordinate Descent algorithm, guaranteed to converge to a stationary point. PerTucker enables efficient data representation for multiple clients and demonstrates effectiveness in anomaly detection, client classification, and clustering through a simulation study and two case studies: solar flare detection and tonnage signal classification.

2 E^{Rpca}: Robust Principal Component Analysis for Exponential Family Distributions

Xiaojun Zheng, Duke University, Durham, NC

Robust Principal Component Analysis (RPCA) is a widely-used method for recovering low-rank matrices corrupted by significant and sparse outliers. The joint identification of the corruptions with its low-rank background is fundamental for process diagnosis and quality control. However, existing RPCA methods do not account for non-Gaussian noise, which arises in a variety of process imaging and monitoring applications. We thus propose a new method called Robust Principal Component Analysis for Exponential Family distributions e^{RPCA}, which can perform the desired decomposition into low-rank and sparse matrices under exponential family noise. We present a novel alternating direction method of multiplier optimization algorithm, and demonstrate the effectiveness of e^{RPCA} in two applications for steel defect detection, and for Atlanta crime activity monitoring.

3 Multi-Sensor Prognostics Modeling for Failure Mode Identification of Systems with Two Failure Modes

Linfeng Song, North Carolina State University, Raleigh, NC, Contact: lsong5@ncsu.edu

The failure of complex engineering systems often can result from one of its multiple components, which yields multiple failure modes. However, it is usually challenging to identify the failure mode of an in-situ system using condition monitoring signals. In this work, we propose a supervised dimension reduction-based failure classification method that can fuse the degradation signals from multi-sensors to identify the failure mode of a partially degraded system. A computationally efficient optimization algorithm is proposed for parameter estimation. The effectiveness of the proposed method is validated using numerical studies.

4 An Adaptive Approach for Online Monitoring of Large Scale Data Streams

Shuchen Cao[1], Ruizhi Zhang[2], [1]University of Nebraska-Lincoln, Lincoln, NE, [2]UGA, Athens, GA, Contact: Ruizhi.Zhang@uga.edu

In this paper, we propose an adaptive top-r method to monitor large-scale data streams where the change may affect a set of unknown data streams at some unknown time. Our proposed method combines the Benjamin-Hochberg (BH) false discovery rate (FDR) control procedure and the CUSUM procedure to construct a global monitoring statistic that can estimate the number of changed data streams adaptively and can detect the change quickly. Theoretically, we show that our proposed method can estimate the number of changed data streams for both the pre-change and post-change status. Moreover, we perform simulations and two case studies to show its detection efficiency.

Monday, October 16, 8:00 AM - 9:15 AM

MA49

CC-North 228B

High-dimensional Data Analysis: Modeling, Monitoring and Control

Community Committee Choice Session

Session Chair: Kamran Paynabar, ISyE Georgia Tech, Atlanta, GA

Session Chair: Mohammad Bisheh, Georgia Institute of Technology, Atlanta, GA

1 Umap for Degradation Modeling and Prognostic Analysis Under Multiple Failure Modes and Working Conditions

Ying Fu, Kaibo Liu, University of Wisconsin-Madison, Madison, WI, Contact: ying.fu@wisc.edu

Complex systems often face multiple failure modes, necessitating diagnostic measures. Using a single prognostic model for RUL prediction often underperforms. Current methods, which require failure mode labels and employ high-dimensional classification, face interpretability, and practicality issues.

To counter this, we adapted UMAP to identify failure modes and trace each unit's degradation. A time-series trajectory-based clustering method was used to determine failure mode labels. For new data, a low-dimensional classification model calculates the probability of each failure mode. RUL prediction is handled by a deep-branched LSTM network with partitioned inputs. The final output, a combination of the LSTM units' outputs weighted by the failure mode probability, has proven effective in assessing multiple failure modes in aircraft gas turbine engines.

2 Latent State Behavior Estimation Through A Variational Autoencoder Structure With Application To Utility Analytics

Afshin Asadi, Ramin Moghaddass, University of Miami, Coral Gables, FL

Identifying factors that derive the consumption behavior of industrial equipment, like compressors and chillers, is a known challenge that requires a comprehensive understanding of the equipment's dynamic behavior as well as hidden variables, such as efficiency and degradation status. Leveraging the power of Variational Autoencoders (VAEs), our model aims to extract undercover latent patterns hidden in power consumption. The VAE's structure captures essential features and generates new data instances. By fusing real-time measurements of known variables with VAE-generated samples, we enable dynamic predictions of the power consumption over time. Through this approach, our model harnesses both VAE capabilities and Seq2Seq architecture to deliver real-time predictions for power consumption, while optimizing data logging in industrial efficiency projects.

3 Image-Based Characterization of Laser Scribing Quality Using Transfer Learning

Mohammad N. Bisheh, Georgia Institute of Technology, Atlanta, GA

This research explores the use of ultrafast laser scribing for microscale materials processing. The study focuses on real-time quality monitoring during the scribing process. A deep transfer learning model is proposed, which leverages a pre-trained CNN model for basic geometric features. The transfer learning model successfully characterizes scribing quality, including debris, scribe width, and straightness, with 96% accuracy using both small and large datasets. The model's performance remains consistent even when applied to a different scribing application with additional training. This approach enables effective measurement of quality characteristics using a smaller image dataset and reduce number of trainable parameters to a third compared to regular CNN models.

4 Reliability Analysis of Multivariate Degradation Processes Considering Long Range Dependence

Ali Asgari, Wujun Si, Wichita State University, Wichita, KS

Multivariate degradation modeling has been widely used to obtain the reliability information of products using degradation data of multiple Performance Characteristics (PCs). Recently, a Long-Term Memory (LTM) effect has been observed in the degradation process of various PCs, which implies that the future degradation process highly depends on both the present degradation state and the past degradation trajectory. However, the LTM effect has not been considered in the current multivariate degradation modeling. In this talk, we will present a new multivariate degradation model that captures the LTM effect, based on which reliability analysis is developed. Simulation and real case studies are proposed to validate the proposed model.

Monday, October 16, 8:00 AM - 9:15 AM

MA50

CC-North 229A

ENRE Energy and Climate Session

Community Committee Choice Session

Session Chair: Max Vanatta, University of Michigan, Ann Arbor, MI

1 A Targeted Approach to Energy Burden Reduction Measures: Comparing the Effects of Energy Storage, Rooftop Solar, Weatherization, and Energy Efficiency Upgrades

Bethel Tarekegne, Jessica Kerby, PNNL, Richland, WA, Contact: bethel.tarekegne@pnnl.gov

As energy prices rise and climate change brings more extreme and frequent days of heating and cooling, households must allocate more of their income to energy bills, increasing their energy burden. Many strategies are employed to alleviate high energy burden, such as weatherization, energy efficiency, and energy storage and rooftop solar, though the benefits of each scale based on factors such as climate, housing characteristics, and energy behaviors. This study used variation in these factors across the United States to create a set of representative houses to investigate the variable responses to different energy burden reduction measures in the simulation environment GridLABD.

2 Energy Planning for Decarbonization in Neighborhoods and Districts

Ben Polly, National Renewable Energy Laboratory
Approaching energy planning for decarbonization at a community scale, such as in urban districts and neighborhoods, can unlock unique opportunities for advanced solutions that deliver deep savings and enhanced benefits. This can include technologies and strategies such as electrified, efficient and energy-flexible buildings; shared energy systems; heat recovery and heat pump-based district thermal systems; integrated distributed energy resources and coordinated controls. However, robust methods and tools are needed to analyze and optimize community-scale decarbonization solutions in conjunction with electricity grid infrastructure, including understanding how demand-side investments can be optimized in conjunction with grid upgrades and controls. This presentation will describe efforts to develop the open-source URBANopt modeling platform to help address these needs, including efforts to make capabilities accessible and highly customizable for practitioners to work with communities to develop equitable and tailored solutions.

3 Opportunities and Challenges for Community Solar: A Case Study on Community Solar to Increase Renewable Energy Deployment in the City of Los Angeles

Ashreeta Prasanna, Jane Lockshin, National Renewable Energy Laboratory, Golden, CO, Contact: ashreeta.prasanna@nrel.gov
Community solar enables access to electricity savings from solar for customers unable to install rooftop solar. The goal of the analysis presented in this paper is to identify potential community solar sites that encourage equitable access to solar in the city of Los Angeles (LA). We find that despite significant technical potential on government owned and other public-use land parcels, only a small proportion of sites (25%) would be economically viable to develop. Additional market factors and other challenges in deployment are likely to reduce this economic potential further resulting in lower deployment. Without targeted incentives and modifications to the current program structure, community solar is unlikely to be deployed at the required scale and provide the benefits of solar deployment, investment, and alleviation of electricity burden for communities in need.

4 Community/Committee'S Choice Submission

Shimekia Nichols, Soulardarity

Monday, October 16, 8:00 AM - 9:15 AM

MA51

CC-North 229B

Resilience and Sustainability Considerations in Power Grid Planning and Operations

Community Committee Choice Session

Session Chair: Brent Austgen, The University of Texas at Austin, Lowell, IN

1 Scenario-based Optimization Models For Power Grid Resilience Decision-making For Extreme Flood Events

Ashutosh Shukla, Erhan Kutanoglu, John Hasenbein, University of Texas at Austin, Austin, TX, Contact: ashutosh.shukla@utexas.edu
Extreme weather events such as hurricanes cause significant damage to the power grid. Consequently, stakeholders must evaluate and adopt mitigation measures to enhance its resilience. To help address this challenge, we present scenario-based optimization models for power grid resilience decision-making, using flooding as a motivating example. We integrate flood forecasts from a physics-based storm-surge model with a power flow model to decide an optimal substation hardening strategy. We account for uncertainties associated with the flood forecasts using robust and stochastic formulations. Finally, we propose a method to suggest near-optimal value of budget that should be allocated for substation hardening to minimize the total disaster cost. We develop our results using a case-study for the Texas coastal region using storm surge scenarios developed by NOAA.

2 Integrated Planning Of Hydrogen Supply Chain Network And Power System

Siqiang Guo[1], Erhan Kutanoglu[2], Shadi Goodarzi[3], [1]University of Texas at Austin, Austin, TX, [2]University of Texas-Austin, Austin, TX, [3]University of Texas Austin, Austin, TX, Contact: siqianggeorgeguo@gmail.com
Hydrogen is an important solution to decarbonize sectors such as heavy-duty transportation, industry, and utility. A comprehensive design of hydrogen supply chains (HSC) makes decisions for the production, distribution, and storage of hydrogen based on its application. Due to high diversity of choices in each of these stages, optimal HSC planning remains challenging. Moreover, renewable hydrogen, which is mainly produced through electrolysis, inherently relates to the power system. It is intuitively right to plan HSC and power system integratedly.
We formulate a model that combines capacity expansion modeling of power system and planning of HSC. We answer questions like: What does the optimal HSC look like? Does

integrated planning differ much from separate planning? We also explore aspects such as carbon tax, different ways of incentives, and their effectiveness.

3 Exploring American Residential Community Distributed Energy Resource Adoption Potential by Energyshed

Eric Scheier, Emergi Foundation, SF Bay Area, CA

Energy equity and distributed resource integration have the potential to interact positively and negatively throughout the energy transition. Here, we estimate the impact of deploying community co-located DERs within each United States electric distribution grid as measured by a number sustainability and resilience metrics alongside market values. We show which cohorts are expected to contribute to and benefit most from different energy transition pathways and demonstrate future scenarios that meet 24/7 energy needs with affordable, clean energy.

4 Accelerating Grid Orchestration And Digital Transformation: Cloud Migration For A Carbon-Neutral Power Grid

Joe Nyangon, PhD, SAS Institute, Cary, NC

Accelerating grid orchestration and decarbonization is pivotal for digital transformation and modernization of power systems, and cloud migration has emerged as the catalyst for this change. This presentation delves into how strategic cloud migration, sustainable software engineering, and optimization can foster this acceleration. Attendees will learn about cloud computing service models, industry analysis, and the benefits of migration. Sustainable and financial gains depend on the provider's renewable power mix, hardware efficiency, and circular value chains. The session will conclude with a discussion on the future of cloud migration, technological innovation, and the utility industry's imperative to orchestrate a clean energy grid.

Monday, October 16, 8:00 AM - 9:15 AM

MA52

CC-North 230

Wildfire Risk Management for Electric Power Systems

Community Committee Choice Session

Session Chair: Line Roald, University of Wisconsin - Madison, Los Alamos, NM

Session Chair: Noah Rhodes, Greenville

1 A Data-Driven Automated Mitigation Approach for Resilient Wildfire Response in Power Systems

Amarachi Umunnakwe, Texas A&M University, College Station, TX, Contact: amarachi@tamu.edu

Wildfires lead to colossal losses on territory, state, and federal levels affecting critical infrastructure, the economy, decarbonization and social sustainability, hence highlighting the need to improve critical infrastructure wildfire-resilience. Existing wildfire mitigation methods are usually compartmentalized, focusing on already progressing wildfires. We present a data-driven, spatiotemporal, low-cost, and resilience-comprehensive model, SL-PWR, that automates wildfire mitigation by optimizing and providing real-time information from processed quantitative, qualitative, and visual data to appropriate emergency response teams. The SL-PWR de-compartmentalizes wildfire response, improving situational awareness and rapidity before, during, and after wildfire incidents, from proactive wildfire detection through to system restoration.

2 Optimal Power System Decision-Making in Presence of Active Wildfires

Anamitra Pal, Arizona State University, Tempe, AZ, Contact: anamitra.pal@asu.edu

In this session, I will talk about a decision-making framework for secure, economical, and resilient power system operation during active wildfires that leverages synchrophasor measurement-based enhanced situational awareness. The methodology involves solving the optimal power flow (OPF) problem iteratively, while incorporating security and stability constraints identified through steady-state and transient stability analyses. Specifically, we formulate a static security-constrained OPF for mitigating branch overloads and cut-set saturation and show the feasibility of transient stability-constrained OPF using machine learning. We also address the challenges of evaluating these constraints under diverse wildfire impacts and time limitations.

3 Risk-Averse Stochastic Programming for Wildfire Fuel Treatment Planning

Lina M. Villa-Zapata, Texas A&M University, College Station, TX, Contact: lina.villa@tamu.edu

Fuel treatment involves removing all or some of the vegetation from a landscape to reduce the potential for fires and their severity. Given the current state of the vegetation and a set of areas, fire managers must first decide on treatment options before fires occur. Then after the fire locations are known, the fire managers need to contain the fires to minimize damage. We model this problem using a rolling horizon framework that captures uncertainties in vegetation growth, weather, and wildfire risk. We parameterize our model through different fuel treatment options, vegetation growth, and wildfire behavior using standard wildfire simulation software. We apply this model to a case study based on historical data for West Texas.

4 Security Constrained Optimal Power Shutoff
Noah Rhodes[1], Carleton Coffrin[2], Line Roald[3], [1]University of Wisconsin-Madison, Madison, WI, [2]Los Alamos National Laboratory, Los Alamos, NM, [3]University of Wisconsin - Madison, Los Alamos, NM, Contact: nrhodes@wisc.edu
Electric grid faults are increasingly the source of ignition for major wildfires. To reduce the likelihood of such ignitions in high-risk situations, utilities use pre-emptive deenergization of power lines, commonly referred to as Public Safety Power Shut-offs (PSPS). This may leave the network particularly vulnerable to unexpected line faults that may occur while the PSPS is in place. Previous works have not explicitly considered the impacts of such outages. To address this gap, we propose the *Security-Constrained Optimal Power Shutoff* (SC-OPS) problem which uses post-contingency security constraints to model the impact of unexpected line faults when planning a PSPS. This SC-OPS model enables the exploration of trade-offs while designing PSPS plans, providing useful insights for utilities and policy makers considering different approaches to PSPS.

Monday, October 16, 8:00 AM - 9:15 AM

MA53

CC-North 231A
Elements of Electricity Market Design
Community Committee Choice Session
Session Chair: Harsha Gangammanavar, Southern Methodist University, Dallas, TX

1 Market Power Mitigation in a Two-Stage Electricity Market
Rajni Kant Bansal[1], Yue Chen[2], Pengcheng You[3], Enrique Mallada[4], [1]Johns Hopkins University, Baltimore, MD, [2]The Chinese University of Hong Kong, Sha Tin, Hong Kong; [3]College of Engineering, Peking University, Beijing, China; [4]Johns Hopkins University, Baltimore, MD, Contact: rbansal3@jhu.edu
Despite an efficient two-stage electricity market design, lack of market competition introduces price manipulation opportunities. To this end, operators are planning system-level market power mitigation (MPM) policies that replace noncompetitive bids. However, policy implementation with a limited understanding of participant incentives may lead to unintended losses. We model interactions of generators and loads in a two-stage settlement market with an MPM policy. For a real-time MPM policy, Nash equilibrium leads to a complete shift in demand allocation to real-time; a scenario highly undesired. The day-ahead MPM policy results in a generalized Stackelberg-Nash game where load makes decisions (leaders) in day-ahead, and generators make decisions (followers) in real-time. Equilibrium analysis leads to a closed-form solution that unveils several insights.

2 Power Sector Reliability Under Decarbonization and Energy Demand Pressures in Hydro-Dominated Regions of China
Michael R. Davidson[1], Ming Wei[2], [1]University of California, San Diego, San Diego, CA, [2]University of California San Diego, San Diego, CA, Contact: m2wei@ucsd.edu
China's electricity sector is key to addressing many of the country's most pressing public policy challenges. Partly as a result of the incomplete transition away from central planning, the sector now faces the paradoxical dilemma of generator overcapacity and seasonal power shortages across many regions. Based on newly collected open-source data, we explore these challenges in southern China, home to hydro-dominated Yunnan province with 100 GW of exploitable capacity. Firstly, we utilize monthly market data from 2016-2022 to analyze the effects of implementing a pay-for-performance capacity market coupled with other market and administrative measures. Secondly, we develop a unit commitment and economic dispatch model to assess historical periods of power tightness and future seasonal supply and demand reliability under different extremes conditions.

3 Spatial Arbitrage Through Bidirectional Electric Vehicle Charging with Delivery Fleets
Mostafa Mohammadian[1], Kyri Baker[1], Constance Crozier[2], [1]University of Colorado Boulder, Boulder, CO, [2]University of Colorado, Boulder, CO, Contact: mostafa.mohammadian@colorado.edu
The adoption of electric vehicles (EVs), including electric taxis and buses, as a mode of transportation, is rapidly increasing in cities.In addition to providing economic and environmental benefits, these fleets can potentially participate in the energy arbitrage market by leveraging their mobile energy storage capabilities. This presents an opportunity for EV owners to contribute to a more sustainable and efficient energy system while also reducing their operational costs. The study introduces deterministic and single-stage stochastic optimization frameworks that aim to maximize revenue by

optimizing the charging, discharging, and travel of a fleet of electric vehicles in the context of uncertainty surrounding both spatial and temporal energy prices.

Monday, October 16, 8:00 AM - 9:15 AM

MA54

CC-North 231B

Optimization Meets Machine Learning

Community Committee Choice Session

Session Chair: Carlos Henrique Cardonha, University of Connecticut, Storrs, CT

1 The Madness of Multiple Entries in March Madness

Jeff Sylvestre-Decary[1], David Bergman[2], Carlos Henrique Cardonha[2], Jason P. Imbrogno[3], Andrea Lodi[4], [1]University of Connecticut, Storrs, CT, [2]University of Connecticut, Storrs, CT, [3]University of North Alabama, Florence, AL, [4]Cornell Tech, New York, NY, Contact: jeff.sylvestre-decary@uconn.edu

This paper presents multi-entry betting strategies for single-elimination tournaments with top-heavy payoff structures. In these betting pools, participants select a winner for each game in the competition, and the number of correct guesses determines their score. A good strategy for bettors is to aim for a set of entries that maximizes the expected result of their best-performing entry. There is no known closed-form expression that computes this expectation for two or more entries, so we present a simulation algorithm and a Neural Network to estimate it. We then embed these methods within optimization procedures tailored to the problem. We tested our algorithms on every March Madness tournament played since 2017, and our results show that our best entries would have won $1 million against some of the best sports bettors in the world in a contest organized by DraftKings.

2 Optimizing over an Ensemble of Trained Neural Networks

Keliang Wang[1], Leonardo Lozano[2], Carlos Henrique Cardonha[3], David Bergman[3], [1]University of Connecticut, School of Business, Storrs, CT, [2]University of Cincinnati, Cincinnati, OH, [3]University of Connecticut, Storrs, CT

Recent literature has explored the use of a single neural network to model either uncertain or complex elements in an objective function. It is well known that ensemble of neural networks produce more stable predictions and have better generalizability than single neural networks. We study how to incorporate a neural network ensemble as the objective function. We develop a two-phase approach for our model that combines preprocessing procedures to tighten bounds for critical neurons in the neural networks with a Lagrangian relaxation-based branch-and-bound approach. Experimental evaluations suggest that using ensembles of neural networks yields more stable and higher quality solutions, compared with single neural networks, and that our optimization algorithm outperforms the state-of-the-art approach in terms of computational time and optimality gaps.

3 Constraint Learning to Define Trust Regions in Predictive-Model Embedded Optimization

Chenbo Shi[1], Mohsen Emadikhiav[2], Leonardo Lozano[3], David Bergman[1], [1]University of Connecticut, Storrs, CT, [2]Florida Atlantic University, Boca Raton, FL, [3]University of Cincinnati, Cincinnati, OH

There is a recent proliferation of research on the integration of machine learning and optimization. One expansive area within this research stream is predictive-model embedded optimization. In this setting, features of the predictive models become decision variables in the optimization problem. Despite a recent surge in publications in this area, only a few papers note the importance of incorporating trust region considerations in this decision-making pipeline. In this paper, we provide an overview of the approaches appearing in the literature to construct a trust region, and propose three alternative approaches. Our numerical evaluation highlights that trust-region constraints learned through isolation forests, one of the newly proposed approaches, outperform all previously suggested approaches, both in terms of solution quality and computational time.

4 Learning Decisions Offline from Censored Observations with □-Insensitive Operational Costs

Minxia Chen[1], Ke Fu[2], Teng Huang[2], [1]Sun Yat-sen University, Guangzhou, China; [2]Sun Yat-sen University, Guangzhou, China. Contact: huangt258@mail.sysu.edu.cn

We investigate the data-driven decision-making problem with an offline dataset that contains the feature data and the censored historical data of the variable of interest, but without the censoring indicators. We propose a novel offline framework to prescribe decisions based on the censored offline dataset via one-step machine-learning algorithms. Specifically, we design and leverage □-insensitive operational costs to deal with the unobserved censoring in an offline data-driven fashion. We derive a tight generalization bound for the custom LR model (LR-□NVC) and a high-probability generalization bound for the custom NN (NN-□NVC) trained by stochastic gradient descent. The numerical

results show that LR-NVC and NN-NVC outperform two benchmarks, with maximum cost savings up to 14.40% and 12.21% compared to the lowest cost generated by the two existing approaches.

Monday, October 16, 8:00 AM - 9:15 AM

MA55

CC-North 231C

Digital Freight Marketplaces

Community Committee Choice Session

Session Chair: Klaas Fiete Krutein, Convoy, Inc., Seattle, WA

1 Routing Synchronization Toward Sustainable Logistics

Alexandre Jacquillat[1], Sean Lo[2], Alexandria Schmid[2], [1]MIT Sloan School of Management, Cambridge, MA, [2]MIT, Cambridge, MA, Contact: alexjacq@mit.edu

Advances in vehicle technologies and freight marketplaces offer opportunities to mitigate the environmental footprint of the logistics sector. Yet, emerging operating models require extensive coordination across logistics networks. This talk presents synchronized routing problems to support this transition, including: (i) a relay logistics problem in which long-haul shipments into short segments traveled by separate drivers; and (ii) an electric routing problem in which routing and charging decisions need to be optimized simultaneously. We propose extended formulations in time-space networks along with column generation algorithms to solve them at scale. Results show the scalability of the methodologies, and the impact of synchronization toward more efficient, reliable and sustainable supply chains. We conclude with emerging research directions.

2 Overcoming Spatial Frictions in Freight Platforms: Novel Contract Designs

Ozan Candogan[1], Klaas Fiete Krutein[2], [1]University of Chicago, Chicago, IL, [2]Convoy, Inc., Seattle, WA

Freight marketplaces connect shippers with carriers. However, spatial frictions can lead to inefficiencies such as carriers struggling to find a backhaul, which may disincentivize some carriers from participating in the marketplace. To address this challenge, we propose innovative contract designs in which carriers commit to the platform, and the platform selects shipments for contract carriers in both the short run and for the backhaul. We develop a model to analyze these contracts, create algorithms to optimize their performance, and highlight their practical implications using real-world data. Our findings shed light on the value of these contract designs in overcoming spatial frictions and improving efficiency in freight marketplaces.

3 Predictions and Demand Optimization in a Digital Freight Network

Felix Cheng, Convoy, Seattle

This abstract explores a pioneering industry initiative that seeks to establish a digital freight network. By leveraging Machine Learning and Optimization, it capitalizes on the extensive knowledge of experienced freight industry veterans across diverse local networks. The application of a TabTranform Deep Learning architecture enables a flexible freight cost prediction framework. Furthermore, it tackles the complex revenue optimization challenge by effectively balancing margin and win rate trade-offs through exploration and exploitation. The overall fundamental cornerstone of success lies in the implementation of a “human in the loop” strategy.

4 Routing for Dedicated-Like Trucking Services in a Digital Freight Marketplace

Klaas Fiete Krutein, Convoy, Inc., Seattle, WA, Contact: fietekrutein@gmail.com

The emergence of digital freight marketplaces has sparked new dynamics in the freight market. With increasing market density, digital marketplaces allow to leverage large amounts of data to increase the efficiency of the freight network through advanced truck routing solutions in dense market environments. There, trucking capacity can be sourced by time spans instead of by shipment, giving the marketplace operator more flexibility in assigning schedules. This presentation will introduce an approach to truck routing that considers the unique circumstances and dynamics of digital freight marketplaces.

Monday, October 16, 8:00 AM - 9:15 AM

MA56

CC-North 232A

Convexification: Theory and Applications

Community Committee Choice Session

Session Chair: Chen Chen, The Ohio State University, Columbus, OH

1 Rank Pump for Polynomial Optimization

Daniel Bienstock[1], Chen Chen[2], Gonzalo Munoz[3],

[1]Columbia University, New York, NY, [2]The Ohio State University, Columbus, OH, [3]Universidad De O'Higgins, Rancagua, Chile. Contact: chen.8018@osu.edu

The feasibility pump is a well-known primal heuristic for integer programming that involves two alternating sequences of projections. The original pump was designed for binary problems, and found such projections using linear programming and simple rounding. Unfortunately, the elegance of the pump may be lost in other settings. For instance, a natural extension of the pump to nonconvex MINLP involves NP-hard projection problems. We present the latest results on our adaptation of the feasibility pump to polynomial optimization, called the rank pump. The rank pump has polynomial-time iterations, as its projection problems can be solved in polynomial time.

2 Sparsity-Exploiting Distributed Projections onto a Simplex

Yongzheng Dai, Chen Chen, The Ohio State University, Columbus, OH, Contact: dai.651@osu.edu

Projecting a vector onto a simplex is a well-studied problem that arises in a wide range of optimization problems. Numerous algorithms have been proposed for determining the projection; however, the primary focus of the literature has been on serial algorithms. We present a parallel method that decomposes the input vector and distributes it across multiple processors for local projection. Moreover, the method can be adapted to parallelize a broad range of serial algorithms from the literature. We fill in theoretical gaps in serial algorithm analysis, and develop similar results for our parallel analogues. Numerical experiments conducted on a wide range of large-scale instances, both real-world and simulated, demonstrate the practical effectiveness of the method.

3 A Slightly Lifted Convex Relaxation for Nonconvex Quadratic Programming with Ball Constraints

Samuel Burer, University of Iowa, Iowa City, IA

Globally optimizing a nonconvex quadratic over the intersection of m Euclidean balls is known to be polynomial-time solvable for fixed m. However, there is no known explicit, tractable, exact convex representation for $m > 2$. In this talk, we construct a new, polynomially sized semidefinite relaxation for this problem, and we demonstrate empirically that it is quite strong and quick compared to existing relaxations. The key idea is a simple lifting of the original problem into one higher dimension.

4 Mixed-Integer Conic Optimization for Reliability Enhancement of Distribution Systems

Milad Dehghani Filabadi, The Ohio State University, Columbus, OH

This paper provides a tractable optimization model for determining the placement of switches, tie lines, and underground cables in order to maximize the reliability of a distribution system. A central novelty in the model is the inclusion of nodal reliability constraints, which consider network topology. The resulting placement problem can be formulated either as a mixed-integer conic optimization problem or as a mixed-integer linear program. We demonstrate both theoretically and empirically that the judicious application of partial linearization is key to rendering a practically tractable formulation. Computational studies indicate that realistic instances can indeed be solved in a practical amount of time on standard hardware.

Monday, October 16, 8:00 AM - 9:15 AM

MA57

CC-North 232B

Perspectives on Novel Business Models and Emerging Technologies

Flash Session

Session Chair: Sara Saberi, Worcester Polytechnic Institute, Worcester, MA

1 A Business Model Approach to the Current State of Microsaas

Isa Mostachetti, Portland State University, Portland, OR

As platforms grow, so do their plugin offerings. Plugins, low code software, mobile applications, and Steam games are all instances of MicroSaaS. However, there is no agreed upon definition of MicroSaaS. This paper attempts to define the MicroSaaS business model based on existing literature. The findings suggest there are two defining features for MicroSaaS. The paper also lists the advantages and disadvantages of choosing the MicroSaaS business model for today's digital entrepreneur.

2 Explainability and Preference Manipulation of Algorithmic Nudge

Yuxiao Luo, Baruch Colege (CUNY), New York, NY, Contact: yuxiaoluo@hotmail.com

This paper investigates the impacts of digital nudging on customer purchase decisions. Drawing on literature of nudge and anchoring effect, this study proposes two types of nudges based on the transparency level: ambiguous badge (ex., *Amazon's Choice*) and specific badge (ex., *Best Seller*).

We further hypothesize that that specific badge will be less likely to manipulate user's preferences than ambiguous badge under the condition of preference mismatch. This study will contribute to the nudge literature, recommendation system and dark side in IS and bring ethical implication to the use of AI/ML model and algorithmic nudging.. The empirical result can be applied to user interface design for lowering the e-commerce product return rate.

3 Closed-Loop Supply Chain Model for Electronic Products: Examiningthe Impact of Blockchain Implementation

Sahar Bajgani[1], Sara Saberi[1], Fuminori Toyasaki[2], [1]Worcester Polytechnic Institute, Worcester, MA, [2]York University, Toronto, ON, Canada. Contact: ssaberi@wpi.edu

The COVID-19 pandemic has caused major supply chain disruptions and a chip shortage, affecting the semiconductor industry. Reverse logistics can optimize supply chains, reduce waste, and increase production capacity, but poses challenges such as e-waste quality, fraud prevention, and secure disposal of sensitive information. Blockchain technology can prevent counterfeit electronic parts and enhance traceability, but implementation requires significant investment and raises security concerns. We propose a closed-loop supply chain model for electronic products to examine the impact of blockchain implementation on outcomes.

Monday, October 16, 8:00 AM - 9:15 AM

MA58

CC-North 232C

Digital Twins and AI Applications

Contributed Session

Session Chair: Shankar Prawesh, Indian Institute of Technology (IIT Kanpur), Kanpur, India

1 Machine Learning-Based Vision for Additive Manufacturing Process

Iida Haghnegahdar, Texas University, Denton, TX

Manufacturing systems are increasingly faced with intrusions not only by traditional malicious actors such as hackers and cyber-criminals but also by some competitors and nations engaged in corporate espionage. Artificial intelligence (AI) is one of the novel approaches that has emerged to overcome the increasing complexity and sophistication of cybersecurity intrusions in manufacturing. These defensive and control-based AI method implements various machine learning algorithms for diverse types of controls, such as intrusion detection and malware detection. In this paper, the authors propose an action for AI-based intrusion and anomaly controls in research and practice for additive manufacturing. This paper proposes a deep convolutional neural network that is the most common type of neural network that use to recognize patterns in AM images through 3D printing.

2 Simulation and Digital Twin: Bridging the Gap

Ana C. Wooley[1], Daniel F. Silva[2], [1]University of Alabama in Huntsville (UAH), Huntsville, AL, [2]Auburn University, Auburn, AL, Contact: anacwooley@gmail.com

Modern industrial processes are being transformed by data-driven decision support tools like simulation, advanced data analytics, and Artificial Intelligence (AI). While Discrete Event Simulation (DES) accurately models manufacturing systems, it can be time-consuming and data-intensive. Integrating methods from big data analytics and AI, a Digital Twin (DT) can provide real-time insights and faithfully represent the system. This research aims to bridge the gap between DES and DT by demonstrating the steps to transform a fully capable DES model to a DT through a case study. Key transformation steps, challenges, and solutions are identified, showcasing the potential benefits of bridging DES and DT. The research concludes with lessons learned, critical success factors, and recommendations for future studies.

3 A Scheduling Framework for Real-Time Large-Scale Job Shop Scheduling

Shankar Prawesh[1], Avijit Khanra[1], Neha Kadu[1], Yuichi Koga[2], Yosuke Watanabe[2], Naoyuki Fujiwara[3], [1]Indian Institute of Technology (IIT) Kanpur, Kanpur, India; [2]Mitsubishi Heavy Industries, Ltd., Tokyo, Japan; [3]Mitsubishi Heavy Industries, Ltd., Tokyo, Japan. Contact: sprawesh@iitk.ac.in

The digital transformation of the manufacturing ecosystem enabled by data generated from disparate sources has created many opportunities for the adoption of lean manufacturing practices. However, there is scant research on using these data for large-scale production scheduling. We present a real-time large-scale job shop scheduling framework that could generate a good just-in-time schedule for operations in the order of millions honoring resource constraints, working shifts, and precedence relations. In this presentation, we will discuss the specifics of real-life job-shop problems that call for a careful design of algorithms and data structure. We will present our approach to solving this problem in detail and discuss how our scheduling framework can be leveraged for developing machine learning algorithms to achieve the just-in-time scheduling objectives.

Monday, October 16, 8:00 AM - 9:15 AM

MA59

CC-West 101A

MCGDM: MultiCriteria Group Decision Making Models

Community Committee Choice Session

Session Chair: Danielle C. Costa Morais, Universidade Federal de Pernambuco - UFPE, Recife - PE, Brazil
Session Chair: Eduarda Asfora Frej, Universidade Federal de Pernambuco, Recife, Brazil

1 Designing Cybersecurity Readiness Assessment Tool (CRAT): Navigating the Dilemma of Selecting the Right MCDM Method and Mapping It to User Interfaces

Abhishek Sharma, Rangaraja P. Sundarraj, Indian Institute of Technology Madras, Chennai, India. Contact: abhisheksharma.27ju@gmail.com

This study gives a design journey of a Cybersecurity Readiness Assessment Tool (CRAT) prototype through the lens of a mixed-mode study entailing four stages. This study's key contribution is the process we followed in developing the prototype tool and evaluating the tool at each stage. Overall the stages of the prototype development include mapping readiness factors and countermeasures and checking its feasibility for application to MCDM methods. We surveyed various MCDM and weighting methods in order to understand the feasibility of the initial design. This led us to test the concept of digital nudging, with respect to the User Interface (UI). We examine how different UIs perform in terms of cognitive effort and time performance and change in decision outcomes by using PL-TOPSIS as a base.

2 Multicriteria Group Decision Model for Ranking Beneficiaries of the Brazilian Agrarian Reform Program

João Batista Sarmento dos Santos-Neto, Carolina Lino Martins, Saulo Gomes Moreira, Nadya Kalache, Federal University of Mato Grosso do Sul, Campo Grande, Brazil. Contact: joao.sarmento@ufms.br

The agrarian reform began to be discussed by the government in Brazil in the late 1950s. Currently, the National Agrarian Reform Program (PNRA) seeks to enable access to land by small farmers by distributing public lands divided into areas. In this context, it is necessary within the scope of public policies for territorial and land governance to use models to define priorities in the occupation of the land in the country. Therefore, this study proposes a multicriteria group decision model to rank the candidate families interested in joining the PNRA to select beneficiaries for public policies aligned with the federal government's strategic social, environmental, and economic goals.

3 Group Decision Model for Sorting Flood Risks in Urban Areas

Danielle C. Costa Morais[1], Lucas da Silva[2], Marcelo Hazin Alencar[3], Rodrigo Ferreira[3], Adiel Teixeira De Almeida[4], [1]Universidade Federal de Pernambuco - UFPE, Recife - PE, Brazil; [2]Universidade Federal do Rio Grande do Norte (UFRN), Natal, Brazil; [3]Universidade Federal de Pernambuco, Recife, Brazil; [4]Universidade Federal de Pernambuco, Recife PE, Brazil. Contact: dcmorais@insid.org.br

Floods in urban areas have caused troubles in several dimensions such as social, economic, and environmental. This kind of problem deals with public decisions characterizing a group decision approach. This study proposes a multicriteria group decision model for sorting flood risks in urban areas, based on different DMs' perspectives regarding risks, using the ALARP (As Low As Reasonably Possible) principle with Utility Theory with the aid of a majority-oriented aggregation rule for establishing the initial preferences. Afterward, using FITradeoff for sorting method to recommend the flood risk categorization of urban areas (Intolerable, Manageable, Tolerable, and Broadly acceptable), to support the implementation of emergency mitigating disaster actions.

Monday, October 16, 8:00 AM - 9:15 AM

MA60

CC-West 101B

MIF Academic Job Search Panel

Panel Session

Session Chair: Diana Gineth Ramirez-Rios, University at Buffalo, Buffalo, NY
Session Chair: Clara Novoa, Texas State University, San Marcos, TX

1 MIF Academic Job Search Panel

Clara Novoa, Texas State University, San Marcos, TX

The purpose of this session is to bring visibility to the students and postdocs looking for academic positions. Panelists from both business and engineering schools will share their experiences. This panel discusses the academic interview process and do's and don'ts associated with the job search.

2 Panelist
Robert F. Dell, University at Buffalo, Monterey, CA

3 Panelist
Johanna Amaya, Pennsylvania State University, University Park, PA

4 Panelist
Muge Capan, University of Massachusetts Amherst, Amherst, MA

5 Panelist
Banafsheh Behzad, California State University, Long Beach, Long Beach, CA

Monday, October 16, 8:00 AM - 9:15 AM

MA61

CC-West 101C

Locational Analysis for Supply Chain Design

Contributed Session

Session Chair: Youssef Boulaksil, UAE University, Al Ain, United Arab Emirates

1 Capacitated Facility Location and Inventory Management Problem Under Stochastic Demand: Multi-Period Closed-Loop Supply Chain Network Design
Sungjune Lee[1], Daeki Kim[2], [1]Korea University Business School, Seoul, Korea, Republic of; [2]Korea University Business School, Seoul, Korea, Republic of. Contact: junandhun@korea.ac.kr
A closed-loop supply chain is a supply chain that seeks to reduce costs and environmental impact by reusing products, and a pallet pooling system is selected as an example in this study. The proposed multi-period closed-loop supply chain optimization problem simultaneously considers the distribution center location decision and the inventory management problem to meet the stochastic customer demand. The non-linear objective function is linearized and CPLEX is adopted to solve conic quadratic mixed-integer programming. The additional constraint and row generation technique are adopted to boost the optimization.

2 Facility Location Optimization Model for Covid-19 in Oklahoma
Hamidreza Samadi[1], Shivakumar Raman[2], [1]The University of Oklahoma, Norman, OK, [2]The University of Oklahoma, Norman, OK, Contact: hamidreza.samadi@ou.edu
This paper implements a facility location-based approach to locate the COVID-19 test centers in the major counties of Oklahoma. The main goal is to minimize the total traveling distance to get tested and pursue a county-based demand approach. The model guarantees that the demand of people in each county will be satisfied. Parameters are assigned based on the released COVID-19 statistics. In the implementation process, two alternative scenarios are applied to the main model and further analysis is conducted. This project suggests a plan to choose the best locations among potential sites in terms of optimal travel distance. It also mentions about proposed model's limitations and possible research extensions.

3 Enhancing Instore Picking Efficiency: A Comprehensive Analysis of Backroom Assignments
Sebastian Köhler, Felicia Theilacker, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany. Contact: sebastian.koehler@kit.edu
Omnichannel services have increased the complexity of instore logistics processes. In today's retail environment, the backroom is typically used only to buffer deliveries. Using the backroom for picking has been shown to improve efficiency, but a comprehensive analytical approach and optimized allocation strategy is lacking. This study presents a model that examines the impact of allocating additional item stock in the backroom on instore logistics and discusses how it differs from warehouse allocation problems. An optimization model is proposed that determines the items and quantities to be assigned to the backroom with the goal of minimizing instore logistical costs. The results contribute to improving instore operations for omnichannel services.

4 Optimizing Modern Retailers' Location in Emerging Markets' Megacities
Youssef Boulaksil, UAE University, Al Ain, United Arab Emirates. Contact: youssef.boulaksil@gmail.com
In this paper, we study the location problem for modern retail stores in a densely populated megacity in an emerging market. A trade-off is made between a higher population density (and hence demand) when getting closer to the city center, and higher opening and logistics cost. We extend Hotelling's line model to an analytical framework that incorporates the specific characteristics of traditional and modern retailers. We analyze the single-store model

analytically and determine the optimal location for a hypermarket. Our numerical study shows how customers' travel cost, appreciation, and price setting influence the optimal locations and profits. Given the complexity of the model, analysis becomes intractable when multiple stores are opened. Therefore, we devise an approximation and show that it can yield accurate results.

Monday, October 16, 8:00 AM - 9:15 AM

MA62

CC-West 102A

Enhancing Community Resilience and Sustainability

Community Committee Choice Session

Session Chair: Andres David Gonzalez, University of Oklahoma, Norman, OK

1 Bi-Level Optimization in Community- and Building-Level Mitigation for Flooding Hazards

Himadri Sen Gupta[1], Omar M. Nofal[2], Andres D. Gonzalez[1], Charles D. Nicholson[1], John W. van de Lindt[3], [1]University of Oklahoma, Norman, OK, [2]Florida International University, Miami, FL, [3]Colorado State University, Fort Collins, CO, Contact: hgupta@ou.edu

This research proposes a bi-level optimization model to minimize direct economic loss and population dislocation in a community due to flood-related building damage. The model considers pre-event short- and long-term mitigation strategies and trade-offs, and integrates information on cost, type of mitigation strategy, and expected losses and population dislocation for each building at different levels of mitigation.

2 A Behavioral Science Centric Understanding of Energy Limiting Behavior

Sheng Lun (Christine) Cao, Destenie S. Nock, Carnegie Mellon University, Pittsburgh, PA, Contact: shenglun@andrew.cmu.edu

Energy limiting behavior arises from a household's inability or unwillingness to consume a safe and healthy level of energy. The Low-Income Home Energy Assistance Program (LIHEAP) is designed to financially assist energy-poor households, but there exist gaps in understanding the effectiveness of LIHEAP as an intervention mechanism. We propose a behavioral science-centric study to understand people's energy use preferences in energy limiting conditions and examine whether LIHEAP is effective. Using a regression model and household energy use data, individual priorities for energy use in energy limiting conditions are revealed. In contrast, stated preferences of LIHEAP participants shows how much extra household energy could be used if they had expanded budgets. These two joint methods provide a holistic view of energy limiting behavior and LIHEAP effectiveness.

3 Two-Stage Stochastic Program for Environmental Relocation Decision-Making

Buket Cilali[1], Kash Barker[1], Andrés David González[1], Ahti Salo[2], [1]University of Oklahoma, Norman, OK, [2]Aalto University, Aalto SCI, Finland. Contact: buket.cilali@ou.edu

Slow-onset climate change impacts have been turning many settlements around the world into uninhabitable regions and the situation is expected to become worse in the upcoming decades. In order to handle the resulting need for a mass movement, we focus on the long-term displacement problem, especially in climate-driven cases in which people will be forced to leave uninhabitable regions to escape unlivable conditions, water stress, crop failure, and sea level rise. We develop a mathematical model where uncertainty in demand is represented with various demand scenarios, demand and capacity are managed dynamically, and integration outcomes and related costs are optimized. In this study, we propose a two-stage stochastic model under three different demand scenarios and analyze the societal impacts of the suggested movements on the host regions.

Monday, October 16, 8:00 AM - 9:15 AM

MA63

CC-West 102B

Service Science Best DEIJ Paper Award Competition

Award Session

Session Chair: Muge Yayla Kullu, University of Central Florida, Orlando, FL

1 Can Customer Ratings be Discrimination Amplifiers? Evidence from a Gig Economy Platform

Fei Teng, Yale University, New Haven, CT

2 Dynamic Exception Points for Fair Liver Allocation

Mustafa Akan, Carnegie Mellon University, Pittsburgh, PA

3 Allocation of Funds in Bilevel Subsidy Welfare Programs
Wei Wei, University of Massachusetts, Boston, MA

4 Differentiating on Diversity: How Disclosing Workforce Diversity Data Influences Consumer Choice
Maya Balakrishnan, Harvard Business School, Boston, MA

5 The Impact of the Opportunity Zone Program on Residential Real Estate
Xiaoyan Liu, Santa Clara University, Santa Clara, CA

Monday, October 16, 8:00 AM - 9:15 AM

MA64

CC-West 102C

Data Analysis and Optimization in Communication and Social Networks

Community Committee Choice Session

Session Chair: Alexander Semenov, University of Florida, Shalimar, FL

1 Optimal Target Selection in Social Networks with Tiered Influence and Activation Thresholds
Qipeng Phil Zheng, University of Central Florida, Orlando, FL
In this study, we address the problem locating those influential users in social media through solving the tiered influence and activation thresholds target set selection problem, which is to find the seed nodes that can influence the most users within a limited time frame. Both the minimum influential seeds and maximum influence within budget problems are considered in this study. Besides, this study proposes several models exploiting different requirements on seed nodes selection, such as maximum activation, early activation and dynamic threshold. To address the computational challenges, this study designs and leverages several efficient algorithms, i.e., Graph Partition, Nodes Selection, Greedy Algorithm, Recursive Threshold Back Algorithm and Two-stage Approach in Time, especially for large-scale networks.

2 Double-Threshold Models for Network Influence Propagation
Vladimir Boginski, University of Central Florida, Orlando, FL
We consider new models of activation/influence propagation in networks based on the concept of double thresholds: a node will "activate" if at least a certain minimum fraction of its neighbors are active and no more than a certain maximum fraction of neighbors are active. These models are more flexible than standard threshold models as they allow to incorporate more complex dynamics of diffusion processes when nodes can activate and deactivate. In a social network, consistently with the hypothesis originally proposed by Granovetter (1978) , a person may "activate'' (e.g., adopt and/or repost an opinion) if *sufficiently many* but *not too many* of their friends (i.e., neighbors in a network) have adopted this opinion. We study several versions of this problem setup under different assumptions on activation/ deactivation mechanisms and initial choices of seed nodes.

3 Reducing Encryption Complexity of Maximum Key Assignments in Sensor Networks Using Spanning Trees
Maciej Rysz[1], Alexander Semenov[2], [1]Miami University, Oxford, OH, [2]University of Florida, Shalimar, FL
We propose an efficient q-composite encryption scheme for large-scale sensor networks. By leveraging spanning trees, we determine the maximum number of non-redundant keys that can be assigned to sensors with limited memory capacities. Our method reduces encryption complexity by finding a spanning tree with known characteristics using a polynomial time algorithm. Our approach demonstrates that network-based algorithms can solve the key cases of the management problem. Numerical experiments confirm the effectiveness and scalability of our approach, enabling secure information exchange in sensor networks.

4 Chance-Constrained Set K-Covering Problem
Shunyu Yao, Neng Fan, University of Arizona, Tucson, AZ, Contact: shunyuyao@arizona.edu
We consider a variant of the set covering problems with uncertain data, which we refer to as the chance-constrained set k-covering problem. In this problem, we assume that there is uncertainty regarding whether a selected set can cover an item, and the objective is to determine a minimum-cost combination of sets that covers each item i at least k_i times with a prescribed probability. We formulate deterministic integer programs and propose solution approaches for this problem using some combinatorial methods.

Monday, October 16, 8:00 AM - 9:15 AM

MA65

CC-West 103A

Frontline Innovation and Sustainability

Community Committee Choice Session

Session Chair: Bilal Gokpinar, UCL School of Management, London, United Kingdom

Session Chair: Leonardo P. Santiago, Copenhagen Business School, Frederiksberg, Denmark

1 Networks of Design Rules - Developing Pharmaceutical Process Innovations Across Dissimilar Networks

Tomas Harrington[1], Nitin R. Joglekar[2], Sriram Narayanan[3], Jagjit Srai[4], [1]University of East Anglia, Norwich, United Kingdom; [2]Boston University Questrom School of Business, Boston, MA, [3]Michigan State University, East Lansing, MI, [4]University of Cambridge, Cambridge, United Kingdom

We address a trans-specialist learning and coordination question: how do structurally dissimilar sub-networks work together to generate, track, and share knowhow while undertaking rapid development to promote process innovation? Using a 10-year micro dataset on the evolution of collaboration networks in pharmaceutical continuous manufacturing (CM) development consortia, we posit that a "network of design rules" as the key mechanism that enables heterogeneous specialist stakeholders to exchange knowledge among one another, create new processes, through trans-specialist understanding. We discuss the implications of the finding for both process and product development beyond pharmaceutical industry.

2 How Do Robots Affect Firms' Innovation Performance? Evidence from Spanish Manufacturers

Yiyao Zhou, Bilal Gokpinar, UCL School of Management, London, United Kingdom. Contact: uceihog@ucl.ac.uk

This paper examines the impact brought by robot use on manufacturing firms' innovation performance. The analysis uses a rich panel dataset of Spanish manufacturing firms over 27 years (1990-2016). Our findings suggest that robot use has a negative effect on firms' process innovation. However, we do not observe a similar effect on firms' product innovation. We also explore mechanisms by which robot use may affect process innovation. We find that the negative effect of robot use on process innovation is only salient for complex manufacturing, rather than light manufacturing or heavy manufacturing. In addition, we find that the negative effects brought by robots on process innovation are smaller for older firms. These results point to a potential mechanism whereby robots may impede process innovation through reducing human involvement.

3 Happy Hour: Markdown Pricing to Reduce Food Waste

Xabier Barriola[1], Lauri Saarinen[2], Lauri Loikkanen[2], Jan Holmström[2], [1]INSEAD, Fontainebleau, France; [2]Aalto University, Helsinki, Finland. Contact: lauri.3.saarinen@aalto.fi

Product expiration in grocery stores contributes significantly to food waste. Retailers use end-of-day markdowns to boost sales and reduce waste, but this method is operationally expensive and lacks accurate inventory info. We analyze the impact of a simple automated markdown pricing on food waste. Our findings reveal that automated markdown pricing benefits the triple bottom line, by reducing food waste, increasing gross margins, and lowering prices through higher discounts. We discuss challenges and opportunities for online and physical retailers adopting automated markdown pricing and provide a qualitative evaluation of available solutions. We highlight the technology and policy impact potential for enabling solutions.

4 The Impact of Demand and Regulatory Uncertainties on Shipowner Investment Decision

Leonardo P. Santiago[1], Franz Maximilian Buchmann[2], [1]Copenhagen Business School, Frederiksberg, Denmark; [2]Copenhagen Business School, Frederiksberg c, Denmark

This paper investigates a design of an emission trading scheme that aims at reaching an industry-wide emission targets on a ship owner's investment decisions. We show that increased uncertainty in the demand for pollution and regulatory risks has a substantial impact on a ship owner's costs of regulation and the value of managerial flexibility. We discuss the implications for regulatory authorities aspiring to incentivize the adoption of clean technologies to decarbonize the maritime industry.

Monday, October 16, 8:00 AM - 9:15 AM

MA66

CC-West 103B

Collaborative Problem-Solving

Community Committee Choice Session

Session Chair: Tian Chan, Emory University, Atlanta, GA

1 Human-AI Collaborative Problem Solving

Binyang Song[1], Qihao Zhu[2], Jianxi Luo[2], [1]MIT, Cambridge, MA, [2]Singapore Univ of Technology & Design, Singapore, Singapore. Contact: binyangs@mit.edu

AI is rapidly advancing, unlocking unprecedented capabilities for generative tasks, creative endeavors, and complex problem-solving. Given these capabilities, it is anticipated that AI will assume diverse collaborative roles in future problem-solving and innovation processes. These roles will facilitate varying modes of human-AI interaction and collaboration, each tailored to specific problem-solving tasks. However, human-AI teams must be meticulously designed to foster value-creating dynamics and mitigate potential risks in diverse contexts. This presentation will explore various designs of human-AI teams for collaborative problem-solving, providing a roadmap for the future.

2 More Investment Less Profit? An R&D Investment Conundrum of a Financially Constrained Firm in a Supply Chain

Junghee Lee[1], Jingqi Wang[2], [1]University of Notre Dame, Notre Dame, IN, [2]Chinese University of Hong Kong (Shenzhen), Shenzhen, China

Firms, especially small and medium enterprises (SMEs), suffer from financial constraints and cannot invest enough in R&D. The issue becomes even more intricate in a supply chain setting, where one firm's R&D investment influences another firm's profit and decisions. To study the impact of a firm's financial constraint for R&D investment on the focal firm and the supply chain, we analyze a supply chain consisting of one supplier and one manufacturer, where the manufacturer has a cost-reduction R&D opportunity with limited resources. Our analysis reveals that the manufacturer's profit may decrease, even if it can afford more investment, which we refer to as the "R&D conundrum" in a supply chain. We also investigate operations and information strategies that the manufacturer can take.

3 Design Thinking in Operations Management

Sebastian Fixson, Babson College, Babson Park, MA

Even substantial interest and efforts in both practice and academia over the past 20 years have so far not produced in the operations management literature a reliable method on how to operationally manage design thinking successfully. In response, I expand the operations management lens by unpacking the definitions of two critical process dimensions in greater detail: the outcomes of an operation, and its transformation function. Applying these dimensions of the expanded framework to a set of over 140 references identifies contributions from other disciplines to explain the conditions under which design thinking operations can be managed successfully, and pinpoints areas for future research.

4 Traversing the Problem-Solution Space: An Investigation of the Creative Problem-Solving Journey in Ikea Hacks

Shi-Ying Lim[1], Tian Chan[2], [1]National University of Singapore, Singapore, Singapore; [2]Emory University, Atlanta, GA, Contact: tian.chan@emory.edu

We theorize and empirically investigate how individual user-innovators navigate between search in the problem space versus the solution space. Using a dataset of user-innovations in IKEA hacks, we characterize the kind of problem-solving journey that would lead to more novel creative problem-solving outcomes. Specifically, starting the journey with a concrete (as opposed to an abstract) problem would lead to more novel outcomes. During the journey, we show that having (1) an abstract search of the solution space, and (2) frequent traversal from problem to solution space and back, are also associated with more novel outcomes.

Monday, October 16, 8:00 AM - 9:15 AM

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CC-West 104A

Exploring the Potential of Data Mining in Higher Education: Strategies and Best Practices

Community Committee Choice Session

Session Chair: Youqin Pan, Salem State University, Salem, MA

1 Digital Divide In Higher Education: A Text-mining Approach

Youqin Pan, Salem State University, Salem, MA

This study examines the development of the digital divide, which refers to the disparities in access, usage, and outcome of information and communication technology. Higher education has experienced faster digitalization and online learning due to the COVID-19 pandemic. Digital divide has attracted a lot of attention since the covid-19 pandemic has further widened the gap. As technology continues to expand and integrate with society, the digital divide may continue to grow. However, there is a lack of research about the process of digital divide and how it can be managed to facilitate the digital transformation in higher education. The results of this study on the digital divide in higher education will provide insights on necessary steps to be taken to bridge the gap.

2 Analyzing Multidimensional Data in an Interactive No Code Environment

Kevin Potcner, JMP Statistical Discovery, San Francisco, CA, Contact: Kevin.Potcner@jmp.com

Fully analyzing data requires an analyst to generate a wide variety of visualizations, analyses, and models. The insights gleaned from each step leads the analyst to a next set of analyses to try, and so on. This exploratory approach can become very cumbersome in a coding environment.Without strong proficiency in programming, students often get frustrated finding themselves unable to run many different analyses and visualization quickly. In this presentation, a statistical scientist from JMP will illustrate how easy it can be to explore multi-dimensional data through interactive visualizations, analyses, and models in a "no code" environment. The audience will see how this approach not only greatly expedites data analysis efforts, but provides students with a much richer and more engaging experience to learning analytics.

3 Calibrating a Car-Following Model to Capture Impacts of Vehicle Driving Automation System on Human-Driven Vehicles

Zhitong Huang[1], John Hourdos[2], Qinzheng Wang[1], Saeid Soleimaniamiri[1], [1]Leidos, McLean, VA, [2]FHWA, McLean, VA

Different levels of vehicle automation systems (VAS) have already started to travel on public roads. The impacts of automation on transportation operations must be accurately assessed to support different transportation agencies in preparing for the deployment and adoption of CAV technology. However, there is a lack of research on human driver behavior when interacting with VAS. To cover this gap, we calibrate the Intelligent Driver Model (IDM) using field data from a data collection project, which involved SAE level 1 and 2 VAS-equipped vehicles. Statistical testing confirms significant behavioral differences between human drivers interacting with VAS and those driving conventional vehicles. We also employ a machine learning-based methodology to refine the IDM model calibration to investigate changes in human driver behavior when interacting with VAS.

4 Intelligent Prevention of Ddos Attacks Using Reinforcement Learning and Smart Contracts

Erotokritos Skordilis, Maikel Leon Espinosa, Avner Yeshurun, Emily Struble, University of Miami, Herbert Business School, Miami, FL

Contemporary computer networks face constant cyber threats, especially in critical areas like finance, power grids, and education. To address this issue, advanced cyber-defense tools using either Blockchain and/or Artificial Intelligence (AI) frameworks have been developed. Smart contracts in Blockchain can isolate nodes at risk of attack, while AI tools can predict attack patterns in advance. This work proposes a novel cyber-defense approach that uses smart contracts and collaborative multi-agent reinforcement learning. Each agent represents a node on the blockchain network, where a smart contract isolates that node from the network when an agent predicts an imminent attack, thus minimizing the impact and costs of the attack. Numerical experiments show the method's ability to predict imminent attacks, reducing the risk of service disruption.

5 Visual Programming for Predicting and Mitigating College Students Attrition

Dursun Delen[1], Behrooz Davazdahemami[2], [1]Oklahoma State University, Tulsa, OK, [2]University of Wisconsin-Whitewater, Whitewater, WI, Contact: dursun.delen@okstate.edu

With the emergence of novel methods for improving machine learning (ML) transparency, traditional decision support systems need an upgrade in their approach toward providing more actionable insights for practitioners. Particularly, given the complex decision-making process of humans, using insights obtained from population-level interpretation of ML models for designing individual interventions may lead to less-than-optimal outcomes. Using a visual programming tool (i.e., KNIME Analytics Platform) along with a large data set of demographics, educational, financial, and socio-economic factors, we developed explainable ML models to provide actionable insights for designing personalized interventions for students who are at risk of drop out.

Monday, October 16, 8:00 AM - 9:15 AM

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CC-West 104B

Novel Data Mining Approaches in the Era of Emerging Technologies and Simulation

Community Committee Choice Session

Session Chair: Md Tariqul Islam, 1</sup

1 Neural Network-Based Intention Recognition for Human-Robot Interaction in Manufacturing: A Virtual Reality Driven Approach

Ali Kamali Mohammadzadeh, Sara Masoud, Wayne State University, Detroit, MI

Intention recognition is an important aspect of human-robot interaction in manufacturing. With the increasing use of virtual reality (VR) in manufacturing, there is a growing need for intention recognition in VR to ensure safe and efficient collaboration between humans and robots. Neural networks, as a branch of machine learning, have shown great potential in recognizing human intentions in various environments. This study uses neural networks for intention recognition in manufacturing. The goal is to investigate the feasibility of using neural networks to recognize human intentions in VR and evaluate its performance in human-robot interaction in manufacturing. The introduction of intention recognition in VR environments will enable more efficient collaboration between humans and robots, thus improving the overall performance of manufacturing systems.

2 Digital Twins Integrated with Dynamic Data Driven Application Systems for Healthcare Systems: Time-Sensitive Simulation and Prediction

Yijie Chen[1], Md Tariqul Islam[2], Young-Jun Son[3], [1]University of Arizona, Tucson, AZ, [2]Purdue University, Lafayette, IN, [3]Purdue University, West Lafayette, IN, Contact: yijiechen@arizona.edu

In this work, we discuss real-time digital twin in two applications: (1) a wearable device-based individual respiration and physiological status monitoring and (2) a Wi-Fi and App-based university infectious disease simulation. Models are developed with two-way data integration and interaction under differenttime frameworks for nowcasting and forecasting to support decision/policy making. The complex data inputs via wearable sensors and discrete event/subjective reports necessitate a more flexible structure for the system and novel model validation and verification approaches with data and model dynamics. We employ agent-based modeling methods for data fusion and integrate it with time convolutional networks for model iteration and prediction updates.

3 A Multivariate, Spatiotemporal, Deep-Learning Model to Predict Covid-19 Infections Based on Historical Cases and Changes in State Policy

MD TARIQUL ISLAM[1], Young-Jun Son[2], [1]Purdue University, West Lafayette, IN, [2]Purdue University, West Lafayette, IN, Contact: islam70@purdue.edu

Epidemiological processes that change quickly and are spatially heterogeneous are challenging to capture using commonly utilized compartmental models. Machine learning models such as deep neural networks can learn complex mappings from inputs to outputs, but the unnoticed geographic dependence between states limits their applicability. The proposed research will develop a deep-learning model framework to forecast COVID-19 infections. A multivariate graph neural network-based long short-term (GCN-LSTM) network will be trained and validated using publicly available multivariate COVID-19 datasets. In addition to temporal dependencies learned through the LSTM structure, the GCN will aid the model in learning spatial dependencies between states.

4 Approach to Data Mining in Healthcare System Process Improvement

Faujia Islam, Inova Health System, VA

Inova Health System is a large, non-profit healthcare provider in Northern Virginia. The system is using data analysis and process improvement tools to improve its performance.
The use of data analysis and process improvement tools has helped Inova to improve its performance in a number of ways. The system has seen reductions in readmission rates, mortality rates, and patient wait times as well as efficiency of its operations.
The use of data analysis and process improvement tools is an important part of Inova's strategy for improving its performance. The system is committed to using these tools to identify areas for improvement, develop and implement interventions, and measure the impact of those interventions.

Monday, October 16, 8:00 AM - 9:15 AM

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CC-West 105A

Towards Data-driven Healthcare: Improving Patient Outcomes through Advanced Analytics

Community Committee Choice Session

Session Chair: Chenxi Yuan, 1</sup

1 Generative Model for Fair Synthetic EHRs

Huan He, Harvard Medical School

Synthetic electronic health records (EHRs) are artificially generated patient records that mimic real-world medical data. They play a crucial role in healthcare research, development, and testing, as well as in training healthcare professionals and improving patient care. However, creating and utilizing synthetic EHRs comes with several challenges including privacy leakage, attribute fairness, and quality. In this, we present a novel diffusion based generative model that can generate fair, and high quality EHRs with minimal privacy leakage issue.

2 Accounting for Network Noise in Graph-Guided Bayesian Modeling of Structured High-Dimensional Data

Wenrui Li, University of Pennsylvania, Philadelphia, PA, Contact: wenrui.li@pennmedicine.upenn.edu

There is a growing body of literature on graph-guided statistical learning methods for analysis of structured high-dimensional data (such as genomic and transcriptomic data) that can incorporate knowledge of underlying networks derived from functional genomics and functional proteomics. However, these methods typically use graphs extracted from existing databases or rely on subject matter expertise which are known to be incomplete and may contain false edges. To address this gap, we propose a graph-guided Bayesian modeling framework to account for network noise in regression models involving structured high-dimensional predictors. We develop an efficient Markov chain Monte Carlo algorithm for posterior sampling. We demonstrate the advantages of our method over existing methods in simulations, and through analyses of omics datasets for Alzheimer's disease.

3 Capturing Uncertainty by Neural Network-Based Prediction Interval Approach for Pain Intensity Estimation

Burcu Ozek, Northeastern University, Boston, MA, Contact: ozek.b@northeastern.edu

Accurately assessing pain severity is imperative for determining the appropriate intervention, but it can be challenging due to its subjective nature in individual experiences. To address this challenge, researchers have employed machine learning models to evaluate pain objectively. However, these models have mainly focused on point estimation, failing to consider uncertainty in the data and model and resulting in overconfident predictions that can be hazardous in clinical settings. To overcome these limitations, this study proposes a neural network-based prediction interval method that estimates ranges for pain severity. This approach establishes a crucial capability that enhances the effectiveness of pain management and reduces the risks associated with improper treatment.

4 Nonparametric Bayesian Functional Modeling for Breast Cancer Racial Disparities

Wenyu Gao, Harvard School of Public Health, Boston, MA, Contact: wgao@hsph.harvard.edu

Different incidence and mortality rates for breast cancer exist among various racial populations. To study these disparities, surface-enhanced Raman spectroscopy (SERS) has been conducted to provide biomolecular fingerprint information. Large intra-class variations exist due to cellular and additional cancerous heterogeneity. To study the differences between two types of triple-negative breast cancer cell lines at the molecular level, we proposed a nonparametric Bayesian functional clustering (via weighted Dirichlet process mixture (WDPM) modeling) and peak point selection method. The proposed method is named WDPM-VS, and it will greatly outperform its comparison methods in root mean squared errors. Based on this proposed method, we identified essential wavenumbers that can explain the racial disparities.

5 Diffusion Models for Longitudinal 3D Structural MRI Imputation in Alzheimer's Disease

Chenxi Yuan, University of Pennsylvania, Philadelphia, PA, Contact: chenxi.yuan@pennmedicine.upenn.edu

Missing data is a significant challenge in medical research. Missing data hinders accurate disease diagnosis, monitoring, and management in individual patients and may bias inference about patient populations using statistical models. To address the problem of missing magnetic resonance imaging (MRI) data in Alzheimer's disease (AD) applications, we propose a Diffusion model-based longitudinal structural MRI Imputation framework (DMRI) which relies on conditional generation of a missing image at a single designated visit. Specifically, the DMRI model imputes a missing 3D MRI image by taking the past visit or both past and future visits as conditions during the image generation. Experimental results show that our method can generate high-quality individual 3D structural MRI with high similarity to the missing visit's observed image.

Monday, October 16, 8:00 AM - 9:15 AM

MA70

CC-West 105B

Frontiers in the Digital Economy

Community Committee Choice Session

Session Chair: Grace Gu, Los Angeles, CA

1 Artificial Intelligence, Lean Start-Up Method and Product Innovations

Gavin Wang, University of Texas at Dallas, Dallas, TX

Despite the transformative potential AI has on business and innovation, many firms fail to reap any benefits from AI. We investigate the organizational support required to make AI perform well. Specifically, we examine the role of the lean startup method (LSM) in explaining the impact of AI capability on product innovations at startups. Using a dataset of 2,000 startups in China from 2011 to 2020, we find that companies that adopt general AI capability create more innovative products every year. Next, we find that AI investments complement LSM in product innovations, and the complementarities depend on the type of product innovations and the type of AI used. Our research shows the importance of treating AI as a heterogeneous construct because different AI capabilities depend upon different organizational processes to succeed.

2 Optimal Design for Revenue-Based Financing
Eryn Juan He, University of Utah, Salt Lake City, UT
VC funding has grown massively recently. However, less than 1% of the new companies ever raise VC funding. Revenue-based financing has emerged as an alternative, which is repaid based on a percentage of future revenues. We aim to develop insights into the value of RB financing, compared with traditional modes.

3 The Impact of Platform Commission Rates on Content Creation and Consumption
Pu Zhao[1], Georgios Zervas[2], Xintong Han[3], [1]Boston University Questrom School of Business, Boston, MA, [2]Questrom School of Business, Boston, MA, [3]Concordia University, Montreal, QC, Canada. Contact: puzhao@bu.edu
Digital marketplaces allow independent creators to flourish by connecting them to larger audiences in exchange for charging them a sales commission. However, these rates are sometimes perceived as controversially high. Using a unique dataset from a leading Chinese creator platform, we study how commission rate changes affect creators' pricing strategies, content production, and consumer welfare. We show that when the platform significantly reduced its commission rate for certain eligible creators, content prices on average went up. We then show that creators who were not eligible for the reduced commission rate exited the platform, reducing competition and resulting in increased prices. We show that these effects were more pronounced in content categories that had fewer creators that were eligible for the reduced rate.

4 Disintermediation Governance and Complementor Innovation: An Empirical Look at Amazon.Com
Gaoyang Cai[1], Xia Han[2], Grace Gu[3], [1]Northwestern University, Evanston, IL, [2]Soochow University, Suzhou, China; [3]University of Southern California, Los Angeles, CA
This study investigates how the disintermediation governance policy, i.e., restricting communication channels through which complementors can persuade buyers to circumvent the platform and transact directly, affects complementors' innovation behavior. Leveraging a governance policy change on Amazon.com that prohibits external website links during buyer-seller communications, based on a coarsened exact matching and a difference-in-differences approach, we find that complementors significantly reduce their number of new products launched on the focal platform after the policy change. Such an effect is mitigated by complementor reputation and strengthened by the capacity constraint. Our results provide implications for platform governance policies against disintermediation and its impact on complementor product innovation both on and off the platform.

Monday, October 16, 8:00 AM - 9:15 AM

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CC-West 105C
Economics of Information Systems
Community Committee Choice Session
Session Chair: Min Chen, George Mason University, Fairfax, VA

1 Live-Stream Selling as a New Channel for Brands
Yichao Yuan[1], Amit Mehra[2], Zhe Zhang[3], [1]Nanjing University, Nanjing, China; [2]University of Texas at Dallas, Richardson, TX, [3]University of Texas Dallas, Richardson, TX, Contact: dg1915012@smail.nju.edu.cn
Live-stream selling adds a great selling channel for brands. Even though selling via an influencer can be costly, the time allocated by an influencer to the brand can reduce consumers' price sensitivity to the product. We develop a game-theoretic model in which two brands engage in price competition in a new market according to the time allocated by an influencer. We find some interesting insights about how the live-stream channel affects the brands' prices and profits, as well as the consumer surplus under competition.

2 The Role of Data Sharing and Analytics Capabilities in Interoperable Healthcare Services
Yeongin Kim[1], Geng Sun[2], Byung Cho Kim[3], [1]Virginia Commonwealth University, Glen Allen, VA, [2]University of Texas Rio Grande Valley, Edinburg, TX, [3]Korea University, Seoul, Korea, Republic of. Contact: ykim3@vcu.edu
Effective data sharing is crucial in delivering high-quality healthcare. This study presents a game-theoretical model of a two-tiered healthcare system. In this system, a general care provider offers initial care with varying data quality, while two specialty care providers offer specialized care based on the data shared by the general care provider. The findings emphasize the significance of market power and analytic capability of the specialists in determining the data quality provided by the general care provider. This research contributes to the existing knowledge on data sharing

in interoperable healthcare and underscores the need to comprehend the dynamics between general care providers and specialists to optimize patient outcomes.

3 Consumer Aversion to Algorithm-Driven Price Volatility: Empirical Investigation of Airbnb

Jiaqi Shi[1], Jinan Lin[1], Tingting Nian[2], Mingyu Joo[3], [1]UC Irvine, Irvine, CA, [2]University of California, New York, NY, [3]University of California-Riverside, Irvine, CA, Contact: jiaqis@uci.edu

Dynamic-pricing algorithms facilitate frequent price adjustments to optimize sales. Yet, overly frequent price fluctuations may complicate consumers' purchase decisions. This paper empirically investigates how algorithm-driven price volatility influences the occupancy rates of rental properties in New York City listed on Airbnb. Because properties on Airbnb can be booked up to 12 months in advance, we compile two price-volatility measures: a property's frequency of price changes across travel dates on a given booking date and a property's frequency of price changes across booking dates on a given travel date. For both measures, the occupancy rates increase from flat pricing to a certain degree of dynamic pricing. However, the occupancy rates start to decrease when prices become too volatile, controlling for the magnitudes of price-level variation.

4 Social Media Platform Policies for User-Shared External Shopping Links

Yan Zhu[1], Jianqing Chen[2], Srinivasan Raghunathan[3], [1]The University of Texas at Dallas, Richardson, TX, [2]The University of Texas at Dallas, Richardson, TX, [3]University of Texas-Dallas, Richardson, TX, Contact: yan.zhu@utdallas.edu

Advertising has been the primary source of revenue for social media platforms. However, the rise of influencer marketing poses challenges for these platforms because influencers and platforms compete for advertising revenue. As a response, some platforms prohibit clickable links, while others allow them but charge a service fee for links directing to shopping sites. This research studies the heterogeneous policies of these platforms regarding shopping links from an economic perspective.

Monday, October 16, 8:00 AM - 9:15 AM

MA72

CC-West 106A

Emerging Concepts, Practices, and Analytics Applications to Democratize Data and Leverage AI

Community Committee Choice Session

Session Chair: Darshan Desai, Berkeley College, New Providence, NJ

1 What Can a Person Change to Obtain a Desired Prediction? an Interpretability Approach

XUEFEI LU[1], Emanuele Borgonovo[2], [1]SKEMA Business School - Université Côte d'Azur, Suresnes, France; [2]Bocconi University, Milano, Italy. Contact: xuefei.lu@skema.edu

Machine learning plays an important role in many deployed decision systems and often appears as a black-box model. Explainable machine learning methods such as LIME and SHAP generate explanations for an individual prediction made by the black-box model, providing results such as the most influential features of a prediction. However, such information does not guide agents on how they should improve to move from one class to another. We propose a method based on finite change decomposition and Shapley values to obtain meaningful insights about the direction of concern. The method is applied to several UCI datasets to discuss several types of technical and managerial insights.

2 An Introduction to Interpretable Simple Structure Identifying Algorithm

Gaurav Arwade, Sigurdur Olafsson, Iowa State University, Ames, IA, Contact: gbarwade@iastate.edu

Highly non-linear machine learning models can attain state-of-the-art performance but lack interpretability; whereas top-down simple models on complex data provide poor performance and intangible interpretability. But many complex datasets comprise simple structures consisting of similar instances; and an ensemble of simple models may improve interpretability and accuracy versus models learned on the entire dataset. Such simple structures are predominantly present in healthcare datasets where interpretability is of prime importance. This paper formally defines the simple structure and assumptions satisfied by a dataset consisting of simple structures and proposes a bottom-up simple structure-identifying algorithm. Using synthetic data, we demonstrate the algorithm's robustness, and how it identifies natural decision boundaries.

3 Transformative Potential of Generative AI: Democratization of Data and Augmented Analytics

Darshan Desai, Berkeley College, New Providence, NJ,

Contact: darshudesai@gmail.com
Recent developments in artificial intelligence (AI) and large language models (LLMs) hold significant implications for data democratization, digital transformation, and analytics strategies. These advancements possess transformative potential, empowering organizations with novel enterprise applications, augmented analytics, and self-service business intelligence (BI). By harnessing the power of generative AI models, organizations can unlock new opportunities for innovation and value creation. This paper explores diverse applications of generative AI within these domains and aims to examine key concepts, practices, and emerging trends, presenting real-world applications that highlight its potential implications on enterprise systems, business intelligence, and analytics strategies and practices.

Monday, October 16, 8:00 AM - 9:15 AM

MA73

CC-West 106B
Reinforcement Learning in Finance
Community Committee Choice Session
Session Chair: Xin Guo, University of California-Berkeley, Piedmont, CA
Session Chair: Jiacheng Zhang, UC berkeley, Berkeley, CA

1 Learning in Continuous-Time Stochastic Control: Estimation, Sensitivity and Regret Analysis
Anran Hu, University of Oxford, Oxford, United Kingdom
Recently, reinforcement learning (RL) has attracted substantial research interests. Much of the attention and success, however, has been for the discrete-time setting. Continuous-time RL, despite its natural analytical connection to stochastic controls, has been largely unexplored and with limited progress. In particular, characterizing sample efficiency for continuous-time RL algorithms with convergence rates or regret bounds remains a challenging and open problem. In this talk, we approach this problem by studying two fundamental problems that have been under-explored in the continuous-time stochastic control literature, namely 1) the sensitivity of the control objective w.r.t. feedback controls and the sensitivity of feedback controls w.r.t. model parameters and 2) the estimation error of the model parameters in terms of collected sample trajectories. For episodic linear-convex RL problems, we study the Lipschitz stability of feedback controls by establishing the stability of the associated forward-backward stochastic differential equation, and derive sample complexities of continuous-time least-squares parameter estimations by exploring the concentration properties of sub-Weibull random variables. The analyses lead to a regret bound of the order $O(\sqrt{N\ ln N})$ for the greedy least-squares algorithm, with N the number of episodes. In the special case of the linear-quadratic RL problem, the analysis reduces to the regularity and sensitivity of the associated Riccati equation and the sub-exponential properties of the estimators, which leads to a logarithmic regret.

2 A Mathematical Framework of Transfer Learning
Haoyang Cao, Johns Hopkins University, Baltimore, MD
Transfer learning is to utilize existing knowledge from previous learning tasks to improve the performance of new ones. This work addresses the feasibility issue of transfer learning. It begins by establishing the necessary concepts and constructing a mathematical framework for transfer learning. It then identifies and formulates the three-step transfer learning procedure as an optimization problem, allowing for the resolution of the feasibility issue. It shows that under certain technical conditions, an optimal procedure for transfer learning exists. This work brings additional insights into various transfer learning problems and sheds light on the impact of feature augmentation on model performance, explores potential extensions of domain adaptation, and examines the feasibility of efficient feature extractor transfer in image classification.

3 Community/Committee'S Choice Submission
Francesca Primavera, 1</sup

4 Adversarial Training for Gradient Descent: Analysis Through Its Continuous-Time Approximation
Xinyu Li, 1</sup
Adversarial training has gained great popularity as one of the most effective defenses for deep neural network and more generally for gradient-based machine learning models against adversarial perturbations on data points. This paper establishes a continuous-time approximation for the mini-max game of adversarial training. This approximation approach allows for precise and analytical comparisons between stochastic gradient descent and its adversarial training counterpart; and confirms theoretically the robustness of adversarial training from a new gradient-flow viewpoint. The analysis is then corroborated through various analytical and numerical examples.

Monday, October 16, 8:00 AM - 9:15 AM

MA74

CC-West 106C

Optimal platform design

Community Committee Choice Session

Session Chair: Yunke Mai, University of Kentucky, Lexington, KY

1 Manufacturing Platform Coopetition: Restructuring Lean Operations in Global Supply Chains

Gang Li[1], Yusen Xia[2], [1]Bentley University, Waltham, MA, [2]Georgia State University, Atlanta, GA, Contact: gli@bentley.edu

We propose a new strategy for competing supply chains to share their manufacturing platforms in response to a global crisis. To this end, we start by examining a lean and agile supply chain design that a company can adopt to provide a guaranteed service to consumers faster and cheaper and then discuss a coopetition mechanism for multiple such supply chains in crisis.

2 E-commerce Platform Finance With Dual Channels

Nina Yan[1], Zhineng Chen[2], Xun Xu[3], Xiuli He[4], [1]Central University of Finance and Economics, Beijing, China; [2]University of Delaware, Newark, DE, [3]Cal State, Carson, CA, [4]UNC-Charlotte, Charlotte, NC

In the platform economy era, e-commerce platforms function as distribution channels for sellers and offer online loans to sellers as financing providers. This study focuses on platform finance, where the platform sets a credit line or interest rate to offer either a limited or generous loan to capital-constrained sellers. The sellers may have sufficient initial capital or be capital-constrained but have access to a generous loan, a limited loan, or no loan. We found that the optimal sellers' channel strategy, choosing either a single channel or online-dominant or offline-dominant dual channels, depends on the platform's credit line, consumers' channel preferences, and their switching behavior between online and offline channels.

3 The Effect of Online Company Responses on Review Quality: An Empirical Study of App Developer Company Responses to Customer Reviews

Qiuli Su, Creighton University, Omaha, NE

Online company responses become important communication tools for companies to interact with customers. This study examines why companies respond to reviews, and how online company responses improve the review quality (measured by review comprehensiveness and review readability) over time. Applying text-mining techniques combined with big data analysis, I find that: 1) companies are more likely to respond to reviews with lower sentiment and higher sentiment deviation scores; 2) online company responses improve review comprehensiveness but don't increase review readability; 3) response intensity does not improve review quality, longer responses enhance review comprehensiveness, and more tailoring responses amplify review readability. Our findings could guide companies to improve their online communication strategy and customer engagement quality.

4 Group Fairness in Online Platform's Assortment Planning

Shuzhang Cai[1], Shaojie Tang[2], [1]University of Texas at Dallas, Richardson, TX, [2]University of Texas-Dallas, Mckinney, TX

We present an innovative assortment planning framework to solve the platform's optimization problem while incorporating group fairness constraints. As the recommendation system significantly increases efficiency and becomes a necessity for online platforms, there arises the concern about fairness. Disadvantaged items have little chance of being selected into the assortment, thereby limiting their visibility and potentially harms the platform's long-term interest as well as societal justice. Our approach takes into account all available items and their respective group categorizations, establishing a minimum exposure rate constraint for each group while maintaining the maximization of the clickthrough rate as the primary objective of the platform. The proposed framework successfully delivers a bunch of near-optimal solution within the polynomial time.

Monday, October 16, 8:00 AM - 9:15 AM

MA75

Session.Location:CC-West 208A

On Bus Transportation System Planning

Contributed Session

Session Chair: Anthony Trasatti, ISyE Georgia Tech, Winchester, MA

1 School Bus Routing Problem with Open Offer Policy: Incentive Pricing Strategy for Students that Opt-Out Using School Bus

Juan Pablo Contreras[1], Hernan Caceres[1], Hernán

Lespay[1], Rajan Batta[2], [1]Universidad Catolica del Norte, Antofagasta, Chile; [2]University at Buffalo (SUNY), Buffalo, NY, Contact: juan.contrerasff@gmail.com

This study introduces the School Bus Routing Problem with Open Offer Policy (SBRP-OOP) for the Williamsville Central School District (WCSD) in New York. The problem addresses the underutilization of school buses, with daily capacities ranging from 22 to 72 percent. To improve efficiency, the SBRP-OOP proposes offering monetary incentives to students willing to forgo bus transportation. By excluding incentivized students from the routing process, the aim is to optimize capacity usage and reduce the number of buses required. Mathematical models are developed to determine a pricing strategy that balances incentive payments and bus savings. The effectiveness of the Open Offer Policy is evaluated using real operational data from New York.

2 Strategies for the Electric Bus Scheduling Problem with Battery Degradation: A Stochastic Perspective

Lea Ricard[1], Guy Desaulniers[2], Andrea Lodi[3], Louis-Martin Rousseau[4], [1]University of Montréal, Montreal, QC, Canada; [2]Polytechnique Montreal & Gerad, Montreal, QC, Canada; [3]Cornell Tech, New York, NY, [4]Polythechnique Montreal, Montreal, QC, Canada. Contact: lea.ricard@umontreal.ca

The battery of battery electric buses (BEBs) constitutes a significant portion of the acquisition cost for new BEBs. Over time, the capacity of lithium-ion batteries gradually diminishes. The aging mechanism of BEBs is notably influenced by the average state of charge (SoC) and the SoC deviation. This presentation introduces a chance-constrained model for addressing the Electric Vehicle Scheduling Problem, which incorporates battery degradation and stochastic energy consumption. The model accounts for the aging mechanisms of the battery by imposing a constraint that ensures the SoC remains above a given threshold with a certain probability. Additionally, we propose a tailored branch-and-price algorithm and provide a numerical case analysis. This analysis yields several valuable managerial insights into effective battery management practices.

3 The On-Demand Bus Routing Problem

Kenneth Sörensen, University of Antwerp, Antwerp, Belgium. Contact: kenneth.sorensen@uantwerpen.be

The on-demand bus routing problem (Melis and Sörensen, 2022) optimizes bus routes and schedules based on passenger requests, in an urban environment where pickups and dropoffs are limited to signposted stops. Passengers request service through an app, and routes are determined that minimize total user ride time, while also assigning pickup and dropoff stops to passengers. Researchers have explored variants with stochastic travel times, dynamic demand, and integration with fixed-line systems. This talk presents the state of the art on this problem and its variants, as well as potential future research directions.

4 Service Fleet Transition Planning Using Electric Vehicles for Sustainable Urban Transportation

Zahide O. Ceylan Gungor, Sule Itir Satoglu, Istanbul Techical University, Istanbul, Turkey. Contact: onbaslis@itu.edu.tr

One of the means of achieving the Paris Aggreement's carbondioxide emission reduction target is the transition of the service fleet, including the passenger and commercial fleets, using the alternative fuel vehicles. Especially, in this study, the fleet transition problem of urban rapid transit bus fleet using the electric vehicles is focused. A bi-objective mathematical model is proposed to plan the next 10 years of fleet transition using electric vehicles (EV), such that the net present value of the cost of ownership as well as the total carbondioxide emissions are minimized, simultaneously. During this transition, building of the EV charging stations infrastructure, alternative scenarios regarding the fuel mix used for electricity generation, incentives, carbon tax are considered. An application of the model for Istanbul city is made.

5 Bus Line Design for On-Demand Multimodal Transit Systems

Anthony Trasatti[1], Beste Basciftci[2], Pascal Van Hentenryck[1], [1]ISyE Georgia Tech, Atlanta, GA, [2]University of Iowa, Iowa City, IA, Contact: anthony.j.trasatti@gmail.com

Many transit agencies have started experimenting with adding on-demand services in attempt to maximize their service quality, accessibility, and coverage within a fixed budget, using shuttles to alleviate their first and last mile issues as part of On-Demand Multimodal Transit Systems (ODMTS). This work presents a novel mixed-integer program (MIP) formulation to incorporate bus line design into the network design problem for On-Demand Multimodal Transit Systems that allow the model to accurately capture wait time and transfer costs in addition to travel time and vehicle costs. To solve large-scale instances, a two-stage reformulation is presented where the first-stage problem decides bus arcs to open and which arcs immediately follow and the second-stage problem decides the multimodal path for each individual trip.

Monday, October 16, 8:00 AM - 9:15 AM

MA76

Session.Location:CC-West 208B

Autonomous Vehicles and Driving

Contributed Session

Session Chair: Xiaochen Shi, Georgia Institute of Technology, Atlanta, GA

1 Real-Time Object Detection and Traffic Simulation of Autonomous Vehicle Deployment

Shivani Shukla[1], Stavan Dholakia[2], [1]University of San Francisco, San Francisco, CA, [2]Microsoft Corp, Seattle, WA, Contact: sgshukla@usfca.edu

Automated and Autonomous Vehicles have the potential to revolutionize transportation but in the absence of interconnection and data sharing between vehicles pose challenges to urban networks. Business models of on-demand and privately-owned autonomous vehicles (AVs) have the potential to significantly impact traffic volume and vehicle miles traveled (VMT). In this paper we develop a model using state-of-the-art algorithms to detect and track autonomous cars using existing camera infrastructure. The results are used as an input into a visualization platform that simulates scenarios around traffic volume. Our work is a step towards filling the current void in data for travel and traffic patterns surrounding AVs.

2 Simulation-Based Optimization of Autonomous Vehicle Model Parameters for Mixed Transportation Network

Jinkun Lee, East Carolina University, Greenville, NC, Contact: leejin18@ecu.edu

As self-driving technology above SAE level 3 is being competitively developed by major automobile manufacturers, autonomous vehicles (AVs) will prevail in the near future transportation network. A mixed traffic network with human driving vehicles and AVs will show transient system behavior based on penetration rate of AVs thereby requiring different optimal AV settings. We are interested in understanding this system behavior over the transitional period to achieve an optimal traffic performance. We investigate the system behavior with an agent-based simulation with different penetration rates and find optimal AV model parameter set per penetration rate by using genetic algorithm (GA). Simulation results with optimal parameter values reveal improvement in average traffic performance measures.

3 Electric Vehicle Routing And Charging Problem For Cooling Shelters Using V2g Technology

Seong Wook Hwang[1], Sang Jin Kweon[2], [1]Sungshin Women's University, Seoul, Korea, Republic of; [2]Ulsan National Institute of Science and Technology (UNIST), Ulsan, Korea, Republic of. Contact: swhwang@sungshin.ac.kr

In recent years, the world has faced pressing challenges related to global warming and the depletion of limited energy resources. To address these pressing challenges, electric vehicles (EVs) have emerged as a promising solution. In this study we address EV routing and charging problem to effectively evacuate heat-vulnerable residents during heat waves while also incorporating V2G technology to harness the advantages achievable through the use of EVs.

4 A Flow Optimization Approach for Infrastructure Guided Self-Driving Vehicles on Street Network

Xiaochen Shi[1], Anton J. Kleywegt[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA, Contact: xshi74@gatech.edu

Our previous study has proved that, with Infrastructure guided self-driving (IGSD) technology, flexible platooning significantly improves the throughput at a single intersection. But developing the coordinated solution for the traffic flow of entire network still faces great challenges, considering the knock-on effect among intersections. Based on flexible platooning, we formulate a MILP model for a 100% IGSD environment, that determines the paths and the velocities of vehicles, and minimizes the total travel time. A network platooning algorithm based on dynamic programming is also proposed to produce an initial feasible solution for the MILP and as a heuristic for controlling vehicle platooning in the network. The simulation results show that in terms of delay and throughput, even the heuristic outperform existing approaches.

Monday, October 16, 8:00 AM - 9:15 AM

MA77

Session.Location:CC-West Lecture Hall

Machine Learning, Sampling, and Optimization

Contributed Session

Session Chair: Lan Hoang, IBM, Warrington, United Kingdom

1 Posterior Sampling from the Spiked Models via Diffusion Processes

Yuchen Wu, Stanford University, Stanford, CA, Contact: wuyc0114@gmail.com

Sampling from the posterior is a key technical problem in Bayesian statistics. Rigorous guarantees are difficult to obtain for Markov Chain Monte Carlo algorithms of common use. In this paper, we study an alternative class of algorithms based on diffusion processes. Our construction of the diffusion is based on the notion of observation process and the related idea of stochastic localization. We apply this method to posterior sampling in the high-dimensional symmetric spiked model. Our sampling algorithm makes use of an oracle that computes the posterior expectation of ⍰ given the data and the additional observation process. We provide an efficient implementation of this oracle using approximate message passing. We thus develop the first sampling algorithm for this problem with approximation guarantees.

2 Diffusion Model-Based Oversampling for Class Imbalanced Problems

Geonhee Jang[1], Wonkeun Jo[1], Sungsu Lim[1], Dongil Kim[2], [1]Chungnam National University, Daejeon, Korea, Republic of; [2]Ewha Womans University, Seoul, Korea, Republic of. Contact: ckrdkg@gmail.com

Oversampling is one of the important approaches to overcome the class imbalanced problems. Several oversampling methods have been studied by utilizing local property of data or generative models. In this work, we propose an oversampling method by employing the denoising diffusion probabilistic models (DDPM) for binary classification. The proposed method adapts the cosine schedular instead of the linear schedular for smooth noising and learns various imbalanced data distributions. We aim to oversample the minority classes' data to make the balance in terms of the frequency of minor to major. The Experimental results demonstrated that our method performed well when compared to existing oversampling methods.

3 Data-Adaptive Threshold Selection for Quantile Feature Screening with FDR Error Rate Control

Saidat Abidemi Sanni, University of Cincinnati, Cincinnati, OH, Contact: sannisa@mail.uc.edu

Selecting an appropriate threshold is of utmost importance when conducting feature screening in ultrahigh-dimensional data. Identifying relevant predictors in such datasets can be highly challenging with heterogeneity and potential OLS assumption violations. We propose the Quantile Data Adaptive Threshold Selection (QDATS), a data-driven and systematic approach for threshold selection with error rate control. We utilize a sample-splitting approach and quantile correlation to differentiate between relevant and irrelevant predictors based on marginally symmetric statistics. The performance of QDATS is demonstrated on ultrahigh dimensional genetic data with blood pressure measurements and simulation studies, achieving reliable true positive rate and false discovery rate control while satisfying the sure screening property under suitable conditions.

4 A Multi Leaders - Follower Framework for Material Discovery

Lan Hoang[1], Michail Smyrnakis[2], [1]IBM, Warrington, United Kingdom; [2]STFC Daresbury, Warrington, United Kingdom. Contact: lan.hoang@ibm.com

Material discovery has been vastly accelerated due to the data revolution and the application of Optimisation and AI. However, there has not yet exist a method that combines optimisation with sequential decision making to utilise the design of material according to a desired property. In this paper, we propose a multi leader - one follower architecture for material discovery to combine human feedback, surrogate models and reinforcement learning.

Monday, October 16, 8:00 AM - 9:15 AM

MA78

Session.Location:CC-West 211A

spORts II

Community Committee Choice Session

Session Chair: Liz Wanless, Ohio University, Athens, OH

1 Renewable Energy Source Diffusion in Professional Sport Facilities

Liz Wanless[1], Chad Seifried[2], Tim Kellison[3], [1]Ohio University, Athens, OH, [2]Louisiana State University, Baton Rouge, LA, [3]Florida State University, Tallahassee, FL, Contact: wanless@ohio.edu

Professional sport facility sustainability initiatives offer sport organizations an opportunity to demonstrate congruence with societal concern for the environment, an effort that also affects stadia revenue generation. Guided by diffusion of innovations theory, this study harnessed diffusion modeling and logistic regression to determine how quickly renewable energy source adoption is diffusing across 175 professional sport stadia in the United States and Canada and the factors catalyzing early renewable energy source adoption.

2 Rating and Ranking Professional Soccer Player Performance

Elizabeth Bouzarth, Furman University, Greenville, SC

Individual contribution to a successful play in soccer is often hard to determine. We develop a system to assess individual player performance in offense, defense, and ball control categories using only play-by-play data and independent of traditional statistics. In collaboration with ESPN, we develop a theoretical valuation of field position by which to reward offense and defense contributions to ball advancement. Additionally, we promote the significance of pass networks and their centrality to evaluate a ball control metric. These ratings are combined to form an overall rating of player contribution to the team. We present results across several professional soccer leagues and seasons.

3 Sports, Magic Numbers, and Full-stack Development

Frederick Coleman, Colorado School of Mines, Golden, CO, Contact: fcoleman@mines.edu

Sports are a global form of entertainment. As the season progresses, individuals may be curious about how many more games a team needs to win in order to achieve a first-place clinch or post-season play. Magic numbers provide this information. We use integer programs to produce more sophisticated calculations and, correspondingly, more precise numbers, which we then display on a website, RiotSports.net. In this way, users are most up-to-date on their teams' standings. We discuss the development of the website, from data scraping to integer-program output.

4 Improving Sports Media's Crystal Ball for the English Premier League

Alexandra M. Newman[1], Eli Olinick[2], Mark Husted[1], Eric Boone[1], Joseph George[1], Christopher Jones[1], [1]Colorado School of Mines, Golden, CO, [2]Southern Methodist University, Dallas, TX

The English Premier League is one of the world's most prominent soccer associations. At the end of each regularseason, a certain number of teams are relegated to lower-tier play, while others are awarded play in the ChampionsLeague, Europa League, and Europa Conference League. We model the process of being relegated or awarded play againstother European teams as a series of mixed-integer programs, and demonstrate how results from our models compare againstinformation common media outlets currently provide.

Monday, October 16, 8:00 AM - 9:15 AM

MA79

Session.Location:CC-West 211B

Daniel H. Wagner Prize I

Award Session

Session Chair: James J. Cochran, The University of Alabama, Tuscaloosa, AL

1 Smart Parcel Consolidation at Cainiao

Biao Yuan, Shanghai Jiao Tong University, Shanghai, China

Cainiao has constructed a smart parcel consolidation system to consolidate parcels ordered by the same consumer during fulfillment from China to 52 countries since 2020, saving tens of millions of dollars annually and shortening the delivery time by at least 50%. The main innovations of this work are: 1) three analytical methods are integrated to support real-world business process decisions successfully, and 2) a two-stage online optimization algorithm with one parameter is proposed to solve the parcel consolidation problem where a parcel may be involved in several times of decisions.

2 The Sort-Assemble-Blend Routing Problem and its Application to Semiconductors

Karl Kempf, Intel Corporation, Chandler, AZ

Although a recent shift from large monolithic die to multiple small die as the preferred method to realize semiconductor product has important advantages, it adds complexity to the design and manufacturing processes. While manufacturing yields and product performance are enhanced, new problems of sorting small die into categories, developing recipes to combine categories, and routing die to maximize their utilization must be solved. A three level iterative system has been developed to address the resulting non-linear non-convex challenge. The system has yielded over $500M in benefits so far.

Monday, October 16, 8:00 AM - 9:15 AM

MA80

Session.Location:CC-West 212A

INFORMS JFIG Best Paper Competition II

Award Session

Session Chair: Albert Solomon Berahas, University of Michigan, Ann Arbor, MI

1 "Be the Buyer"-Leveraging the Wisdom of the Crowd inE-Commerce Operations

Leela Aarthy Nageswaran, University of Washington, Seattle, WA

We study a new business practice of using crowdvoting, wherein a retailer first seeks input from customers on the desirability of the product and then bases the purchasing decision on their votes. By leveraging the staggered introduction of crowdvoting at a subscription-based apparel rental platform, we find that after the adoption, both short- and long-term rental rates increase. We show that the platform makes better inventory depth decisions and users become more engaged with the platform.

2 **On the Optimization Landscape of Nonconvex Matrix Recovery: When Are True Solutions Identifiable?**
Salar Fattahi, University of Michigan, Ann Arbor, MI
Low-rank matrix recovery is typically solved via a nonconvex method called Burer-Monteiro factorization (BM). If the rank of the ground truth is known and the measurements are noiseless, BM is free of sub-optimal local minima, and its true solutions coincide with the global minima. When the rank of the ground truth is unknown, it must be over-estimated, giving rise to an over-parameterized BM. In this work, we show that, for over-parameterized BM, the true solutions are neither global nor local minima.

3 Approximation Algorithms for Dynamic Inventory Management on Networks
Levi DeValve, University of Chicago, Chicago, IL
We provide the first approximation algorithm for dynamic inventory management on a network with stochastic demand and backlogging. Specifically, under a mild cost condition, we prove the cost of a specially designed base-stock policy is less than 1.618 times the cost of an optimal policy. We develop a novel stochastic programming analysis to prove this result: we carefully calibrate two stochastic programs (providing upper and lower bounds on the optimal policy), and compare their objectives. The upper bound arises from a new class of base-stock policies we define to address the currently unresolved issue of how to assign and fulfill backlogs in a system with fulfillment flexibility. The lower bound is derived through a novel cost accounting scheme that captures the trade-off between current inventory decisions and future backlog decisions. We show that this analysis extends to a variety of settings.

Monday, October 16, 8:00 AM - 9:15 AM

MA81

Session.Location:CC-West 212B

Managing Experiential Learning in Business Analytics

Panel Session

Session Chair: Kenneth E. Murphy, University of California Irvine

1 Managing Experiential Learning in Business Analytics
Kenneth E. Murphy, University of California Irvine
Experiential learning is one of the most valuable elements of our students' education, and this is especially true for those completing OR/MS/Analytics degree programs. Planning and delivering impactful practical experience requires significant effort on the part of faculty and administrators. In this panel our colleagues will share insights on implementing experiential education effectively and efficiently with an eye on the undergraduate student population. Topics to be covered include, but are not limited to Managing Practicum Projects, Student Informs Chapters, and the new Associate Certification for Analytics Professionals (ACAP).

2 Panelist
Jeff D. Camm, Wake Forest University, Winston-Salem, NC

3 Panelist
Goutam Chakraborty, Oklahoma State University, Stillwater, OK

4 Panelist
Brett M. Duarte, Arizona State University, Tempe, AZ

5 Panelist
Janet Moss, Georgia Southern University, Statesboro, GA

6 Panelist
Bill Griffin, INFORMS, Catonsville, MD

Monday, October 16, 8:00 AM - 9:15 AM

MA82

Session.Location:CC-West 212C

Appointment Scheduling in Healthcare: From Patients to Physicians

Contributed Session

Session Chair: Pelin Damci Kurt, Perfectserve, Danville, CA

1 Selecting and Scheduling Patients on Parallel Non-Homogenous Servers Considering Setup Times and Time Window Constraints
Payman Jula, Simon Fraser University, Vancouver, BC, Canada. Contact: pjula@sfu.ca

This talk addresses the problem of selecting and scheduling different types of patients on parallel servers with sequence dependent setup times and strictly enforced time windows. We depart from existing literature by considering continuous time and introduce a mathematical programming model based on disjunctive constraints to solve small and medium size problems to optimality and propose heuristics to solve large scale problems. The efficiency and effectiveness of proposed algorithms are reported and applications in patient scheduling in healthcare industry are highlighted.

2 Controling Appointment Schedules: How and when to Intervene

Roshan Mahes, University of Amsterdam, Amsterdam, Netherlands. Contact: a.v.mahes@uva.nl

Traditionally, appointment schedules have been determined by minimizing a specific cost function consisting of clients' waiting times and server idling. These schedules are often studied in a static sense; once announced no further updates will follow. However, advancements in technology have opened up the possibility of communicating with upcoming clients, which can lower costs. Yet, excessive updates may cause confusion and frustration among clients. In this study, we consider how many updates one should send and what are the ideal moments to send these updates. On the operational level, the findings have broad applications in the management of appointment scheduling.

3 Fatigue Management Constraints in Physician Scheduling

Pelin Damci Kurt[1], Elizabeth Loggia[2], [1]Perfectserve, Knoxville, TN, [2]Perfectserve, Knoxville, TN, Contact: pelin@lightning-bolt.com

We consider fatigue management constraints in physician scheduling problems based on a study from the aviation industry. We minimize the fatigue level for each physician on a given day of the schedule by adding constraints to a mixed integer programming model. There are different metrics that are used in identifying fatigue such as total hours worked during day and night, maximum length of a shift, amount of breaks and night call per 7 days.

Monday, October 16, 8:00 AM - 9:15 AM

MA83

Session.Location:CC-West 213A

Data Analytics Applications

Contributed Session

Session Chair: Meghna Maity, Kansas State University, Manhattan, KS

1 Enabling and Maximizing Data Potential for Mapping Research Impact

Jane Payumo, Michigan State University, East Lansing, MI, Contact: payumoja@msu.edu

This paper aims to share institutional experience of AgBioResearch - research arm of Michigan State University's College of Agriculture and Natural Resources, in building and maintaining integrated and inclusive research evaluation and data analytics systems that support a thriving academic research enterprise. It will showcase how modern information management systems and associated data and data analytics are used to track and evaluate research performance, productivity, quality, and return on investments expectations for academic research. Thirdly, it will also showcase a framework on how these systems support faculty recruitment and retention, professional development, and diversity, equity, and inclusion. Finally, this paper will showcase some of the requirements and principles that underpin a thriving data and analytics culture at MSU AgBioResearch.

2 Optimizing a Two-Stage Genetic Manufacturing System with Markov Decision Process

Mohammad Maydanchi[1], Gregory Purdy[2], Daniel F. Silva[2], [1]Auburn University, Auburn, AL, [2]Auburn University, Auburn, AL

Synthetic biology and genetic engineering are crucial in biotechnology. Genetic Manufacturing Systems (GMS) streamline genetic construct production. Inspections ensure high-quality outputs. This study models GMS using a Markov decision process, addressing multistage inspection allocation. It examines how GMS characteristics affect optimal inspection strategies. The mathematical model aids in designing optimal inspection strategies for GMS. These findings optimize high-quality genetic construct production, benefiting professionals in synthetic biology.

3 Process Optimization in Cheese Production to Mitigate Bacterial Contamination

Meghna Maity[1], Ashesh Sinha[1], Shing Chang[1], Jayendra Amamcharla[2], [1]kansas state university, Manhattan, KS, [2]kansas state university, Manhattan, KS, Contact: mmaity@ksu.edu

Process Optimization in Cheese
Production to reduce wastage
Due to globalization of markets, perishable products are moving throughout the country and exported. Quality monitoring and traceability along the supply chain is essential. The purpose of our research is to develop a

holistic approach to ensure optimum yield in cheese supply chain by optimizing specified set of parameters involved in cheese production. We developed a reinforcement learning technique (Q-leaning model) to filter relevant parameters impacting cheese quality and yield like temperature, rennet amount, salt quantity etc. The Q-learning model gives us the best action or optimized value of parameters at all stages of cheese production thus ensuring minimum wastage .

Monday, October 16, 8:00 AM - 9:15 AM

MA84

Session.Location:CC-West 213B

Service Systems Operations

Contributed Session

Session Chair: Wouter van Eekelen, Tilburg University, Tilburg, Netherlands

1 Coping with Service Cancellation: Strategic Role of Capacity Allocation

YoungJae Jang[1], YoungSoo Park[2], Bosung Kim[3], Jaeung Sim[4], [1]MineIS, Seoul, Korea, Republic of; [2]Korea Advanced Institute of Science and Technology, Seoul, Korea, Republic of; [3]Kyung Hee University, Seoul, Korea, Republic of; [4]University of Connecticut, Stamford, CT

This paper proposes a game-theoretic framework for the firm's capacity allocation between the two refund options, where customers purchase products considering product availability upon arrival, relative prices between the options, and their uncertainty of future consumption. We identify three main effects of capacity allocation: customer transition, customer replacement, and sales loss effects. Based on this framework, we show that the firm has no incentive to offer both options to all customers. Instead, allocating a slightly higher non-refundable capacity than the first-best demand enables the firm to leverage the customer transition and avoid sales loss. We also show that such restrictions on refund options improve rather than reduce consumer surplus by mitigating misalignments of interests.

2 Impact of Cancellation Policy on Rental Sharing Platforms

Xing Hu[1], Lifei Sheng[2], Hao Zhang[3], Xuying Zhao[4], [1]University of Hong Kong, Hong Kong, China; [2]University of Houston Clear Lake, Houston, TX, [3]University of British Columbia, Vancouver, BC, Canada; [4]Texas A&M University, College Station, TX, Contact: hao.zhang@sauder.ubc.ca

We study the cancellation policies on C2C platforms such as Airbnb. Three parties are considered: the platform, a host, and a sequence of consumers (guests). Two representative policies are considered: a strict cancellation policy (fully refundable if the booking is cancelled before a cutoff date) and a flexible cancellation policy (fully refundable before the check-in date). We identify market conditions under which the host and the platform have misaligned preferences on the cancellation policy. We also find that either cancellation policy can generate higher social welfare than the other under suitable market conditions.

3 Large-scale Service Systems Provisioning An Uncertain Market Of Rational, Delay-sensitive Customers

Wouter van Eekelen, Tilburg University, Tilburg, Netherlands

In this talk, we consider a large-scale service provider that caters to a market of rational, delay-sensitive individuals and operates in an environment in which the market size varies stochastically. Within this uncertain market environment, the firm needs to establish its pricing policy and determine the appropriate service capacity to acquire. We aim to strike the optimal balance between these two control parameters, enabling the firm to maximize its profit while taking into consideration the inherent uncertainty of the market environment.

Monday, October 16, 9:45 AM - 10:35 AM

MP01

CC-West 301ABC

Plenary Panel: Harnessing the Data Revolution in Supply Chains

Plenary Session

1 Harnessing the Data Revolution in Supply Chains

Anne G. Robinson, Kinaxis, Ottawa, ON, Canada

Supply chains vast scope and impact generate huge amounts of data, which represent a treasure trove of insights. Some areas are amply explored with techniques well known to our field, such as inventory optimization, demand forecasting, production planning and scheduling, and transportation. And yet with the advent of technical advances in the ability to store and calculate data, we can collect and compute in ways never before possible. The internet of things generates signals across the supply chain, and far more external data options exist, ranging from federated sources like microeconomic data, weather, and consumer demand to social media sentiment. Machine learning can ingest these signals to augment insights across the supply chain network. Algorithmic research also provides modern approaches that integrate machine learning and optimization in new ways. All of these changes offer unparalleled opportunity to harness the data revolution in the practice of supply chains, which is fortunate given that disruptions show no sign of ceasing and supply chains are on the board room agenda like never before. This panel of experts bring decades of experience looking at these issues and will share their perspectives on what areas represent the most promise and which the most peril.

2 Panelist
Derrick Fournier, Bristol Myers Squibb, Philadelphia, PA

3 Panelist
Pascal Van Hentenryck, ISyE Georgia Tech, Atlanta, GA

4 **Panelist**
Kelly Thomas, Worldlocity, Ottawa, ON, Canada

5 **Panelist**
Feryal Erhun, University of Cambridge, Cambridge, United Kingdom

Monday, October 16, 10:45 AM - 12:00 PM

MB01

CC-North 120A
Integer Programming Games: A Gentle Computational Overview
Tutorial Session
Session Chair: Douglas R. Shier, Clemson University, Pittsboro, NC

1 Integer Programming Games: A Gentle Computational Overview
Andrea Lodi[1], Margarida Carvalho[2], Gabriele Dragotto[3], Sriram Sankaranarayanan[4], [1]Cornell Tech, New York, NY, [2]University of Montreal & CIRRELT, Montreal, QC, Canada; [3]Princeton University, Princeton, NJ, [4]Polytechnique Montreal
Nash equilibria enlighten the structure of rational behavior in multi-agent decision-making. However, besides its existence, the concept is as helpful as one can efficiently compute it. Little is known about the computation of Nash equilibria in non-convex settings, a relevant context because non-convexities, often in the form of integer requirements. We provide a gentle overview of the recent bundle of work that deals with computing Nash equilibria for integer programming games. We do that by using the general and practically relevant context of attacking and protecting a critical infrastructure, and we highlight the characteristics and compare the differences of a sequential approach (Stackelberg game) versus a simultaneous one (Nash game). Finally, we guide the reader to the use of relevant software for computing Nash equilibria for integer programming games.

Monday, October 16, 10:45 AM - 12:00 PM

MB03

CC-North 120D
Artelys Corp
Technology Tutorial

1 Nonlinear Optimization Using Artelys Knitro
Richard Waltz, Artelys, Los Angeles, CA, Contact: richard.waltz@artelys.com
Artelys Knitro is a leading solver focused on large-scale, nonlinear (potentially non-convex), optimization problems. Knitro offers both interior-point and active-set algorithms for continuous models, as well as tools for handling problems with integer variables and other discrete structures. This tutorial will introduce the key features of Knitro, and demonstrate how to use Knitro to model and solve an optimization problem from within the python environment by working through a real-world application in the energy industry. We will also highlight some of the latest developments in Knitro, focusing on some of the recent advances in solving mixed-integer nonlinear problems, and heuristics for finding global (or improved local) solutions for non-convex problems.

2 Optimizing Hydropower and Reservoir Management: Advanced Modeling and Strategic Optimization
Carlyle Deligny, Artelys, Montreal, QC, Canada. Contact: carlyle.deligny@artelys.com
With 15,300 MW of installed capacity in 8 countries and 85% of hydropower capacity, Brookfield Renewable is one of the biggest hydropower producers worldwide. Artelys has worked closely with Brookfield Renewable to model and optimize the operations of 2 of their major hydropower

plants (650 MW of installed capacity in Pennsylvania, USA). The objective was to develop a software solution to model hydropower plant operations. Artelys carried out a study that led to around 10% potential gain in the annual generated revenue and implemented a software solution based on Artelys Crystal Energy Planner to optimize short-term schedules for the 2 hydropower plants. Using Artelys Crystal Energy Planner, Artelys modelled the Brookfield Renewable system considering all specific operational and market-related constraints to take advantage of all the sources of flexibility to automatically generate reliable least cost production schedules.
This customized solution uses a powerful optimization engine to assist hydropower producers in maximizing their generation benefit while taking into account all specific operational, environmental, and market-related constraints. The objective of the presentation is to present the solution, with a focus on the steps taken to integrate these powerful algorithms into an operational scheduling process.

Monday, October 16, 10:45 AM - 12:00 PM

MB04

CC-North 121A

Market Design and Matching Controls

Community Committee Choice Session

Session Chair: Ali Aouad, London Business School, London, United Kingdom

1 Neural Inventory Control in Networks via Hindsight Differentiable Policy Optimization

Matias Alvo[1], Daniel Russo[2], Yash Kanoria[3], [1]Columbia University, New York, NY, [2]Columbia University, New York, NY, [3]Columbia Business School, New York, NY

Inventory management offers unique opportunities for reliably evaluating and applying deep reinforcement learning (DRL), as one can compare to the optimum itself in several problem classes with hidden structure. Our DRL methods consistently recover near-optimal policies in such settings. In others, they can vastly outperform problem-specific heuristics. We leverage two insights. First, one can directly optimize the hindsight performance of any policy using stochastic gradient descent. This uses (i) an ability to backtest any policy's performance on a subsample of historical demand observations, and (ii) the differentiability of the total cost incurred on any subsample with respect to policy parameters. Second, we propose a natural neural network architecture to address problems with weak coupling constraints between locations in an inventory network.

2 A Nonparametric Framework and Improved Relaxations for Online Decision-Making with Correlated Arrivals

Ali Aouad[1], Will Ma[2], [1]London Business School, London, United Kingdom; [2]Columbia University, New York, NY, Contact: willma353@gmail.com

The design of online policies for stochastic matching and revenue management settings is usually bound by the Bayesian prior that the demand process is formed by a fixed-length sequence of queries with unknown types, each drawn independently. This assumption of serial independence implies that the demand of each type, i.e., the number of queries of a given type is approximately Poisson-distributed. Thus, matching policies are often based on ``fluid'' LPs that only use the expectations of these distributions. This paper explores alternative stochastic models for online matching that allow for nonparametric, higher variance demand distributions. We propose two new models, Indep and Correl, that relax the serial independence assumption in different ways by combining a nonparametric distribution for the demand with standard assumptions on the arrival patterns.

3 Welfare Distribution in Two-Sided Random Matching Markets

Geng Zhao[1], Itai Ashlagi[2], Mark Braverman[3], [1]UC Berkeley, Berkeley, CA, [2]Stanford University, Stanford, CA, [3]Princeton University, Princeton, NJ, Contact: gengzhao@berkeley.edu

We study the welfare structure in two-sided large random matching markets with logit-based preferences. Under a contiguity condition, we provide a tight description of stable outcomes. First, we identify an intrinsic fitness for each agent that represents her relative competitiveness in the market, independent of the realized stable outcome. Second, in every stable (or even approximately stable) matching, the welfare or the ranks of the agents on each side of the market, when scaled by their intrinsic fitness, have an approximately exponential empirical distribution. Moreover, the average welfare of agents on one side of the market is sufficient to determine the average on the other side. Overall, each agent's welfare is determined by a global parameter, her intrinsic fitness, and an extrinsic factor with exponential distribution across the population.

4 Online Matching in Random Graphs

Flore Sentenac, 1</sup

The theory of online matching in graphs received a gain of interest in recent years due to its application to ad allocation on the internet. A large body of work considered the problem in general classes of graphs, introducing algorithms with worst-case guarantees.
Beyond this approach, we study online matching in models of random graphs relevant to the ad allocation problem. In particular, we will look at the so-called configuration model. We estimate the performance of the most straightforward algorithm, GREEDY, by approximating some stochastic discrete processes by their continuous counterparts, which are solutions of an explicit system of partial differential equations. Thanks to these techniques, we theoretically highlight in which instances GREEDY far outperforms its worst-case guarantee.

Monday, October 16, 10:45 AM - 12:00 PM

MB05

CC-North 121B

Value Creation in Online Platforms

Contributed Session

Session Chair: Jiang Jiang, Cornell University, Ithaca, NY

1 Price Obfuscation in Online Platforms: When Can Transparency Pay?

Jose Lopez[1], Edward G. Anderson[2], [1]MIT, Cambridge, MA, [2]University of Texas-Austin, Austin, TX, Contact: jllopez@mit.edu

Many popular consumer-facing platforms offer to reduce search costs and efficiently find lowest prices. Under competitive pressure, however, the platform's incentives may not directly align with those of their consumers. We study the effects of price obfuscation on platform performance, and on consumer welfare, by augmenting current models to incorporate multiple sources of competitive pressure, consumer behavioral learning, and explicitly account for the role of trust, and the effects of reputation building.

2 To Partner or Not to Partner? the Partnership Between Platforms and Data Brokers in Two-Sided Markets

Xin Zhang[1], Lihong Cheng[1], Yugang Yu[1], Yong Tan[2], [1]University of Science and Technology of China, Hefei, China; [2]University of Washington, Seattle, WA, Contact: chenglh@ustc.educ.cn

As data has become an important competitive asset, platforms usually partner with data brokers to acquire external data to enhance their targeting capabilities, but this practice has stoked consumer privacy concerns. This study develops a game-theoretic model to examine the economic mechanism underlying the partnership between competing platforms and a data broker in a two-sided market. Interestingly, our analysis shows that the increase in consumer privacy concerns caused by the data broker may incentivize platforms to partner with the data broker rather than discouraging them. We find that the platform-data broker partnership hurts consumer surplus when platforms adopt a pure ad-sponsored model without charging consumers, but it may benefit consumer surplus when platforms adopt a mixed model with ad-sponsored and subscription-based revenue.

3 Optimal Dynamic Pricing In The Presence Of Strategic Consumers: A Game-theoretic View

Ziqi Zhang[1], Zelin Zhang[2], Guoqing Guo[1], [1]Renmin Univerisity of China, Beijing, China; [2]Renmin University of China, Beijing, China. Contact: zikizhang5@ruc.edu.cn

The current research explores a monopolist's dynamic pricing decisions facing strategic consumers under limited capacity. While previous literature has proved the existence of a unique Nash equilibrium in a seller-consumer game, we challenge this finding and show there may exist multiple Nash equilibria under such pricing policies. We highlight the interdependency (implicit collusion) and mix strategies of customers' decision-making, resulting in the inefficiency of seller's pricing policy. To address this issue, we propose a maximum-matching dynamic pricing strategy that can lead to a unique pure Nash equilibrium while generating significant profits. We also conduct a behavioral experiment to examine the effectiveness of our proposed pricing policy on reducing strategic waiting behavior and creating higher profits, compared to other pricing policies.

4 Information Disclosure Requirements In P2P Lending Platforms

Peng-Chu Chen, Ran Tao, The University of Hong Kong, Hong Kong, Hong Kong. Contact: taoran13@connect.hku.hk

In a peer-to-peer (P2P) lending market, borrowers persuade lenders to grant loans by sending unverifiable information, verifiable information, or both. Although borrowers can exaggerate unverifiable information, lenders may not fully trust such information. In this study, we use a signaling game to model the interaction between borrowers and lenders and study the impact of disclosure requirements imposed by P2P lending platform operators. We show that requirements that allow only unverifiable information to be sent are beneficial to borrowers but harmful to lenders. In contrast, requirements that allow only verifiable information have the opposite effect. Allowing both types of information balances information asymmetry and the difficulty of obtaining financing in the market.

5 Optimizing Hotel Ranking Strategies to Mitigate Off-Platform Purchases at Online Travel Agencies (Otas)

Jiang Jiang, Chris K. Anderson, Cornell University, Ithaca, NY, Contact: jj438@cornell.edu

Online travel agencies (OTAs) face fierce competition with strategic consumers who compare prices across multiple platforms before making a purchase. We investigate how platforms can employ ranking mechanisms to mitigate the loss from off-platform purchases. More specifically, we propose a variant of the multinomial logit model incorporating a ranking discounting factor and off-platform purchase probabilities calculated with competitor price information. The model is estimated on a censored dataset where there is no indication whether consumers did not make a hotel selection or made their purchase through alternative platforms. We used genetic algorithm - expectation maximization (GA-EM) method to increase efficiency of the estimation. Simulation is given to compare various ranking heuristics.

Monday, October 16, 10:45 AM - 12:00 PM

MB06

CC-North 121C

Causal Inference and Machine Learning in Operations

Community Committee Choice Session

Session Chair: Dennis Zhang, Washington University in St Louis, ST LOUIS, MO

Session Chair: Bing Bai, Washington University in St. Louis, Saint Louis, MO

1 Blessing from Human-AI Interaction: Super Reinforcement Learning in Confounded Environments

Jiayi Wang, University of Texas at Dallas, Richardson, TX

As AI becomes more prevalent throughout society, effective methods of integrating humans and AI systems that leverages their respective strengths and mitigates risk have become an important priority. We introduce the paradigm of super reinforcement learning that takes advantage of Human-AI interaction for data driven sequential decision making. This approach utilizes the observed action, either from AI or humans, as input for achieving a stronger oracle in policy learning for the decision maker (humans or AI). In the decision process with unmeasured confounding, the actions taken by past agents can offer valuable insights into undisclosed information. By including this information for the policy search in a novel and legitimate manner, the proposed super reinforcement learning will yield a super-policy that is guaranteed to outperform both the standard optimal policy and the behavior one (e.g., past agents' actions). We call this stronger oracle a blessing from human-AI interaction. Furthermore, to address the issue of unmeasured confounding in finding super-policies using the batch data, a number of nonparametric and causal identifications are established. Building upon on these novel identification results, we develop several super-policy learning algorithms and systematically study their theoretical properties such as finite-sample regret guarantee.

2 A Two-Part Machine Learning Approach to Characterizing Network Interference in A/B Testing

Yuan Yuan[1], Kristen Altenburger[2], [1]Purdue University, West Lafayette, IN, [2]Meta Inc., Menlo Park, CA, Contact: yuanyuan@purdue.edu

This paper introduces a machine learning method for addressing interference in A/B tests, a limitation of conventional testing when a unit's response is affected by others. Traditional literature fails to account for latent network structures of interference and requires human expertise for modeling. Our solution utilizes causal network motifs to automatically characterize interference from local network structures and treatment assignments. We then use decision trees and nearest neighbors to link motifs to an "exposure condition". This approach is validated through a simulated experiment on a Watts-Strogatz network and a large-scale Instagram user test. The result is an automated method that enhances expert capabilities in managing A/B testing interference.

3 Deep-Learning-Based Causal Inference for Large-Scale Combinatorial Experiments

Zikun Ye[1], Zhiqi Zhang[2], Dennis Zhang[3], Heng Zhang[4], Renyu Zhang[5], [1]University of Illinois Urbana Champaign, Urbana, IL, [2]Washington University in St. Louis, St. Louis, MO, [3]Washington University in St Louis, ST LOUIS, MO, [4]Arizona State University, Tempe, AZ, [5]The Chinese University of Hong Kong, Hong Kong, China. Contact: philipzhang@cuhk.edu.hk

Online platforms launch hundreds of randomized experiments every day to iterate their operations and marketing strategies. The combinations of these treatments are typically not exhaustively tested. We develop a novel framework combining deep learning and doubly robust estimation to estimate the causal effect of any treatment combination for each user on the platform when observing only a small subset of treatment combinations. Our approach leverages Neyman orthogonality and allows for valid inference. To empirically validate our method, we collaborated with a large-scale video-sharing platform and implemented our framework. Our method significantly outperforms other benchmarks to accurately estimate and infer the average treatment effect of any treatment combination, and to identify the optimal treatment combination.

4 Interference in Experimentation in Two-Sided Markets

Wassim Dhaouadi[1], Ramesh Johari[2], Gabriel Weintraub[1], [1]Stanford Graduate School of Business, Stanford, CA, [2]Stanford University, Stanford, CA

We provide a novel model and associated analysis to study interference arising in experiments in two-sided markets. Our model allows to characterize biases for a broad set of experimental designs and estimators. We use our results to provide ways to alleviate such biases in practice.

Monday, October 16, 10:45 AM - 12:00 PM

MB07

CC-North 122A

Experimentation and Interference

Community Committee Choice Session

Session Chair: Hannah Li, MIT, Cambridge, MA

Session Chair: Hongseok Namkoong, Columbia University, New York, NY

1 Effects of Interference on Marketplace Experiments and Decision-Making

Gabriel Weintraub[1], Ramesh Johari[2], Hannah Li[3], Inessa Liskovich[4], [1]Stanford Graduate School of Business, Stanford, CA, [2]Stanford U, Stanford, CA, [3]MIT, Menlo Park, CA, [4]Airbnb, SF, CA, Contact: gweintra@stanford.edu

Online marketplace platforms rely on experiments to aid decision-making. In a marketplace setting, prior work shows that common estimators for the treatment effect can be biased due to interference. These treatment effect biases, however, are not the only source of bias that can affect platform decisions. An additional source of bias arises when estimating the standard error, which can lead to confidence intervals that are too wide or too narrow, leading the platform to be under or over-confident in their decisions. We evaluate the impact of both types of biases on the resulting decisions that a platform makes, as well as the impact of bias corrections for both treatment and standard error bias. Finally, we assess the impacts of biases on decisions made in the Airbnb marketplace.

2 Influence Effects in Social Networks: Inward and Outward Spillovers of One Unit's Treatment

Fei Fang, Laura Forastiere, Yale University, New Haven, CT, Contact: fei.fang@yale.edu

In a social network, users may have varying levels of influence on others when they themselves receive interventions. Evaluating such effects can provide insights for various applications such as targeting strategies. We define the effect of one unit's treatment on the outcome of their network neighbors in two ways: i) the inward spillover effect on a unit's outcome of a neighbor's treatment, and ii) the outward spillover of a unit's treatment on their neighbors' outcomes. In both causal effects, we marginalize over the distribution of the treatment vector in the rest of the network under a hypothetical Bernoulli trial. We compare these two effects with different properties, including the conditions under which they are equivalent. We also develop Horvitz-Thompson estimators for both types of causal effects and their design-based variance in randomized experiments.

3 Design-Based Confidence Sequences: A New Approach to Risk Mitigation in Online Experimentation

David Ham[1], Michael Lindon[2], Martin Tingley[3], Iavor Bojinov[4], [1]Harvard, Cambridge, MA, [2]Netflix, New York, NY, [3]Netflix, Los Gatos, CA, [4]Harvard Business School, Somerville, MA, Contact: ibojinov@hbs.edu

We introduce design-based confidence sequences for analyzing sequential experiments with uniform type-1 error guarantees, allowing managers to “peek” at results as new data becomes available without compromising the validity of the statistical analysis. The proposed method is versatile and applicable to various experiments, including multi-arm bandits, time series, and panel experiments. We conduct comprehensive simulations and analyze three Netflix experiments to validate our approach. The results demonstrate that our confidence sequence method can quickly terminate harmful experiments, reducing costs and mitigating risk. For instance, we show our method could have stopped an experiment on the first day after observing only 63 units.

Monday, October 16, 10:45 AM - 12:00 PM

MB08

CC-North 122B

Online & Dynamic Matching: Innovative Approaches

Community Committee Choice Session

Session Chair: Sophie Yu, Duke University, Durham, NC

1 A Nonparametric Framework for Online Stochastic Matching with Correlated Arrivals

Ali Aouad[1], Will Ma[2], [1]London Business School, London, United Kingdom; [2]Columbia University, New York, NY

Matching decisions are important operational controls for online marketplaces, with applications including order fulfillment, ride-hailing, and service platforms. Existing stochastic models often rely on an assumption of "serial independence," which implies that the demand is approximately Poisson-distributed and low-variance. By relaxing this assumption, we develop a nonparametric framework for online matching that can represent high-variance and correlated arrivals. We demonstrate that fluid relaxations, which rely solely on expected demand information, have arbitrarily bad performance guarantees. Instead, we propose tighter linear programming relaxations that leverage distribution knowledge and use a novel rounding scheme to obtain matching algorithms that achieve optimal (worst-case) performance guarantees.

2 The Power of Greedy for Online Minimum Cost Matching on the Line

Eric Balkanski, Yuri Faenza, Noemie Perivier, Columbia University, New York, NY

In the online minimum cost matching problem, there are n servers and, at each of n time steps, a request arrives and must be irrevocably matched to a server that has not yet been matched to, with the goal of minimizing the sum of the distances between the matched pairs. Online minimum cost matching is a central problem in applications such as ride-hailing platforms and food delivery services. Despite achieving a worst-case competitive ratio that is exponential in n even on the line, the simple greedy algorithm, which matches each request to its nearest available server, performs well in practice and has a number of attractive features such as strategyproofness. A major question is thus to explain greedy's strong empirical performance. In this talk, we aim to understand the performance of greedy on the line over instances that are at least partially random.

3 On the Optimality of Greedy Policies in Dynamic Matching

Süleyman Kerimov[1], Itai Ashlagi[2], Itai Gurvich[3], [1]Rice University, Jones Graduate School of Business, Houston, TX, [2]Stanford University, Management Science and Engineering, Stanford, CA, [3]Northwestern University, Kellogg School of Management, Evanston, IL, Contact: kerimov@rice.edu

We study centralized dynamic matching markets with finitely many agent types and heterogeneous match values. A network topology describes the pairs of agent types that can form a match and the value generated from each match. A matching policy is hindsight optimal if the policy can (nearly) maximize the total value simultaneously at all times. We find that suitably designed greedy policies are hindsight optimal in two-way matching networks.

We first show that the greedy longest-queue policy with a minor variation is hindsight optimal. Importantly, the policy is greedy relative to a residual network, which includes only non-redundant matches with respect to the static optimal matching rates. Moreover, when the residual network is acyclic (eg, as in two-sided networks), we prescribe a greedy static priority policy that is also hindsight optimal.

4 Feature Based Dynamic Matching

Yilun Chen[1], Yash Kanoria[2], Akshit Kumar[2], Wenxin Zhang[2], [1]CUHK Shenzhen, Shenzhen, China; [2]Columbia Business School, New York, NY, Contact: chenyilun@cuhk.edu.cn

We consider a feature-based dynamic matching problem faced by centralized platforms in a highly heterogeneous market. Specifically, a set of heterogeneous supply units, each characterized by i.i.d. supply feature vector, is available initially. In each period, a customer arrives with an i.i.d. demand weight vector describing her type, and requests to consume a supply unit. The platform seeks a dynamic matching policy that assigns supply units to customers to maximize the expected average matching utility. We propose and analyze a simple, simulation-based matching policy, dubbed Simulate-Optimize-Assign-Repeat (SOAR). We prove that SOAR enjoys a surprisingly universal (near) optimality guarantee, achieveing the optimal regret scaling under various modelling assumptions. Extensive numerical simulations support the robustness of the performance of SOAR.

Monday, October 16, 10:45 AM

- 12:00 PM

MB09

CC-North 122C
Statistical Methods on Causal Inference, Inference and Reinforcement Learning
Community Committee Choice Session
Session Chair: Raaz Dwivedi, Harvard and MIT, CAMBRIDGE, MA
Session Chair: Kyra Gan, Harvard University, Cambridge, MA

1 Kernel-Based Universal Debiasing for Pathwise Differentiable Parameters
Brian Cho[1], Kyra Gan[2], Ivana Malenica[2], Yaroslav Mukhin[3], [1]Cornell University, New York City, NY, [2]Harvard University, Boston, MA, [3]MIT, Boston, MA, Contact: bmc233@cornell.edu
Modern estimation methods achieve optimal performance by relying on knowledge of the (efficient) influence function (EIF) for the target parameter. We propose a novel way to estimate functions of the data-generating distributions that provides optimal performance without requiring knowledge of the EIF. Distinct from existing approaches, our method requires a single distribution for plug-in estimation for all target parameters. We present a novel use case of Universal RKHS to eliminate the plug-in bias and achieve the nonparametric efficiency bound. Our theoretical results show that any pathwise differentiable parameter estimated utilizing a plug-in approach is asymptotically normal, with the correct limiting variance. We validate these results for several target parameters and show that our approach performs comparably to existing approaches.

2 Role Of Lookahead In Reinforcement Learning Algorithms
Anna Winnicki, R. Srikant, University of Illinois at Urbana-Champaign, Urbana, IL, Contact: annaw5@illinois.edu
A common technique in reinforcement learning is to evaluate the value function from Monte Carlo simulations of a given policy, and use the estimated value function to obtain a new policy which is greedy with respect to the estimated value function. A well-known longstanding open problem in this context is to prove the convergence of such a scheme when the value function of a policy is estimated from data collected from a single sample path obtained from implementing the policy. We present a solution to the open problem by showing that a first-visit version of such a policy iteration scheme indeed converges to the optimal policy provided that the policy improvement step uses lookahead rather than a simple greedy policy improvement. We provide results both for the original open problem in the tabular setting and also present extensions to the function approximation setting.

3 On Counterfactual Inference with Unobserved Confounding
Abhin Shah[1], Raaz Dwivedi[2], Devavrat Shah[1], Gregory W. Wornell[1], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Harvard and MIT, Cambridge, MA, Contact: abhin@mit.edu
Given an observational study with n independent units, our goal is to learn counterfactuals for each unit in the presence of unobserved confounding using only one p-dimensional sample per unit containing covariates, interventions, and outcomes. Modeling the underlying joint distribution as an exponential family, we reduce learning unit-level counterfactual distributions to learning n exponential family distributions with heterogeneous parameters and only one sample per distribution. We propose a convex objective to jointly learn all n parameter vectors, and provide a unit-wise mean squared error bound that scales linearly with metric entropy of parameter space, e.g., when parameters are s-sparse linear combination of k known vectors, error is O(s log k/p). En route, we derive conditions for compactly supported distributions to satisfy log-Sobolev inequality.

4 On the Identifiability and Interpretability of Gaussian Process Models
Didong Li, UNC
In this talk, we critically examine the prevalent practice of using additive mixtures of Mat\'ern kernels in Gaussian process (GP) models. In particular, we derive a series of theoretical results showing that the smoothness of a mixture of Mat\'ern kernels is determined by the least smooth component, and that a GP with such a kernel is effectively equivalent to the least smooth kernel component. Furthermore, we demonstrate that none of the mixing weights or parameters within individual kernel components are identifiable. Our findings are supported by extensive simulations and real applications. This work provides insights into kernel selection and interpretation for GP models, emphasizing the importance of choosing appropriate kernel structures for different tasks.

Monday, October 16, 10:45 AM - 12:00 PM

MB10

CC-North 123

Theoretical Foundations of Decision Making under Uncertainty

Community Committee Choice Session

Session Chair: Zaiwei Chen, California Institute of Technology, Atlanta, GA

1 Automatic Outlier Rectification via Optimal Transport

Jiajin Li, Stanford University, CA

This talk proposes a novel conceptual framework to detect outliers using optimal transport. Conventional outlier detection approaches typically use a "two-stage" outlier removal procedure. Instead, we propose an automatic outlier rectification mechanism that integrates rectification and estimation within a joint optimization framework. The key idea is to use an optimal transport distance with a concave cost function to construct a novel rectification set in the space of probability measures. Then, we select the best distribution within this set to perform the estimation task, which introduces a transporter that efficiently rectifies the data and automatically detects outliers during the optimization process. We demonstrative its effectiveness on mean estimation, least absolute regression, and the fitting of option implied volatility surfaces.

2 Sharper Model-Free Reinforcement Learning for Average-Reward Markov Decision Processes

Zihan Zhang[1], Qiaomin Xie[2], [1]Princeton University, Princeton, NJ, [2]University of Wisconsin-Madison, Madison, WI

We develop several provably efficient model-free reinforcement learning (RL) algorithms for infinite-horizon average-reward Markov Decision Processes (MDPs). We consider both the online setting and the setting with access to a simulator. In the online setting, we propose model-free RL algorithms based on reference-advantage decomposition. Our algorithm achieves $O(\sqrt{T})$ regret after T steps. Our results are the first to achieve optimal dependence in T for weakly communicating MDPs. In the simulator setting, we propose a model-free RL algorithm that nearly matches with the minimax lower bound. Our results are based on two new techniques that are unique in the average-reward setting: 1) better discounted approximation by value-difference estimation; 2) efficient construction of confidence region for the optimal bias function with space complexity $O(SA)$.

3 A Finite-sample Analysis Of Payoff-based Independent Learning For Zero-sum Stochastic Games.

Zaiwei Chen, California Institute of Technology, Pasadena, CA, Contact: zchen458@caltech.edu

In this work, we study two-player zero-sum stochastic games and develop a natural variant of best-response learning dynamics that is payoff-based, convergent, rational, and symmetric between players. Our theoretical results present the first last-iterate finite-sample analysis of such learning dynamics. Specifically, in the stateless setting (which corresponds to zero-sum matrix games), we establish a sample complexity of $O(\epsilon^{-1})$ to find the Nash distribution and a sample complexity of $O(\epsilon^{-8})$ to find a Nash equilibrium. For general stochastic games, our learning dynamics also enjoys a sample complexity of $O(\epsilon^{-8})$ to find a Nash equilibrium. To establish the results, we develop a coupled Lyapunov drift approach to capture the evolution of multiple sets of coupled and stochastic iterates, which might be of independent interest.

4 Measure Gradient Descent

Di Yu[1], Raghu Pasupathy[2], Shane Henderson[3], [1]Purdue University, West Lafayette, IN, [2]Purdue University, West Lafayette, IN, [3]Cornell University, Ithaca, NY, Contact: yu1128@purdue.edu

Motivated by certain emergency response problems and certain variational problems, we present the measure gradient descent algorithm for optimizing a convex cost functional over the space of signed measures, and over the space of measures constrained by a budget. Assuming that the cost functional is equipped with a von Mises derivative, we present a useful necessary and sufficient diagnostic for optimality expressed in terms of the influence function. This diagnostic is then used within a descent algorithm over measure space that is reminiscent of stochastic gradient descent. We demonstrate a descent lemma, consistency in the functional space, and a complexity rate result. We also discuss implementation strategies.

Monday, October 16, 10:45 AM - 12:00 PM

MB11

CC-North 124A

Socially Responsible Computing in OR

Community Committee Choice Session

Session Chair: Chara Podimata, UC Berkeley, Allston, MA

1 Model-Sharing Games

Kate Donahue, Cornell, Ithaca, NY

Federated learning is a distributed learning paradigm where multiple agents, each only with access to local data, jointly learn a global model. This talk describes three papers analyzing game theoretic models of federated learning, all joint with Jon Kleinberg. In the first, we propose our framework ("Model-Sharing Games") and analyze the stability of federating coalitions through hedonic game theory. In the second, we provide an efficient algorithm to calculate an optimal (error-minimizing) arrangement and give the first Price of Anarchy bound in this game. In the third, we analyze fairness in error rates between federating agents and provide theoretical guarantees for when two commonly-used notions of fairness can be satisfied: egalitarian fairness (bounds how dissimilar error rates can be) and proportional fairness (rewards players proportional to data size).

2 Multicalibration as Boosting for Regression

Ira Globus-Harris, Declan Harrison, Michael Kearns, Aaron Roth, Jessica Sorrell, University of Pennsylvania, Philadelphia, PA, Contact: igh@seas.upenn.edu

We study the connection between multicalibration and boosting for squared error regression. Characterizing multicalibration in terms of a swap regret condition, we give a simple boosting algorithm that requires only a standard regression oracle to achieve multicalibration with respect to a class H. We give a weak learning assumption on H that ensures convergence to Bayes optimality without the need to make any realizability assumption, giving us an agnostic boosting algorithm for regression. We show that our weak learning assumption on H is both necessary and sufficient for multicalibration with respect to H to imply Bayes optimality, and generalize the weak learning condition to one relative to a constrained class of functions.

3 Learning from a Biased Sample

Roshni Sahoo[1], Lihua Lei[2], Stefan Wager[3], [1]Stanford University, Palo Alto, CA, [2]Stanford University, Palo Alto, CA, [3]Stanford GSB, Stanford, CA, Contact: rsahoo@stanford.edu

When learning data-driven decision rules, we may be concerned that certain groups are over- or under-represented in the training data relative to the test population. We give a model of sampling bias called Γ-biased sampling, where observables can impact sample selection probabilities arbitrarily but the effect of unobservables is bounded by a constant. Applying distributionally robust optimization, we give a method for learning a decision rule that minimizes the worst-case risk incurred under a family of test distributions that can generate the training distribution under Γ-biased sampling. We show that this problem is equivalent to an augmented convex risk minimization problem, provide statistical guarantees for learning the robust model, and give a simple implementation using deep learning.

4 Bidding Strategies for Proportional Representation in Advertisement Campaigns

Judy Hanwen Shen, Stanford

Many companies use advertising platforms for recruitment. However, equitable bidding may not result in equitable outcomes due to heterogeneous competition. We compare two fairness objectives: one in which the advertisers bid equally for yield with group-parity guarantees, and another in which the bids are not constrained; only the yield must satisfy parity constraints. We show that requiring parity for both bids and yield can result in an arbitrarily large decrease in efficiency compared to requiring equal yield proportions alone. We find that autobidding is a natural way to realize this latter objective and extend existing techniques to provide efficient bidding strategies with high utility while satisfying group parity constraints.

Monday, October 16, 10:45 AM - 12:00 PM

MB12

CC-North 124B

Optimization via Simulation

Community Committee Choice Session

Session Chair: David J. Eckman, Texas A&M University, College Station, TX

1 Confidence Regions on the Efficient and Pareto Sets in Multi-Objective Convex Quadratic Stochastic Programs

Susan R. Hunter, Ziyu Liu, Raghu Pasupathy, Purdue University, West Lafayette, IN

We consider the context of constructing confidence regions on the efficient and Pareto sets of multi-objective convex quadratic stochastic programs. Our main result is a uniform central limit theorem (CLT) on the efficient and Pareto set estimators constructed from a sample-average approximation of the objectives. Importantly, the uniform CLT reflects the structure inherent in the quadratic performance measures, obtained through an exact calculation of the Frechet derivative of the efficient and Pareto sets as a function of a scalarization parameter. The result provides the required theoretical foundation for constructing asymptotically exact confidence regions, which we illustrate with an example.

2 Reference Alternatives Based Knockout Tournament Procedure for Ranking and Selection

Ying Zhong[1], Jianzhong Du[2], Deng-Feng Li[1], Zhaolin Hu[3], [1]University of Electronic Science and Technology of China, Chengdu, China; [2]School of Management, Fudan University, Shanghai, China; [3]Tongji University, Shanghai, China. Contact: yzhong4@uestc.edu.cn

The knockout-tournament procedure is an efficient parallel procedure developed to solve large-scale ranking and selection problems. The procedure selects the best alternative by conducting "matches" between paired alternatives round-by-round. To further improve the procedure's performance from the aspect of the total sample size, we propose a major modification of the procedure. In each round of the selection, before pairing the alternatives, we first select an alternative as the reference alternative and then add the reference alternative to each "match". We show that by carefully choosing the reference alternative and pairing scheme for the remaining alternatives, the procedure can achieve significant improvements in both the average sample size required in each "match" and the total number of "matches", and thus can achieve an overall sample size reduction.

3 Using Generative Adversarial Networks (GANs) for Simulation: A Case Study of Wearable Sensor Data Synthesis

Yining Huang[1], Hong Wan[2], [1]North Carolina State University, Raleigh, NC, [2]NC State University, Raleigh, NC, Contact: yhuang43@ncsu.edu

This study delves into the utilization of Generative Adversarial Networks (GANs) for generating subject-specific time series sensor dat. We undertake an in-depth comparative analysis of DoppelGANger and ctGANs, two prominent GAN variants for time series data generation, evaluating their efficiency and efficacy. The sensor data for this investigation was sourced from The National Health and Nutrition Examination Survey (NHANES), which served as the foundational training set. We evaluated the synthesized subject-specific sensor data, focusing on the temporal and multi-dimensional statistical properties. Our empirical findings underscore the potential of GANs to adeptly capture the time-dependent correlations and the intricate statistical characteristics inherent in multi-dimensional data.

4 All-Purpose Screening Procedures for Ranking and Selection

Jinbo Zhao[1], David J. Eckman[2], [1]Texas A&M Univeristy, College Station, TX, [2]Texas A&M University, College Station, TX, Contact: jinbozhao@tamu.edu

We introduce a class of screening procedures designed for ranking-and-selection problems featuring multiple objectives or stochastic constraints. The procedures guarantee to return either all acceptable systems, or each acceptable system, with high probability, where the definition of acceptability is flexible and can include optimality. Specifically, the procedures construct separate confidence regions for each system's performance and search within these regions for a configuration of performances for which a given system is acceptable. By implementing the procedures within a parallel computing environment, their running time can be reduced without compromising screening power. We demonstrate the effectiveness and efficiency of the procedures through numerical experiments.

Monday, October 16, 10:45 AM - 12:00 PM

MB13

CC-North 125A

Economic Issues of Homeland Security

Community Committee Choice Session

Session Chair: Aniruddha Bagchi, Kennesaw State University, Kennesaw, GA

1 A Model of Fortification Using Bayesian Persuasion

Jomon A. Paul, Abhra Roy, Kennesaw State University, Kennesaw, GA, Contact: jpaul17@kennesaw.edu

We analyze a model of communication between a Sender and multiple Receivers using Bayesian Persuasion in the context of fortification of critical infrastructure. The government receives noisy signals about whether an attack is imminent and searches for an optimal persuasion rule that maximizes the government's payoff under different intelligence settings.

2 Defense and Connectivity of Weakest-Link Networks

Colin Deurlington, University of California, Irvine, Irvine, CA

I study a model of weakest-link network defense, where the defender determines the accessibility of a valuable asset and allocates defensive resources prior to an attack. Under different exogenous parameters, two subgame equilibrium resource allocations can arise: (1) both the defender and attacker allocate a positive level of resources, or (2) the defender spends a sufficient level of resources to deter attacks. As the defender's cost-adjusted valuation of an asset increases relative to the attacker, the defender is more likely to increase access to this asset. If the defender only has a slightly larger cost-adjusted valuation of an asset relative to the attacker, however, the defender's decision to increase access depends on whether she is defending nodes individually or with an infrastructure technology.

3 U.S. Global Hegemony: Military Versus Economic Power

Joao RICARDO Faria, FLORIDA ATLANTIC UNIVERSITY, Boca Raton, FL, Contact: jfaria@fau.edu

Abstract: This paper discusses the US strategies to keep global hegemony. The U.S. can use military, economic power or a combination of both to achieve its objectives. In a dynamic model that allows an incumbent government reelection as a function of success in these strategies, we derive six different scenarios and rank them. With no reelection, if the marginal impact of economic power is greater [smaller] than the marginal impact of military power on world's reaction, the best strategy to keep U.S. global hegemony is through aggressive projections of military [economic] power. With reelection, the best strategy is to use a combination of military and economic power.

4 When Does a Country Attack an Adversary? the Joint Role of Cost of Attack and Quality of Information

Aniruddha Bagchi, Kennesaw State University, Kennesaw, GA

I examine a game between two countries (Home and Foreign) to determine how the quality of intelligence affects the choice between offense and defense. The foreign country is interested in attacking the home country and expends effort in developing a viable plan of attack. The outcome of this effort is uncertain, and the home country spends resources to find out if the foreign country succeeds in developing the plan. I allow for two kinds of intelligence errors- missed alarm and false alarm. Based on the intelligence input, the home country first decides whether to undertake a pre-emptive strike. If it decides not to strike, then in the next period, the home country can choose to fortify itself, while the foreign country decides whether to attack. I examine how the cost of attack and quality of information jointly help the Home country choose between offense and defense.

Monday, October 16, 10:45 AM - 12:00 PM

MB14

CC-North 125B

Session on Socially Responsible and Sustainable Operations

Community Committee Choice Session

Session Chair: Telesilla Olympia Kotsi, The Ohio State University, Columbus, OH

1 Classifying And Quantifying The Impact Of Social Sustainability Issues In Public Firms And Their Supply Chains

Soh Hyun Chu, Christian Blanco, James Hill, The Ohio State University, Columbus, OH, Contact: hill.249@osu.edu

This study explores the impact of different Social Sustainability issues on a firm's financial performance over three decades. We compare the severity of the impact of social misconducts whether they arose in focal firms or supply chains. Text analytics method is used to identify and classify the negative news articles on publicly traded companies appearing across 210 U.S. news outlets from 1990- 2019. We find that the rank of the severity ranges from child labor, forced labor, wage-hour-condition, harassment, health and safety, and discrimination. Notably, the severity of wage-hour-condition and harassment are only salient for the supply chain. We find that the impact of social issues on market values is short-lived, and may be why we see them recur. Finally, we construct an index of social sustainability of the largest publicly traded companies in the U.S.

2 The High Impact of Disasters on Prices in Low-Income Communities

Xabier Barriola[1], William Schmidt[2], [1]INSEAD, Fontainebleau, France; [2]Cornell University, Ithaca, NY

Responding to natural disasters requires the deployment of food, shelter, and medical assistance to relieve the immediate needs of the victims. Low-income communities may bear a disproportionate burden from these disasters due to disparities in local infrastructure. We test for differences in prices paid between low-income and high-income communities after three Atlantic hurricanes. We find that affected low-income communities endure higher price increases within grocery categories compared to high-income communities. We see that low-income communities experience a larger drop in price promotions, higher price increases at the product level, more stockouts, and more substitution from low-priced products to high-priced products.

Monday, October 16, 10:45 AM - 12:00 PM

MB15

CC-North 126A

Integrated Multi-disciplinary Analysis supporting Deterrence: A Star Wars Story

Community Committee Choice Session

Session Chair: Jonathon Leverenz, Systems Planning and Analysis, Inc, Alexandria, VA

1 Episode I - The Phantom Message

Zachary Hunt, Systems Planning and Analysis, Inc., Alexandria, VA

Meaningful analysis, without meaningful messaging, is actually meaningless. The impact of effective analysis hinges on effective communication. This presentation will address how integration of a communication strategy into the analytic process can amplify message effectiveness and consistency. It will highlight communication techniques that tap into the brain's natural processing to connect with your audience while maintaining the integrity of your analysis.

2 Deterrence Strategy and Policy - A New Hope

Bobby Eldridge, Systems Planning & Analysis, Alexandria, VA

Deterrence strategy and policy is foundational to shaping both national and international security. In extreme circumstances, this means preventing war and requires capability, credibility, and communication to execute. This presentation will demonstrate how understanding the relationship between the qualitative fundamentals of deterrence strategy and policy and the quantitative analysis provided by Operations Research (OR) is critical to the accuracy of both.

3 Or Strikes Back - Objective Analysis for Deterrent Force Structures

Derek R. Shortt, Jonathon Leverenz, Systems Planning and Analysis, Inc, Alexandria, VA, Contact: dshortt@spa.com

Establishing objective measures assists in determining acceptable force structures for achieving deterrence objectives. This presentation covers establishing objective measures from deterrence objectives, and measures candidate force structures that meet those measures using OR techniques.

4 Optimization of Response Bases to Intercept Rogue Aircraft

Ramzi Mirshak, Defence Research and Development Canada, Ottawa, ON, Canada

Intercepting rogue aircraft from a small set of selected air bases creates a challenging optimization problem. Past efforts maximized the ability to respond to key locations within a given time window (for example, arriving in 30 minutes or less). We develop a new approach that instead maximizes the likelihood of intercepting a rogue aircraft sufficiently quickly to affect the outcome. A probabilistic model considers uncertainties in decision times, indications and warning, and threat speed to assess the likelihood of a successful response. Results are then superimposed on a geospatial grid to derive optimal basing using an integer programming approach. This presentation gives an overview of the method and presents results for a notional example.

5 Return of the Analysis (In Less than 12 Parsecs)

Jonathon Leverenz[1], Derek Roy Shortt[2], [1]Systems Planning and Analysis, Inc, Alexandria, VA, [2]Systems Planning and Analysis, Inc., Arlington, VA, Contact: jonathon.leverenz@gmail.com

Effective analysis requires the timely delivery of results. Timeliness is achieved not just through fast hardware and good models, but also by following an analytic framework that builds a path connecting message, measures of effectiveness, models, and data. This presentation explores one such framework and some techniques that can aid operations research analysts consistently deliver results when needed.

Monday, October 16, 10:45 AM - 12:00 PM

MB16

CC-North 126B

Building Blocks Towards Effective Leadership

Panel Session

1 Building Blocks Towards Effective Leadership

Lavanya Marla, University of Illinois at Urbana-Champaign, Urbana, IL

Filling Your Cup - What It Takes To Be an Effective Leader: WORMS invites all attendees to join this special session presentation. The transition from individual contributor to people leader is often unnecessarily painful, and learning how to be an effective leader takes practice. During this session we will talk about the skills necessary to become a successful leader from delegation to setting boundaries, providing impactful feedback to managing up. We will learn how to "Fill our Cups" to become comfortable with the uncomfortable and realize we are right where we are supposed to be. This session is applicable to everyone, regardless of where you are in your career. Session attendees will have an opportunity to sign up for a 1-1 coaching session later in the day.

2 Session Chair: Lavanya Marla, University of Illinois at Urbana-Champaign, Urbana, IL

3 Panelist

Angelika Leskovskaya, SMU Cox School of Business, Dallas, TX

4 **Panelist**

Janice Lichtenwaldt, Virago Coaching, Seattle, WA, Contact: janice@viragocoaching.com

Monday, October 16, 10:45 AM - 12:00 PM

MB17

CC-North 127A

Human Behavior in Service Operations

Community Committee Choice Session

Session Chair: Brett Hathaway, Brigham Young University, Provo, UT

1 Limited Movement Means Vanishing Visits: How Patient Mobility and Signal Coarseness Reordered Healthcare Traffic in the Wake of Covid-19

RJ Niewoehner[1], Bradley R. Staats[2], [1]Kelley School of Business, Indiana University, Bloomington, IN, [2]University of North Carolina at Chapel Hill, Chapel Hill, NC, Contact: rniewoeh@iu.edu

Traffic represents a key operational input, but with the emergence of COVID-19 in 2020, traffic to many healthcare clinics fell dramatically overnight. Using aggregate measures of patient mobility, we seek to characterize factors that explain the drops in traffic. Our empirical analysis combines observations from healthcare clinics across several US states, anonymized cellphone mobility data, COVID-19 severity measures, and stay-at-home orders. We find (i) increases in personal mobility drive returns to clinic traffic, (ii) decreases in personal mobility lead to drops in traffic, and (iii) both effects are amplified for vaccination traffic. Combining observations from multiple sources allows us to evaluate how traffic to healthcare clinics changed with willingness to travel, stay-at-home orders, and other signals of environmental safety.

2 Multitasking in Livechat Support Centers

Robert Batt[1], Santiago Gallino[2], [1]Wisconsin School of Business, UW-Madison, Madison, WI, [2]University of Pennsylvania, Philadelphia, PA, Contact: bob.batt@wisc.edu

We explore the effect of multitasking on system performance in a livechat customer contact center. We find that while multitasking leads to increased chat handle time, the effect is does not increase linearly with multitasking level. We show that this can effect the optimal work assignment rule.

3 The Effect of Compensation Structure on Consumption Behavior

Paige Tsai, Harvard Business School, Boston, MA

We study the consumption behavior of individuals with multiple sources of labor income as compared to individuals with a sole source of labor income. While mental accounting literature has previously revealed that individuals mentally encode their financial activities differently based on the source of income, research to-date has yet to explore precisely how individuals treat labor income from a secondary labor income source. As part of this, we also examine the effect of income concentration on savings and spending behavior.

4 The Psychology of Virtual Queue: When Waiting Feels Less like Waiting

Kejia Hu[1], Xun Xu[2], Ao Qu[3], [1]Vanderbilt University, Nashville, TN, [2]California State University-Stanislaus, Turlock, CA, [3]MIT, Boston, TN

This study examines the impact of Virtual Queue (VQ) on customers' waiting complaints and overall satisfaction using restaurants' review data from 2015 to 2019. The study finds that VQ reduces customers' pre-process waiting complaints and enhances overall satisfaction but does not affect in-process waiting complaints. Service providers with high substitutability or low-value service benefit the most from VQ. The study recommends implementing VQ to manage perceived pre-process waiting time and generate positive online reviews.

Monday, October 16, 10:45 AM - 12:00 PM

MB18

CC-North 127B

Data-Driven Healthcare Operations

Community Committee Choice Session

Session Chair: Hamsa Bastani, 1</sup

Session Chair: Angel Chung, Wharton School,

Philadelphia, PA

1 A Hybrid Approach To Scalable Real-world Oncology Data Curation By Machine Learning And Human Experts

Holly Mika Wiberg, Carnegie Mellon University, Pittsburgh, PA, Contact: hwiberg@andrew.cmu.edu

Machine learning has the potential to increase the scale of real-world data curated from electronic health records, but maintaining data quality is important to avoid biasing downstream analyses. To increase scale without compromising quality, we propose a hybrid data curation approach that employs both manual abstraction by clinical experts and automated extraction by ML models. Our method determines when to employ manual abstraction using a confidence score associated with each model output. We describe a process for selecting confidence thresholds based on simulations validated against a reference-standard labeled dataset. To establish the fitness of our methodology for retrospective research, we apply it to a cohort selection task on a large real-world oncology database. Joint work: M. Waskom, K. Tan, A. Cohen, B. Wittmerhaus, W. Shapiro (Flatiron Health).

2 Learning Personalized Treatment Strategies with Predictive and Prognostic Covariates in Adaptive Clinical Trials

Andres Alban[1], Stephen E. Chick[2], Spyros Zoumpoulis[3], [1]Harvard Medical School, Boston, MA, [2]INSEAD, Fontainebleau, -, France; [3]INSEAD, Fontainebleau, France

We consider the problem of sequentially allocating sample observations to learn personalized treatment strategies, motivated by the design of adaptive clinical trials that aim to learn the best treatment as a function of patient covariates. In such settings there may be clinical knowledge of which covariates are predictive (they may interact with the treatment choice) and which are prognostic (they may influence the outcome independent of treatment choice). We extend the expected value of information (EVI)/knowledge gradient framework to develop useful heuristics for a context with predictive and prognostic covariates. We show that several of our proposed allocation policies are asymptotically optimal in learning treatment strategies. We run simulation experiments motivated by an application for clinical trial design to assess potential treatments of sepsis.

3 Privacy-Utility Tradeoffs in Healthcare Data

Sukanya Kudva[1], Anil Aswani[2], [1]UC Berkeley, Berkeley, CA, [2]UC Berkeley, Berkeley, CA, Contact: sukanya_kudva@berkeley.edu

Medical data is very valuable in healthcare: for care providers to make better-informed treatment decisions and in building AI algorithms for clinical decision support systems. However, a privacy breach in health data can mean unfair treatment, loss of livelihood, or social boycotts for an individual. The increasing awareness of the importance of data privacy has led to a changing privacy law landscape. In this work, we investigate: Can hospitals be incentivized to pay data dividends for collecting and using health data? Should they invest in protecting patient data? We construct a principal-agent model using a Stackelberg game to calculate hospitals' and patients' optimal decisions and qualitatively discuss the implications in policy.

4 Deep Generative Modeling for Patient Census Prediction

Tianchun Li, Pengyi Shi, Purdue University, West Lafayette, IN, Contact: li2657@purdue.edu

Patient census prediction is essential to hospital flow management and staffing decisions. However, challenges arise when predicting multi-day census time-series driven by correlated arrivals and discharges. We leverage state-of-art generative modeling and machine learning, integrated with patient flow dynamics, to design novel predictions and overcome these challenges.

Monday, October 16, 10:45 AM - 12:00 PM

MB19

CC-North 127C

Advances on Decision Analysis

Contributed Session

Session Chair: HUA CHEN, UGA, Athens, GA

1 As-If and Process Models of Labor Provision: A Case Study of the Taxi Market

Florian Artinger[1], Gerd Gigerenzer[2], Nikita Kozodoi[3], Florian von Wangenheim[4], [1]Berlin International University of Applied Sciences, Berlin, Germany; [2]Max Planck Institute for Human Development, Berlin, Germany; [3]Amazon Web Services, Berlin, Germany; [4]ETH Zürich, Zürich, Switzerland. Contact: florian.artinger@gmail.com

A fundamental assumption of expected utility models is that agents make predictions by formulating rational expectations. Building on this assumption, the literature has addressed to what extent neoclassical or behaviorally informed utility models best describe intertemporal substitution of labor and leisure, focusing on the taxi market. Using data from

10 million taxi trips, we find that hourly earnings are barely predictable. Under such uncertainty, satisficing models predict behavior of drivers better than utility models. These models do not require calculating expected earnings and terminate shifts when reaching an aspiration level on shift duration or earnings.

2 On the Disclosure of Defensive Posture: Adversarial Belief Formation and Target Selection Decisions

Kyle J. Hunt[1], Richard S. John[2], Sule Guney[3], Jun Zhuang[4], [1]University at Buffalo, Buffalo, NY, [2]University of Southern California, Los Angeles, CA, [3]University of California, Irvine, Irvine, CA, [4]University at Buffalo, Buffalo, NY, Contact: kylehunt@buffalo.edu

We focus on the problem of technology deployment and information disclosure in security and defense settings. We conduct human subject experiments (N = 975) to study (i) adversarial beliefs regarding where new defense technology is deployed (including how such beliefs are formed) and (ii) target selection/attack decisions. In the experiments, the participants played the role of an adversary, and were tasked with making target selection decisions in response to (potentially deceptive) information released by a defender. Among many interesting insights, we find that the information released by the defender, and the defender's target valuations (which is treated as common knowledge), have a significant effect on the participants' beliefs regarding where the new technology is deployed. These beliefs also transfer to the participants' target selection decisions.

3 Training Scalable Personalization Policies with Constraints

Haihao Lu[1], Duncan I. Simester[2], Yuting Zhu[3], [1]University of Chicago Booth School of Business, Chicago, IL, [2]MIT, Cambridge, MA, [3]National University of Singapore, Singapore, Singapore. Contact: y.zhu@nus.edu.sg

Personalization has attracted broad attention in both academia and industry. While most research has focused on training personalization policies without managerial constraints, in practice, many firms face managerial constraints when implementing these policies. For example, firms may face volume constraints on the maximum or minimum number of actions they can take. They may also face similarity (fairness) constraints, that require similar actions with different groups of customers. These constraints can introduce difficult optimization challenges, particularly when the firm intends to implement personalization policies at scale. We show how recent advances in linear programming can be adapted to the personalization of marketing actions. We implement the proposed method, and compare it with benchmark methods on feasibility and computation speed.

4 Decision-Making as Categorization

Yifan Hong[1], Chen (Mavis) Wang[2], [1]Tsinghua University, Beijing, China; [2]Tsinghua University, Beijing, China. Contact: hongyf19@gmail.com

Humans can make quick decisions in complex environments. One possible explanation is that: humans perform rule-based decision-making based on the inferred category of the context, which reduces task-irrelevant information and supports powerful generalization to different contexts. We transform common decision models (including typical normative and descriptive models) into categorization tasks that directly map contextual features to decision options. We propose a categorization model based on a hierarchical mixture of probabilistic principal components that simultaneously learn a parsimonious set of categories and features. We validate the model through simulation and large-scale behavioral experiments.

5 Does Information Matter: Contests in a Complex Structure

Hua Chen[1], Kevin Chung[2], [1]The University of Georgia, Athens, GA, [2]University of Wisconsin-Madison, Madison, WI, Contact: huachen@uga.edu

Consider a contest conducted in a 3-tier organization where the owner provides a winning prize for branches to compete and the manager of each branch offers a reward to motivate his agents. The standard economic theory predicts that the information on total winning prize or the reward offered to the opponent agents would have no impact on the effort decisions by the focal agent. Using an incentive-aligned lab experiment, however, the authors find that: 1) the agents adjust their effort based on their knowledge about the total winning prize or the reward offered to the opponent agents; 2) the managers modify their reward upward (downward) when either (both) of the information is revealed to the agents. These behavioral regularities are explained by a model that incorporates the fairness concerns (vertical and horizontal) into the agent's utility function.

Monday, October 16, 10:45 AM - 12:00 PM

MB20

CC-North 128A

Health and Public Policy

Flash Session

Session Chair: Sze-chuan Suen, University of Southern California, Los Angeles, CA
Session Chair: Suyanpeng Zhang, University of Southern California, Los Angeles, CA

1 A Greedy Discretization for Continuous State Dynamic Programming in Infectious Disease Control

Suyanpeng Zhang, Sze-chuan Suen, University of Southern California, Los Angeles, CA

The Covid-19 outbreak emphasized the need to study policies to prevent and control the transmission of infectious diseases. However, the continuous state space of compartmental models for describing infectious disease render it difficult to implement tractable Markov decision processes (MDPs) to identify the optimal disease control policy over time. We therefore develop an algorithm for discretizing continuous states for approximate MDP solutions in this context and demonstrate its performance against several benchmarks in a example of COVID-10 in Los Angeles County.

2 Forecasting the 10-Year Evolution of the Covid-19 Surgical Procedure Gap in Ontario, Canada

Rachel Stephenson[1], Vahid Sarhangian[1], David Gomez[2], Timothy C. Y. Chan[1], [1]University of Toronto, Toronto, ON, Canada; [2]Unity Health, Toronto, ON, Canada

The COVID-19 pandemic has caused major disruption to surgery rates worldwide, resulting in significant procedure gaps that must be addressed. We used Negative Binomial regression to estimate the expected size of procedure gaps for a set of procedure groups in Ontario, Canada as of June 2022. We applied Monte Carlo simulation to estimate the evolution of the procedure gaps over 10 years under different future COVID and surgical capacity scenarios. We found that significant increases in surgical capacity are required to reduce the procedure gap in the near term. For these investments to be fair and effective, they must consider the heterogeneity of the impacts of COVID on different procedure groups. Procedure groups with the largest current gaps may not be the ones most in need of increased capacity.

3 A Mechanistic Simulation Model for Integrating Social Conditions and STIs: A Case Study of HIV and HPV

Xinmeng Zhao[1], Chaitra Gopalappa[2], [1]University of Massachusetts Amherst, Amherst, MA, [2]University of Massachusetts, Amherst, Amherst, MA, Contact: xinmengzhao@umass.edu

Social conditions are among key drivers of behaviors that increase the risk of sexually transmitted infections (STI). In addition to common behavioral factors, presence of one STI can biologically increase the risk of another. We developed methods to mechanistically model behaviors as function of social conditions and jointly simulate STIs, for analyses of structural and behavioral intervention decisions.

4 Modelling Trade-Offs in Efficiency, Equity, and Fairness in Public Defibrillator Placement

K.H. Benjamin Leung[1], Gareth Clegg[2], Diane Lac[2], Timothy Chan[1], [1]University of Toronto, Toronto, ON, Canada; [2]The University of Edinburgh, Edinburgh, United Kingdom. Contact: benkh.leung@mail.utoronto.ca

The maximum coverage location problem (MCLP) is a useful approach to determine optimal locations to publicly accessible defibrillators for out-of-hospital cardiac arrest, and has been shown to outperform population-guided heuristics and clinical guidelines. Prior research has focused on maximizing spatial coverage of cardiac arrests across the whole study region; however, this may lead to allocations that are inequitable or unfair across communities of varying geographies, demographics, and socioeconomic levels. We introduce formulations that incorporate trade-offs between the efficiency, equity, and fairness of coverage across study subregions, and compare the standard MCLP with our proposed formulation using cardiac arrest and defibrillator location data from Scotland.

5 Novel Renewable Energy Network Optimization for Global Health Clinics

Rebecca Alcock[1], Justin J. Boutilier[2], [1]University of Wisconsin–Madison, Madison, WI, [2]University of Wisconsin-Madison, Madison, WI, Contact: ralcock@wisc.edu

We have devised a framework for the sizing of solar + storage + EV energy systems for rural health clinics in resource-limited settings. The results allow stakeholders to explore the tradeoff between upfront cost and the system's resilience to unusual weather and demand events. We will present a case study of an indigenous community in northern Colombia, who have partnered with us on this effort.

6 A Microsimulation Model of Mpox in Los Angeles County: The Impact of Vaccination Strategies and Sexual Behavior Changes Among Men Who Have Sex with Men (Msm)

Citina Liang[1], Sze-chuan Suen[1], Chenglin Hong[2], Andrea Kim[3], Rita Singhal[3], Paul Simon[3], Mario Perez[3], Ian Holloway[2], [1]University of Southern California, Los Angeles,

CA, [2]University of California, Los Angeles, Los Angeles, CA, [3]Los Angeles County Department of Public Health, Los Angeles, CA, Contact: citinal@usc.edu

The 2022 mpox outbreak in Los Angeles County (LAC) emphasized the need to prepare for preparedness in addressing emergent infectious diseases. We developed an individual-level microsimulation model of MSM in LAC that tracked mpox health and vaccination states over time. Our study assessed the impact of varying vaccination rates, timing of vaccination roll-out, and allocation strategies targeting different racial/ethnic groups and PLWH, along with a delayed reduction or rebound in sexual behavior. Results emphasized the significance of prompt interventions, strategic vaccination approaches, and focusing on vulnerable risk groups like PLWH in controlling mpox. Moreover, our model demonstrated the potential effectiveness of adjusting sexual contact rates and combining these factors to optimize disease control.

7 Assessing the Impact of Covid-19 on HIV Outcomes: A Modeling Study

Evin Jacobson, CDC, Atlanta, GA

To better understand the implications of COVID-19 on HIV outcomes in the United States, we used a national-level compartmental model. We ran the model accounting for pandemic-related changes in behavior and HIV care provision and then ran it again without those changes in a hypothetical comparator scenario. The COVID-19 scenario had lower ART adherence, viral suppression, and diagnosis rates compared with the comparator scenario, leading to higher incidence over the period 2020-30. Our analysis suggested that disruptions from COVID-19 may have led to sustained adverse effects on national HIV outcomes. These results underscore the need for increased HIV testing, prevention, and care services to offset setbacks in the fight against HIV.

8 Modeling the Impact of Injectable Versus Oral Pre-Exposure Prophylaxis (PrEP) on HIV Incidence and Cost Outcomes in the United States

Nidhi Khurana[1], Katherine A. Hicks[2], Justin Carrico[2], Evin Jacobson[1], Paul G. Farnham[1], [1]CDC, Atlanta, GA, [2]RTI, Research Triangle Park, NC, Contact: kqt3@cdc.gov

Oral PrEP programs for HIV prevention continue to face the challenges of low adherence and high dropout rates. Injectable PrEP could help overcome some of these challenges. We used a dynamic compartmental model to estimate HIV incidence and cost outcomes in the United States from 2022 to 2031 for different portions of people initiating and re-initiating PrEP using injectable versus oral PrEP starting with its introduction in 2022. The model included two levels of adherence, which affected cost and effectiveness of PrEP. We assumed lower dropout rates, higher annual costs, and higher efficacy for injectable PrEP compared with oral PrEP. Our results showed that the scenarios with increasingly higher injectable PrEP versus oral PrEP uptake resulted in more people on PrEP overall, fewer new HIV infections, higher PrEP spending, and lower HIV treatment and care spending.

9 Sexual Mixing Matrix Calculator

Shalome Hanisha Anand Tatapudi, University of South Florida, Tampa, FL, Contact: tatapudi@mail.usf.edu

Understanding human mixing behavior is pertinent to developing disease transmission models, especially for sexually transmitted infections. Models commonly use aggregate behavior patterns and interactions from survey data or assumptions to develop contact matrices that consider age and sexual activity levels as the main factors. However, such models fail to examine the inherent heterogeneities in human interactions that are dictated by sexual orientation, race, occupation, geography, and partnership type. In this study we developed an agent-based model that aims to simulate heterogenous features in human behavior and track contacts based on mixing patterns related to sexual behavior. The output is a dynamic contact matrix that evolves over time, with sexual preferences based on behavior, and can be integrated with existing models that use contact matrices.

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Healthcare Delivery Analytics

Community Committee Choice Session

Session Chair: Yichuan Ding, McGill University, Montreal, QC, Canada

Session Chair: Yiwen Jin, University of British Columbia, Sauder School of Business, Vancouver, BC, Canada

1 Network Models for Centralized Surgical Scheduling with Heterogeneous Operating Time Distributions

Andre Augusto Cire[1], Carlos Henrique Cardonha[2], Adam Diamant[3], [1]University of Toronto Scarborough, Rotman School of Management, Toronto, ON, Canada; [2]University of Connecticut, Storrs, CT, [3]Schulich School of Business, Toronto, ON, Canada. Contact: andre.cire@rotman.utoronto.ca

We propose an approximation architecture for prescriptive models with probabilistic constraints that utilizes network-based encodings. Each network represents a compressed decision tree that establishes a sequence of decisions, and the size of these decision trees can be adjusted to relax or restrict the risk associated with violating the probabilistic constraint. We apply our approach to determine how best to schedule and sequence surgeries to reduce the surgical backlog brought on by the COVID-19 pandemic. In contrast to existing work, the network-based approach allows us to account for surgeon-specific surgical durations. We compare our model to existing approximations for chance-constrained models using a dataset of approximately 24,000 surgeries and 80 surgeons to demonstrate its effectiveness at reducing the surgical backlog in a real-world setting.

2 A Data-Driven Approach to Address Fragmented Hospital Readmission Among Older Adults

Vedat Verter[1], Somayeh Ghazalbash[2], Manaf Zargoush[3], [1]Queen's University, Kingston, ON, Canada; [2]McMaster University, Hamilton, ON, Canada; [3]Health Policy & Management, DeGroote School of Business, McMaster University, Hamilton, ON, Canada. Contact: vedat.verter@queensu.ca

Disruption in the continuity of care occurs when a patient receives the same level of care (e.g., primary, acute, or specialty care) from different providers. To help mitigate fragmented readmissions and associated inequities, we aim at predicting its occurrence and suggest targeting the interventions on patients with a high risk of this undesirable event. We examine the fairness implications of the proposed analytical framework at both predictive and prescriptive stages to ensure parity among patients and comprehensively assess algorithmic bias using eleven prominent notions of fairness. The resulting framework includes equity considerations in the data-driven decision-making process to reduce disparities among equity-seeking populations through fair resource allocation, potentially reducing direct and indirect costs associated with care fragmentation.

3 Health It Adoption and Outpatient Market Competition: The Role of Patient Portals

Yao Li[1], Lin Qiu[1], Susan F. Lu[2], Lauren Xiaoyuan Lu[3], [1]Southern University of Science and Technology, Shenzhen, China; [2]Purdue University, West Lafayette, IN, [3]Dartmouth College, Hanover, NH

Patient portals provide patients online access to their health information without constraints of time and location. This smooths the communication between patients and care providers and may influence patients' selection of hospitals. This study examines the impacts of patient portal adoption on the outpatient traffic of hospitals, with hospital-level yearly outpatient visit data from 2008 to 2017. We find that patient portal adoption increases outpatient visits by 7.8% and this effect is moderated by hospital size, regional market condition, and patient portal adoptions of neighboring hospitals. We further conduct a patient-visit level analysis, suggesting that the attracting effect of the patient portal diminishes as patients' traveling distance to hospitals increases.

4 Patient Arrival Times in Hospitals: A Dynamic Queueing Game and Mechanism Design

Yichuan Ding, McGill University, Montreal, QC, Canada. Contact: daniel.ding@mcgill.ca

In this study, we analyze patients' decision-making regarding arrival times at an endoscopy center operating on a first-come, first-served basis. While patients prefer to complete their treatment as early as possible, arriving too early can result in longer waiting times. Our research focuses on a queueing game in which each patient selects an arrival time that minimizes their expected cost. Utilizing data from an endoscopy center, we investigate patients' arrival time choices within a dynamic game framework. We then model this scenario as a repeated game and demonstrate that the arrival times converge to a Nash equilibrium. Furthermore, we explore the design of mechanisms that can guide the system toward an equilibrium with improved social welfare.

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Using Data Analytics to Improve Healthcare Systems

Community Committee Choice Session

Session Chair: Shan Liu, University of Washington, Seattle, WA

1 Variation in Ineligible Donor use in the Us is Mostly Driven by Decisions at the Level of the Transplant Center Rather than the Organ Procurement Organization

Yili Wang, Luke DeRoos, Mariel Sofia Lavieri, David W. Hutton, Peter Todd, Neehar Parikh, University of Michigan, Ann Arbor, MI

Rising organ demand and improved transplantation practices boosted the use of ineligible donors. Enhancing the utilization of these donors is crucial to provide more lifesaving organ transplantation. This study investigates how demographic and system-level factors, such as waitlist size, organ discard rates, and number of donors, affect ineligible donor use at both the organ procurement organization (OPO) and transplant center (TC) levels. Using donor data from the Organ Procurement and Transplantation Network's Standard Transplant Analysis and Research (January 2008 to December 2021), beta regression models were developed to analyze these factor relationships. At the TC level, higher donation volume, larger waitlist, and increasing waitlist size were associated with higher ineligible donor use, but these associations were not significant at the OPO level.

2 Mechanistic Modeling of Social Conditions into Disease Predictions for Public Health Intervention-Analyses

Chaitra Gopalappa[1], Amir Khosheghbal[2], [1]University of Massachusetts, Amherst, Amherst, MA, [2]UMass Amherst, Amherst, MA, Contact: chaitrag@umass.edu

Decision analytic models typically simulate infection spread as a function of behaviors, and evaluate the impact of behavioral interventions. As social conditions are key determinants of health, some models superficially consider the need for structural interventions as part of behavioral interventions. Using HIV as a case study, we developed a methodological framework, using Markov random field model to estimate joint probability distributions between social conditions and behaviors, and mechanistically modeled behaviors as functions of social conditions, prior to simulating HIV transmissions as a function of behaviors. We present the methodology and sample what-if intervention analyses to demonstrate its potential use in informing intervention decisions.

3 Estimated Effectiveness and Cost-Effectiveness of Opioid use Disorder Treatment Under U.S. Regulatory Relaxations: A Model-Based Analysis

Gary Qian[1], Margaret L. Brandeau[2], [1]Stanford, Stanford, CA, [2]Stanford University, Stanford, CA

The COVID-19 pandemic prompted new flexibilities in treatment for opioid use disorder, including telehealth treatment and take-home doses of medications for OUD (MOUD). A current legislative proposal aims to make several of these regulatory relaxations permanent. We used a model-based analysis to assess thepotential effectiveness and cost-effectiveness of MOUD provision under the proposed regulatory relaxations, allowing for both potential benefits (increased access to and retention in treatment) and harms (misuse or diversion of take-homedoses). Our findings underscore the importance of rigorous ongoing evaluation and flexible policy design to adapt to evolving healthcare landscapes and patient needs.

4 Queueing-Location-Allocation Model Under Stochastic Demand

Yinsheng Wang, Shan Liu, Chaoyue Zhao, University of Washington, Seattle, WA, Contact: yinshw@uw.edu

Minimizing turnaround time for HIV viral load testing by placing point-of-care testing machines in a hub-and-spoke network is crucial to improve HIV care, particularly in resource limited settings. Our previous research has successfully developed practical decision-support tools for HIV viral load and drug resistance testing in western Kenya. In light of demand uncertainty in testing samples, we extend our work to formulate and solve a Queueing-location-allocation model with integer programming, leveraging Conditional Value at Risk (CVaR). By incorporating CVaR, we effectively manage uncertainties and risks associated with testing demand, thereby enhancing the delivery of HIV care.

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Continuous Location Analysis I

Community Committee Choice Session

Session Chair: Pawel J. Kalczynski, California State University-Fullerton, Fullerton, CA

Session Chair: Zvi Drezner, California State University Fullerton, Fullerton, CA

1 Stochastic Multipurpose Shopping Trips and Location

Zvi Drezner[1], Morton O'Kelly[2], Pawel J. Kalczynski[3], [1]California State University Fullerton, Fullerton, CA, [2]Ohio State University, Columbus, OH, [3]California State University-Fullerton, Fullerton, CA, Contact: pkalczynski@fullerton.edu

In the competitive multi-purpose (MP) trips model, it is assumed that the proportion of customers that do MP trips is given. In this paper, we investigate the model with a stochastic proportion of MP trips. Five decision analysis criteria are analyzed for finding the best location for a new facility under these circumstances. Such an analysis can be applied to other location models (not necessarily competitive) when a parameter of such models is stochastic.

For example, in conditional location or competitive models, there is uncertainty about whether one of the existing facilities will stay in business. In the leader-follower (Stackelberg equilibrium) model, there is a probability that a future competitor will establish a competing facility. The probability is not necessarily equal to 1.

2 On the Combined Inverse-square Effect of Multiple Points in Multidimensional Space

Keaton P. Coletti[1], Pawel J. Kalczynski[2], Zvi Drezner[3], [1]University of Georgia, Athens, GA, [2]California State University-Fullerton, Fullerton, CA, [3]California State University Fullerton, Fullerton, CA, Contact: keaton.coletti@uga.edu

The inverse-square law states that the effect a source has on its surroundings is inversely proportional to the square of the Euclidean distance from that source. Its applicability spans fields including physics, engineering, and computer science. This study investigates the combined effect of multiple point sources surrounding a region in multidimensional space. It shows that, regardless of source configuration and region shape, the maximum effect in D dimensions is on the region's boundary if D≤4, and the minimum is on the boundary if D≥4.

3 Solving Unconstrained Optimization Problems by a Trajectory Solution Approach

Zvi Drezner[1], Malgorzata Miklas-Kalczynska[2], [1]California State University Fullerton, Fullerton, CA, [2]California State University - Fullerton, Fullerton, CA

We propose solving non-constrained optimization problems by a trajectory method. A parameter is introduced into the optimization problem. For a particular value = 0, the optimal solution is easily obtained. The original optimization problem is defined for another value = 1. A trajectory connects the easily obtained solution for 0, to the desired solution for 1. We trace the trajectory and the solution for 1 is at the end of the trajectory. The procedure is tested on a competitive location problem with good results.

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Emerging Topics in Decision-Making Under Uncertainty

Community Committee Choice Session

Session Chair: Hansheng Jiang, University of California, Berkeley, Berkeley, CA

1 An Active Learning Framework for Multi-Group Mean Estimation

Abdellah Aznag[1], Rachel Cummings[2], Adam Elmachtoub[2], [1]Columbia University, New York City, NY, [2]Columbia University, New York, NY, Contact: aa4693@columbia.edu

We consider an active learning framework for estimating the means of multiple distinct groups. In each period, we observe a single sample from a group of our choice and update the corresponding mean estimate. The goal is to dynamically collect samples to minimize the norm of the vector of variances of our estimators after T rounds. Using a UCB-like algorithm, we show that the regret of our algorithm is O(T^-2) for finite norms and O(T^-1.5) for the infinite norm. Moreover, we provide matching lower bounds to prove tightness of our algorithm.

2 Pricing in On-Demand (And One-Way) Vehicle Sharing Networks

Xiaobing Shen, Saif Benjaafar, University of Minnesota, Minneapolis, MN, Contact: shen0341@umn.edu

We consider the dynamic pricing problem that arises in the context of an on-demand vehicle sharing system with one-way trips. In this paper, we use a recursive relationship that relates system availability in a system with K vehicles to one with K-1 vehicles to produce a sequence of increasingly tight bounds. The worst of these bounds is given by K/(N+K-1+/μ), where is the total demand (sum of all trip requests) rate and 1/μ is the average trip travel time, implying a convergence rate that is at least of order 1- O(1/K) in the number of vehicles for fixed /μ. The same recursive relationship can be used to obtain a bound that is independent of /μ and that is tighter than previous bounds, implying a convergence rate that is at least of order 1-O(1/√K).

3 Partitioning with a Move Budget

Elaheh Fata[1], Mina Dalirrooyfard[2], Majid Behbahani[3], Yuriy Nevmyvaka[4], [1]Queen's University, Kingston, ON, Canada; [2]Morgan Stanley, London, United Kingdom; [3]Morgan Stanley, Montreal, QC, Canada; [4]Morgan Stanley, New York City, NY

Given a set of k terminals, the Multiway cut problem asks for a partitioning of the graph into k partitions such that each partition has exactly one terminal and the sum of the weights of the edges between partitions (i.e., the cut value) is minimized. In many real-world scenarios, there already exists a k-partitioning of an underlying graph and the goal is to reduce the cut value by only moving a few nodes across partitions. This motivates us to introduce and study the r-move k-partitioning problem. Given a graph, a set of k terminals and an initial partitioning, the r-move k-partitioning problem asks to find a k-partitioning with minimum-weighted cut among all the k-partitioning that are created by moving at most r non-terminal nodes to partitions different from their initial ones. We develop several approximation algorithms for this problem.

4 Online Discrete Convex Optimization

Jefferson Huang[1], Louis Chen[2], [1]Naval Postgraduate School, Monterey, CA, [2]Naval Postgraduate School, Monterey, CA

In online optimization, a decision-maker (DM) plays the following repeated game: In each round, after selecting a feasible decision, the DM receives feedback from a (possibly adversarially chosen) cost function. We consider online discrete optimization where the cost functions have properties that are analogous to convexity, which are also relevant to many operations models. Specifically, we present algorithms and performance guarantees for online L-natural convex minimization, and for online M-natural concave maximization. When the decision vectors are binary, the former corresponds to online submodular minimization, while the latter corresponds to a special case of online submodular maximization.

5 A General Equilibrium Model for Transportation Systems with Ride-Hailing Services and Customer Waiting

Wei Gu, Maged Dessouky, Jong-Shi Pang, Qin Ba, University of Southern California, Los Angeles, CA, Contact: weig@usc.edu

In this study, we develop a general equilibrium model to understand the relationship between ride-hailing services and customers' waiting time in urban transportation networks. The equilibrium model includes three interacting sub-models: ride-hailing company choice, customer choice, and customer waiting time. The ride-hailing companies' choices and customers' choices are formulated as a generalized Nash equilibrium, while customers' waiting times are formulated using queueing theory. Then we provide the conditions under which there exists an equilibrium solution. The proposed model is validated using numerical experiments.

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CC-North 131A

Recent Advancements in Healthcare Operations

Community Committee Choice Session

Session Chair: Jong Myeong Lim, Tuck School of Business at Dartmouth, Hanover, NH

1 Improving Broader Sharing to Address Geographic Inequity in Liver Transplantation

Shubham Akshat, Carnegie Mellon University, Pittsburgh, PA

In the transplant community, broader organ sharing is believed to mitigate geographic inequity (intergeographic variation in transplant rates, patient survival rates, waiting times, and offers) in organ access, and recent policies are moving in that direction in principle. In this study, we develop a patient's dynamic choice model to analyze the patient's strategic response to a policy change. We use this to evaluate several (existing and proposed) organ-allocation policies. On historical data, we show that our model's predictions are more precise than the existing liver simulated allocation model. It more accurately captures (1) a patient's change in organ offer acceptance probability (with their sickness level) and (2) the behavioral change of a patient in terms of organ offer acceptance probability with a change in policy. Next, we conduct counterfactual studies.

2 Assortment Optimization of Crowdsourcing Contests for Medical Diagnosis Based on "revealed Motivations" of Participants

Olumurejiwa Fatunde[1], Gonzalo Romero[2], [1]Rotman School of Management, Toronto, ON, Canada; [2]Rotman, University of Toronto, Toronto, ON, Canada

In this paper we study how contest offerings can be selected optimally to improve crowdsourcing, using data from a healthcare platform that runs rank-order tournaments to collect and aggregate diagnostic opinions. The platform owners can tailor contest offerings/ prizes in order to attract users and improve accuracy. We borrow from the dynamic assortment planning literature by framing the contest offering decision as an assortment problem with independent search, perishable goods and non-independent demand. We use historical data to "learn" whether users are primarily driven by learning opportunities, monetary prizes, or affinity for competition. We define the optimal assortment, considering both motivation-specific user utility and platform aims. This paper applies assortment planning in a unique setting, incorporating the behavioral factors shaping demand.

3 Health on Loan: The Effect of Local Creditavailability on Hospital (Re)admissions

Yuan Ma, Andrew Wu, Jun Li, Ross School of Business, University of Michigan, Ann Arbor, MI, Contact:

yuanmato@umich.edu
Bank loans are crucial sources of finance for hospitals. This paper assesses the effect of increases in localcredit supply on healthcare outcomes. We show that the total admission drop when there are more creditsavailable in local banks, and the decrease is driven by decreases in readmission.

4 It Takes Two to Make It Right: How Nurses' Response to Sepsis Alerts Impacts Physicians' Process Compliance

Zahra Mobini[1], Mehmet U.S. Ayvaci[2], Ozalp Ozer[3], [1]Georgia Tech, Atlanta, GA, [2]The University of Texas at Dallas, Richardson, TX, [3]Amazon, Richardson, TX, Contact: zahra.mobini@gatech.edu

We empirically examine how a clinical team, consisting of the two roles of nurse and physician, provides care in compliance with evidence-based standards using a sepsis alert system. In particular, we study whether and when nurses' timely response to sepsis alerts (i.e., acknowledging the alert and notifying physicians within a designated time frame) impacts physicians' compliance with sepsis care standards (i.e., performing diagnostic or treatment actions within a designated time frame). Using data from a hospital system in the US, we find that nurses' timely response to alerts has a positive spillover effect on physicians' compliance, and this effect becomes stronger as workload increases and weaker as the number of false alerts increases.

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CC-North 131B

New Developments in the Operations-Finance Interface

Community Committee Choice Session

Session Chair: Kashish Arora, Indian School of Business, Hyderabad, India

1 Can Risk Disclosures Contribute to Supply Chain Risk Transparency? Evidence from the Covid-19 Pandemic

Keno Theile[1], Kai Hoberg[2], Vinod R. Singhal[3], [1]Kuehne Logistics University, Hamburg, Germany; [2]Kühne Logistics University, Hamburg, Germany; [3]Georgia Institute of Technology, Atlanta, GA, Contact: keno.theile@the-klu.org

Materialized supply chain risks have detrimental operational and financial outcomes. Gathering a priori risk information is challenging for firms. Publicly traded firms must disclose risks in 10-K reports, but the informativeness of this information remains uncertain. Using COVID-19 as a natural experiment, we find that firms disclosing pandemic risks experience increased equity and idiosyncratic risks, but no change in systematic risk. Risk disclosures are valuable, as disclosing firms are riskier when the risk materializes.

2 Operational and Financial Hedging Decisions in the Presence of Business Cycles

Rene A. Caldentey[1], Abel Cadenillas[2], [1]The University of Chicago, Chicago, IL, [2]University of Alberta, Edmonton, AB, Canada. Contact: rene.caldentey@chicagobooth.edu

We consider a corporation whose operational cashflows evolve according to a jump-diffusion process that is partially correlated with capital returns in the financial market. The corporation selects investment and operational policies continuously to maximize its expected utility of terminal wealth. We obtain explicit solutions for logarithmic and power utility functions. We study the impact of the corporation's risk aversion, the correlation between the operational and the capital returns, and the regime of the economy on the optimal policy. We find, among other things, that the regime of the economy, and the correlation between the operational and the capital returns, have a significant effect on the optimal policy.

3 A Structural Model of Operating Cash Flow Management

Kashish Arora[1], Vishal Gaur[2], [1]Indian School of Business, Hyderabad, India; [2]Cornell University, Ithaca, NY, Contact: kashish_arora@isb.edu

A firm's cash flow from operations is a function of the contemporaneous and lagged values of its operational variables---sales, operating cost, inventory, payables, etc. Estimating this function is important for forecasting and managing cash flows. However, cash flow forecasting and management are challenging problems. In this paper, we propose a generalizable model of a firm's operations to disentangle this endogeneity and estimate causal impacts among variables. By estimating our model using quarterly public financial data from S\&P's Compustat database for 1990-2020, we obtain several results. We provide evidence that cash flow has both endogenous and lagged relationships with sales and inventory. Also, our model helps quantify the short- and long-run impacts of structural shocks in variables on the entire system.

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CC-North 131C

Service Operations with Strategic Queueing

Community Committee Choice Session

Session Chair: Andrew E. Frazelle, The University of Texas at Dallas, Richardson, TX

Session Chair: Pnina Feldman, Boston University, Boston, MA

1 Matching Technology and Competition in Ride-Hailing Marketplaces

Kaitlin Daniels[1], Danko Turcic[2], [1]Washington University in St. Louis, Olin Business School, Saint Louis, MO, [2]University of California, Riverside, 900 University Ave., CA, Contact: k.daniels@wustl.edu

Operational differences distinguish taxis from Uber. To form matches, taxis use street hailing while Uber uses central dispatch. Moreover, taxi supply is regulated while individual driver decisions determine Uber's supply. We provide a novel characterization of the distribution of street hailing wait times, which we compare to the established wait distribution with central dispatch. While central dispatch typically delivers much shorter average wait, street hailing can offer a higher chance of a short wait. We construct a model of competition between taxis and Uber over heterogeneous and wait-sensitive passengers and ask whether taxis capture more market share if they imitate Uber's central dispatch. While this strategy improves matching efficiency, the reaction to this change among Uber drivers and heterogeneous passengers can leave taxis worse off.

2 On The Value Of Service-age Information

Ricky Roet-Green[1], Lin Zang[2], [1]Simon Business School, University of Rochester, Rochester, NY, [2]University of Rochester, Rochester, NY, Contact: ricky.roet-green@simon.rochester.edu

We study how service-age information, which is the information regarding the time elapsed since the beginning of the current service, influences customers' strategic joining decisions in queueing systems with general service distributions. We analyze the joining behavior of a new arriving customer who observes both the queue length and the current service age. To explore the value of information, we compare the results with those of an observable M/G/1 queue without service-age information. We show that customers decisions are simplified when service age is provided. We find that disclosing service-age information can increase both throughput and social welfare. Our results imply that a revenue-maximizing provider (social planner) should disclose (conceal) service-age information when system congestion is high and conceal (disclose) it otherwise.

3 Strategic Double-Booking and Its Impact on Healthcare Operations

Olga Bountali[1], Arseniy Gorbushin[2], Opher Baron[3], Binyamin Oz[4], [1]Rotman School Of Management, University of Toronto, Toronto, ON, Canada; [2]Rotman School of Management, Toronto, ON, Canada; [3]University of Toronto, Toronto, ON, Canada; [4]Hebrew University of Jerusalem, Jerusalem, Israel. Contact: arseniy.gorbushin@rotman.utoronto.ca

During the COVID-19 vaccination process, a significant mass of patients booked double (or multiple) appointments for their vaccines with the hope of receiving treatment faster. This led to many unfulfilled appointments (a.k.a. no-shows) worldwide, left capacity under-utilized, and hindered the efficiency of the vaccination process during a very crucial period. We introduce a queuing model with strategic patients to capture the single- vs. double-booking decisions and examine their impact of system performance and patient outcomes. We use a benchmark representative of transparency, where a central mechanism allows patients to only single book, and quantify the corresponding loss/gain induced by double-booking. We further explore potential interventions for central planners and policy makers to mitigate the negative effects of double-booking.

4 Two-Sided Subsidies for Complementary Products: The Case of Electric Vehicles

Runyu Tang[1], Saed Alizamir[2], Michael Blair[2], [1]Xi'an Jiaotong University, Xi'an, China; [2]Yale University, New Haven, CT

Electric Vehicles (EVs) are touted as the future of urban transportation and a solution to climate change. Many governments have introduced financial incentive policies, ranging from directly supporting EV purchasers to hybrid policies that subsidize both buyers and station developers. We analyze a government's problem of designing subsidy policies for EVs and investigate the benefits of implementing a hybrid policy. Our model captures the complementarity between EVs and charging stations, which helps us characterize the optimal subsidy mechanism for both sides of the market. We examine the impact of different technology and market characteristics on the government's policy and calibrate our model with real-life data and measure the benefits of subsidizing purchasers and investors simultaneously.

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Emerging Topics in Inventory and Revenue Management

Community Committee Choice Session

Session Chair: Zhichao Feng, Hong Kong Polytechnic University

1 Sample Complexity of Policy Learningfor Inventory Control with Censored Demand

Xiaoyu Fan, Stern School of Business, New York University, New York, NY

We consider the newsvendor problem with unknown demand distribution and propose sampling-based approximation policies using censored demand data. We develop both upper and lower bounds for the number of samples required to guarantee that the performance of our proposed policy is close to that of the true optimal policy at any given accuracy level.

2 M/M/s on Demand: Queues with On-Demand and Reserved Servers

Zhichao Feng[1], Milind Dawande[2], Ganesh Janakiraman[3], Anyan Qi[2], [1]Hong Kong Polytechnic University, Kowloon, Hong Kong; [2]The University of Texas at Dallas, Richardson, TX, [3]University of Texas- Dallas, Richardson, TX, Contact: zhi-chao.feng@polyu.edu.hk

We analyze a canonical M/M/s queueing system that employs both "reserved" and "on-demand" servers - the number of reserved servers is decided at the beginning of the time horizon while the number of on-demand servers is decided dynamically as needed, in real time. We study two problems. The first is that of minimizing the infinite-horizon, expected discounted cost incurred in the hiring of the servers and in the waiting of the jobs in the queue. The second is that of minimizing the long run average cost. Our main result is the structure of the optimal policies for these two problems. In particular, we show that, in each of these problems, the optimal on-demand capacity control is a threshold-based bang-bang policy: If the number of jobs in the system is below a threshold, then no on-demand servers are employed. Otherwise, the number of on-demand servers is chosen such that no jobs wait.

3 Selling to a Market with a Finite Population

Arnoud den Boer, University of Amsterdam

Much of the dynamic pricing literature assumes Poisson arrivals of buyers. This implies that demand is in principle unbounded, which is not always realistic. We therefore consider dynamic pricing for a finite population of potential buyers. This completely changes the dynamics. With calculus-of-variations techniques we are able to derive an explicit expression for the optimal price as function of time. The firm does not need to know the market size to derive this function. Interestingly, the dynamic nature of prices turns out to be a first-order effect: even without inventory constraints, the optimal price changes over time. In contrast, dynamic pricing is merely a second-order effect in the Poisson arrival model, where a fixed-price policy is optimal in a large-inventory regime or if inventory is infinite.

4 Multi-Product Dynamic Upgrades

Xiao Zhang, Justin Goodson, Saint Louis University, Saint Louis, MO, Contact: xiao.zhang@slu.edu

Upgrades in travel industry are often static and offered either at the booking time or at the check-in time. In this paper, we study dynamically-offered upgrades by a multi-product firm via notifications (e.g., emails) between the booking and the check-in times. We investigate a general multi-level upgrade policy in which a customer may be upgraded to any better products and two single-level upgrade heuristics which are less computationally intensive. Both heuristics have clean structures and are easy to implement. We adopt discrete concavity concepts into our analysis and identify monotonicity properties for the optimal single-level upgrade policies.

5 Taylor Approximation of Inventory Policies for One-Warehouse, Multi-Retailer Systems with Demand Feature Information

Jingkai Huang[1], Kevin Shang[2], Yi Yang[1], Weihua Zhou[1], Yuan Li[3], [1]Zhejiang University, Hangzhou, China; [2]Duke University, Durham, NC, [3]Alibaba, Hangzhou, China. Contact: khshang@duke.edu

We consider a distribution system in which retailers replenish perishable goods from a warehouse. Demand at each retailer depends on exogenous features and a random shock, and unfulfilled demand is lost. To obtain an effective data-driven replenishment and allocation policy, we first develop the Talyor Approximation (TA) policy by using Taylor expansion to approximate the retailer's inventory cost and show its asymptotic optimality in the number of retailers. Next we estimate the TA solution from data to obtain the Data-Driven Taylor Approximation (DDTA) Policy and prove its consistency. Using a real data set provided by Fresh Hema, we find the DDTA policy reduces the cost by 10.9%

compared to Hema's policy. Finally, we show that the main results still hold in the cases of correlated demand features, positive lead times, and censored demand.

Monday, October 16, 10:45 AM - 12:00 PM

MB29

CC-North 132B

Managing the Transition to Cleaner Energy

Community Committee Choice Session

Session Chair: Michael Blair, Yale University, New Haven, CT

1 Dynamic Valuation and Optimal Control of a Battery Under Performance Degradation

Joonho Bae[1], Roman Kapuscinski[2], John M. Silberholz[1], [1]University of Michigan Ross School of Business, Ann Arbor, MI, [2]Ross School of Business, Ann Arbor, MI, Contact: baejh@umich.edu

We consider a battery providing energy arbitrage (buying at low prices and selling at high prices) over some time period. One key difficulty of profitably operating a battery over time is that battery performance degrades in two ways (capacity and efficiency degradation), each having a nonlinear dependency on the usage profile. To study the effect of different degradation dynamics, we consider three degradation models: (1) capacity-degradation-only, (2) efficiency-degradation-only, and (3) both degradations. To the best of our knowledge, this paper is the first analytical modeling paper characterizing optimal dynamic policies under different degradation models of battery capacity and efficiency. This work shows systematic differences in the desired use of batteries when facing different types of battery degradation.

2 Clean Energy Transition, Scarcity and Urban Mining

Clara Carrera[1], Serasu Duran[2], Atalay Atasu[1], Luk N. Van Wassenhove[1], [1]INSEAD, Fontainebleau, France; [2]Haskayne School of Business, Calgary, AB, Canada. Contact: clara.carrera@insead.edu

Clean energy technologies require large amounts of critical materials such as cobalt and lithium for energy storage, rare earth minerals for wind turbines, and silver and silicon for solar panels. The supply of these critical materials cannot keep up with skyrocketing demand, and maintaining the clean energy transition momentum requires alternative strategies. We formulate an analytical model that represents the key trade-offs of the two prevalent strategies: (i) Material Reduction, i.e., changes to production technology to reduce the critical materials used; (ii) Urban Mining, i.e., recovering and recycling critical materials from end-of-life clean energy products. We study how the effectiveness of these two approaches depends on the levels of material scarcity and systemic leakage in circular infrastructures and discuss policy implications.

3 Sustainable Bioeconomy as Climate Change Mitigation

Hannah Wang, Yale University, New Haven, CT, Contact: hannah.wang.sw2285@yale.edu

Bioeconomy is an economic system that utilizes renewable biomass, such as plants, to produce goods, services, and energy. Past studies have separately discussed the climate benefits of those bio-based products - bioenergy, biochar, and bioplastic - to name a few. Nevertheless, none investigated the synergistic sustainability effects of distributing biomass to produce the various product pathways. As a result, large-scale deployment for a mixture of biomass circular economy is still limited. Therefore, this study aims to address the research gap. The objective of the talk is two-fold - (1) investigate various aspects of life cycle sustainability impacts for disparate bio-based products; (2) build a dynamic model that designs an optimal biomass utilization strategy according to the market demand, budgets, and resource constraints for any given location.

4 Reducing Energy Consumption Through Targeted Thermostat Interventions

Michael R. Blair[1], Saed Alizamir[2], Shouqiang Wang[3], [1]Wilfrid Laurier University, Waterloo, ON, Canada; [2]University of Virginia, Charlottesville, VA, [3]The University of Texas at Dallas, Richardson, TX, Contact: mrblair@wlu.ca

Residential energy consumption for heating and cooling is one of the largest end uses of energy, and the amount of energy is significantly influenced by the weather. As we continue to feel the effects of climate change, these energy requirements will rise and become more volatile, leading to increased operational costs and challenging capacity decisions for power generators.

Smart thermostats have great potential to reduce household energy consumption. However, recent works show that how the thermostat is used plays a critical role in energy savings. In this preliminary work we use a dataset of smart thermostat users to illustrate the potential value of targeting interventions such as occupancy detection and temperature setbacks. We then discuss ongoing efforts to test the impact of different appeals (financial vs. environmental benefits) through a field experiment.

Monday, October 16, 10:45 AM - 12:00 PM

MB30

CC-North 132C

Advances in Theory of Innovation and Product Development

Community Committee Choice Session

Session Chair: Onesun Steve Yoo, UCL School Of Management, University College London, London, United Kingdom

1 Advances in Theory of Innovation and Product Development

Qiong Chen[1], Mengyang Pan[2], Wenli Xiao[3], [1]Southwestern University of Finance and Economics, Chengdu, China; [2]Swufe, Chengdu, China; [3]University of San Diego, San Diego, CA, Contact: wenlixiao@sandiego.edu

In the context of radical innovation, we draw from knowledge network theory to investigate how the firm can manage its alliance portfolio to speed up radical innovation. We examine the effects of the firm's current innovation alliance composition and its position in its previous innovation alliance network on radical innovation speed. In analyzing the empirical data on COVID-19-related radical innovation projects, we find that the presence of an industry partner slows down innovation speed, while the presence of a research partner speeds up the radical innovation process. The presence of a government partner does not influence innovation speed unless the firm has a high level of collaboration experience with its current partner. As for the position of the firm in its alliance network, a firm that is more centrally located experiences faster radical innovation speed.

2 Empowering Women and Combating Harassment: The Women Powerline Initiative in Uttar Pradesh, India

Anupam Agrawal, Texas A&M University, College Station, TX, Contact: anupam@tamu.edu

We study deployment of a mobile-based call center in India to track and reduce crimes against women, particularly those that are rarely reported to the police such as eve-teasing, violence, and online bullying. The program takes a holistic approach to harassment, targeting both the victim and the harasser, with the aim of educating and rehabilitating the offender, thereby reducing the likelihood of future incidents. Simultaneously, the program strives to ensure the safety and comfort of the victim, offering recourse for women in even the most remote areas. This research seeks to draw policy implications from the growth of this program, with a particular focus on the adoption of technology by women in rural areas to report crimes, changes in this adoption over time, and the potential for deployment of similar programs in other regions of India and other countries.

3 The Matthew Effect in an Experimental Market-Entry Game

Jeeva Somasundaram[1], Kostas Stouras[2], Sanjiv Erat[3], [1]INSTITUTO DE EMPRESA, Madrid, Spain; [2]UCD, Dublin, Ireland; [3]University of California-San Diego, La Jolla, CA, Contact: konstantinos.stouras@ucd.ie

In this study, we present the first experimental investigation of the Matthew effect in market-entry games, namely that an entrant's past market earnings reinforce their future earnings. Across all of our 2×2×2 between-subject conditions, we find that the Matthew effect leads to more inequality in terms of the Gini coefficient, as well as, in terms of the standard deviation in earnings. Building on Cumulative Prospect Theory, we develop interventions to reduce the Matthew effect and we test them via a second experiment. Our findings illustrate that showing average past earnings and letting agents communicate with each other promotes equity and prevents attrition in sharing economy platforms.

4 Optimal Management of Renewable Energy Certificates: A Reinforcement Learning Approach

Daeho Kim[1], Dong Gu Choi[2], Michael Lim[3], [1]Pohang University of Science and Technology, Pohang, Korea, Republic of; [2]Pohang University of Science and Technology (POSTECH), Pohang, Korea, Republic of; [3]Seoul National University, Seoul, Korea, Republic of. Contact: milim@snu.ac.kr

Renewable Portfolio Standards (RPS), which require electricity suppliers to purchase Renewable Energy Certificates (RECs) from renewable energy generators to meet the standard levels, have led to the emergence of a brokerage service for renewable generators. Our research focuses on optimizing REC management for brokerage service providers. We use a Markov Decision Process framework to formulate the problem and identify key structural properties of the optimal policy. We then develop a deep reinforcement learning (DRL) algorithm and verify its performance based on real market data. Finally, we employ eXplainable AI techniques to understand the logic behind our black-box DRL algorithm.

Monday, October 16, 10:45 AM

- 12:00 PM

MB32

CC-North 221B

Modeling Smart Mobility Markets with Multi-players: Matching, Pricing, and Design

Community Committee Choice Session

Session Chair: Bingqing Liu, New York University, Brooklyn, NY
Session Chair: Joseph Y J Chow, New York University, Brooklyn, NY

1 How Would Mobility-as-a-Service (MaaS) Platform Survive as an Intermediary? from the Viewpoint of Stability in Many-to-Many Matching

Rui Yao[1,2], Kenan Zhang[3,1], [1]École polytechnique fédérale de Lausanne - EPFL, Lausanne, Switzerland; [2]Technical University of Denmark, Copenhagen, Denmark; [3]ETH Zurich, Zurich, Switzerland

Mobility-as-a-service (MaaS) provides seamless door-to-door trips by integrating different transport modes. Although many MaaS platforms have emerged in recent years, most of them remain at a limited integration level. This study investigates the assignment and pricing problem for a MaaS platform as an intermediary in a multi-modal transportation network, which purchases capacity from service operators and sells multi-modal trips to travelers. The analysis framework of many-to-many stable matching is adopted to decompose the joint design problem and to derive the stable condition such that both operators and travelers are willing to participate in the MaaS system.

2 A Smart Mobility Platform with Equitable Peer-to-Peer Congestion Pricing and Its Policy and Equity Implications

Siwei Hu[1], Daisik Nam[2], Pengyuan Sun[1], R. Jayakrishnan[1], Michael Hyland[1], [1]University of California, Irvine, Irvine, CA, [2]Inha University, Incheon, Korea, Republic of. Contact: siweih3@uci.edu

Researchers have investigated different congestion pricing schemes to alter travelers' selfish driving behaviors to direct the state of transportation networks from User Equilibrium (UE) to System Optimal (SO). However, the unfair feelings among drivers about the tolls and the unclear toll usage and distribution among the population make congestion pricing difficult to implement. To address those issues, we proposed a smart mobility platform with an equitable peer-to-peer envy-based congestion pricing scheme that allows travelers to coordinate their path choices through monetary exchanges. The simulation results show that with as little as 5% of travelers engaging in peer-to-peer route choice coordination, the transportation system state could be directed from UE to an SO equitably, resulting in a 13% increase of network space mean speed from 31 mph to 35 mph.

3 Dynamic Usage Allocation and Pricing for Curbside Space Operation

Jisoon Lim, Neda Masoud, University of Michigan, Ann Arbor, MI

The importance of curbside management is quickly growing in a modernized urban setting. Dynamic allocation of curbspace to various usages and dynamic pricing for those usages can together attract more users and promote user turnover. To model such operations, we develop a Stackelberg leader-follower game between a leader who sets curbspace allocation and pricing of each curbside usage and multi-followers who accept or reject the proposed prices. We model this game as a bi-level nonlinear program, and reconstruct it into a single-level convex program by applying the Karush-Kuhn-Tucker conditions, objective function transformation, and constraints linearization. We then devise a Benders decomposition algorithm to ensure the tractability of the problem, and perform numerical experiments to show the practicability of the model and draw curbside management insights.

4 On-Demand Ridesharing with Autonomous Modular Vehicles

Xi Cheng[1], Jane Lin[2], [1]University of Illinois, Chicago, Chicago, IL, [2]University of Illinois-Chicago, Chicago, IL, Contact: xicheng5@uic.edu

This paper presents an on-demand ridesharing system operated with the emerging autonomous modular vehicle (MAV) technology. Modularity enables flexible capacity configuration through in-motion joining and disjoining, which also brings potential energy savings (similar to platooning). A design framework is proposed to assign shared-ride trip requests to MAVs to minimize the total operating cost (in terms of both agency and passenger costs). The problem is formulated into integer linear programming. We investigate the feasibility of such a system in terms of potential cost and energy savings by ridesharing and in-motion joining and disjoining.

5 Prediction of Pareto Fronts for Multimodal Travel Itineraries

Jan F. Ehmke[1], Thomas Horstmannshoff[2], Marlin Wolf Ulmer[2], [1]University of Vienna, Vienna, Austria; [2]Otto-von-Guericke Universität Magdeburg, Magdeburg, Germany.

Contact: jan.ehmke@univie.ac.at

Integrated mobility platforms promise travelers to create door-to-door itineraries considering their individual preferences considering the breadth of mobility services such as trains, buses, flights, and ridesharing services. Finding the complete Pareto-optimal set of itineraries with multiple traveler preferences in a multimodal setting is a significant challenge. We approximate the set of Pareto-optimal itineraries by solution sampling equally distributed over the solution space. We also investigate offline learning (with a random-forest prediction model) and online learning (with Gaussian Process Regression) to make our solution framework smarter. Based on a large real-world data set, we investigate the performance and the effectiveness of our framework.

Monday, October 16, 10:45 AM - 12:00 PM

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CC-North 221C

Contributions to the Theory of Integer Programming

Community Committee Choice Session

Session Chair: Prachi Shah, ISyE, Georgia Institute of Technology, Atlanta, GA

1 Consistency of Branching Rules with Respect to Cutting Planes

Prachi Shah[1], Santanu Dey[2], [1]ISyE, Georgia Institute of Technology, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA, Contact: prachi.shah@gatech.edu

Better IP formulations obtained by adding cuts, give better dual bounds at the root node and are expected to be solved by smaller branch-and-bound trees. In this work, we address the question of whether adding cuts always leads to improved branching decisions. Contrary to the expectation, we prove that there exists instances where adding a single valid cut, which improves the dual bound at the root note, increases the size of branch-and-bound trees by an exponential factor for some of the most popular branching rules.

2 Copositive Dual and Sensitivity Analysis of 0-1 MILP

Jingye Xu, Santanu Dey, Diego Cifuentes, Georgia Tech, Atlanta, GA, Contact: jxu673@gatech.edu

Burer proved that every 0-1 MILP can be exactly reformulated as a conic convex completely positive program. We study properties of the dual of this convex program which helps in sensitivity analysis corresponding to changes in the right-hand-side of the IP. In particular, we prove that optimal solution of the dual has be constructed in closed form using the knowledge of the solution of the original MILP.

3 M-Decomposable Sets in Integer Programming

Diego A. Moran[1,2], [1]Universidad Adolfo Ibañez, Santiago, Chile; [2]Rensselaer Polytechnique Institute, Troy, NY, Contact: diego.moran@uai.cl

An M-decomposable set is a closed convex set which is the sum of a compact convex set and a closed convex cone. We present properties of these sets in the context of integer programming. In particular, we present properties of their integer hull, some cutting plane closures and subadditive duality.

4 Decomposition-Based Polyhedral Disjunctive Cuts

Ricardo Fukasawa[1], Aleksandr M. Kazachkov[2], [1]University of Waterloo, Waterloo, ON, Canada; [2]University of Florida, Gainesville, FL

Traditionally, cutting planes, or cuts, for mixed-integer linear programs are generated via rounds of “shallow” cuts to obtain a significant bound improvement. As this can be computationally costly and lead to numerical instability, an alternative is to find a single large disjunction that forms a tighter relaxation of the mixed-integer feasible region, reducing the need for recursion. However, the resulting disjunctive cuts can be dense, causing the linear relaxation to solve more slowly. In this work, we generate globally-valid disjunctive inequalities from subproblems of an instance using a decomposition of the constraint matrix. We present conditions under which these sparse subproblem-based inequalities also cut into the original problem’s linear relaxation. Finally, we report on preliminary computational experiments with a variant of our procedure.

5 Generalized Scaling for the Constrained Maximum-Entropy Sampling Problem

Zhongzhu Chen, The University of Michigan, Ann Arbor, MI, Contact: zhongzhc@umich.edu

The best practical techniques for exact solution of instances of the constrained maximum-entropy sampling problem, a discrete optimization problem arising in the design of experiments, are via a branch-and-bound framework applied to a variety of concave continuous relaxations of the objective function. A standard and computationally-important bound-enhancement technique in this context is scaling, via a single positive parameter. Scaling adjusts the shape of continuous relaxations to reduce the gaps between the upperbounds and optimal value. We extend this technique to generalized scaling, employing a positive vector of parameters, which allows much more flexibility and thus significantly reduces the gaps further. We give mathematical results aimed at supporting algorithmic methods and computational results demonstrating the state-of-art performance.

Monday, October 16, 10:45 AM - 12:00 PM

MB34

CC-North 222A

Network Expansion

Community Committee Choice Session

Session Chair: Anthony Degleris, Scalable Multi-Value Joint Transmission and Generation Expansion Planning via Implicit Differentiati, Stanford, CA

1 Approximation Algorithms for Augmenting Network Connectivity

Michael Zlatin, Carnegie Mellon University, Pittsburgh, PA, Contact: mzlatin@andrew.cmu.edu

Given a k-edge-connected graph G, how do we add a cheapest subset of links to G so that it becomes (k+1)-edge-connected? This is the Connectivity Augmentation Problem and is a fundamental problem in network design and combinatorial optimization. Primal-dual methods and iterative rounding achieve an approximation ratio of 2, which was the state of the art until recent breakthroughs by Traub and Zenklusen - bringing the approximation ratio down to 1.5+epsilon.

In this work, we consider the generalization of the Connectivity Augmentation Problem to Steiner networks, where we are only interested in connectivity between a special subset of nodes. We give improved algorithms for this setting, and open the door to tackling many variants of classic problems in network connectivity.

2 Power Grid Operation During Severe Weather: Application of Stochastic Optimization and Machine Learning

Mostafa Sahraei-Ardakani, University of Utah

Extreme weather events are the leading cause of power outage in the United States. The outages are mainly due to the failure of transmission and distribution elements. Transmission failures can be mitigated through a preventive dispatch. To compute this dispatch line outage probabilities should be integrated within grid operation problems, resulting in extremely large stochastic mixed-integer linear programs. Unfortunately, the formulated problems cannot be solved within the industry time limits. This talk discusses three techniques that we have developed to reduce the solution time: (i) enhanced formulation and constraint screening, (ii) efficient scenario selection, and (iii) the use of machine learning. Together, these methods enable computation of an efficient preventive dispatch within strict industry limits, resulting in reduced power outages.

3 Locating Obnoxious Facilities Using a Mixed-Integer Programming-Based Heuristic

Tamara Bigler, University of Bern, Bern, Switzerland

Obnoxious facilities refer to facilities that have negative side effects on the nearby population. In the obnoxious p-median problem, a set of clients and a set of potential locations for obnoxious facilities are given. From these potential locations, p facilities must be opened such that the total distance from each client to the nearest open facility must be maximized. We propose a matheuristic for this problem in which diverse initial solutions are improved iteratively using mixed-integer programming. We compare different improvement strategies, such as facility removal and addition and facility replacement. Our computational results indicate that the remove-add strategy yields superior solution quality compared to other strategies.

4 Joint Expansion of Power and Water Distribution Systems

Sai Krishna Kanth Hari, Los Alamos National Laboratory, Los Alamos, NM, Contact: hskkanth@gmail.com

Power and water networks are interdependent through elements such as pumps and hydro plants. However, their design and operations are planned independently. While the joint planning of these networks is believed to offer benefits such as reliability, flexibility, and efficiency, its practical realization is hindered by two major reasons: 1) lack of quantitative understanding of the benefits offered, and 2) lack of computational methods to support such large-scale planning. In this work, we address the first challenge by solving a Mixed Integer Nonlinear Program that considers the nonlinear governing physics of individual networks, constraints modeling the interdependency between the networks, and discrete expansion and operational decisions.

5 Scalable Multi-Value Joint Transmission and Generation Expansion Planning via Implicit Differentiation

Anthony Degleris, Abbas El Gamal, Ram Rajagopal, Stanford University, Stanford, CA, Contact: degleris@stanford.edu

We introduce the multi-value expansion planning (MEP) problem, a general bilevel optimization problem in which a planner can optimize arbitrary functions of the dispatch outcome in the presence of an uncontrolled, competitive electricity market. This framework can, for example, be used to identify grid investments that minimize emissions in lieu of carbon tax, or to maximize the profit of a portfolio of renewable investments and long-term energy contracts. The MEP problem is nonconvex, making it difficult to solve exactly for large real-world systems. We propose a fast stochastic implicit gradient-based heuristic that scales well to large networks and many scenarios. We further evaluate the performance of our heuristic using a scalable convex relaxation-based lower bound. We demonstrate the model and algorithm using a large model of the U.S. Western Interconnect.

Monday, October 16, 10:45 AM - 12:00 PM

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CC-North 222B

Recent Advances in Policy Optimization and Reinforcement Learning - Part I

Community Committee Choice Session

Session Chair: Yan Li, Georgia Tech, Atlanta, GA

Session Chair: Guanghui Lan, Georgia Institute of Technology, Atlanta, GA

1 Policy Value Descent Method for Regularized MDPs

Tianjiao Li, Georgia Institute of Technology, Atlanta, GA, Contact: tli432@gatech.edu

In this work, we propose a new policy optimization algorithm, named policy value descent, for solving reinforcement learning (RL) problems. The proposed method achieves an O(1/epsilon) sample complexity for solving the RL problems with strongly convex regularizers.

2 Online Switching Control with Stability and Regret Guarantees

Yingying Li[1], James Preiss[2], Na Li[3], Yiheng Lin[2], Adam Wierman[4], Jeff Shamma[5], [1]UIUC, Urbana, IL, [2]Caltech, Pasadena, CA, [3]Harvard University, Cambridge, MA, [4]California Institute of Technology, Pasadena, CA, [5]University of Illinois Urbana-Champaign, Champaign, IL, Contact: yl101@illinois.edu

This paper considers online switching control with a finite candidate controller pool, an unknown dynamical system, and unknown cost functions. The candidate controllers can be unstabilizing policies. We only require at least one candidate controller to satisfy certain stability properties, but we do not know which one is stabilizing. We design an online algorithm that guarantees finite-gain stability throughout the duration of its execution. We also provide a sublinear policy regret guarantee compared with the optimal stabilizing candidate controller. Lastly, we numerically test our algorithm on quadrotor planar flights and compare it with a classical switching control algorithm, falsification-based switching, and a classical multi-armed bandit algorithm, Exp3 with batches.

3 On the Global Convergence of Risk-Averse Policy Gradient Methods with Expected Conditional Risk Measures

Xian Yu[1], Lei Ying[2], [1]The Ohio State University, Columbus, OH, [2]The University of Michigan, Ann Arbor, Ann Arbor, MI, Contact: yu.3610@osu.edu

Risk-sensitive reinforcement learning (RL) has become a popular tool to control the risk of uncertain outcomes and ensure reliable performance. While policy gradient methods have been developed for risk-sensitive RL, it remains unclear if these methods enjoy the same global convergence guarantees as in the risk-neutral case. In this paper, we consider a class of dynamic time-consistent risk measures, called Expected Conditional Risk Measures (ECRMs), and derive policy gradient updates for ECRM-based objective functions. Under direct and softmax parameterization, we provide global convergence guarantees and iteration complexities of the corresponding risk-averse policy gradient algorithms. We test a risk-averse variant of REINFORCE algorithm on a stochastic Cliffwalk environment to demonstrate the efficacy of our algorithm and the importance of risk control.

Monday, October 16, 10:45 AM - 12:00 PM

MB36

CC-North 222C

Recent Progress in Optimization Software I

Community Committee Choice Session

Session Chair: Hans Mittelmann, Arizona State University, Tempe, AZ

1 Recent Advances in the Cardinal Optimizer

Benjamin Mueller[1], DongDong Ge[2], [1]COPT GmbH, Berlin,

Germany; [2]Shanghai University of Finance and Economics, Shanghai, China. Contact: mueller@copt.de

In this talk, we present the recent developments in the Cardinal Optimizer (COPT). We discuss some key techniques that contributed to the performance improvements of our MIP solver and present performance numbers of the latest COPT release for all problem classes.

2 New Performance Techniques in the Gurobi Optimizers

Zonghao Gu[1], Ed Klotz[2], [1]Gurobi Optimization, Beaverton, OR, [2]Gurobi Optimization, Incline Village, NV

This talk will discuss various new techniques or ideas to improve the performance to solve linear programs, mixed integer programs, quadratic programs and nonlinear mixed integer programs.

3 Recent Progress in Optverse Solver

Zirui Zhou, Huawei Technologies Canada, Burnaby, Canada

In this talk, we present latest development of Optverse solver and some of its successful applications. We also show some new advances in harnessing large language models for enhanced modelling workflow.

Monday, October 16, 10:45 AM - 12:00 PM

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CC-North 223

Robust Prescriptive Analytics

Community Committee Choice Session

Session Chair: Li Chen, National University of Singapore, Singapore, Singapore

1 Range Value-At-Risk Under Distributional Ambiguity: Tight Bounds with Support Information

Zhi Chen[1], Zhenyu Hu[2], Guangwu Liu[3], Ruiqin Wang[4], [1]College of Business, City University of Hong Kong, Kowloon, Hong Kong; [2]National University Singapore, Singapore, Singapore; [3]City University of Hong Kong, Kowloon, Hong Kong; [4]National University of Singapore, Singapore, Singapore. Contact: ruiqin_wang@u.nus.edu

Estimating risk measures, such as value-at-risk (VaR) and conditional value-at-risk (CVaR), plays an important role when making decisions with limited information. In this paper, we examine the problem of bounding a more general class of risk measures called, range value-at-risk (RVaR), over mean-variance and Wasserstein ambiguity sets. While existing results all assume unbounded support, we characterize tight upper and lower bounds when there is support information. Our numerical results further demonstrate the significant value of support information.

2 Differential Privacy via Distributionally Robust Optimization

Aras Selvi, Imperial College London

In recent years, differential privacy has emerged as the *de facto* standard for sharing statistics of datasets while limiting the disclosure of private information about the involved individuals. This is achieved by randomly perturbing the statistics to be published, which in turn leads to a privacy-accuracy trade-off: larger perturbations provide stronger privacy guarantees, but they result in less accurate statistics that offer lower utility to the recipients.

We develop a class of mechanisms that enjoy non-asymptotic and unconditional optimality guarantees. To this end, we formulate the mechanism design problem as an infinite-dimensional distributionally robust optimization problem and show that the problem affords a strong dual, and we exploit this duality to develop converging hierarchies of finite-dimensional upper and lower bounding problems.

3 Robust Workforce Management with Crowdsourced Delivery

Chun Cheng[1], Sim Melvyn[2], Yue Zhao[3], [1]Ecole Polytechnique de Montreal, Montreal, QC, Canada; [2]National University of Singapore, Singapore, Singapore; [3]Institute of Operations Research and Analytics, National University of Singapore, Singapore, Singapore. Contact: zhaoyue6174@gmail.com

We investigate the crowdsourced delivery problem, where the objective is to minimize the hiring costs of contracted couriers and the crowdsourcing costs of ad-hoc couriers while considering the uncertain availability and behavior of the latter. Due to the complication of calibrating these uncertainties through data-driven approaches, we instead introduce a basic reduced information model to estimate the upper bound of the crowdsourcing cost and a generalized reduced information model to obtain a tighter bound. Subsequently, we formulate a robust satisficing model associated with the generalized reduced information model and show that a binary search algorithm can tackle the model exactly by solving a modest number of convex optimization problems. Experiment with Solomon and simulation data demonstrate the merits of our models.

4 A Distribution-Free Approach to Long Chain Resilience

Qinghe Sun[1], Li Chen[2], Mabel C. Chou[3], [1]The Hong Kong

Polytechnic University, Hong Kong, Hong Kong; [2]National University of Singapore, Singapore, Singapore; [3]National University of Singapore, SG, SG, Singapore. Contact: qinghe.sun@polyu.edu.hk

Process flexibility has been a well-established supply chain strategy that enhances responsiveness to demand uncertainty. In this study, we extend the scope of this strategy to supply disruption mitigation by analyzing a long chain system. We investigate the effectiveness of long chain systems in the face of random supply disruption and under ambiguous demand. Our study derives a closed-form, tight bound on the ratio of expected sales under supply disruption for the long chain system relative to that of a fully flexible system. To comprehensively handle supply disruption and demand uncertainties, we introduce a moment decomposition approach that easily adapts to general piece-wise polynomial performance metrics. Our approach can also incorporate higher moment information of the random demand while maintaining tractability through a semi-definite program (SDP).

5 Joint Capacity Allocation and Job Assignment Under Uncertainty

Peng Wang[1], Yun Fong Lim[2], Gar Goei Loke[3], [1]Singapore University of Social Sciences, Singapore, Singapore; [2]Singapore Management University, Singapore, Singapore; [3]Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands. Contact: peng.wang.2016@pbs.smu.edu.sg

We consider a multi-period joint capacity allocation and job assignment problem. The planner simultaneously decides on allocating resources across J different supply nodes, and assigning jobs from I different demand origins to these J nodes, so as to maximize the reward for matching or minimize the cost of failure to match. The setting can be applied in many service management settings such as ride-sharing fleet re-positioning, and patient management in healthcare. We introduce a distributive decision rule, which decides the proportion of jobs to be served by each of the supply nodes. Our model has a convex reformulation and can be solved by a sequence of linear programs. We test our model against state-of-the-art models that focus solely on capacity allocation or job assignment decisions. The result records 1-15% reductions in costs and shorter computation times.

Monday, October 16, 10:45 AM - 12:00 PM

MB38

CC-North 224A

ONR Program Review: Optimization with Uncertainty

Community Committee Choice Session

Session Chair: David Phillips, Office of Naval Research, University of New Mexico, Catonsville, MD

1 New Methods for Solving Stochastic Integer Programming Problems

Jim R. Luedtke, University of Wisconsin-Madison, Madison, WI

We summarize two recent directions for solving stochastic integer programs. The first direction is a method for generating valid inequalities to be used in Benders decomposition derived from multi-term disjunctions defined by a partial enumeration of the first-stage variables. We demonstrate how restricting the support of such cuts to be sparse enables efficient cut generation, while empirically yielding strong bound reduction. In the second direction we present results exploring techniques for “learning” from the process of solving one sampled SAA approximation of a SIP to enable more efficient solution of SAA approximations defined by different samples.

2 Principles of Noisy Nonlinear Optimization

Jorge Nocedal, Northwestern University, Evanston, IL

The question of how to design nonlinear optimization algorithms that are robust in the presence of noise in the function and/or gradient has recently received much attention. Established methods for deterministic optimization have proved to be successful in a wide range of disciplines but are not directly applicable in the stochastic setting. In this talk, we argue that one can design effective methods by preserving the underlying properties of deterministic methods and making judicious modifications following certain design principles presented here. We test our new algorithms on an optimal design problem where the goal is to optimize the efficiency of an acoustic horn assuming that some of the physical properties of the system are only known through a distribution.

3 Confidence Regions in Infinite-Dimensional Stochastic Optimization

Raghu Pasupathy[1], Yi Chu[2], Di Yu[2], [1]Purdue University, West Lafayette, IN, [2]Purdue University, West Lafayette, IN, Contact: pasupath@purdue.edu

We investigate operator recursions for constrained stochastic optimization (SO) problems, where the decision variables lie in an infinite-dimensional space, e.g., the space of smooth functions, or space of probability measures. Example settings include fluid flow, emergency response, and optimal transport. We highlight the question of statistical inference (or uncertainty quantification), in particular, how to compute a confidence region on the optimal value or solution in SO using iterates generated by a recursion? Using a Bahadur representation theorem that we show to hold across a wide variety of SO settings, we construct a simple but compute-intensive batching method for confidence regions. The method is valid in the sense of being consistent, and implementable in the sense of the classical Student's t statistic, that is, there are no unknown parameters.

4 Next Generation Algorithms for Stochastic Optimization with Constraints

Albert S. Berahas[1], Frank E. Curtis[2], Baoyu Zhou[3], Daniel Robinson[4], [1]University of Michigan, Ann Arbor, MI, [2]lehigh university, Bethlehem, PA, [3]University of Chicago, Chicago, IL, [4]Lehigh University, Bethlehem, PA, Contact: albertberahas@gmail.com

Stochastic gradient and related methods for solving stochastic optimization problems have been studied extensively in recent years. It has been shown that such algorithms and much of their convergence and complexity guarantees extend in straightforward ways when one considers problems involving simple constraints, such as when one can perform projections onto the feasible region. However, settings with general nonlinear constraints have received less attention, and many of the approaches that have been proposed for solving such problems resort to using penalty or (augmented) Lagrangian methods, which are often not the most effective strategies. In this work, we propose and analyze stochastic optimization methods based on the sequential quadratic optimization (commonly known as SQP) methodology. We discuss advantages and disadvantages of such techniques.

Monday, October 16, 10:45 AM - 12:00 PM

MB39

CC-North 224B

Panel: Future of Transportation Science and Logistics

Panel Session

1 Future of Transportation and Logistics Panel

Sibel Alumur Alev, University of Waterloo, Waterloo, ON, Canada

The Transportation Science and Logistics panel on the future of transportation and logistics.

Session Chair: Sibel Alumur Alev, University of Waterloo, Waterloo, ON, Canada

2 Panelist

Karen Smilowitz, Northwestern University, Evanston, IL

3 Panelist

Anton J. Kleywegt, ISyE Georgia Tech, Atlanta, GA

4 Panelist

Ann Melissa Campbell, University of Iowa, Iowa City, IA

5 Panelist

Emma Frejinger, Université de Montreal, Montreal, QC, Canada

Monday, October 16, 10:45 AM - 12:00 PM

MB40

CC-North 225A

AI in Transportation Decision-making

Community Committee Choice Session

Session Chair: Zemian Ke, 1</sup

1 Fractal-Like Growth of Urban Congestion and Its Control Based on Deep Reinforcement Learning

Hao Zhou, University of South Florida, Tampa, FL, Contact: zhouhao@gatech.edu

Recently it has been found that congested urban networks tend to be insensitive to signal control, and the success of deep reinforcement learning (DRL) could quickly deteriorate in congested networks given random rerouting. As a sequel study, we verified those findings with more realistic network settings and found that similar challenges hold for perimeter control, and those learning instabilities mainly result from frequent spillback queues or gridlock, where the flow (reward) and the queue length (state) both have a long-tail/power-law distribution. Those findings imply that congestion grows as fractals and its complexity can be responsible for the deterioration of DRL. The paper further presents a novel DRL algorithm designed to control the growth of fractals, which can be potentially transferred to other complex systems with similar issues.

2 A Deep Reinforcement Learning Based Distributed Control Strategy for Connected Automated Vehicles in Mixed Traffic Platoon

Haotian Shi[1], Danjue Chen[2], Nan Zheng[3], Xin Wang[1], Yang

Zhou[4], [1]University of Wisconsin–Madison, Madison, WI, [2]University of Massachusetts Lowell, Lowell, MA, [3]Monash University, Australia; [4]Texas A&M University, College Station, TX

This paper introduces a novel control strategy for connected automated vehicles in mixed traffic, addressing the stochasticity of human-driven vehicle behaviors. Instead of focusing on individual HDV trajectories, we treat consecutive HDVs as a unit to capture the macroscopic features to reduce HDVs' adverse impact. Macroscopic traffic properties are modeled on the Newell model to capture aggregated HDV behaviors based on the generic 'CAV-HDVs-CAV' pattern. Physics-informed deep reinforcement learning is employed to develop the controller. Simulations validate our approach regarding oscillation dampening, eco-driving, and generalizability.

3 Solving System Optimum with Uncertain Demands and System Dynamics: A Reinforcement Learning Framework Enhanced by Traffic Models

Zemian Ke, Carnegie Mellon University, Pittsburgh, PA, Contact: zemiank@andrew.cmu.edu

System optimal routing can mitigate congestion by assigning vehicles routes that minimize the system travel time. However, solving the optimal routing policy is challenging with uncertain demands. In this paper, we propose a novel reinforcement learning algorithm named TransRL, which not only captures the uncertainties of the system dynamics but also learns the optimal policies efficiently by utilizing the information from a traffic model-based policy (i.e., the teacher policy). The experiments unveiled three appealing features of TransRL: (1) Compared with the deterministic method, TransRL can better adapt to demand uncertainties by learning from experiences; (2) Leveraging the teacher policy, TransRL explores more efficiently than model-free reinforcement learning; (3) TransRL is robust to inaccurate traffic models with proper confidence parameters.

4 Artificial Intelligence-Enabled Perimeter Metering Control Methods

Dongqin Zhou, Penn State University, PA

Perimeter metering control based on macroscopic fundamental diagrams has attracted increasing research interests over the past decade. While numerous control methods have been proposed in the literature, most of them require detailed information regarding the traffic dynamics modeling. This work presents several perimeter control methods as enabled by artificial intelligence techniques. These methods can serve as an introduction to more broader application of AI methods on macroscopic traffic control.

5 Enhancing Real-Time Bus Arrival Time Prediction with a Machine Learning-Driven Markov Process Approach

Xiaoyu Ma, Xiaozheng He, Rensselaer Polytechnic Institute, Troy, NY, Contact: max8@rpi.edu

Accurate bus arrival information is crucial for riders' satisfaction, operation efficiency, and equity. However, some highly dynamic and uncertain factors, such as traffic and weather conditions, make it challenging to accurately train traditional prediction models that require massive data collection and complicated analysis. Our research formulates the sequential bus arrival time at each stop as a Markov process. For a given bus route, the transition matrices between the arrival times at every two adjacent stops are learned from historical bus arrival data. The trained model can then run online to predict the arrival times for subsequent stops using the latest bus arrival information. In essence, the proposed model learns the dynamic arrival patterns affected by the uncertainties without relying on the detailed data.

Monday, October 16, 10:45 AM - 12:00 PM

MB41

CC-North 225B

Advances in Nonlinear Programming

Contributed Session

Session Chair: Utku Tarik Bilgic, University of Pittsburgh, Pittsburgh, PA

1 State-Constrained Optimization Problems Under Uncertainty: A Tensor Train Approach

Akwum Onwunta, Lehigh University, Bethlehem, PA, Contact: ako221@lehigh.edu

We present a tensor-train decomposition approach to solve optimization problems constrained by partial differential equations under uncertainty, with almost sure constraints on the state variable. The state constraints are handled using Moreau-Yosida regularization. In the most general setting, we derive constraint violation estimates. When the optimization problem is strongly convex, we establish strong convergence of the regularized solution to the optimal control. This result mimics the deterministic setting and provides a rate of convergence. A second order Newton type method with a fast matrix-free action of the approximate Hessian is presented. Both function and gradient approximations are carried out using tensor-train decomposition. We test our algorithm on benchmark high dimensional problems to illustrate that our proposed algorithm is efficient.

2 Automatic Decomposition and Modified Progressive Hedging Algorithms for Solving Mixed-Integer Programs

Sheng-I Chen, Yu-Ting Tseng, National Yang Ming Chiao Tung University, Hsinchu, Taiwan. Contact: sichen@nycu.edu.tw

We develop algorithms to decompose a mathematical program automatically based on Bender's decomposition scheme. Our decomposition algorithm aims to obtain similar size sub-problems as many as possible. The progressive hedging algorithm is then applied to solve the problem using the decomposition result. Additionally, we enhance the progressive hedging algorithm in order to deal with integer decision variables in the decomposed master problem. The computational experiment tests our algorithms using stochastic integer programs from the public problem instance. The result shows that our method outperforms the commercial solver for large-scale problem instances.

3 A Rank-Adaptive Augmented Lagrangian Approach To Solving Large-Scale SDPs

Arnesh Sujanani[1], Renato D.C. Monteiro[1], Diego Cifuentes[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, Contact: asujanani6@gatech.edu

This work presents a rank-adaptive augmented Lagrangian approach to solving large-scale SDPs. At each iteration, our method constructs an augmented Lagrangian subproblem, which is factorized using the Burer-Monteiro approach. Each subproblem is approximately solved using a combination of the Frank-Wolfe method and an accelerated proximal point method. Our method begins with a small rank in the Burer-Monteiro factorization of the AL-subproblem and the rank is gradually increased as the method proceeds, helping reduce storage costs. A global complexity bound for finding an approximate optimal solution of the SDP is also established. Computational experiments on large-scale SDPs illustrate the effectiveness of our approach.

4 New Randomized Coordinate Optimistic Gradient Algorithms for Nonlinear Inclusions and Applications

Tran-Dinh Quoc, The University of North Carolina at Chapel Hill, Chapel Hill, NC

In this talk, we will present two randomized block-coordinate optimistic gradient algorithms to approximate a solution of nonlinear inclusions involving both monotone and co-hypo-monotone operators. We establish the best-known convergence rates of both algorithms under mild assumptions. Then, we apply them to solve a finite-sum inclusion arising from federated learning systems. We show that our new algorithms cover a broader class of problems in federated learning, including optimization and minimax models, than previous work.

5 A Study of Admm for Hierarchical Decision Making

Utku Tarik Bilgic[1], Xiaoning Qian[2], Bo Zeng[3], [1]University of Pittsburgh, Pittsburgh, PA, [2]Texas A&M University, College Station, TX, [3]University of Pittsburgh, Pittsburgh, PA, Contact: utb3@pitt.edu

In this talk, we present our findings on solving hierarchical decision making problems in a distributed manner by making use of modified alternating direction method of multipliers (ADMM) algorithm.

Monday, October 16, 10:45 AM - 12:00 PM

MB42

CC-North 226A

Roundtable Session of RAS I

Panel Session

Session Chair: Jay Baillargeon, 1</sup

Session Chair: Andrew Straatveit, 1</sup

1 Roundtable session of RAS I

Jay Baillargeon, Federal Railroad Administration, Pueblo, CO

Rail is one of the safest and most efficient means of moving both goods and people. Regulatory agencies were established with the authority to ensure compliance with safety standards to protect the lives of those working on or living near the railroad. With new technologies enabling large volumes of data to be collected regularly, regulators are finding ways to use these technologies to achieve their mission. This session will provide an overview of the regulators' role in safety compliance and how they collaborate with operators to advance railroad safety, as well as a look at the ways in which new technology and analytics are being leveraged to ensure safe and efficient rail transportation for all.

2 Panelist

Andrew Straatveit, Federal Railroad Administration, Herndon, VA

3 Panelist

Daniel Einbinder, ENSCO, Springfield, VA

4 Panelist
César Rivera Trujillo, Gobierno de México, Mexico City, Mexico

Monday, October 16, 10:45 AM - 12:00 PM

MB43

CC-North 226B
AAS Best PhD Dissertation and Best Paper Awards
Award Session
Session Chair: Vikrant Vaze, [1</sup]
Session Chair: Sebastian Birolini, [1</sup]

1 Award Presenter
TBD Tbd, [1</sup]

2 Award Presenter
TBD Tbd, [1</sup]

Monday, October 16, 10:45 AM - 12:00 PM

MB44

CC-North 226C
OR via Reinforcement Learning and Beyond
Community Committee Choice Session
Session Chair: Zhiwei (Tony) Qin, Lyft, San Francisco, CA

1 A Learning-Based Approach for High Capacity Ridesharing
Xu Chen, Columbia University, New York, NY
This work proposes a learning framework to tackle a combinatorial optimization problem in high-capacity ridesharing systems. In particular, we focus on how vehicles can pick up passengers with multiple origin-destination (OD) pairs, which refers to the sequence of chaining OD pairs. Unlike pick-up sequences in traditional VRP, the OD sequence requires the preliminary consideration of visiting order for vehicles' pick-up and drop-off decisions. To address the challenge of enumerating all possible combinations of OD pairs, this work designs a learning operator that can efficiently explore feasible OD sequences. We demonstrate the performance of our approach in dispatching problems with different sizes. Our learning operator provides a computationally efficient tool for studying high-capacity ridepooling systems.

2 Advanced Manufacturing: Reinforcement Learning And Surrogate Model Applied To Wire Arc Additive Manufacturing
Sam St John, Anahita Khojandi, University of Tennessee, Knoxville, TN, Contact: sstjohn3@vols.utk.edu
Wire Arc Additive Manufacturing (WAAM) is a metal 3D printing approach that uses arc welding to create layers of material. The deposition process includes a potential for defects in deposition, such as waviness, humping, and crookedness. As subsequent layers are deposited, these defects can have an additive impact and drastically impact the shape of the generated part. Therefore, we investigate methods to leverage WAAM settings and prior deposition details to predict a future height profile. Our surrogate model is then used in a reinforcement learning model to create a map of actions that drive toward a consistent bead height. This approach builds upon prior research through a unique approach to the surrogate model that allows a clearer understanding of the small-scale build process.

3 A Reinforcement Learning Method to Accelerate the Benders Decomposition in Stochastic Unit Commitment
Nur Banu Altinpulluk[1], Murat Yildirim[1], Paritosh Ramanan[2], [1]Wayne State University, Detroit, MI, [2]Oklahoma State University, Stillwater, OK, Contact: nurbanu@wayne.edu
Stochastic unit commitment (SUC) is a fundamental optimization problem in power systems with significant computational challenges, which are exacerbated by increasing grid complexity, and operational uncertainty. Evidently, effective SUC solution methodologies play a pivotal role in ensuring competitiveness and reliability. In this talk, we propose a hybrid reinforcement learning and optimization approach for the SUC problem. Our approach accelerates Benders decomposition algorithm by leveraging reinforcement learning to intelligently select a subset of Benders optimality cuts to yield the fastest convergence. We demonstrate that our approach provides significant solution time improvements over traditional Benders decomposition approaches.

4 A Unified State Representation Framework for the Two-Sided Marketplace of Ridesharing
Alex Chin, Zhiwei (Tony) Qin, Lyft, San Francisco, CA
Ridesharing platforms are a particular type of two-sided marketplace where `supply-demand (SD) balance' is critical to the market efficiency and is also complex to analyze.

We describe an analytical framework based on the graph equilibrium metric (GEM) for quantifying the supply-demand spatiotemporal state of a ridesharing marketplace. GEM was developed as a generalized Wasserstein distance between the supply and demand distributions in a ridesharing market and has been used as an evaluation metric for algorithms expected to improve SD alignment. We extend the GEM framework to support a dual-view (supply and demand side) of balance in a market. We show that there are often disparities between the two views and how this dual-view leads to the notion of market efficiency, in which we propose a test statistic for capturing improvement.

5 Analysis of Search Time for Target Search Applications Under Different Behavior Policies

Carlos Hurtado[1], Lei Fang[2], Ze-xu Li[2], M. Amin Rahimian[1], [1]University of Pittsburgh, Pittsburgh, PA, [2]University of Pittsburgh, Pittsburgh, PA, Contact: cah259@pitt.edu

In search theory, we want to find an object considering the following elements involved in every search operation: searcher kinematics, detection uncertainties, and target location probability and optimization of the search. In our problem setting, our goal is to minimize the time an agent takes to find a hidden object with a static but unknown location, which can be learned using detection devices. We guided the agent under different movement rules using sequential decision-making. Thus, in each round, the agent has to make a trade-off between exhaustive searches, which lead to a good estimation (exploration), and efficient searches, which lead to optimum cost-benefit ratios (exploitation). We provide upper bounds on the expected search time under different search paradigms: pure exploration, pure exploitation, fixed threshold hold policy, and multi-armed bandit.

Monday, October 16, 10:45 AM - 12:00 PM

MB45

CC-North 227A

Machine Learning for Discrete and Global Optimization 1

Community Committee Choice Session

Session Chair: Can Li, Purdue

Session Chair: Rohit Kannan, Los Alamos National Laboratory, Los Alamos, NM

1 Optimization Proxies for Continuous and Discrete Optimization

Pascal Van Hentenryck, ISyE Georgia Tech, Atlanta, GA

Optimization proxies aim at replacing an optimization model by the combination of a machine-learning model and a repair step. They have been shown to be particularly useful in real-time applications in a variety of areas including energy systems, supply chains, and transportation systems. This talk will provide an overview of the science, engineering, and applications of optimization proxies.

2 Learning Convex Approximations for AC Optimal Power Flow with Zero-Injection Feasibility Guarantees

Gonzalo E. Constante-Flores[1], Can Li[2], [1]Purdue University, West Lafayette, IN, [2]Purdue University, West Lafayette, IN, Contact: geconsta@purdue.edu

This work presents a convex approximation of the AC optimal power flow problem (AC-OPF) based on the prediction of a subset of primal and dual variables. The AC-OPF is formulated as a difference of convex functions programming problem and convexified around the set of predicted nodal voltages. To avoid infeasibilities in the convexified constraints, we add a slack variable whose penalty weight in the objective function is predicted from a subset of dual variables of the AC-OPF. To predict the primal and dual variables, we propose a neural network that guarantees that zero-injection buses are enforced using an explicit projection layer, whose weights are fixed and determined offline solely based on the power system's topology.

3 Learning to Accelerate the Global Optimization of Quadratically-Constrained Quadratic Programs

Rohit Kannan, Harsha Nagarajan, Deepjyoti Deka, Los Alamos National Laboratory, Los Alamos, NM, Contact: harsha@lanl.gov

Non-convex QCQPs arise in several practical applications such as synthesis of process networks and power grids, to name a few. Efficient algorithms to solve such QCQPs to near global optimality is a key to addressing these applications. Leveraging recently-developed efficient MIP relaxation of a QCQP, we propose the novel problem of "strong partitioning" (SP) to optimally partition variable domains "without" sacrificing global optimality guarantees. We design a local method for solving the SP problem and replace this "ideal strategy" with a machine learning (ML) approximation for homogeneous QCQP families. Numerical studies demonstrate that SP and its ML approximation can significantly reduce the average run times of partitioning-based algorithms by factors of "3.5 - 16.5" and "2 - 4.5", respectively, on different families of non-convex QCQPs.

4 Le^{2}Go: Learning an End-To-End Partitioning Policy for the Global Optimization of Quadratically-Constrained Quadratic Programs

Rohit Kannan, Harsha Nagarajan, Deepjyoti Deka, Los Alamos National Laboratory, Los Alamos, NM, Contact: rohitk@alum.mit.edu

We use machine learning to accelerate the guaranteed global minimization of families of nonconvex quadratically-constrained quadratic programs (QCQPs). Specifically, we consider how to optimally partition variable domains while constructing mixed-integer programming (MIP) relaxations of nonconvex QCQPs and train a feedforward neural network (NN) end-to-end to map the features of a QCQP instance to its set of prescribed partitioning points. The goal of our end-to-end learning setup is to maximize the average MIP-based lower bound for the QCQP family. Numerical experiments demonstrate the advantages of end-to-end learning over a two-step strategy that fits an NN model to predict optimal partitioning points.

Monday, October 16, 10:45 AM - 12:00 PM

MB46

CC-North 227B

Strategies for Resilience and Social Justice

Community Committee Choice Session

Session Chair: Himadri Sen Gupta, University of Oklahoma, Norman, OK

Session Chair: Andres Gonzalez, University of Oklahoma, Norman, OK

1 Risk-Informed Community Resilience Planning Considering Social Vulnerability and Equity

Tasnim Ibn Faiz[1,2], Kenneth Harrison[1], [1]National Institute of Standards and Technology, Gaithersburg, MD, [2]University of Maryland, College Park, MD, Contact: tasnimibn.faiz@nist.gov

Proactive mitigation actions can improve a community's resilience against natural hazards. However, the mitigation planning problem is challenging due to the diverse and numerous stakeholders and the uncertainty associated with the hazard events. A decision-making framework is constructed to identify risk-informed mitigation decisions to achieve community resilience goals while ensuring equitable allocation of resources. The usefulness of the proposed framework in developing alternative mitigation strategies is presented with a case study of a community in Shelby County, Tennessee, subjected to earthquake hazards.

2 Mitigating Food Under-Served Areas: The Policy-Maker Problem

Sofía Pérez-Guzmán[1], Jose Holguin-Veras[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Rensselaer Polytechnic Institute, Troy, NY

This research proposes a mathematical formulation to reduce food under-served areas (FUAs), also known as food deserts. The proposed formulation, the Policy-Maker Problem (PMP), seeks to capture the decision-making behavior of a policy-maker interested in achieving the most appropriate tradeoff between benefits to the community and public-sector investments to mitigate FUAs. Such public-sector investments fund demand and supply-side initiatives that foster increased food distribution to small food outlets. This research also proposes the integration of the PMP with the Food Distributor Problem (FDP). The FDP, previously proposed by the same authors, is a Prize Collecting Traveling Salesman Problem that recreates the mechanisms by which food distributors decide whether or not to serve a food outlet.

3 Optimizing Treatment Facility Locations in Oklahoma Using Haversine Distance Optimization

Karen R. Roberts-Licklider, Theodore B. Trafalis, University of Oklahoma, Norman, OK

Drug court data was used for each county in Oklahoma to optimize the placement of treatment facilities. The objectives of this model were to optimally place treatment facilities minimizing cost and total haversine distance and maximizing the total number of facilities located, while not exceeding the number of facilities allowed to be located according to the maximum covering location problem. An integer multi-criteria nonlinear programming model was utilized with several models comparing the results with and without fairness constraints, using a fairness measures such as Hoover and Gini coefficient at various thresholds.

4 Justice Will be Served, One Slice of Cake at a Time: A Bilevel Programming Approach for Fair Resource Allocation in Interdependent-Network Flow Problems

Samuel Rodriguez[1,2], [1]University of Oklahoma, Norman, OK, [2]Universidad de los Andes, Bogotá, Colombia. Contact: s.rodriguez@ou.edu

This research addresses self-interested behavior undermining fair resource allocation in interdependent-network flow problems. Inspired by Shelby County's Gas, Water, and Power networks, certain end users allocations must transit through others, allowing intermediate users to act selfishly and withhold allocated resources. To address this, we propose a mixed integer bilevel linear programming approach with supervision mechanisms. Leveraging fair cake cutting, we allocate homogeneous divisible cake pieces to promote fairness among users while considering self-interest. The approach minimizes deviation from the egalitarian Nash allocation scheme, addressing "anarchic behavior" within the network.

Monday, October 16, 10:45 AM - 12:00 PM

MB47

CC-North 227C

QSR Best Refereed Paper Competition

Award Session

Session Chair: Mostafa Reisi, University of Florida, Gainesville, FL

Session Chair: Xiaowei Yue, Virginia Tech, Blacksburg, VA

Session Chair: Li Zeng, 1</sup

Monday, October 16, 10:45 AM - 12:00 PM

MB48

CC-North 228A

Integration of Machine Learning and Statistical Approaches for Quality Improvement

Community Committee Choice Session

Session Chair: Haoqian Li, University of Wisconsin-Madison, Pittsburgh, PA

Session Chair: Kaibo Liu, UW-Madison, Madison, WI

1 Directed Graphical Models for Multimodal Systems Collecting Heterogeneous Data

Manni Zhang, Ana Maria Estrada Gomez, Purdue University, West Lafayette, IN

Complex sensing systems collect heterogeneous data, including scalars, functional signals, images, and point clouds. We use directed graphical model to represent the relationships between variables in such system and aim to predict its structure and perform root cause analysis. Methods considering single type of data in the system have been proposed whereas dealing with heterogeneous data does not have a clear solution. In this article, we propose a universal tensor representation for data and assume linear interactions between the variables. When the structure is known, we learn the parameters of fitted tensor regressions; when it is unknown, we minimize the sum of least squares, group lasso, and penalties using a cyclic coordinate accelerated proximal gradient decent algorithm. The performance of our method on simulation experiments shows its advantages.

2 Adaptive Sampling and Quick Anomaly Detection in Large Networks

Xiaochen Xian[1], Alexander Semenov[2], Yaodan Hu[3], Andi Wang[4], Yier Jin[1], [1]University of Florida, Gainesville, FL, [2]University of Florida, Shalimar, FL, [3]Idaho State University, Pocatello, ID, [4]Arizona State University, Mesa, AZ, Contact: asemenov@ufl.edu

The monitoring of data streams with a network structure have drawn increasing attention due to its wide applications in modern process control. In these applications, high-dimensional sensor nodes are interconnected with an underlying network topology. In such a case, abnormalities occurring to any node may propagate dynamically across the network and cause changes of other nodes over time. We incorporate network structure information into the monitoring and adaptive sampling methodologies for quick anomaly detection in large networks where only partial observations are available. We develop a general monitoring and adaptive sampling method and further extend it to the case with memory constraints, both of which exploit network distance and centrality information for better process monitoring and identification of abnormalities.

3 Plural: 3D Point Cloud Transfer Learning via Contrastive Learning with Augmentations

Michael Biehler[1], Jianjun Shi[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA, Contact: mbiehler3@gatech.edu

Unlocking the power of 3D point cloud models can be a challenge due to the need for extensive labeled datasets. Transfer learning can help overcome this challenge. Traditional (2D) transfer learning methods struggle with 3D domain adaptation, due to differences in physical environments and sensor configurations. To address this issue, we propose a novel methodology based on contrastive learning with augmentations. We propose a co-training architecture and extend the approach of contrastive instance alignment to 3D point cloud modeling by considering physics-informed hard sample mining. Our experiments on simulation and real-world datasets demonstrate that PLURAL outperforms state-of-the-art transfer learning methods by a significant margin.

4 Online Monitoring of High-Dimensional Partially Observable Data Streams with Statistical Double Dueling Deep Q-Network

Haoqian Li[1], Ziqian Zheng[2], Kaibo Liu[3], [1]University of Wisconsin-Madison, Madison, WI, [2]University of Wisconsin-Madison, Madison, WI, [3]UW-Madison, Madison, WI, Contact: hli788@wisc.edu

With the fast advancements in Internet of Things (IoT) technology and sensing infrastructure, a wide range of systems generate a massive amount of data. Meanwhile, the practical resources constraint such as limited bandwidth or processing capability, and the exorbitant price of collecting high-frequency information from all sensors restrict the full observability of data streams. In this article, we propose a deep reinforcement learning framework to online monitor high dimensional data streams based on dynamically sampled partial observations at each data acquisition time. A Double Dueling Q-network is trained which can automatically decide the most informative data streams to monitor in each time epoch. Both simulations and a case study are thoroughly conducted to evaluate the performance and demonstrate the superiority of the proposed method.

Monday, October 16, 10:45 AM - 12:00 PM

MB49

CC-North 228B

Starting Academic Career for New and Prospective QSR Faculty

Panel Session

Session Chair: Wenmeng Tian, Mississippi State University, Mississippi State, MS

Session Chair: Chen Kan, University of Texas-Arlington, Arlington, TX

1 **Moderator**

Wenmeng Tian, Mississippi State University, Mississippi State, MS

A panel of senior QSR faculty will provide their advice, tips, and best practices for starting a successful academic career. The panel will discuss multiple academic topics including writing proposals, publishing in top journals and conferences, networking, and mentoring students.

Panelist

Peihua Qiu, University of Florida - Department of Biostatistics, Gainesville, FL

Panelist

Yao Xie, Georgia Institute of Technology, Atlanta, GA

Panelist

Jeffrey P. Kharoufeh, Clemson University, Clemson, SC

Monday, October 16, 10:45 AM - 12:00 PM

MB50

CC-North 229A

ENRE Climate and Energy Session

Community Committee Choice Session

Session Chair: Apurv Shukla, [1</sup]

Session Chair: Le Xie, Texas A&M University, College Station, TX

1 Frequency-Secured Unit Commitment: Tight Approximation Using Bernstein Polynomials

Bo Zhou[1], Ruiwei Jiang[1], Siqian Shen[2], [1]University of Michigan, Ann Arbor, MI, [2]U of Michigan/NSF, Ann Arbor/Alexandria

As we replace conventional synchronous generators with renewable energy, the frequency security of power systems is at higher risk. We study the frequency-secured unit commitment (UC) under significant wind power uncertainty. To depict the frequency dynamics, we incorporate a differential-algebraic equation (DAE) with the dead band and variable inverter droop factors into the UC model. Notably, we apply Bernstein polynomials to derive tight inner approximation of the DAE and obtain mixed-integer linear constraints. Case studies demonstrate the tightness and effectiveness of the proposed method in guaranteeing frequency security.

2 Learning and Control for Decarbonized Energy Systems

Apurv Shukla, Texas A&M, New York, NY

We analyze the lookahead dispatch policy for power system dispatch problems. We propose tight performance bounds for such a policy pertaining to the power system context. These results are further demonstrated on synthetic and real-world sized synthetic grid datasets.

3 Integrating Distributed Solar and Battery Resources into the Wholesale Energy Market: A Mean-Field Game Approach

Chen Feng[1], Andrew Lu Liu[2], [1]PURDUE UNIVERSITY, WEST LAFAYETTE, IN, [2]Purdue University, West Lafayette, IN, Contact: feng219@purdue.edu

Utilizing battery storage and demand response allows better alignment of distributed renewable energy supply with the overall system's demand patterns. However, prosumers lack the expertise to directly participate in wholesale energy markets. We propose a mean-field game framework to help prosumers (automatically) learn optimal decision policies in response to market price fluctuations and their own variable solar outputs. We prove the existence of a mean-field equilibrium (MFE) for the wholesale energy market. Our numerical experiments point to convergence to an MFE and show that our framework effectively reduces peak load and price fluctuations, especially during exogenous demand or supply shocks.

4 Optimal Control with Discrete Technologies and Market Frictions Under a Carbon Budget Constraint

Christoph Weber, University Duisburg-Essen, Essen, Germany

Countries around the world, including the US, Germany, the EU and China, have defined target years for attaining climate neutrality. Also climate science suggests that there is a maximum total budget of GHG emissions which must not be exceeded if global warming is to be limited to 2° C or less (cf. IPCC 2021). In this contribution, the optimal strategy for staying within a predefinied carbon budget is investigated in a stylized two-technology case (e.g. gas heating vs. electric heating with zero carbon electricity). The standard optimal control approach is contrasted with a setting where there is heterogeneity both in technology cost and consumer preferences. Also the effect of a present bias among decision makers is analysed, Both analytical and numerical results are provided.

Monday, October 16, 10:45 AM - 12:00 PM

MB51

CC-North 229B

Energy, Health, Equity Nexus

Community Committee Choice Session

Session Chair: Rodrigo Fernandez, 1</sup

1 Inequalities in Electricity Consumption, Subsidies, and Cooling Comfort in Mexico

Mauricio Hernandez Hernandez, Dalia Patino-Echeverri, Adli Imam Muhammad, Duke University, Durham, NC, Contact: mauricio.hernandez@duke.edu

This paper estimates electricity consumption and subsidies of 100,000 Mexican households surveyed in Mexico in 2018. Using information from the Mexican Utility Federal Electricity Commission, we expand these two datasets into a comprehensive source data representative of all of Mexico. Our estimates show that large consumers receive large subsidies, with the top 20 % of the highest consuming households receiving 50 % of the subsidies. We also find that electricity consumption is determined by socio-economic status. In the extremely hot region, families in the highest income decile consume 57 %-66 % more than those in the lowest. For this reason, Mexicans in the highest income brackets benefit the most from subsidies; the average subsidy per household for those in the two highest income brackets is almost twice the average subsidy for those in the lowest bracket.

2 A Spatial Analysis of Power-Dependent Medical Equipment and Extreme Weather Risk in the Southeastern United States

Taylin Spurlock, Appalachian State University, NC

Extreme weather events endanger critical health infrastructure, and many individuals rely on infrastructure to meet their basic needs, such as heat, water, and medical devices. The purpose of this study is to identify spatially explicit at-risk populations for power outages due to these extreme weather events. Through our analysis, we identified vulnerable areas for high rates of disasters and electricity-dependent durable medical equipment (DME) to be located in communities along the coast. We also found higher concentrations of DME in rural areas compared to urban areas. These results will inform public health officials where to target interventions to ensure continuity of care for vulnerable populations during power outages at the community level.

3 Distributed Energy Resources for Rural Resilience: The Nexus of Energy and Health

Rodrigo Mercado Fernandez, Tecnologico de Monterrey, Guadalajara, Mexico

This study explores the impacts of power outages on the rate of hospitalizations for various physical and mental health conditions in North Carolina. Using several years worth of power outage and health data, we merged the two datasets to quantify the impacts of power outages on household health. Our objective is to provide a comprehensive analysis of the impact of power outages on the health of North Carolina residents. We also aim to identify the most vulnerable populations during power outages. This study provides important insights for policymakers and stakeholders in the energy and healthcare sectors to address the impacts of power outages on household health.

4 Spatiotemporal Distribution of Power Outages with Climate Events and Social Vulnerability in the USA

Vivian Do[1], Heather McBrien[1], Nina Flores[1], Alexander Northrop[2], Jeffrey Schlegelmilch[3], Mathew Kiang[4], Joan Casey[5,1], [1]Columbia Mailman School of Public Health, New York City, NY, [2]Vagelos College of Physicians and Surgeons, New York City, NY, [3]National Center for Disaster Preparedness at the Columbia Climate School, New York City, NY, [4]Stanford, Palo Alto, CA, [5]University of Washington, Seattle, WA, Contact: vd2349@cumc.columbia.edu

STUDY AIM US power outages remain under-studied. We aim to identify the spatiotemporal distribution of outages at a county level and characterize their relationship to vulnerability and climate events. METHODS With PowerOutage.US data, we defined an outage to be whenever >0.5% of county customers were without power for 8+ and 1+ hours. Vulnerability was the Centers for Disease Control and Prevention's Social Vulnerability Index and Medicare electricity-dependent durable medical equipment (DME) use. We ran descriptive and bi-variate local indicators of spatial association analyses. RESULTS From 2018-2020, there were 17,484 8+ and 231,174 1+ hour outages, occurring frequently in the South, Northeast, and Appalachia. Outages were more frequent with increasing social vulnerability and often co-occurred with weather/climate events like cyclones and wildfires.

Monday, October 16, 10:45 AM - 12:00 PM

MB52

CC-North 230

Data-Driven Optimization for Energy Systems

Community Committee Choice Session

Session Chair: Kai Pan, The Hong Kong Polytechnic University, Hung Hom, Hong Kong

1 Optimized Dimensionality Reduction for Moment-Based Distributionally Robust Optimization

Jianqiang Cheng[1], Shiyi Jiang[2], Kai Pan[3], Zuo-Jun Max Shen[4], [1]University of Arizona, Tucson, AZ, [2]Hong Kong Polytechnic University, Hong Kong, China; [3]The Hong Kong Polytechnic University, Hung Hom, Hong Kong; [4]University of California Berkeley, Berkeley, CA

In this talk, we propose an optimized dimensionality reduction approach to solve moment-based distributionally robust optimization (DRO). We first show that the ranks of the matrices in the SDP reformulations are small, by which we are then motivated to integrate the dimensionality reduction of random parameters with the subsequent optimization problems. Such integration enables two outer and one inner approximations of the original problem, providing two lower bounds and one upper bound correspondingly. As these approximations are nonconvex low-dimensional SDPs, we develop modified Alternating Direction Method of Multipliers algorithms to solve them efficiently. Numerical results show significant advantages of our approach on the computational time and solution quality over the three best possible benchmark approaches.

2 Optimal Planning of Preventive Maintenance Tasks on Electric Power Transmission Systems

Mariana Rocha[1], Miguel F. Anjos[2], Michel Gendreau[1], [1]Polytechnique Montreal, Montreal, QC, Canada; [2]University of Edinburgh, Edinburgh, United Kingdom. Contact: anjos@stanfordalumni.org

Preventive maintenance scheduling of transmission lines must be carefully planned to ensure uninterrupted power supply while reducing equipment failures and maintaining network reliability. The transmission maintenance scheduling problem is concerned with selecting the optimal periods to remove specified lines from operation to carry out preventive maintenance. We propose a mixed-integer linear optimization formulation that schedules preventive maintenance for one year while ensuring that the system stays connected even in case of an unexpected line failure. The resulting large-scale optimization problem is solved using a decomposition approach. We report computational results demonstrating that our algorithm achieves the required accuracy and solves the problem more efficiently than solving the complete formulation without decomposition.

3 Distributionally Robust Trading in Two-Stage Energy Markets with a Single-Price Balancing Stage

Bob Pepin, Technical University of Denmark, Kgs. Lyngby, Denmark

We will show how to use Distributionally Robust Optimization and Optimal Transport to derive robust bidding strategies in two-stage energy markets. The market consists of a forward and a balancing stage with a single-price scheme and we assume that we have access to a set of samples from the joint distribution of forward and balancing prices. The main challenge is the presence of a discontinuity in the objective function as a function of prices and we show how to derive explicit optimal transport plans for the worst-case distribution, leading to robust bidding decisions.

4 A Data-Driven Approach to Unit Commitment Under Uncertainty Using Contextual Information
Ogun Yurdakul, Argonne National Laboratory, Lemont, IL
To take unit commitment (UC) decisions under uncertain net load, most stochastic optimization (SO) frameworks adopt a generic representation of uncertainty. While net load levels that materialize on a particular day are influenced by various covariates (such as the day of the week or temperature), SO frameworks typically disregard such side observations, squandering useful information that could markedly enhance decision quality. In this talk, we discuss contextual stochastic optimization frameworks for taking UC decisions under uncertain net load, which can effectively exploit covariate observations together with machine learning algorithms to improve the out-of-sample performance of UC decisions. Using real-world data harvested from the New York ISO grid, we compare the performance of the frameworks against alternative methods proposed in the literature.

Monday, October 16, 10:45 AM - 12:00 PM

MB53

CC-North 231A

Sustainable Electricity Markets and Transportation

Community Committee Choice Session

Session Chair: Arash Khojaste, 1</sup

Session Chair: Golbon Zakeri, University of Massachusetts - Amherst, Amherst, MA

1 Who Bears the Risk? the Case of Battery Market Models
Mahan Mansouri, Pacific Gas and Electric (PG&E), Oakland, CA, Contact: mahan.ma@gmail.com
In California, battery operators co-located with other electric generation resources choose between two market models which may have differential risks and rewards for batteries and the system operator. The choice of market model may substantially affect resource valuation and bidding strategies due to risk asymmetries.

2 Hybrid Electricity Market Models: Combining Zonal and Nodal Pricing for Congestion Management
Endre Bjørndal, Benjamin Fram, Mette Bjørndal, Norwegian School of Economics, Bergen, Norway. Contact: endre.bjorndal@nhh.no
We propose several novel hybrid pricing models for congestion management in electricity markets. Hybrid models manage congestion by allowing certain market areas to use nodal pricing and others to use zonal pricing and have been previously shown to offer significant welfare improvements over zonal pricing models. We present two classes of hybrid models: simultaneous and sequential. Simultaneous models clear the market in a single step where nodal and zonal pricing areas are both cleared at once. Sequential models first clear a fully zonal model, fix the resulting power flow quantities between market areas, and then re-clear the nodal pricing areas in a second modelling step. We also present several subvariants of these models where we aggregate, partially disaggregate, and fully disaggregate the transfer capacities of lines connecting market areas.

3 Prequalifying Residential Distributed Energy Resources (DERs) for Providing Flexibility to Power Markets
Yijiao Wang[1], Ben Field Hobbs[2], Michael Blonsky[3], Elina Spyrou[4], Mengmeng Cai[3], [1]Johns Hopkins University, Baltimore, MD, [2]Johns Hopkins University, Baltimore, MD, [3]National Renewable Energy Laboratory, Golden, CO, [4]Imperial College London, Golden, CO, Contact: ywang303@jhu.edu
With increasing amounts of intermittent renewables in the electricity mix, managing the high variability and high uncertainty of these renewables is a growing challenge for grid operators. Operators can use the flexibility of DERs to hedge system reliability risks (supply-demand imbalances). This study develops an advanced prequalification technique for demand-based DERs to select aggregated small-scale residential customers for flexibility provision in day-ahead markets based on numerous user characteristics. Specifically, a set of indices depicting the reliability of DERs can be developed focusing on control of HVAC systems and water heaters. Based on the reliability indices, grid operators are able to identify most valuable small-scale aggregation for various power market applications.

4 Optimizing Fleet Electrification Strategies for Sustainable Bus Transit
Mahsa Arabi, Jimi Oke, University of Massachusetts Amherst, Watertown, MA

The transition to electric fleets is essential for public transit agencies aiming to achieve timebound climate change targets sustainably. We present a decision-making framework for bus electrification strategies to minimize emissions. Our framework incorporates a machine learning-enhanced vehicle-specific energy consumption model for conventional, hybrid and battery electric powertrains and considers various constraints, including budget and charging capacity. Using a case study of the Pioneer Valley Transit Authority, we evaluate competing strategies in terms of fleet composition and timeline, analyze vulnerabilities and provide recommendations. By empowering fleet managers with informed decision-making capabilities, our research contributes to the acceleration of sustainable transportation and the reduction of greenhouse gas emissions.

Monday, October 16, 10:45 AM - 12:00 PM

MB54

CC-North 231B

Exploring the Intersection of Machine Learning and Discrete Optimization: Techniques and Applications

Community Committee Choice Session

Session Chair: Mikhail Bragin, University of California, Riverside, Riverside, CA
Session Chair: Bing Yan, Rochester Institute of Technology, Rochester, NY
Session Chair: Anbang Liu, 1</sup

1 Learn to Solve Large-Scale Job Shop Scheduling by Integrating Machine Learning and Mathematical Optimization

Anbang Liu[1], Peter B. Luh[2], Kailai Sun[1], Mikhail Bragin[3], Bing Yan[4], [1]Tsinghua University, Beijing, China; [2]University of Connecticut, Storrs, CT, [3]Southern California Edison, Rosemead, CA, [4]Rochester Institute of Technology, Rochester, NY, Contact: liuab19@mails.tsinghua.edu.cn

In this talk, we focus on machine learning (ML) for complex job-shop scheduling problems. However, direct learning suffers from difficulties in large-scale instances. To overcome this, we developed a novel approach that integrates ML methods within the price-based decomposition-and-coordination framework of the Surrogate Lagrangian Relaxation. Specifically, the approach involves learning to solve part subproblems, which are easier to learn by establishing surrogate subproblems, developing a DNN based on Pointer Network, and devising a masking mechanism for feasibility. The numerical results on several large-scale instances demonstrate that subproblem solutions can be obtained based on predictions in less than 0.01 seconds, and high-quality overall solutions are thus obtained in a computationally efficient manner.

2 Synergistic Integration of Interpretable Machine Learning and Mathematical Optimization for Sub Hourly Unit Commitment

Jianghua Wu[1], Bing Yan[2], Yonghong Chen[3], Zongjie Wang[1], Mikhail Bragin[4], [1]University of Connecticut, STORRS, CT, [2]Rochester Institute of Technology, Rochester, NY, [3]National Renewable Energy Laboratory, Golden, CO, [4]Southern California Edison, Rosemead, CA, Contact: bxyeee@rit.edu

To adapt to renewable intermittency and to enhance power system flexibility, sub-hourly Unit Commitment (UC) has been suggested. However, for sub-hourly UC, traditional optimization is time-consuming, and machine learning (ML) poses feasibility concerns. To resolve these difficulties, an ML model combining Gated Recurrent Units, Attention, and Masking Operations is utilized to swiftly predict subproblem solutions within our advanced decomposition and coordination framework. Compared to the overall solution of the entire problem, subproblem solutions are much easier to learn. Moreover, the learning process based on "shadow prices" is highly interpretable and consistent with the supply-demand principle. ML successfully predicts 78% of subproblem solutions in <1% of total CPU time, and this ratio is expected to be further increased through advanced ML models.

3 Deep Learning-Based Transmission Line Screening for Unit Commitment

Farhan Hyder, Sriparvathi Bhattathiri, Bing Yan, Michael Kuhl, Rochester Institute of Technology, Rochester, NY, Contact: fh6772@rit.edu

Unit commitment is a challenging discrete optimization problem in power systems. A way to obtain high-quality solutions fast is to remove redundant network constraints. Traditional optimization methods are too conservative while machine learning methods fail to maintain feasibility. To resolve these issues, a novel regression-based classification deep-learning approach is developed to safely identify redundant constraints by capturing the temporal relationships between past line-loading levels, nodal demands, and future line-loading levels. Once trained, the model can be used under different classification thresholds. Results show that CPU time reduces by 60% by safely removing 75% of network constraints while maintaining the same solution quality. The approach can be extended to identify redundant constraints in other discrete optimization problems.

Monday, October 16, 10:45 AM - 12:00 PM

MB55

CC-North 231C

Empirical Insights into Platform Service Delivery and Health Equity

Community Committee Choice Session

Session Chair: Ming Hu, University of Toronto, Minneapolis, MN

Session Chair: Zhoupeng Zhang, NULL, NULL

1 An Empirical Analysis of the Impact of On-Time Delivery on a Grocery Platform

Hailong Cui[1], Guo Li[2], Na Li[3], [1]University of Minnesota, Minneapolis, MN, [2]Beijing Institute of Technology, Beijing, China; [3]Nankai University, Tianjin, China

We empirically study the effects of early or late delivery of grocery orders on an online platform in terms of customer's subsequent order frequency, order amount and order size. We collect unique panel data sets from the online grocery delivery platform and use piecewise regression models and generalized method of moments (GMM) as empirical strategies to identify the effects.

2 Designing a Mental Health Service Recommender System: Sensing and Responding to the Personalized Support Needs and Advancing Equity in Mental Healthcare Delivery

Yi Tang[1], Kingshuk K. Sinha[2], Adam Moen[3], [1]Carlson School of Management, Minneapolis, MN, [2]University of Minnesota SCO, Minneapolis, MN, [3]Real EmPowerment Solutions Inc., Minneapolis, MN, Contact: tangx688@umn.edu

Online platforms have recently become a space where people with mental health concerns would gather and exchange peer support. However, such platforms lack the ability to refer users to mental health services when chatting in online platforms is not enough. In this study, we develop a mental health service recommender system to address this need. By applying natural language processing techniques, the system is capable of capturing the core concern of users, interacting with users via a chatbot, and finally providing them with personalized recommendations to care options, taking into consideration of their preferences for mental health providers such as gender, experience serving certain sexuality / race-ethnicity populations. We develop this recommender system following an intervention study approach by collaborating with a panel of mental health professionals.

3 Timing Matters:Sourcing On-Demand Workers on Freight Matching Platforms

Guangwen (Crystal) Kong[1], Ziqi Dong[1], Jingxuan Geng[1], Qiuping Yu[2], [1]Temple University, Philadelphia, PA, [2]Georgetown University, Washington, DC, Contact: guangwen.kong@temple.edu

We study the time that a freight matching platform sourcing truck drivers

4 Product Development in Crowdfunding: Theoretical and Empirical Analysis

Sidika Tunc Candogan[1], Philipp Benjamin Cornelius[2], Bilal Gokpinar[3], Ersin Korpeoglu[4], Chris S. Tang[5], [1]NUS Business School, Singapore, Singapore; [2]Rotterdam School of Management, Rotterdam, Netherlands; [3]UCL School of Management, London, United Kingdom; [4]University College London, London, United Kingdom; [5]University of California-Los Angeles, Los Angeles, CA, Contact: sidika.c@nus.edu.sg

We study an entrepreneur's product development and improvement decisions in crowdfunding. Analyzing a game-theoretical model and testing its predictions empirically, we show that as the product's level of enhancement at campaign launch increases, the likelihood of product improvement during a campaign first increases and then decreases. Furthermore, although our theoretical model intuitively predicts that the likelihood of campaign success always increases with the level of enhancement at campaign launch, our empirical analysis shows that the likelihood of campaign success first increases but then decreases. This counterintuitive result may be due to customers being overwhelmed with the complexity of highly enhanced products.

Monday, October 16, 10:45 AM - 12:00 PM

MB56

CC-North 232A

New Advances in Low-Rank Optimization

Community Committee Choice Session

Session Chair: Ryan Cory-Wright, MIT, Cambridge, MA

1 On the Partial Convexification of the Low-rank Constrained Optimization

Yongchun Li, Weijun Xie, Georgia Institute of Technology, Atlanta, GA, Contact: ycli@gatech.edu

The low-rank constrained optimization arises in various machine learning and optimization problems. It minimizes a linear objective function subject to multiple linear inequalities and a low-rank domain set, which is generally NP-hard. A viable approach is to convexify the domain set, known as "partial convexification"; however, its solution quality lacks theoretical guarantees. To fill this gap, (i) we investigate when the partial convexification is exact; and (ii) we guarantee the worst-case rank of the partial convexification solution. To solve the partial convexification, we develop a column generation algorithm combined with a rank-reduction algorithm, which ensures that the output solution satisfies the theoretical guarantees. Finally, we numerically verify the strength of the partial convexification and the efficacy of the proposed algorithms.

2 Sparse and Low Rank Matrix Decomposition: A Discrete Optimization Approach

Nicholas Andre G. Johnson, Massachusetts Institute of Technology, Cambridge, MA, Contact: nagj@mit.edu

We study the Sparse Plus Low-Rank decomposition problem (SLR) - a fundamental problem in Operations Research and Machine Learning which arises in various applications. We introduce a novel formulation for SLR for which we develop an alternating minimization heuristic that computes high-quality solutions and a novel semidefinite relaxation that provides meaningful bounds for the solutions returned by our heuristic. We also develop a custom branch-and-bound algorithm to solve small instances of SLR to certifiable (near) optimality. Given an input n-by-n matrix, our heuristic scales to n=10000 in minutes, our relaxation scales to n=200 in hours, and our branch-and-bound algorithm scales to n=25 in minutes. Our numerical results demonstrate that our approach outperforms existing state-of-the-art approaches while maintaining a comparable runtime.

3 Optimal Low-Rank Matrix Completion: Semidefinite Relaxations and Eigenvector Disjunctions

Ryan Cory-Wright[1], Dimitris Bertsimas[2], Sean Lo[3], Jean Pauphilet[4], [1]Imperial College London, London, United Kingdom; [2]Massachusetts Institute of Technology, Cambridge, MA, [3]MIT, Cambridge, MA, [4]London Business School, London, United Kingdom

Low-rank matrix completion consists of computing a matrix of minimal complexity that recovers a given set of observations as accurately as possible. Unfortunately, existing matrix-completion methods are heuristics that, while highly scalable, do not possess optimality guarantees. We reexamine matrix completion with an optimality-oriented eye, by reformulating low-rank matrix completion as a convex problem over the non-convex set of projection matrices, and proposing a disjunctive branch-and-bound scheme that solves low-rank problems to provable optimality. In numerical experiments, we showcase the performance of our branch-and-bound method and demonstrate that it solves problems over 150 x 150 matrices to optimality in hours.

Monday, October 16, 10:45 AM - 12:00 PM

MB57

CC-North 232B

Quantum Linear Algebra and Optimization

Community Committee Choice Session

Session Chair: Mohammadhossein Mohammadisiahroudi, Lehigh University, Bethlehem, PA

1 Inexact Feasible Quantum Interior Point Methods for Linear and Semidefinite Optimization

Tamas Terlaky[1], Mohammadhossein Mohammadisiahroudi[2], Ramin Fakhimi[2], Brandon Augustino[3], Giacomo Nannicini[4], Luis F. Zuluaga[2], [1]Lehigh University, Bethlehem, PA, [2]Lehigh University, Bethlehem, PA, [3]Lehigh University, Landing, NJ, [4]University of Southern California, Los Angeles, CA, Contact: terlaky@lehigh.edu

We apply Quantum Linear System Algorithms (QLSAs) to Newton systems within Interior Point Methods (IPM) to gain quantum speedup in solving linear and semi-definite optimization problems. Due to their inexact nature, direct use of QLSAs lead to inexact infeasible variants of IPMs (II-IPMs). By developing novel Newton systems, we propose Inexact-Feasible IPMs (IF-IPMs) that compute inexact but feasible iterations. We show that IF-IPMs enjoy the to-date best iteration complexity. Further, we explore how iterative refinement schemes can be used efficiently both at the QLSA and optimization problem levels to find an exact optimal solution without excessive calls to QLSAs.

2 New Developments to Reduce Cost Per Iteration in Interior Point Methods

Mohammadhossein Mohammadisiahroudi[1], Ramin Fakhimi[1], Brandon Augustino[2], Zeguan Wu[1], Giacomo Nannicini[3], Tamas Terlaky[1], [1]Lehigh University, Bethlehem, PA, [2]Lehigh University, Landing, NJ, [3]University of Southern California, Los Angeles, CA, Contact: mom219@

lehigh.edu
Interior Point Methods (IPMs) are the most prevailing methods to solve linear optimization problems with fast convergence. However, the cost per iteration can be considerably high for large-scale problems. We highlight how quantum linear system algorithms can reduce the cost per iterations in IPMs. However, the significant challenge is that the efficiency of these methods depends on the condition number of the coefficient matrix. It is known that the condition number of the linear systems arising in IPMs may grow to infinity as optimality is approached. To address this challenge, we use three tools: iterative refinement methods, preconditioning, and regularization. We also compare the performance of these methods from both the theoretical and practical aspects.

3 Hybrid Quantum-classical Algorithms For Linear Optimal Control
Jiaqi Leng[1], Connor Clayton[2], Yiling Qiao[2], Kaiqing Zhang[3], Ming Lin[2], Xiaodi Wu[4], [1]University of Maryland, College Park, College Park, MD, [2]University of Maryland, College Park, College Park, MD, [3]University of Maryland, College Park, College Park, MD, [4]University of Maryland, College Park, College Park, MD, Contact: jiaqil@umd.edu
Linear optimal control naturally arises in the control of linear dynamical systems and constitutes the foundation of nonlinear control theory. Given their simplicity, linear control problems could still be challenging for classical computers due to high dimensionality. In this paper, we propose an efficient hybrid quantum-classical algorithm for the Linear-Quadratic Regulator (LQR). The quantum advantage of our algorithm is established. The hybrid design significantly reduces the quantum resources (qubits, coherent times, etc.) required by our algorithm, making it feasible on early fault-tolerant or even near-term devices. Furthermore, we show that our hybrid quantum-classical algorithm is readily adapted to solve nonlinear control problems via linearization. Numerical simulations of our algorithm for both linear and nonlinear control are presented.

4 Fast Algorithms for Quantum Signal Processing
Yulong Dong[1], Jiasu Wang[1], Xiang Meng[2], Hongkang Ni[3], K. Birgitta Whaley[1], Lin Lin[1], [1]University of California, Berkeley, Berkeley, CA, [2]MIT, Cambridge, MA, [3]Stanford University, Stanford, CA, Contact: dongyl@berkeley.edu
The recently developed quantum singular value transformation (QSVT) provides a unified viewpoint of a large class of practically useful quantum algorithms. At the heart of QSVT is a perhaps new way of representing polynomials, called quantum signal processing (QSP), which encodes a polynomial using parameterized products of matrices in SU(2). For a given polynomial, finding the parameters (called "phase factors") is a challenging problem. I will introduce optimization based fast algorithms, which are able to solve a large-scale QSP problem parameterized by more than 10,000 phase factors. I will then discuss the energy landscape of the optimization problem, which allows us to solve the open problem of finding phase factors using only standard double precision arithmetic operations.

Monday, October 16, 10:45 AM - 12:00 PM

MB58

CC-North 232C
Sustainability and Energy
Contributed Session
Session Chair: Alva Dillon, Alva Dillon, Tyngsborough, MA

1 Optimal Decision Tree-Based Feature Selection for Enhanced Renewable Carbon Content Quantification in Co-Processed Fuels
Liang Cao, Kaixun Hua, Yankai Cao, University of British Columbia, Vancouver, BC, Canada. Contact: huakaixun@gmail.com
Addressing the challenge of accurately quantifying renewable carbon in co-processed fuels, we propose a method utilizing an optimal decision tree model. Existing methods are designed to process the feature selection on the whole dataset, without considering different working conditions. Our approach partitions the dataset into subsets based on the decision tree model. Each subset independently establishes a robust linear regression model, using features from the corresponding decision tree prediction path. This method has demonstrated its effectiveness in real-world oil refining data, offering a precise renewable fuel content assessment tool.

2 Optimal Subsidy Policy to Manage Solar Adoption in a Region
Swapnil Rayal, University of Washington, Seattle, WA, Contact: srayal@uw.edu
A central planner of a region aims to achieve a certain level of solar adoption at the end of the planning horizon. The two products available in the region are roof-top and subscription solar. The region is heterogenous in the household income and the demand for electricity. We model the demand evolution as a stochastic differential equation and derive a closed form expression for the distribution of optimal adoption time of each income level for a given subsidy using a optimal stopping formulation. Using the

derived distribution function of random adoption times and given income distribution, we develop a contrainted non-linear optimization model to derive optimal subsidy policy to ensure fair and efficient solar adoption in presence of heterogenity in the region.

3 Electric Vehicle Routing Problem with Dynamic Pricing and Carryover

Chihiro Maeda, Hiroshi Morita, Osaka University, Suita, Japan. Contact: chihiro.maeda@ist.osaka-u.ac.jp

The trend toward decarbonization has led to the introduction of EVs in the home delivery business. In addition, the oversupply of electricity during the daytime due to solar power generation is causing electricity prices to fluctuate depending on the time of day. In this study, we propose a mathematical model to determine the optimal delivery route and charging plan in response to fluctuating electricity prices. In addition, we also consider the electricity price not only on the day of the delivery but also on the following day.

4 Data Monitoring for Environmental Safety

Alva Dillon, Brandeis University, Waltham, MA, Contact: devondillon333@gmail.com

The C-10 Research & Education Foundation has been operating a 24-hour radiation monitoring network in communities surrounding the Seabrook Station nuclear power plant since 1991.Through actively monitoring and analyzing radiation levels C-10 provides valuable insight regarding potential radiation hazards to ensure the safety of the community.To meet their needs we developed an interactive application using the Python framework Streamlit. The application allows authenticated users to visualize the radiation time series and related wind data over a desired time frame.Specific users can also update the database with the most recent data using an automated procedure.The program's user-friendly interface empowers the organization's experts to quickly analyze and communicate radiation information to stakeholders.

Monday, October 16, 10:45 AM - 12:00 PM

MB59

CC-West 101A

Negotiation Models

Community Committee Choice Session

Session Chair: Eduarda Asfora Frej, Universidade Federal de Pernambuco, Recife, Brazil

1 The Consequences of Preference Correlation for Fair Division of Indivisible Items

Fahimeh Ziaei, Wilfrid Laurier University, Waterloo, ON, Canada

The fair allocation of indivisible items among multiple individuals is a fundamental problem in collective decision-making. In this paper, we consider only the problem of allocating two of four indivisible items to each of two players based on strict rankings. We Investigate preference correlation (Kendall Tau) and fair allocation properties (envy-free, Pareto-optimal, maximin, max BordaSum). We also examine correlation's impact on Fallback Bargaining, including depth of agreement and a (two-way) tie probability. Our results suggest that as preferences correlate more, Pareto-optimal and maximin allocations increase, while envy-free allocations decrease. Correlation also makes Fallback Bargaining less compelling. We provide insights into the trade-offs between allocation properties and preference correlation in fair allocation of indivisible items.

2 Bargaining-Based Surplus-Sharing Rules for Restoring Equality

Juan C. Gómez[1], P.V. Balakrishnan[2], [1]University of Washington, Bothell, Bothell, WA, [2]University of Washington, Bothell, WA, Contact: jcgomez@uw.edu

We consider surplus-sharing problems where a fixed amount of money is allocated among agents with different claims. We introduce two new rules that are inspired by bargaining solution concepts and aim to reduce inequality among agents. We show that these rules are part of a parametric family of surplus-sharing rules and contrast them with traditional proportional rules. We analyze their properties and performance in various settings.

Monday, October 16, 10:45 AM - 12:00 PM

MB60

CC-West 101B

INFORMS Minority Issues Forum (MIF) Early Career Award 2023

Award Session

Session Chair: Wesley Javier Marrero, Thayer School of Engineering at Dartmouth, Hanover, NH

1 2023 Informs MIF Early Career Award Presenter

Wesley Javier Marrero, Thayer School of Engineering at Dartmouth, Hanover, NH

The INFORMS Minority Issues Forum (MIF) Early Career Award recognizes outstanding contributions to the theory or practice of OR/MS *and* service made by early career, active members of MIF. The award recognizes exceptional researchers who have shown promise early in their academic or industrial career. Scholars who are pre-tenure and within 8 years of receiving their doctorate (or equivalent) degree are eligible to apply.

2 Melding Socio-theoretical Principles and Optimization into Novel Decision Technologies

Adolfo Escobedo, North Carolina State University, Raleigh, NC

In recent years, there has been a growing interest in the development of decision-making mechanisms that infuse socio-theoretical principles. Such efforts are meant in part to serve as a counterbalance against "black box" decision-making technologies, and they have led to improved outcomes in business, technology, and various other domains. Yet, real-world implementation of the more robust methodologies—in the sense that their outputs guarantee desirable socially beneficial properties—remains severely limited due to a combination of incompatible assumptions and computational challenges.

The first part of this talk will highlight our prior work in melding novel socio-theoretical insights and optimization techniques to make theoretical and computational advances in two research areas. One is preference aggregation, where we have derived exact and inexact methods with formal guarantees and introduced social choice concepts to handle preference data that may be high-dimensional, incomplete, and/or contain ties. The other is territorial districting, where we have developed optimization models and algorithms for satisfying definite planning criteria that are beneficial to logistics and service applications. The talk will also summarize additional prior contributions and future research directions.

The second part this talk will provide an overview of my prior service activities, with a focus on ongoing efforts to provide broader educational and research opportunities to undergraduate and master's students. This includes the organization of a summer research internship program, four years running, for students from various universities in the U.S. and abroad

Monday, October 16, 10:45 AM - 12:00 PM

MB61

CC-West 101C

Modeling to Improve Local Communities

Community Committee Choice Session

Session Chair: Emily L. Tucker, Clemson University, Clemson, SC

Session Chair: EunSu Lee, New Jersey City University, Jersey City, NJ

1 Improving Equity in Access to Local Parks

Emily L. Tucker, Clemson University, Clemson, SC

Local parks are foundational for neighborhoods and communities. Yet, disparities persist in who has access to high-quality parks. We present a model to optimize locations for new parks by minimizing inequity in access. Access is a function of distance, crowding, and environmental factors. We consider a case study of Asheville, NC and evaluate several policies to improve access.

2 An Investigation into Retirement Decision-Making

Mehrnaz Behrooz, Ilbin Lee, Ivor Cribben, University of Alberta, Edmonton, AB, Canada. Contact: mbehrooz@ualberta.ca

Retirement, as a significant life transition, requires careful planning and decision-making. Our research leverages the data revolution to optimize retirement decision-making. By combining the analysis of rich aging date resources with advanced optimization models, we strive to enhance the retirement planning process. Using longitudinal data on aged individuals, we identified which and how different factors affect retirement decisions and developed a mathematical model to personalize the optimal age of retirement and retirement saving plans. These findings have implications for policy-makers to improve pension programs, while individuals can make more informed decisions on retirement planning, ultimately enhancing their retirement outcomes.

3 Predicting and Understanding Residential Water use with Interpretable Machine Learning

Benjamin Rachunok[1], Sarah Fletcher[2], Aniket Verma[2], [1]North Carolina State University, Raleigh, NC, [2]Stanford Universty, Stanford, CA, Contact: barachun@ncsu.edu

Predicting household water use is critical to efficiently manage urban water resource systems. Current approaches examining residential water use either identify the drivers of household water through parametric or non-parametric statistical approaches. Here, we use recent advances in interpretable machine learning to understand the drivers of residential water use. Specifically, we use post-hoc interpretability methods to examine how drivers of water use interact, focusing on environmental, demographic, physical housing, and utility policy factors. We find all four categories of factors are important for estimating water use with environmental and utility policy factors playing the largest role. We show this approach provides high predictive accuracy and identification of complex water use factors, offering important insight for urban water management.

4 Where is Oasis in Urban Dessert? Using GIS and Location Analytics

EunSu Lee, New Jersey City University, Jersey City, NJ

This study demonstrates a community mapping approach in community-engaged learning to investigate grocery stores selling fresh food in an urban desert. Spatial analytics using geographic information systems is utilized to map the locations and potential locations of oases in the urban desert.

Monday, October 16, 10:45 AM - 12:00 PM

MB62

CC-West 102A

Humanitarian and Disaster Response Logistics

Community Committee Choice Session

Session Chair: zhili Tian, NULL

1 Mobilizing Firms for Climate Action: Paris Climate Agreement, National Instutions, and Corporate Green Bonds

Yifan Wei[1], Kenneth Guang-Lih Huang[2], Ya Gao[3], [1]University of Manitoba, Winnipeg, MB, Canada; [2]National University of Singapore, Singapore, Singapore; [3]University of Manitoba, Winnipeg, MB, Canada. Contact: ya.gao@umanitoba.ca

We examine firms' voluntary environmental practices under mounting regulatory pressure and consider a quasi-natural experiment to identify the causal effect of the Paris Climate Agreement on the issuance of corporate green bonds (CGBs), a new financial instrument for sustainability. Using a difference-in-differences analysis, we find that firms in the affected industries are more likely to issue CGBs after the Agreement than firms in the minimally affected industries. Also, such effect is stronger in countries with more media attention but weaker in countries with stronger legal enforcement. Our study contributes to the management literature on corporate environmental behaviors by highlighting the temporal dimension of firms' responses to the changing institutional environment and adds to the burgeoning literature on green financing.

2 Social Determinants of Health: Multi-Level Models to Understand Spatiotemporal Variation of Social Vulnerabilities During Hurricane-Pandemics

Arda Vanli, Florida A&M University, Florida State University (FAMU-FSU) College of Engineering, Tallahassee, FL, Contact: oavanli@eng.fsu.edu

A spatiotemporal modeling approach is proposed to understand spatially varying social, demographic and health drivers of pandemic spread during hurricanes from longitudinal infection data collected from geographical units. A multilevel mixed-effects model is developed to investigate the association between census tract-level Covid-19 case count trajectories and demographic, socioeconomic and health factors. A case study for modeling the spatiotemporal variation of social vulnerability with data from Covid-19 pandemic and Hurricane Sally in Florida is presented to illustrate the application of the approach.

3 Truckload Transportation Procurement During Disasters

Shraddha Rana, Massachusetts Institute of Technology, Cambridge, MA, Contact: srana@mit.edu

During disasters, as the demand for truckload transportation increases to stock up and distribute emergency supplies, the ability decreases due to infrastructure damage. With the increase in frequency of natural disasters it is important to model historical impact in order to be prepared for transportation procurement for future disasters. First, we quantify the causal effects of disaster conditions and public sector disaster relief activities on private sector truckload transportation spot prices. For this we use a difference-in-difference methodology. Next, we assess the efficiency of existing truckload transportation procurement process for disaster relief use by public sector and identify improved alternate strategies. We use a segmentation approach for the same and test it on a real life case study of Hurricane Ian.

Monday, October 16, 10:45 AM - 12:00 PM

MB63

CC-West 102B

Service Science Best Student Paper Award Competition (I)

Award Session

1 A Multi-Treatment Forest Approach for Analyzing the Heterogeneous Effects of Team Familiarity

Minmin Zhang[1], Guihua Wang[2], Wallace J. Hopp[3], Michael Mathis[4], [1]University of Texas at Dallas, Richardson, TX, [2]The University of Texas at Dallas, RICHARDSON, TX, [3]University of Michigan, Ann Arbor, MI, [4]University of Michigan Medical School, Ann Arbor, MI

Extensive research has revealed that prior collaborative experiences among team members (called "team familiarity") enhance outcomes of group work in many different environments. In this study, we examine the effect of team familiarity on surgery duration and extend the literature on team dynamics by examining whether the effect of team familiarity is heterogeneous across patients. We find (1) an increase in team familiarity score, especially the anesthesiologist-nurse and surgeon-anesthesiologist familiarity scores, significantly reduces surgery duration, and (2) the effect of team familiarity is heterogeneous across patients with different features. Finally, we develop an optimization model to assess the value of leveraging the heterogeneous effects of team familiarity to better match surgical teams with patients.

2 Pricing Under The Generalized Markov Chain Choice Model: Learning Through Large-scale Click Behaviors

Mo Liu[1], Junyu Cao[2], Zuo-Jun Max Shen[1], [1]University of California Berkeley, Berkeley, CA, [2]The University of Texas at Austin, Austin, TX

We study how to leverage large-scale random click behaviors of customers for online retailers in the pricing problem. We present a new click model that is developed based on the generalized Markov chain choice model (GMCCM), which we justify both theoretically and empirically using real-world data. Based on our click model, we propose a data-driven framework to learn customers' browsing and purchasing behaviors from the click data, where we consider the low-rank structure of the transition matrix. For the static pricing problem, our theoretical results reveal that a higher click rate does not necessarily lead to higher optimal prices. For the dynamic pricing problem in the online setting, we design an exploration-free algorithm and prove a significantly lower regret bound compared to the algorithms that do not consider the low-rank structure of the transition matrix.

3 Can Predictive Technology Help Improve Acute Care Services? Investigating the Impact of Virtual Triage Technology Adoption

Jiatao Ding[1], Michael Freeman[1], Sameer Hasija[2], [1]INSEAD, Singapore, Singapore; [2]Insead, Singapore, Singapore

This paper investigates the operational implications and policy impacts of virtual triage adoption within the acute care service setting. A central problem in this context is patients' (in)ability to self-triage accurately, a notable contributor to emergency department overcrowding and treatment delays. While traditional triage solutions, such as phone services, can mitigate these issues to an extent, they struggle with accessibility and accuracy problems. However, recent developments in predictive analytics have led to the development and deployment of virtual triage tools, which offer immediate, cost-effective, and potentially more accurate triage recommendations. Despite their potential benefits and increasing adoption, the impact of virtual triage tools on healthcare systems remains poorly understood. This paper, therefore, develops a queueing game model to examine how virtual triage influences patient behavior and system performance, and explores policy actions that maximize the operational advantages of these tools. Our findings underline the pressing need for effective regulation and thorough assessment of operational consequences to harness the full potential of virtual triage in improving acute care system performance.

4 Optimizing Equitable Resource Allocation In Parallel Any-scale Queues With Service Abandonment And Its Application To Liver Transplant

Shukai Li, Sanjay Mehrotra, Northwestern University, Evanston, IL

We study the problem of equitably and efficiently allocating resources, modeled as service rates, to multiple queues with abandonment. The problem is motivated by the national liver allocation system, which includes numerous small-scale patient waitlists in terms of arrival intensities, with the possibility of patients abandoning (death) until the required service is completed (matched donor livers arrive). We model each waitlist as a GI/MI/1+GI queue. To evaluate the queue performance, we develop a finite approximation method, which is further used within an optimization model. We find that increasing the proportion of livers allocated to waitlists with small scales or high abandonment (death) risks improves allocation equity. This suggests a proportionately greater allocation of organs to smaller transplant centers and those with more vulnerable populations.

Monday, October 16, 10:45 AM - 12:00 PM

MB64

CC-West 102C

Data Analytics in Social Media Platforms

Community Committee Choice Session

Session Chair: Sagar Mahesh Badve, Virginia Tech, Blacksburg, VA

1 Branding Effects in the Era of Content Entrepreneurship: Decoding Consumer Associations with Family and Individual Content Creators

Gajanan L. Ganji, Stephanie Brooke Escudero, The University of Texas at Arlington, Arlington, TX, Contact: gajananlaxmanra.ganji@mavs.uta.edu

We seek to answer the questions (1) What cognitive associations do family content-creators evoke in the minds of consumers? and (2) How do these perceptions affect interactions in the comments? To do so, we examine differences between family and individual YouTube channels on the six Organizational Virtue Orientation (OVO) dimensions - Integrity, Empathy, Warmth, Courage, Conscientiousness, and Zeal. We hypothesize that, similar to "family-owned" firms, family YouTube channels demonstrate higher levels of OVO, positively influencing consumer perception. We discuss domain-specific implications for the established role of family branding on consumer perception in the context of content creation-based platforms.

2 Everyone Can Communicate in Emergencies, UGC Aids EMS

Varada Krishnaswamy, Virginia Tech, Chantilly, VA

Information systems research can help organizations use social media data for crisis management by promoting its benefits and overcoming organizational and technological constraints. Everyone can communicate in emergencies. User-generated content can help EMS. Researchers in information systems could create a social media analytics tool for crisis management that provides customizable filter functions while maintaining a high level of usability even under duress.

3 Through the Eyes of Employees: Measuring Firm Reputation Using Glassdoor Data

Siddhi Nair, Roopa Ramesh Desai, Gajanan L. Ganji, The University of Texas at Arlington, Arlington, TX, Contact: siddhi.nair@mavs.uta.edu

In this paper, we draw from research in information systems on topic modeling and strategic management to conceptualize firm reputation using employee reviews and measure its implication on an organization's market impression. Building on firm reputation literature and positioning employees as key stakeholders, our hypotheses elaborate on the relationship between key themes emerging from employee reviews and different firm performance measures and how the underlying themes are distinct from commonly used rankings.

Monday, October 16, 10:45 AM - 12:00 PM

MB65

CC-West 103A

TIMES Best Dissertation Award

Award Session

Session Chair: Hyunwoo Park, Seoul National University, Seoul, Korea, Republic of

1 Exploit or Explore? an Empirical Study of Resource Allocation in Scientific Labs

Ran Zhuo, University of Michigan, Ross School of Business, Ann Arbor, MI

Allocating innovation resources to their most productive uses is a challenge because innovators have incomplete information about which projects are productive. I empirically study how a group of large scientific labs traded off the exploitation of safe projects to maximize short-term productivity versus the exploration of high-variance projects to acquire information and improve long-term productivity. To recover how these labs made the tradeoff, I estimate a dynamic decision model, assuming the labs approximated the value of exploration with an Upper Confidence Bound (UCB) index. The model captures the labs' decisions well. Estimates of its free parameters suggest that the labs explored extensively. Counterfactual simulations show that, had the labs not explored, their output quantity would have decreased by 51%, and their citations would have decreased by 57%.

2 Impacts of Innovative Technologies and Services in Supply Chain via Mobile Apps

Zenan Zhou, Arizona State University, Tempe, AZ

This dissertation examines the profound impact of emerging mobile app technologies on diverse supply chain stakeholders like carriers, brokers, and customers. It investigates how these innovations affect productivity, profitability, and customer welfare, recognizing the mutual evolution of business practices and technology innovations. Adopting a dynamic competition perspective, the dissertation empirically explores in-app baggage tracking's impact on airlines' baggage operations, and the effects of digital freight matching apps on carriers/brokers and their spillover effects from trucking to air freight, respectively. The findings reveal non-trivial benefits and potential challenges of mobile app innovations, offering actionable insights.

3 From Shakira to Van Gogh: Operations for the World of Culture

Abhishek Deshmane, Georgia Institute of Technology, Barcelona, Spain

Cultural markets encompass diverse sectors like music, art, and tourism, holding economic and social significance. The advent of digitalization has facilitated the analysis of production and consumption data, offering insights into this sector. This dissertation employs an Operations Management perspective to investigate two themes: (I) Product Innovation and Diffusion to study product portfolios, and (II) Sequential Consumption of Experiences directed towards experience curation. Theoretical contributions link service and people-centric operations, vital for capturing cultural sector nuances. Empirical models utilizing retrospective and experimental data establish causal links, while analytical models provide prescriptions. Industry collaborations, including the Van Gogh Museum and Deezer, contribute real-world relevance. The dissertation concludes by summarizing insights from six chapters and suggesting future research avenues for cultural markets.

4 Innovation and Supply Networks

Shubhobrata Palit, Esade, Barcelona, Spain

The doctoral dissertation aims to improve our understanding of how external partners of a firm in its supply chain can drive its innovation. Specifically, it examines the influence of a firm's network of direct buyers and suppliers as a source of external technological knowledge spillovers and, subsequently, on its innovation performance. Such understanding is important for effectively managing technological knowledge, which is critical to enhancing a firm's manufacturing and service capabilities by improving existing products and processes, and generating new products and processes.

5 Behavioral Aspects in Project Management—A Comparison of Agile and Waterfall Project Management

Tobias Lieberum, Technical University of Munich, München, Germany

This dissertation compares agile project management with the traditional waterfall approach in light of human behavior. The first study shows quantitatively higher performance from agile sprints, which mitigate the newly described "Progression Fallacy" present in traditional project management. The second study shows qualitatively ambiguous performance effects from agile sprints. In conclusion, the choice of project management approach should depend on the project.

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CC-West 103B

NSF Program Director Panel

Panel Session

Session Chair: Georgia-Ann Klutke, National Science Foundation, Alexandria, VA

Session Chair: Reha Uzsoy, National Science Foundation, Alexandria, VA

1 NSF Program Directors

Georgia-Ann Klutke, National Science Foundation, Alexandria, VA

Program Directors representing multiple programs at the National Science Foundation discuss opportunities for Operations Research in their programs and various cross-disciplinary solicitations.

2 Panelist

Siqian Shen, National Science Foundation, Alexandria, VA

3 Panelist

Daan Liang, National Science Foundation, Alexandria, VA

4 Panelist

Linkan Bian, National Science Foundation, Alexandria, VA

5 Panelist

Reha Uzsoy, National Science Foundation, Alexandria, VA

6 Panelist

Janis Terpenny, National Science Foundation, Alexandria, VA

7 **Panelist**

Janis Terpenny, National Science Foundation, Alexandria, VA

Monday, October 16, 10:45 AM - 12:00 PM

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CC-West 104A

Disaster Management: Networks and Grids

Community Committee Choice Session

Session Chair: Hootan Kamran, 1</sup

Session Chair: Ozlem Cosgun, Montclair State University, Wayne, NJ

1 Defense Critical Supply Chain Networks and Risk Management with the Inclusion of Labor

Anna B. Nagurney, University of Massachusetts Amherst, Amherst, MA

A rigorous methodological framework is presented for defense critical supply chain networks that captures the behavior of defense firms, who care about revenues as well as risk. Variational inequality theory is used to provide alternative formulations of the governing Nash Equilibrium conditions. A defense supply chain network efficiency/performance measure is proposed and an associated importance indicator for the supply chain network components. A resilience measure is also given that quantifies the resilience of the defense supply chain network economy to disruptions in labor. The modeling and algorithmic framework, as well as the measures, are illustrated via numerical examples.

2 Holistic Asset Management to Counter Dynamic Risks in Power Infrastructure: The Role of Big Data, Iot, and Analytics in Disaster Management

Massoud Amin, Energy Policy & Security Associates, Minneapolis, MN, Contact: massoud@eps-associates.com

Big Data, IoT, and advanced analytics are transforming the power and energy industries. This presentation focuses on the security and resilience of Smart Grids, IoT, Smart Cities, and Big Data in disaster management. Adopting a holistic asset management approach, energy companies can weigh the risks and economics of maintenance, repair, retrofit, and replacement or retirement for infrastructure elements, leveraging capabilities to improve reliability and service quality. Aging infrastructure poses risks like physical vulnerability and cyber threats, leading to system-wide outages. Probabilistic risk management can identify high-risk substations and lines to tailor resiliency investments. Resource allocation can achieve optimal solutions specific to utility needs, legacy systems, location, asset management, and technology roadmap.

3 Assessment of Telehealth Utilization Across Us States During the Covid-19 Outbreak

Ying-Chih Sun[1], Ozlem Cosgun[2], Raj Sharman[3], [1]Bradley University, Peoria, IL, [2]Montclair State University, Wayne, NJ, [3]State University of New York-Buffalo, Buffalo, NY, Contact: ysun@fsmail.bradley.edu

The surge in telehealth utilization during the COVID-19 outbreak results from the need to prevent exposures for providers who demand telehealth to ensure the service's commitment and ease various staffing shortage issues. This research focuses on the efficiency perspective. It investigates the optimal allocation of resources such as healthcare resources and other social determinants of health factors by combining Data Envelopment Analysis (DEA) with ML (ML-DEA) to make a statewide comparison on the efficiency of telehealth utilization.

4 NEEDS TITLE

Atoosa Rezaei, Harrisburg University of Science and Technology, Harrisburg, PA, Contact: arezaei@my.harrisburgu.edu

This proposal outlines a research project on using artificial intelligence (AI) with a cognitive architecture for stock trade prediction and recommendation. The project aims to develop a system that can learn from historical data, analyze current trends, and make accurate predictions about future stock prices. The proposed system will be built on a cognitive architecture that allow the system to use a feedback loop to enable the system to observe the results of the made decisions and enhance its performance over the time.The research will involve the use of machine learning algorithms and neural networks to train the AI model on historical stock data, as well as the evaluation of different cognitive architectures to identify the most effective approach for stock prediction and recommendation.

Monday, October 16, 10:45 AM - 12:00 PM

MB68

CC-West 104B

Graph Mining for Business Intelligence

Community Committee Choice Session

Session Chair: Jeongsub Choi, West Virginia University, Morgantown, WV

1 Competitor Identification in Interfirm Transaction Networks

Jeongsub Choi[1], Byunghoon Kim[2], [1]West Virginia University, Morgantown, WV, [2]Hanyang University, Sangnok-Gu, Ansan-Si, Korea, Republic of

Competitor identification (CI) in complex business environments is essential to establish an effective competitive strategy. Recently, network-based CI methods have been studied in the literature, aiming to shed light on blind spots in the radar of organizations. However, interfirm financial transactions were overlooked in the existing CI, although financial transactions contain critical information as basic business units. In this talk, we present new network-theoretic CI methods based on networks constructed using interfirm financial transactions.

2 Robust Asymmetric Non-Negative Matrix Factorization for Clustering Nodes in Directed Networks

Yi Yu, Rutgers University, Piscatawat, NJ, Contact: yy479@scarletmail.rutgers.edu

Directed networks appear in an expanding array of applications. A critical task in analyzing directed networks is clustering, where the goal is partitioning the network's nodes based on their similarities while accounting for the direction of relationships between nodes. Non-negative matrix factorization (NMF) has been used to cluster the nodes in directed networks efficaciously. However, the errors could deviate from the Gaussian distributions assumed in various real-world networks. In this presentation, we propose a robust asymmetric non-negative matrix factorization method to cluster the nodes in directed networks. The proposed method assumes that the errors follow a Cauchy distribution instead of the Gaussian distribution. Experiments using real world as well as artificial networks show that the proposed method outperforms existing NMF methods.

3 A New Customer Recommendation Method for Identifying Potential Entrants in a B2B Transaction Network

Byunghoon Kim[1], Jeongsub Choi[2], Aparajita Bose[1], [1]Hanyang University, Sangnok-Gu, Ansan-Si, Korea, Republic of; [2]West Virginia University, Morgantown, WV, Contact: bhkim825@gmail.com

A financial transaction network is composed of nodes and links that respectively represent firms and transactions. Link prediction in transaction networks is a useful approach to identify unknown customers of a focal firm, enabling the focal firm to recognize new customers based on predicted links. However, an existing study recommends competitors of the focal firm as new customers, rather than new entrants. To overcome this limitation, we propose a novel method to predict potential customers who are new entrants in the financial transaction network. Additionally, we propose a novel similarity measure to identify new entrants in the network. Our experimental results show that our proposed method outperforms existing work in terms of the AUC score of link prediction.

4 Leveraging Heterogeneity in the Network Structure for Link Prediction in Inter-Firm Transaction Networks

Ali Tosyali, Rochester Institute of Technology, Rochester, NY

Link prediction in inter-firm transaction networks is used to predict future connections between firms based on their past transaction history and it is critical because it can help firms identify potential business partners or customers, as well as assess the risk of doing business with certain firms. In this study, we propose a new link prediction approach that leverages the heterogeneity in the inter-firm transactions. The proposed method is validated using a real-world transaction database.

Monday, October 16, 10:45 AM - 12:00 PM

MB69

CC-West 105A

Data Analytics and Optimization

Community Committee Choice Session

Session Chair: Tulay Flamand, Colorado School of Mines, Golden, CO

1 Online Contextual Decision Making with a Smart Predict-then-Optimize Method

Paul Grigas, UC Berkeley, Berkeley, CA, Contact: pgrigas@berkeley.edu

We study an online contextual decision-making problem with resource constraints. At each time period, the decision-maker first predicts a reward vector and resource consumption matrix based on a given context vector and then makes a decision. The final goal is to maximize the summation of the reward and the utility from resource consumption, while satisfying the resource constraints. We propose an algorithm that mixes a prediction step based on the "Smart Predict-then-Optimize (SPO)" method with a dual update. The regret bound is sublinear and depends on the risk bounds of the surrogate loss used to learn the prediction model. Our algorithm and regret bounds apply to a general convex feasible region for the resource constraints, including both hard and soft constraints, and they apply to a wide class of prediction models in contrast to linear context or finite policy spaces.

2 Towards a Nonparametric Bump Hunting Algorithm in High-Dimensional Data

Rym Nassih, Abdelaziz Berrado, Mohammed V University in Rabat, Rabat, Morocco. Contact: berrado@emi.ac.ma
PRIM is a Bump Hunting algorithm that is used in a supervised learning setting to find regions in the input variables subspace specified by the data analyst, that are associated with the highest or lowest occurrence of a target label of a class variable. We present in this ongoing work a non-parametric version of PRIM that involves all the relevant attributes for rule generation and that provides an additional post processing step for rule pruning and organization.

3 Exponential Tail Bounds and Large Deviation Principle for Heavy-Tailed U-Statistics

Milad Bakhshizadeh, Stanford University, Stanford, CA, Contact: miladba@stanford.edu
We study deviation of U-statistics when samples have heavy-tailed distribution so the kernel of the U-statistic does not have bounded exponential moments at any positive point. We obtain an exponential upper bound for the tail of the U-statistics which clearly denotes two regions of tail decay, the first is a Gaussian decay and the second behaves like the tail of the kernel. For several common U-statistics, we also show the upper bound has the right rate of decay as well as sharp constants by obtaining rough logarithmic limits which in turn can be used to develop LDP for U-statistics. In spite of usual LDP results in the literature, processes we consider in this work have LDP speed slower than their sample size n.

4 Identifying Bayesian Optimal Experiments for Uncertain Biochemical Pathway Models

Natalie M. Isenberg[1], Susan D. Mertins[2], Byung-Jun Yoon[3,1], Kristofer Reyes[4,1], Nathan M. Urban[1], [1]Brookhaven National Laboratory, Shirley, NY, [2]Frederick National Laboratory for Cancer Research, Frederick, MD, [3]Texas A&M University, College Station, TX, [4]University at Buffalo, Buffalo, NY, Contact: nisenberg@bnl.gov
Mathematical models of protein signaling pathways are useful tools for studying the dynamics of novel therapeutic drugs. However, pathway models are known to possess significant uncertainty with respect to parameter data. This uncertainty leads to an inability to discriminate between the performance of different drug molecules. Therefore, we must restore reliable model predictions via parameter uncertainty reduction to use these models for novel drug candidate screening. In this work, we utilize Bayesian optimal experimental design (BOED) and high-performance computing capabilities to identify experimental measurements that decrease uncertainty in key model parameters in a pathway model for PARP1-inhibited cell apoptosis. We show that BOED can constrain the pathway model output and restore model predictability by recommending optimal experiments.

5 AI and Remote Sensing in Port Operations: Estimating Cargo Volume and Identifying Usable Industrial Outdoor Storage for Congestion Alleviation

Minseok Kim, Rutgers University, New Brunswick, NJ
Recent years have witnessed port congestion disrupting the global supply chain, highlighting the need for real-time and affordable monitoring. In response, our research proposes an innovative approach that employs image processing and AI techniques to gauge port operational levels through remote sensing. We deploy advanced segmentation models for cargo identification and shadow extraction techniques on satellite imagery to estimate cargo volume accurately. Moreover, the model identifies alternative storage sites, providing comprehensive solutions to mitigate disruptions. By harnessing diverse data and advanced AI techniques, our research offers insights that enhance operational performance and sustainability, benefiting both academia and industry professionals.

Monday, October 16, 10:45 AM - 12:00 PM

MB70

CC-West 105B

AI Innovation and eBusiness

Community Committee Choice Session

Session Chair: Jing Tian, Pennsylvania State University, University Park, PA

1 Designing Live Streaming Advertisement Per User Engagement: Evidence from a Field Experiment

Keran Zhao[1], Ni Huang[2], Gordon Burtch[3], [1]University of Houston, Stafford, TX, [2]University of Miami, Gilbert, AZ, [3]Boston University, Boston, MA, Contact: krzhao@uh.edu
Digital advertising plays an essential role in the live streaming ecosystem. However, real-time advertising is challenging as the insertion policies can only be evaluated counterfactually. In this study, we propose two engagement-triggered live advertisement policies and conduct a field experiment on Twitch.tv, the most popular live streaming platform worldwide, to evaluate the advertisement performance of the proposed policies. By randomly assigning 677 streams into

three groups, we compare the difference in ad performance and examine the post-ads viewership. The main result shows that ad insertion at a low engagement time point has a higher clickthrough rate and clicks than the insertions for high engagement and base group (every 12 minutes). And the low engagement insertion has lower risks of losing viewers after ads than the high engagement insertion policy.

2 Ai Ground-Truth Uncertainty in Professional Judgment Contexts: Mechanisms and a Paradoxical Approach

Hengqi Tian[1], Arun Rai[2], Angelos Kostis[3], Jonny Holmström[3], [1]University of Colorado Denver, Denver, CO, [2]Georgia State University, Atlanta, GA, [3]Umeå University, Umeå, Sweden

A labeled dataset is the foundation for supervised AI/ML development. In contrast to the dominant objective view on ground truth labels, we aim to uncover and approach ground-truth uncertainty (GTU) inherent in professional judgment contexts. Drawing on human cognition and sensemaking literature, we conceptualize GTU as a multi-faceted phenomenon comprised of both epistemic and interpretive uncertainty and theorize their interplays in shaping data label discrepancies. We further propose a paradoxical perspective to adopt a both/and labeling logic and incorporate multiple "ground truth" labels in training and evaluating ML models. The expected contributions are to provide a novel GTU perspective and a paradoxical approach to transform how we define and generate "ground-truth" labels for AI/ML development in professional judgment contexts.

3 Using Store AI to Enhance Consumer Purchase Decisions by Promoting the Sense of Autonomy

Jinghui Hou[1], Shuai Yang[2], Guiyang Xiong[3], Paul Pavlou[4], [1]University of Houston, Houston, TX, [2]Donghua University, Shanghai, China; [3]Syracuse University, Syracuse, NY, [4]University of Houston, Houston, TX

Many retailers have started using store AI systems to help consumers choose products that "best" fit their preferences, and thus enhance consumer purchase decisions. For AI that is aimed to improve consumers' decisions, it is critical to examine how such an AI can be designed and used to work *for* humans and enhance human decisions. We theorize the mechanism of the sense of autonomy in making decisions with AI to support purchase decisions. Across five lab and two field experiments, we show that promoting consumers' sense of autonomy leads them to consider more of their personal needs and preferences in the decision process, and consequently improve consumer decision-making. We show that a novel design of a smartphone-based store AI can promote the sense of autonomy. With field data, we also show the real-world significance of positive impacts in real-life settings.

4 How Does the Stock Market View Firms' AI-Related Initiatives?

Junyoung Park, Auburn University, Auburn, AL

Recent advances in generative artificial intelligence (AI), such as ChatGPT, have led to increased adoption of similar technologies by firms seeking to enhance their businesses through AI-supported products and labor inputs supplemented by AI. This research examines the financial impact of public announcements of U.S. firms related to generative AI and investigates how this impact varies based on firm characteristics. I also compare the impact with that of general information technology investment announcements. The study aims to provide insights into the disruptive nature of generative AI and its market valuation.

5 The Impact of AI Explanation Timing on Users' Subsequent AI-Aided Decision-Making Performance

Renzhi (Fred) Zhao, Georgia State University, J. Mack Robinson College of Business, Atlanta, GA, Contact: fredrzz@hotmail.com

When artificial intelligence (AI)-aided decision results under-perform, explanations are crucial for enabling adjustment in subsequent decision-making. This study examines how the timing of delivering AI explanations affects subsequent AI use for decision-making. Via the agentic IS artifacts delegation framework and psychological bias theories, I hypothesize that the effects of AI explanation timing on subsequent AI-aided decision-making performance are predicated on the underperformance sources. Pre- or post-outcome AI explanations are most effective when the underperformance source is algorithm limitations or unpredictable environmental factors. I test these hypotheses in a series of experiments involving a financial investing task. The findings contribute to AI transparency literature and offer practical implications for explainable AI design.

Monday, October 16, 10:45 AM - 12:00 PM

MB71

CC-West 105C

IS Cluster Best Paper and Best Session Chair Award Session

Award Session

Session Chair: Olivia R Liu Sheng, University of Utah, Salt Lake City, UT
Session Chair: Jason Chan, University of Minnesota, Minneapolis, MN

Monday, October 16, 10:45 AM - 12:00 PM

MB72

CC-West 106A

Recent Advances on the Unified Frameworks of Stratified Models and Multi-Task/Transfer/Few-Shot Learning

Community Committee Choice Session

Session Chair: Junzi Zhang, Amazon.com Services LLC, Bellevue, WA

1 Incremental Proximal Multi-Forecast Model Predictive Control

Xinyue Shen[1], Stephen P. Boyd[2], [1]Meta, Menlo Park, CA, [2]Stanford University, Stanford, CA, Contact: xinyueshen@outlook.com

Multi-forecast model predictive control (MF-MPC) is a control policy that creates a plan of actions over a horizon for each of a given set of forecasted scenarios or contingencies, with the constraint that the first action in all plans be the same. In this note we show how these coupled plans can be found by solving a sequence of single plans, using an incremental proximal method. We refer to this policy as incremental proximal model predictive control (IP-MPC). We have observed that even when the iterations in IP-MPC are not carried out to convergence, we obtain a policy that achieves much of the improvement of MF-MPC over single-forecast model predictive control (MPC).

2 Graph Neural Networks for Modeling Volatility Spillover Effects

Chao Zhang, Oxford University, United Kingdom

We propose a novel methodology for forecasting multivariate realized volatilities using graph neural networks. This approach extends "Graph-based methods for forecasting realized covariances" and explicitly incorporates the spillover effects from multi-hop neighbors and nonlinear relationships into the volatility forecasts. Our findings provide strong evidence that the information from multi-hop neighbors does not offer a clear advantage in terms of predictive accuracy. However, modeling the nonlinear spillover effects significantly enhances the forecasting accuracy of realized volatilities over up to one week. Our model allows for training with different loss functions, and the results generally suggest that using Quasi-likelihood as the training loss can significantly improve the model performance, compared to the commonly-used mean squared error.

3 Joint Graph Learning And Model Fitting In Laplacian Stratified Models

Junzi Zhang[1], Ziheng Cheng[2], Akshay Agrawal[3], Stephen P. Boyd[4], [1]Citadel Securities, Chicago, IL, [2]Peking University, Beijing, China; [3]Marimo Inc., Palo Alto, CA, [4]Stanford University, Stanford, CA, Contact: saslascroyale@gmail.com

Laplacian regularized stratified models (LRSM) leverage categorical features to enhance parameter learning by drawing data from neighboring groups. LRSM has been widely applied in machine learning and signal processing, however, existing works either assume a known graph or are restricted to specific applications. We propose a generic approach to jointly learn the graph and fit model parameters by solving a single optimization problem, with convergence guarantees and efficient algorithm implementation. Numerical examples demonstrate the efficiency of our approach compared to existing methods.

Monday, October 16, 10:45 AM - 12:00 PM

MB73

CC-West 106B

Machine Learning in Finance

Community Committee Choice Session

Session Chair: Paul Glasserman, Columbia University, New York, NY

1 Neural Optimal Stopping Boundary

Max Reppen[1], H. Mete Soner[2], Valentin Tissot-Daguette[2], [1]Boston University Questrom School of Business, Boston, MA, [2]Princeton University, Princeton, NJ

A method based on deep artificial neural networks and empirical risk minimization is developed to calculate the boundary separating the stopping and continuation regions in optimal stopping. The algorithm parameterizes the stopping boundary as the graph of a function and introduces relaxed stopping rules based on fuzzy boundaries to facilitate efficient optimization. Several financial instruments, some in high dimensions, are analyzed through this method, demonstrating its effectiveness. The existence of the stopping boundary is also proved under natural structural assumptions.

2 Robust Hedging GANs - Towards Automated Robustification of Hedging Strategies

Yannick Limmer[1], Blanka Horvath[2], [1]University of Oxford, Oxford, United Kingdom; [2]University of Oxford, Oxford, United Kingdom. Contact: yannick.limmer@maths.ox.ac.uk

The deep hedging framework has revolutionized hedging under different market conditions. However, models are prone to errors, and deviations from market reality can lead to risks. This raises the question of how to deal with model ambiguity in an automated way. We propose a GAN-based solution using concepts from rough-path theory to automate robustification in hedging. Our method uses a hedging engine, a market generator, and a metric to measure distances between data and beliefs. It can operate independently of the data generating process and is easily adaptable for existing functional settings. We demonstrate this in various examples, and this approach is expected to inspire solutions for related challenges.

3 Deep Learning Statistical Arbitrage

Greg Zanotti[1], Markus Pelger[2], Jorge Guijarro-Ordonez[3], [1]Stanford University, Stanford, CA, [2]Stanford University, Stanford, CA, [3]Stanford University, Stanford, CA, Contact: gzanotti@stanford.edu

Statistical arbitrage exploits temporal price differences between similar assets. We develop a unifying conceptual framework for statistical arbitrage and a novel data driven solution. First, we construct arbitrage portfolios of similar assets as residual portfolios from conditional latent asset pricing factors. Second, we extract their time series signals with a powerful machine learning time series solution, a convolutional transformer. Lastly, we use these signals to form an optimal trading policy that maximizes risk-adjusted returns under constraints. Our comprehensive empirical study on daily US equities shows a high compensation for arbitrageurs to enforce the law of one price. Our arbitrage strategies obtain consistently high out-of-sample mean returns and Sharpe ratios, and substantially outperform all benchmark approaches.

4 Does Overnight News Explain Overnight Returns?

Paul Glasserman, Kriste Krstovski, Paul-Robert Laliberte, Harry Mamaysky, Columbia University, New York, NY

Over the past 30 years, nearly all the gains in the U.S. stock market have been earned overnight, while average intraday returns have been negative or flat. We find that a large part of this effect is explained by differences between intraday and overnight news. Our analysis uses a collection of over a million news articles. We apply a novel technique for supervised topic analysis that selects news topics based on their ability to explain contemporaneous market returns. We find that differences in the mix of news topics and differences in the responses to news topics both contribute to the difference in intraday and overnight returns. In out-of-sample tests, our approach forecasts which stocks will do particularly well overnight and particularly poorly intraday.

Monday, October 16, 10:45 AM - 12:00 PM

MB74

CC-West 106C

Customer Engagement and Loyalty on Platforms

Community Committee Choice Session

Session Chair: Mika Sumida, Marshall School of Business, University of Southern California, Los Angeles, CA

Session Chair: Chamsi Hssaine, Cornell University, Ithaca, NY

1 Matchmaking Strategies for Maximizing Player Engagement in Video Games

Mingliu Chen[1], Adam N. Elmachtoub[1], Xiao Lei[2], [1]Columbia University, New York, NY, [2]University of Hong Kong, New York, NY

We propose a general framework to analyze the dynamic matching problem in online video games, aiming to maximize player engagement. Players have different skill levels, which affect the outcomes of matches, and the win-loss record influences their willingness to remain engaged. We fully characterize the optimal matching policy on a stylized model where there are two skill levels, and players churn only when they experience a losing streak. The optimal policy always matches as many low-skilled players who are not at risk of churning to high-skilled players who are one loss away from churning. Compared to the industry status quo that matches players with the same skill level together, we prove the benefit of optimizing the matchmaking system grows linearly with the number of skill levels. Our framework can also handle the addition of AI bots and pay-to-win system.

2 The Challenge of Understanding What Users Want: Inconsistent Preferences and Engagement Optimization

Manish Raghavan, Massachusetts Institute of Technology, Cambridge, MA

Online platforms have a wealth of data, run countless experiments and use industrial-scale algorithms to optimize user experience. Despite this, many users seem to regret the time they spend on these platforms. We suggest the problem stems in part from a mistaken revealed-preference assumption: To understand what users want, platforms look at what users do. Yet we often make choices in the moment that are inconsistent with what we actually want. In this work, we develop a model of media consumption where users have inconsistent preferences. Our model highlights how user engagement and welfare can be at odds with one another. By linking these effects to abstractions of platform design choices, our model thus creates a theoretical framework and vocabulary in which to explore interactions between design, behavioral science, and social media.

3 Optimizing and Learning Assortment Decisions with Platform Disengagement

Mika Sumida[1], Angela Zhou[2], [1]Marshall School of Business, University of Southern California, Los Angeles, CA, [2]USC Marshall School of Business Data Sciences and Operations, Los Angeles, CA

We consider a problem where customers repeatedly interact with a platform. During each interaction with the platform, the customer is shown an assortment of items and selects among these items according to a MNL choice model. The probability that a customer interacts with the platform in the next period depends on the customer's purchase history. The goal of the platform is to maximize the total revenue obtained from each customer over a finite time horizon. First, we study a non-learning version of the problem and prove structural properties of the optimal policy. Next, we provide a formulation in a contextual episodic reinforcement learning setting, where the parameters governing contextual consumer preferences and return probabilities are unknown. We develop an algorithm based on the principle of optimism under uncertainty and provide a regret bound.

4 Diverse Assortments in Online Recommendations

Mahsa Hosseini[1], Shreyas Sekar[2], Opher Baron[2], Azarakhsh Malekian[3], [1]Rotman School of Management, Toronto, ON, Canada; [2]University of Toronto, Toronto, ON, Canada; [3]University of Toronto Joseph L Rotman School of Management, Toronto, ON, Canada

This paper explores the business benefits of incorporating diverse content into recommendation systems, particularly in online marketplaces and platforms that rely on ranking algorithms. While promoting popular content in the short term may improve user engagement, it can also lead to a lack of diversity and undermine the long-term health of the marketplace. In this paper, we make a connection between customer engagement and satiation. We find conditions under which a more diverse policy is optimal. Moreover, we show that optimal policy favors diversity in earlier periods, and after some time, the optimal policy keeps offering the product with the largest value. This implies that a more diverse recommendation is preferred over longer time horizons. We show that we have a satiation threshold policy, determining the optimal policy for any satiation value at every period.

Monday, October 16, 10:45 AM - 12:00 PM

MB75

Session.Location:CC-West 208A

Charging Infrastructure Management for Electric Vehicles

Contributed Session

Session Chair: Kaize Yu, School of Management and Economics, University of Electronic Science and Technology of China, Chengdu, China

1 Electrifying Travels Along the Lake Michigan Circle Tour

Amirali Soltanpour[1], Alireza Rostami[1], Mehrnaz Ghamami[1], Ali Zockaie[1], Jessica Crawford[2], Robert Jackson[3], [1]Michigan State University, East Lansing, MI, [2]Michigan Department of Environment, Great Lakes, and Energy, Lansing, MI, [3]Lawrence Technological University, Southfield, MI

Electric vehicles (EV) are a sustainable substitution for conventional vehicles reducing emissions and fossil fuel dependence. However, alleviating EV's range anxiety requires significant investment in infrastructure. This study proposes an integrated modeling framework to find the optimal location and number of chargers in an interconnected network of destination and fast chargers around Lake Michigan. The main contribution of this study is capturing the variety of travel and charging behaviors and their interconnections. The model minimizes total system costs, including charger, queuing, and detour costs. A metaheuristic algorithm is developed to solve the proposed computationally complex optimization model. Findings suggest that the circuit would benefit from the combination of destination and fast chargers as it has the optimal total system cost.

2 Optimizing Fast Charging Infrastructure for Electric Vehicles in Urban Networks Using an Activity-Based Approach

Alireza Rostami, Amirali Soltanpour, Ali Zockaie, Michigan State University, East Lansing, MI, Contact: alireza.darzian.rostami@gmail.com

This study focuses on optimizing the configuration of fast charging infrastructure for electric vehicles (EVs) in urban networks considering EV users' daily activities, and charging behavior. The study proposes a simulation model for charging behavior that considers factors such as initial state of charge (SOC), travel distance, availability of home chargers, and daily trip schedules. The problem is formulated as a Mixed-Integer Nonlinear Programming that considers travel time and distance dynamics, the interdependency of trips made by each driver, the limited range of EVs, spatiotemporal charging pricing, waiting time in queue, and the detour to charging stations. This problem is solved using a metaheuristic approach for a large-scale case network under different charging powers, battery efficiency, electricity pricing, and utility cost scenarios.

3 Real-Time Optimizing Electric Vehicles' Charging Policy with Battery Degradation Awareness by Using Multi-Agent Reinforcement Learning

Pengyu Yan[1,2], Kaize Yu[2], Yang Liu[3], [1]Yangtze Delta Region Institute (Huzhou), University of Electronic Science and Technology of China, Chengdu, China; [2]School of Management and Economics, University of Electronic Science and Technology of China, Chengdu, China; [3]Department of Civil and Environmental Engineering, National University of Singapore, Singapore, Singapore. Contact: yanpy@uestc.edu.cn

Given the substantial replacement costs associated with electric vehicle (EV) batteries, effectively managing battery depreciation has become increasingly crucial. Because drivers' charging habits can accelerate battery degradation, this paper focused on charging policies for EVs on e-hailing platforms, aiming to maximize driver revenue while minimizing battery degradation in a stochastic environment. We formulate the problem as a Markov decision process and propose an efficient multi-agent reinforcement learning (MARL) approach. The MARL allows each EV (agent) to interact with the environment, facilitating real-time information exchange and updating charging policies. Numerical experiments demonstrate that the learned charging policy can effectively extend the lifespan of EV batteries and increase revenue for drivers simultaneously.

Monday, October 16, 10:45 AM - 12:00 PM

MB76

Session.Location:CC-West 208B

Methods for Traffic Monitoring

Contributed Session

Session Chair: Viswanath Potluri, Arizona State University, Mesa, AZ

1 Learning to Control and Coordinate Hybrid Traffic Through Robot Vehicles at Complex and Unsignalized Intersections

Dawei Wang[1], Weizi Li[2], Lei Zhu[3], Jia Pan[1], [1]University of Hong Kong, Hong Kong, Hong Kong; [2]University of Memphis, Memphis, TN, [3]University of North Carolina at Charlotte, Charlotte, NC

Ever-existing traffic congestion demands an innovative and transformative solution. Robot vehicles have the potential to revolutionize our transportation system, but the timeline of a fully automated transportation system is unknown and the mechanism for smoothing traffic via robot vehicles remains elusive. Observing that a mixture of robot and human-driven vehicles, i.e., hybrid traffic, will be the dominant transport mode in the decades to come, we explore the potential of controlling hybrid traffic by harvesting the latest capability of AI. As a result, we show the first successful evidence of controlling and coordinating hybrid traffic through robot vehicles at complex and unsignalized intersections. This work paves the road for city-scale hybrid traffic control and sheds light on obtaining the hypothetical benefits of integrating robot vehicles into traffic.

2 Integrating Physical Laws into Neural Networks for Enhanced Data Cleaning and Fusion in Traffic Model Calibration

Xiangyong Luo[1], Xuesong Zhou[2], [1]Arizona State University, Tempe, AZ, [2]Arizona State University, Tempe, AZ, Contact: xluo70@asu.edu

This presentation introduces a comprehensive framework that incorporates physical laws into Physics-Informed Neural Networks (PINNs) for traffic model calibration. Leveraging diverse data sources such as Probe Vehicle Data, High-Resolution Vehicle Trajectory Data, Connected and Automated Vehicle (CAV) Data, and Crowd-sourced Platforms Data, this framework addresses the challenges associated with data reliability, accuracy and granularity. By integrating knowledge of physical laws, including conservation laws, flow-density relationships, shockwave theory, car-following models, and lane-changing models, our approach enables accurate prediction and analysis of traffic conditions. The computational graph representation of the model is solved using a forward-backward method, with numerical experiments with real-world datasets.

3 A Customized Column Generation for Network Design and Routing of Patrol Police Vehicles

Asya Atik[1], Leila Hajibabai[2], [1]North Carolina State University, Raleigh, NC, [2]North Carolina State University, Raleigh, NC, Contact: aatik@ncsu.edu

This study introduces a novel location-routing approach for optimizing patrol vehicle deployment, combining Lagrangian relaxation and column generation techniques. The approach is integrated with a density-based spatial clustering of applications with noise (DBSCAN) technique that aggregates the demand nodes. The proposed scheme aims to minimize travel time and deployment costs. The algorithm was tested using real-world instance from Raleigh, NC, and the results confirm the efficacy of the proposed methodology. Comparison with current police district limits highlights the potential benefits of implementing the proposed approach in practice to optimize patrol vehicle deployment.

4 Real-Time Proactive Traffic Control of Fully Autonomous Vehicles Through Unsignalized Intersections Using V2x Communication

Viswanath Potluri[1], Pitu Mirchandani[2], [1]Arizona State University, Maricopa, AZ, [2]Arizona State University, Tempe, AZ, Contact: vpotlur1@asu.edu

This abstract centers around *harnessing the data revolution* in the context of proactive traffic control for fully autonomous vehicles at unsignalized intersection without conventional traffic lights. The talk will specifically focus on leveraging *Vehicle-to-Infrastructure (V2I)* and *Vehicle-to-Vehicle (V2V)* communication to enable *real-time* vehicular control. To achieve this, deep *reinforcement learning* techniques will be developed and applied, enabling agent learning that generalizes across various scenarios. The objective is to optimize *traffic flow*, *enhance safety*, and *improve efficiency* in autonomous vehicle interactions at these intersections.

Monday, October 16, 10:45 AM - 12:00 PM

MB77

Session.Location:CC-West Lecture Hall

AI Applications and Data Mining

Contributed Session

Session Chair: Sriram Sambasivam, Estee Lauder, Edison, NJ

1 Understanding Children’s Digital Maturity: A Machine Learning Approach

Aqib Siddiqui[1], Konstantina Valogianni[2], [1]IE Business School - IE University, Madrid, Spain; [2]IE Business School - IE University, Madrid, Spain. Contact: aqib.siddiqui@student.ie.edu

Our research utilizes sophisticated machine learning to identify patterns of ICT usage in children & analyze their Digital Maturity. Using a data-driven approach we classify children into different categories based on their digital maturity & ICT usage patterns with high accuracy. Our findings suggest that children with high digital maturity are responsible, respectful self-learners, while children with moderate digital maturity lack individual growth. Those with low digital maturity are prone to maladaptive behaviors, cybercrimes & poor wellbeing. Our research provides valuable insights into digital inequalities among children, allowing targeted interventions to alleviate differences & improve family functioning. The implications of this research extend to schools as our results can inform effective programs promoting higher digital maturity in children.

4 Challenges and Opportunities of Using AI for Retail Demand Planning in the Post-Covid World

Sriram Sambasivam, Estee Lauder, Long Island City, NY, Contact: sriramsambasivam@gmail.com

The COVID-19 pandemic has significantly impacted the retail industry, making demand planning more challenging than ever. Retailers are now turning to artificial intelligence (AI) to help with decision-making. This paper examines the challenges and opportunities of using AI for retail demand planning. AI can improve demand forecasting accuracy, optimize inventory levels, and enhance customer satisfaction. However, it also poses challenges like data quality, privacy, and bias, which can be addressed through better data management and algorithmic transparency. The benefits of AI in retail demand planning include cost savings and increased profitability. By leveraging the opportunities and addressing the challenges of AI in retail demand planning, retailers can improve their overall performance and adapt to the rapidly changing market.

2 Simple Two-Stage Forecast Upscaling for Long Horizon Intermittent Demand

Yigit M. Arisoy, Amazon.com Services LLC, Atlanta, GA, Contact: yarisoy@amazon.com

Intraday forecasts have broad applications in the industry. When combined with long-horizon requirements, forecasting at a high temporal resolution is often a challenging problem due to high memory requirements, training times and cost, especially with some Deep Learning models. The problem becomes even more challenging when the data is intermittent / sparse, and when various feature interactions need to be considered. We propose a new method that can convert low temporal resolution (e.g., weekly) forecasts to higher resolution (e.g., intraday) forecasts as a secondary step on top of an existing forecasting model of choice, provided that the higher resolution data is available in the in-sample set. On real-world datasets, our method achieves similar or better results with less costs compared to other methods that directly forecasts at high resolution.

3 A Novel Discretization Method Based on CACC and Ant Colony Optimization

Uijong Hwang[1], Dong-Joon Lim[2], [1]Sungkyunkwan University, Suwon, Korea, Republic of; [2]Sungkyunkwan University, Suwon, Korea, Republic of. Contact: huj1024@skku.edu

In this paper, we present a novel multivariate discretization approach that considers feature interactions. Our method begins by generating candidate sets of cut points for each feature using CACC, a popular discretization method. We then employ Ant Colony Optimization to search for the optimal discretization scheme by combining these candidates. The main advantage of our method is its ability to address the limitations of CACC, excessive splitting of continuous features and premature termination of the discretization process, both of which are undesirable for constructing effective discretization schemes. To evaluate our approach, we compared it with three other discretization methods using 23 different datasets. The results demonstrate that our proposed method generates more suitable discretization schemes, leading to improved classification performance.

Monday, October 16, 10:45 AM - 12:00 PM

MB78

Session.Location:CC-West 211A

spORts III

Community Committee Choice Session

Session Chair: Christopher Gaffney, Drexel University, Philadelphia, PA

1 Inefficient Forecasts at the Sportsbook: An Analysis of Real-Time Betting Line Movement

Jay Simon, American University, Washington, DC, Contact: jaysimon@american.edu

This paper tests the efficiency of a set of sports betting markets using detailed betting line movement from opening until closing for four different sportsbooks for each of 3,681 Major League Baseball games. The reliability of the markets' forecasts are assessed at several lead times. They are mostly reliable, but there are simple betting strategies that would have yielded significant profit. Forecasts do not always improve monotonically as the games get closer; forecasts at weekend day games' start times are significantly worse than forecasts 90 minutes earlier. Furthermore, there is sufficient evidence to reject weak form market efficiency; specifically, betting lines tend to overreact, exhibiting significant negatively autocorrelated changes that could be exploited by sophisticated bettors.

2 Real-Time Analytics: The Next Frontier for Women's Car Ball Esports

Walt DeGrange, CANA, Chapel Hill, NC

This presentation is a review of the development, deployment, and challenges faced in 2022 and 2023, providing real-time analytics to a worldwide eSports league. This effort provided insights into player performance, and analytics helped viewers better understand the game and increase engagement. Analytics also helped commentators provide more in-depth analysis and commentary, which enhanced the viewer experience.

3 Decision Science And Football -- A Few Examples

Scott Nestler, Sumer Sports LLC, Granger, IN

This presentation is based on a series of recent articles about applying decision science to decision-making in (American) football. It will include a variety of tools and methods (e.g. decision trees, decision-making under uncertainty, multi-criteria decision-making and more) applied to a variety of decisions in football. These situations will range from off-season roster building to in-game decisions, and everything in-between.

4 Elo Ratings, Betting Lines, and NFL Win Probabilities

Christopher Gaffney, Drexel University, Philadelphia, PA, Contact: ctg39@drexel.edu

Elo ratings are calculated for NFL teams under varying assumptions. These ratings are subsequently used to derive game winning probabilities for historical games. These probabilities are compared to those implied by betting lines and to actual game results. Finally, we create an ensemble model for probability prediction.

Monday, October 16, 10:45 AM - 12:00 PM

MB79

Session.Location:CC-West 211B

Daniel H. Wagner Prize II

Award Session

Session Chair: James J. Cochran, The University of Alabama, Tuscaloosa, AL

1 Delta Coverage: The Analytics Journey to Implement a Novel Nurse Deployment Program

Pengyi Shi, Purdue University, West Lafayette, IN

We embarked on a journey in partnership with Indiana University (IU) Health System, the largest health system in Indiana with 16 hospitals, to jointly develop a suite of advanced data and decision analytics to support their new internal travel nursing program. This program leverages a flexible pool of resource nurses that can be moved between the 16 hospitals. To support this program, we developed an integrated decision support tool (DSS), which was implemented in October 2021 with annualized savings estimated at over $400K with over 220 understaffed shifts being avoided.

Monday, October 16, 10:45 AM - 12:00 PM

MB80

Session.Location:CC-West 212A

Algorithmic Foundation in Non-smooth Optimization

Community Committee Choice Session

Session Chair: Jiajin Li, 1</sup

Session Chair: Jiawei Zhang, MIT, Cambridge, MA

1 Risk-Adaptive Decision Rules

Johannes Royset, Naval Postgraduate School, Monterey, CA

For mixed-binary optimization problems dependent on unsettled parameters, we construct decision rules that prescribe near-optimal courses of action across a set of parameter values. The decision rules are constructed by solving risk-adaptive training problems over classes of continuous mappings and thus we permit affine, piecewise affine, and polynomial decision rules as well as those based on common neural networks. In asymptotic and nonasymptotic analysis, we establish that the decision rules are locally near-optimal for specific parameter values of the actual problem of interest without relying on linearity, convexity, or smoothness. The development also accounts for practically important aspects such as inexact computation of functions, solution tolerances in training problems, regularization, and reformulations to solver-friendly models.

2 Optimization Problem with Superquantile Constraints: A Fast Computational Approach

Ying Cui, University of California, Berkeley, Berkeley, CA, Contact: yingcui@berkeley.edu

We consider an efficient and scalable second-order framework for solving large-scale optimization problems with superquantile constraints. Unlike empirical risk models, superquantile models have non-separable constraints that make typical first-order algorithms difficult to scale. We address the challenge by adopting a hybrid of the second-order semismooth Newton method and the augmented Lagrangian method, which takes advantage of the structured sparsity brought by the superquantiles. The key to make the proposed computational framework scalable in terms of the number of training data is that the matrix-vector multiplication in solving the resulting Newton system can be computed in a reduced space due to the aforementioned sparsity. Our developed solver is expected to help control the risk of adverse events for safety-critical applications.

3 An Away-Step Frank-Wolfe Method for Minimizing Logarithmically-Homogeneous Barriers

Renbo Zhao, University of Iowa, Iowa City, IA, Contact: renboz@mit.edu

We present and analyze a new away-step Frank-Wolfe method for the convex optimization problem ${\min}_{x\in\mathcal{X}} f(\mathsf{A} x) + \langle c, x\rangle$, where f is a θ-logarithmically-homogeneous self-concordant barrier, A is a linear operator, $\langle c, \cdot\rangle$ is a linear function and $\mathcal{X}$ is a nonempty polytope. We establish the global linear convergence rate of our Frank-Wolfe method in terms of both the objective gap and the Frank-Wolfe gap. This, in particular, settles the question raised in Ahipasaoglu, Sun and Todd (2008) on the global linear convergence of the away-step Frank-Wolfe method specialized to the D-optimal design problem.

4 Testing Stationarity Concepts for ReLU Networks: Hardness, Regularity, and Robust Algorithms

Lai Tian, Anthony Man-Cho So, The Chinese University of Hong Kong, Hong Kong, China. Contact: tianlai.cs@gmail.com

We study the computational problem of the stationarity test for the empirical loss of ReLU neural networks. We show that checking a certain first-order approximate stationarity concept for a piecewise linear function is co-NP-hard. As a corollary, we prove that testing so-called first-order minimality for functions in abs-normal form is co-NP-complete, which was conjectured by Griewank and Walther (SIAM J. Optim., vol. 29, 2019). Then, we establish a necessary and sufficient condition for the validity of an equality-type subdifferential chain rule in terms of various subdifferentials of the empirical loss of two-layer ReLU networks. Finally, we introduce an algorithmic scheme to test near-approximate stationarity in terms of both Clarke and Fréchet subdifferentials. This is the first practical and robust stationarity test approach for two-layer ReLU networks.

5 First-Order Algorithms for Machine Learning: Smoothed-GDA and Adam

Zhi-Quan Luo[1], Jiawei Zhang[2], Yushun Zhang[1], Ruoyu Sun[1], Peijun Xiao[3], Congliang Chen[1], Naichen Shi[4], [1]The Chinese University of Hong Kong, Shenzhen, Shenzhen, China; [2]Massachusetts Institute of Technology, Cambridge, MA, [3]University of Illinois, Champaign, IL, [4]University of Michigan, Ann Arbor, MI

Consider nonconvex-concave min-max problems (e.g. robust adversarial training). A popular approach to solve this problem is the Gradient Descent-Ascent (GDA) algorithm, which unfortunately can exhibit oscillation in case of nonconvexity. We propose a new algorithm called Smoothed-GDA with a new "smoothing" scheme to stabilize the oscillation and ensure convergence. We prove that Smoothed-GDA algorithm achieves the best known convergence rate for a wide class of nonconvex-concave problems. We also analyze the Adaptive Moment estimation (Adam) algorithm, which is the main workhorse for modern neural-network training. Under practical settings, we prove that Adam converges without any modification on update rules. Under a relaxed condition, we establish faster convergence rate of Adam over Stochastic Gradient Descent (SGD).

Monday, October 16, 10:45 AM - 12:00 PM

MB81

Session.Location:CC-West 212B

Data Analytics Teaching and Business Applications

Contributed Session

Session Chair: Timothy R. Anderson, Portland State University, Portland, OR

1 Impact of Remort Work on Firms' Data Breach Risks

WANG Kedi, Baofeng HUO, Zhejiang University, Hangzhou, China. Contact: drkediwang@zju.edu.cn

As firms switch to long-term remote workforces as the effects of COVID-19 linger, how to effectively deal with data breach risks has become a critical and thorny issue. Does remote work increase firms' data breaches? If yes, under what circumstances can the negative impact be offset? To answer these research questions, we manually integrate data breach leakage data from two major databases and match the data breach data with firms' remote work arrangement data. We also employ a quasi-experimental design using the PSM-DID analysis method to compare the treated and control groups. The results reveal that remote work arrangements significantly increase firms' data breaches. We further examined that the negative impact may be mitigated if firms have prior data breach experience before WFH arrangements and have a high level of IT input.

2 A Certificate Focused Major in Business Analytics

Frederick Kelly Augustine, Joseph Woodside, William Sause, Judson P. Stryker, Stetson University, DeLand, FL, Contact: faugusti@stetson.edu

As organizations attempt to harness the power of data, there we have seen a significant increase in use of analytics in business and the proliferation of curricula which feature analytics. Thus, it is important for educators and academic administrators to evaluate and improve their academic offerings in this area. Whether for competitive reasons or to exhibit the continuous improvement required by accreditation agencies, it is essential that the academic programs that we create are both meaningful and distinctive. This paper offers an example of an academic major in Business Analytics that offers added value to the curriculum and course offerings by focusing on the attainment of certificates by the students participating in the major.

3 Teaching or Using R

Timothy R. Anderson, Portland State University, Portland, OR, Contact: tim.anderson@pdx.edu

After years of teaching introductory management science using spreadsheets, I recently pivoted to using R and the R eco-system of tools as a way to introduce analytics to future technical professionals. This has a number of benefits including making them aware of platforms, documentation practices, reproducible research, and version control. This enables students with different technical backgrounds to do participate more deeply as well including making github contributions. In this presentation, we talk about the journey from spreadsheets to R and links to the developed open resources.

Monday, October 16, 10:45 AM - 12:00 PM

MB82

Session.Location:CC-West 212C

Empirical Evaluation of Health System Performance and Outcomes

Contributed Session

Session Chair: Alshwarya Shukla, Simon Fraser University, Burnaby, BC, Canada

1 The Impact of Hospital and Patient Characteristics on Psychiatry Readmissions

Hossein Hejazian[1], Beste Kucukyazici[2], Javad Nasiry[3], Vedat Verter[2], Daniel Frank[4], [1]McGill University, MONTREAL, QC, Canada; [2]Queen's University, Kingston, ON, Canada; [3]McGill University, Montreal, QC, Canada; [4]Jewish General Hospital, MONTREAL, QC, Canada. Contact: hossein.hejazian@mail.mcgill.ca

The "practice makes perfect" constituting a positive volume-outcome relationship in operations management problems, may change in people-centric environments. We study hospitals' operational characteristics contributing to the readmission of psychiatry patients. We find that the number of patients admitted to a hospital increases the risk of readmission. In contrast, this risk reduces with the degree to which a hospital specializes in a specific diagnosis class. We propose that length of stay (LOS) mediates these effects and patient characteristics moderate them. We provide evidence on the negative volume-outcome and nonlinear LOS-outcome relationships. Our results provide insights for policymakers to manage the flow of psychiatry patients and the burden imposed on the health systems by unplanned readmissions from patients with chronic disorders.

2 The Effect of Removing the Four-Hour Access Standard in the Ed: A Retrospective Observational Study

Tomas Momesso[1], Bilal Gokpinar[1], Rouba Ibrahim[1], Adrian Boyle[2], [1]UCL School of Management, London, United Kingdom; [2]Addenbrooke's Hospital, Cambridge, United Kingdom. Contact: tomas.momesso.20@ucl.ac.uk

Time-based targets are used to improve patient flow and quality of care within Emergency Departments. While previous research often highlighted the benefits of these targets, some studies found negative consequences of their implementation. We found that lifting the four-hour standard was associated with a drop in short-stay admission and an increase in the average length of stay in the ED.

3 The Effect of the Clinical and Non-Clinical Practices on Mortality Rate: An Econometric Analysis

Aber Elsaleiby, Georgetown University, Washington, DC

Physicians believe in linking results to only the clinical treatment with little to no tendency to believe in anything other than the clinical treatment (Tonelli, 2016). Our study investigates the effect of the clinical and non-clinical care on mortality rate using longitudinal data from all US acute care hospitals.

4 Identifying Fake Physician Reviews Using Transformers and Generative Models: Evidence from a Novel Dataset

Jaspal Singh[1], Avinash Saraswat[1], Alshwarya Deep Shukla[2], Jie Mein Goh[2], Ketan Paithankar[1], Laksh Agarwal[2], [1]Konverge AI, Nagpur, India; [2]Simon Fraser University, Burnaby, BC, Canada

This study compares state-of-the-art language models, GPT-3 and BERT in recognizing textual patterns to detect fraudulent reviews. The dataset consists of pre annotated physician reviews, labelled as fraudulent if self-authored by the doctors and authentic if provided by the patients. This work highlights the comparative capabilities of the two models and establishes the efficacy of pattern recognition with GPT-3. GPT-3's sequential text generation facilitates enhanced interpretability, providing a more intuitive understanding, whereas BERT's word-level embeddings pose challenges in straightforward interpretation. GPT-3 excels in capturing subtle nuances leveraging its vast parameter size, and showcases generalizability of findings.

Monday, October 16, 10:45 AM - 12:00 PM

MB83

Session.Location:CC-West 213A

Academic Job Search Panel

Panel Session

1 Academic Job Search Panel

Priyank Arora, University of South Carolina, Columbia, SC

The purpose of this session is to bring visibility to the students, and postdocs looking for academic positions. Panelists from both business and engineering schools will share their experiences. This panel discusses the academic interview process and do's and don'ts associated with the job search.

2 **Panelist**
Gloria Urrea, University of Colorado, Boulder, CO

3 **Panelist**
Tingliang Huang, The University of Tennessee-Knoxville, Knoxville, TN

4 **Panelist**
Taewoo Lee, University of Pittsburgh, Pittsburgh, PA

5 **Panelist**
Hari Balasubramanian, University of Massachusetts, Amherst, Amherst, MA

Monday, October 16, 10:45 AM - 12:00 PM

MB84

Session.Location:CC-West 213B

Agricultural Supply Chains

Contributed Session

Session Chair: Haitao Li, University of Missouri - St. Louis, Saint Louis, MO

1 A Model for Perishable Inventory Management in Cold Chains
Ulku Gurler, Bilkent University, Ankara, Turkey. Contact: ulku@bilkent.edu.tr
We consider a single location perishable inventory model in which items are shipped in a cold chain, which maintains their freshness either perfectly or to a large extent in comparison with traditional media. Upon arrival items start aging and expire after a fixed time. A modified (Q,r) policy is employed for inventory control with a single batch retained on the shelf at any time - usable items are discarded in a secondary market when a new batch is received. We study the impact of various freshness-preserving technologies on the performance of the inventory system. We present theoretical findings as well as some numerical examples.

2 A Study of Cold Chain Practices Across Four Sectors
Sundaravalli Narayanaswami, Indian Institute of Management Ahmedabad, Ahmedabad, India. Contact: sundaravallin@iima.ac.in
We study and analyse Cold chain practices for perishable goods. India has a total installed capacity of 34.9 Mn MT of cold storage to support perishable goods supply chain. Despite an impressive producing capacity in dairy, meat, fisheries and agriculture, the country has a capacity to store only 11% of its total production of all perishable goods. This results in significant loss in perishable supply-chain yield. Overall market size for Indian Cold Chain is projected to a CAGR of 14.8% by 2025. However with a highly fragmented structure, 10% of the market share is held by top ten players. Classifying the business of Cold Chain as three verticals: Cold Storage, Cold Transport, and Other Value-added services, we analyse in-depth the perishable goods supply chain as fisheries, pharma, agri-good, and dairy products, along with state policies. Inferences and insights are discussed

3 Blockchain-enabled Traceability Of Greenhouse Gas Emissions: Evidence From Moroccan Agriculture Production
Zakaria El Hathat[1], Tarik Zouadi[1], V. Raja Sreedharan[2], [1]Rabat Business School, International University of Rabat, Rabat, Morocco; [2]Cardiff School of Management, Cardiff Metropolitan University, Cardiff, United Kingdom. Contact: zakaria.elhathat@uir.ac.ma
In the face of climate change, the food supply chain stands vulnerable and affected. The escalating global demand for transparency, traceability, and sustainability pushes firms to explore emerging technologies. Among these, blockchain emerges as a robust tool. This study introduces a pioneering approach utilizing blockchain-enabled traceability smart contracts. These smart contracts monitor and capture the intricacies of greenhouse gas emissions (GHG) within the Moroccan olive oil supply chain in three critical phases: farm, processing plant, and transportation to the port.

4 The Economics and Optimal Design of Indoor Farming Supply Chains
Haitao Li, University of Missouri - St. Louis, Saint Louis, MO, Contact: lihait@umsl.edu
Indoor farming is one of the fastest-growing industries in the U.S. Its projected compound annual growth rate averages more than 27% between 2016 and 2026. Although indoor farming has well-known advantages over traditional farming, the high initial technology and setup investments plus operating costs related to production, packaging, distribution can outweigh the benefits. In this presentation, I will talk about the need for economics study and sustainability of indoor farming startups. An optimization model will be presented to demonstrate how the use of data and mathematical programming can provide valuable data-driven decision-support for the optimal design and operation of an end-to-end indoor farming supply chain.

Monday, October 16, 12:45 PM - 2:00 PM

MC01

CC-North 120A

Stockpyl: A Python Package for Inventory Optimization and Simulation

Tutorial Session

Session Chair: Ebru Korular Bish, University of Alabama, Tuscaloosa, AL

1 Stockpyl: A Python Package for Inventory Optimization and Simulation

Larry V. Snyder, Lehigh University, Bethlehem, PA

Stockpyl is a Python package for inventory optimization and simulation. It implementsclassical single-node inventory models like the economic order quantity (EOQ),newsvendor, and Wagner-Whitin problems. It also contains algorithms for multiecheloninventory optimization (MEIO) under both stochastic-service model (SSM)and guaranteed-service model (GSM) assumptions. And, it has extensive features forsimulating multi-echelon inventory systems. In this tutorial, we provide an overview of Stockpyl, including a short primer on the inventory models and algorithms that underlie the modules in Stockpyl. Python code snippets are used throughout, and a Jupyter notebook containing all of the code is available on the GitHub repository for the Stockpyl project.

Monday, October 16, 12:45 PM - 2:00 PM

MC04

CC-North 121A

Learning and Experimentation in Markets

Community Committee Choice Session

Session Chair: Yichun Hu, Cornell University, New York, NY

1 Adaptively Learning to Rank in Online Platforms

Ruohan Zhan, Hong Kong University of Science and Technology, Stanford, CA

We aim to adaptively rank items on online platforms to maximize cumulative user engagement. Using a contextual-bandits approach, we adjust predicted engagement scores with an upper confidence bound, balancing exploration and exploitation. Our algorithm aggregates these adjusted scores across the item list, using maximum weight matching techniques. We show that our algorithm achieves sublinear regret, reduces dependency on the factorial growth of the action space size, and outperforms various benchmarks on both simulated and real-world datasets.

2 Learning to Price Under Competition for Multinomial Logit Demand

Vineet Goyal[1], Shukai Li[2], Sanjay Mehrotra[3], [1]Columbia University, New York, NY, [2]Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, IL, [3]Northwestern University, Evanston, IL

We study the multi-seller sequential price competition with multinomial logit (MNL) customer demand. The MNL parameters are unknown a priori, and the sellers do not communicate sale histories or future prices after the start of the selling horizon. We develop the first online learning algorithm that converges to the static price competition's Nash equilibrium while maximizing sellers' individual revenues. The algorithm lets each seller learn the model using its own data as if this seller were the only seller in a market under logit customer demand. Thus in our context Nash equilibrium can be interpreted as an outcome of learning. Our algorithm admits a regret bound of $O(T^{\ frac{2}{3}}\log T\log ^2N)$ for each seller, where N and T are the number of sellers and customers, respectively.

3 Multi-Armed Bandit Experimental Design: Online Decision-Making and Adaptive Inference

David Simchi-Levi, Chonghuan Wang, Massachusetts Institute of Technology, Cambridge, MA, Contact: chwang9@mit.edu

Multi-armed bandit has been famous for its efficiency in online decision-making in terms of minimizing participants' welfare loss during experiments (i.e., regret). In clinical trials and many other scenarios, inferring treatment effects (i.e., gaps between mean outcomes of different arms) is also crucial. However, minimizing the regret entails harming the statistical power of estimating the treatment effect, since the observations from some arms can be limited. We investigate the tradeoff between efficiency and statistical power by casting the multi-armed bandit experimental design into a minimax multi-objective optimization. We introduce Pareto optimality to characterize the situation where neither statistical power nor efficiency can improve without degrading the other. We derive a useful sufficient and necessary condition for Pareto optimal solutions.

4 Expansion Of Interference W.r.t. Tightness And Linear Regression Design

Nian Si[1], Zhihua Zhu[2], Zheng Cai[3], Ramesh Johari[4], [1]The University of Chicago Booth School of Business, Chicago,

IL, [2]Tencent, Shenzhen, China; [3]Tencent, Shezhen, China; [4]Stanford University, Stanford, CA, Contact: niansi@chicagobooth.edu

Interference in two-sided markets arises when sellers and buyers compete for limited resources. Recently, Johari et al. (2022) and Bajari et al. (2022) introduced a novel experimental design known as two-sided randomization (TSR). This approach involves randomization on both the seller and buyer sides. While their simulation study showed promising empirical results with minimal bias and variance, no theoretical evidence has been provided to justify the superior performance of TSR.

In this paper, we propose a new variant of TSR and identify a specific regime in which TSR achieves asymptotic optimality. Furthermore, we derive an expansion of market interference with respect to the budget tightness. To validate our proposed methods, we conducted A/B tests in a real-world industrial environment, yielding valid testing results.

5 Leveraging Consensus Effect to Optimize Ranking in Online Discussion Boards

Gad Allon[1], Joseph Carlstein[1], Yonatan Gur[2], [1]University of Pennsylvania, Philadelphia, PA, [2]Stanford University, Stanford, CA

We formalize the level of consensus in discussion boards as an engagement driver, and study how it could be leveraged by ranking algorithms to increase engagement. We propose a new dynamic model for ranking optimization, and a class of algorithms that account for consensus when prescribing rankings. In a randomized experiment held in an education setting, our proposed algorithm outperformed the approach used in current practice.

Monday, October 16, 12:45 PM - 2:00 PM

MC05

CC-North 121B

Recent Advances in Revenue Management

Community Committee Choice Session

Session Chair: Xiao Lei, University of Hong Kong, New York, NY

1 Demand Balancing in Primal-Dual Optimization for Blind Network Revenue Management

Yining Wang[1], Sentao Miao[2], [1]University of Texas at Dallas, Richardson, TX, [2]McGill University, Montreal, QC, Canada

This paper proposes a practically efficient algorithm with optimal theoretical regret which solves the classical network revenue management (NRM) problem with unknown, nonparametric demand. Over a time horizon of length T, in each time period the retailer needs to decide prices of N types of produc tswhich are produced based on M types of resources with unreplenishable initial inventory. In this paper, we improve the previous result by proposing a primal-dual optimization algorithm which is not only more practical, but also with an improved regret free from additional high-order terms. A key technical contribution of the proposed algorithm is the so-called demand balancing, which pairs the primal solution (i.e., the price) in each time period with another price to offset the violation of complementary slackness on resource inventory constraints.

2 On the Performance of Myopic and Revenue-Ordered Policies for a Multi-Period Assortment Optimization Under an MNL Model with Popularity Bias

Izak Duenyas[1], Stefanus Jasin[2], Zhuodong Tang[3], [1]University of Michigan-Ann Arbor, Ann Arbor, MI, [2]University of Michigan, Ann Arbor, MI, [3]University of Michigan, Ann Arbor, MI, Contact: zdtang@umich.edu

We consider a monopoly firm that aims to maximize its total revenue over a finite horizon by optimizing the assortments across different periods. Customers make their purchase decisions according to a variant of the MNL model that incorporates popularity bias, which is quantified as an increasing concave function of cumulative historical sales. We show that the assortment optimization problem is NP-Hard, and we focus on studying the performance of the myopic and revenue-ordered policies. We show that the myopic policy can perform arbitrarily badly compared to the optimal policy. In contrast for a fixed number of periods, the best stationary revenue-ordered policy guarantees a constant fraction of the optimal revenue regardless of the problem instances. Moreover, this guarantee is tight in the worst-case sense within the class of all feasible revenue-ordered policies.

3 Socially Responsible Pricing

Hongqiao Chen[1], Ming Hu[2], Jing Peng[3], [1]Nanjing University, Nan Jing Shi, China; [2]University of Toronto, Minneapolis, MN, [3]University of Toronto, Toronto, ON, Canada

We examine three socially responsible pricing schemes with the same corporate social responsibility (CSR) level. The social responsibility (S) scheme is to maximize the firm's profit plus the CSR level times the consumer surplus. The Nash bargaining (B) scheme follows a weighted proportional fairness notion with the weight on consumer surplus to be the CSR level. The Rawlsian fairness (R) scheme aims at generating consumer surplus to be a fraction of the social welfare at the given CSR level. For a given customer valuation distribution and CSR level, we show that B leads to a lower price than S and R. Moreover, when the firm has to commit to a scheme while facing the uncertainty of valuation distributions, we show that with the same CSR level, S is robustly preferred from the profit perspective, while B is robustly preferred from the consumer surplus and social welfare perspectives.

4 Online Resource Allocation with Convex-Set Machine-Learned Advice

Negin Golrezaei[1], Patrick Jaillet[2], Zijie Zhou[3], [1]Massachusetts Institute of Technology, Lexington, MA, [2]M.I.T., Cambridge, MA, [3]Massachusetts Institute of Technology, Cambridge, MA, Contact: zhou19981107@gmail.com

Decision-makers are frequently equipped with a machine-learned uncertainty set or advice, which can be utilized for online decision-making. However, relying on this advice can be difficult due to its potential lack of accuracy. To address this challenge, we propose a framework that enhances resource allocation decisions by incorporating potentially unreliable machine-learned advice. Our framework utilizes a general convex uncertainty set to account for the uncertain nature of the demand vector. We design a parameterized class of Pareto-optimal algorithm, which balances both consistent and robust ratios. The consistent (resp. robust) ratio measures algorithm performance under the adversarial demand when the ML advice is accurate (resp. inaccurate). Specifically, our algorithm maximizes the robust ratio while ensuring that the consistent ratio is at least C.

Monday, October 16, 12:45 PM - 2:00 PM

MC06

CC-North 121C

Data-Driven Methods and Revenue Management

Community Committee Choice Session

Session Chair: Santiago Balseiro, Columbia University, Armonk, NY

Session Chair: Christian Kroer, Columbia University, New York, NY

1 Online Resource Allocation with Costly Overbooking: Optimal Algorithms via Primal-Dual

Rad Niazadeh[1], Yiding Feng[2], Farbod Ekbatani[3], [1]Chicago Booth School of Business, CHICAGO, IL, [2]Microsoft Research, Cambridge, MA, [3]Chicago Booth School of Business, Chicago, IL, Contact: rad.niazadeh@chicagobooth.edu

Motivated by applications in cloud spot markets and selling banner ads, we study online resource allocation with “costly overbooking.” To model this problem, we consider the classic edge-weighted online matching problem where the decision maker can recall (i.e., buyback) any fraction of an offline resource that is pre-allocated to an earlier online vertex; however, by doing so, not only the previously allocated reward is lost, there will be a non-negative constant factor f of this lost reward as an extra penalty. Parameterizing by the buyback factor f, our main result is obtaining optimal competitive algorithms for all values of f through a novel primal-dual family of algorithms. We show how algorithms in our family of primal-dual algorithms can obtain the exact optimal competitive ratio in all of these variants, demonstrating the power of our algorithmic framework.

2 Equilibria in Repeated Games Under Regret Minimization with Dynamic Benchmarks

Ludovico Crippa, Stanford University, Stanford, CA

In repeated games of incomplete information strategies are often evaluated by their ability to guarantee the performance of the single best action in hindsight, property called Hannan consistency (HC). Yet, the efficacy of this yardstick is limited as any static action may perform poorly in dynamic settings. We formalize dynamic benchmark consistency (DBC) property, requiring strategies to guarantee the performance of any dynamic sequences of actions (that exhibit number of changes that scales sublinearly with the horizon). We show that many DBC strategies exist, and that they result in distributions of play that coincide with coarse corelated equilibria of the stage game (the Hannan set). Then, relative to HC, DBC strategies provide stronger guarantees against arbitrary strategies, but maintain the same worst case social welfare when all players adopt DBC strategies.

3 Online Resource Allocation Under Horizon Uncertainty

Santiago Balseiro, Christian Kroer, Rachitesh Kumar, Columbia University, New York, NY

We study stochastic online resource allocation: a decision maker needs to allocate limited resources to stochastically-generated sequentially-arriving requests in order to maximize reward. At each time step, requests are drawn independently from a distribution that is unknown to the decision maker. Online resource allocation and its special cases have been studied extensively in the past, but prior results crucially and universally rely on the strong assumption that the total number of requests (the horizon) is known to the decision maker in advance. However, in many applications such as revenue management and online advertising, the number of requests can vary widely because of fluctuations in demand or user traffic intensity. This work aims to address this disconnect by developing online algorithms that are robust to the horizon uncertainty.

4 Context-Based Offline Pricing and Demand Learning with Separable Demand Models

Menglong Li[1], David Simchi-Levi[2], Renfei Tan[2], Chonghuan Wang[2], Michelle Xiao Wu[2], [1]City University of Hong Kong, Hong Kong, China; [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: rftan@mit.edu

Motivated by a collaboration with a leading retailer of consumer electronics in the Middle East, this paper explores the problem of demand forecasting and pricing using separable demand models. The retailer faces an unknown expected demand function that follows a separable structure f(p)+g(x), where p R and x R^d denote the product's price and contextual features respectively. The exact expressions of f(p) and g(x) are unknown, and the retailer's objective is to use an offline dataset to find optimal prices that maximize expected revenue. We analyze the statistical complexity of the demand learning problem with the separable structure, highlighting how the separable structure helps reduce the sample size needed for learning. Additionally, we propose an efficient iterative algorithm for learning f(p) and g(x) with convergence guarantees.

Monday, October 16, 12:45 PM - 2:00 PM

MC07

CC-North 122A

Learning and Data-driven Decision-making

Community Committee Choice Session

Session Chair: Yifan Feng, NUS Business School, Singapore, Singapore

Session Chair: Pin Gao, The Chinese University of Hong Kong, Shen Zhen, Shenzhen, China

1 Distribution-Free Model-Agnostic Regression Calibration via Nonparametric Methods

Shang Liu, Zhongze Cai, Martin Haugh, Xiaocheng Li, Imperial College Business School, London, United Kingdom. Contact: z.cai22@imperial.ac.uk

In this paper, we consider the uncertainty quantification problem for regression models. Specifically, we consider an individual calibration objective for characterizing the quantiles of the prediction model. We propose simple nonparametric calibration methods that are agnostic of the underlying prediction model. Our approach enables a better understanding of the possibility of individual calibration, and we establish matching upper and lower bounds for the calibration error of our proposed methods. Numerical experiments show the advantage of such a simple approach under various metrics, and also under covariates shift. We hope our work provides a simple benchmark and a starting point of theoretical ground for future research on regression calibration.

2 Bayesian Design Principles for Frequentist Sequential Learning

Yunbei Xu, Assaf Zeevi, Columbia University, New York, NY, Contact: yunbei.xu@gsb.columbia.edu

We develop a general theory to optimize the frequentist regret for sequential learning problems, where efficient bandit and reinforcement learning algorithms can be derived from unified Bayesian principles. We propose a novel optimization approach to create "algorithmic beliefs" at each round, and use Bayesian posteriors to make decisions. This is the first approach to make Bayesian-type algorithms prior-free and applicable to adversarial settings, in a generic, optimal, and computationally efficient manner. As a major application, we present a novel algorithm for multi-armed bandits that achieves the "best-of-all-worlds" empirical performance in the stochastic, adversarial, and non-stationary environments. And we illustrate how these principles can be used in linear bandits, bandit convex optimization, and reinforcement learning.

3 Myopic Quantal Response Policy: Thompson Sampling Meets Behavioral Economics

Jingying Ding[1], Yifan Feng[2], Ying Rong[1], [1]Shanghai Jiao Tong University, Shanghai, China; [2]NUS Business School, Singapore, Singapore. Contact: jingyding@sjtu.edu.cn

We study a new family of multi-armed bandit (MAB) algorithms called Myopic Quantal Response (MQR). It prescribes a simple way to randomize over arms according to historical data and a "coefficient of exploitation," which explicitly controls the exploration-exploitation trade-off. We show that MQR partially extends the Thompson Sampling (TS) algorithm. It is also a dynamic version of quantal response models where the expected utilities are directly estimated from historical rewards. Based on theoretical analysis and numerical experiments, we believe the significance of MQR is: it provides a conceptual framework to understand further the exploration-exploitation trade-off; it can be used as a structural estimation tool to learn from realized actions and rewards how much a given policy (either generated by human beings or algorithms) is "under" or "over" exploring.

Monday, October 16, 12:45 PM - 2:00 PM

MC08

CC-North 122B

Novel Applications of Online Allocation Algorithms

Community Committee Choice Session

Session Chair: Deeksha Sinha, Facebook Inc., Freemont, CA

Session Chair: Xuan Zhang, Meta, Core Data Science, Menlo Park, CA

1 Fair Notification Optimization: An Auction Approach

Deeksha Sinha, Facebook Inc., Freemont, CA

Notifications are important for the user experience in mobile apps. A typical mobile app usually has several types of notification, managed by distinct teams with objectives that are possibly conflicting with each other. In this work, we study a novel centralized approach for notification optimization designed as an auction market.We show that an Eisenberg-Gale-style convex program allows us to find an allocation that is fair to all notification types in hindsight. Further, we present an online algorithm that allocates notifications via auctions using a pacing-multiplier approach. Through an A/B test, we show that the auction system improves over a decentralized optimization system, leading to its launch in production.

2 Algorithmic Size Improvements for Mobile Apps

Mine Su Erturk, Meta, Menlo Park, CA

ReDex is an open-source Android bytecode optimizer originally developed at Meta, which aims to make mobile apps faster and smaller via various optimization passes. In this talk, we will introduce a new optimization pass in ReDex, called Interdex Reshuffle Pass, that can significantly reduce the uncompressed sizes of apps through a class reordering scheme.

3 Fully Dynamic Online Selection Through Online Contention Resolution Schemes

Riccardo Colini Baldeschi, Meta

We study fully dynamic online selection problems in an adversarial/stochastic setting subject to combinatorial constraints. This models, for example, the online matching of tasks to workers with task/worker-dependent working times. A successful approach to online selection problems in the adversarial setting is given by the notion of Online Contention Resolution Scheme (OCRS), that uses a priori information to formulate a linear relaxation of the underlying optimization problem, whose optimal fractional solution is rounded online for any adversarial order of the input sequence. Our main contribution is providing a general method for constructing an OCRS for fully dynamic online selection problems. Then, we show how to employ such OCRS to construct no-regret algorithms in a partial information model with semi-bandit feedback and adversarial inputs.

Monday, October 16, 12:45 PM - 2:00 PM

MC09

CC-North 122C

APS Next-Market Showcase

Award Session

Session Chair: Andrew Daw, University of Southern California, Marshall School of Business, Los Angeles, CA

Session Chair: Christina Lee Yu, Cornell University, Ithaca, NY

Monday, October 16, 12:45 PM - 2:00 PM

MC10

CC-North 123

Learning on Networks

Community Committee Choice Session

Session Chair: Souvik Dhara, 1</sup

1 All-Something-Nothing Phase Transitions in Planted Subgraph Recovery

Jiaming Xu[1], Julia Guadio[2], Colin Sandon[3], Dana Yang[4], [1]Duke University, Durham, NC, [2]Northwestern University, Evanston, IL, [3]EFPL, Lausanne, Switzerland; [4]Cornell University, Ithaca, NY, Contact: jiaming.xu868@duke.edu

This presentation delves into the problem of recovering a spanning k-regular graph embedded within an ER random graph. We discover an intriguing "all-something-nothing" phase transition phenomenon. Specifically, we show that as the average degree surpasses a critical threshold of 1/k, the inference problem undergoes a transition from near-perfect recovery (“all” phase) to partial recovery (“something” phase). Moreover, as the average degree continues to grow to infinity, the accuracy of recovery diminishes to zero, leading to the onset of the “nothing” phase. This discovery complements the recent result by Mossel et al., which identified an “all-or-nothing” phase transition for certain sufficiently dense subgraphs, jumping from near-perfect recovery to near-zero accuracy.

2 Graphons in Machine Learning
Luana Ruiz, Johns Hopkins University, Baltimore, MD, Contact: ruizl@mit.edu
Graph neural networks are successful at learning representations from graph data but suffer from limitations in large graphs. Yet, large graphs can be identified as being similar to each other in the sense that they share structural properties, and indeed graphs can be grouped in families converging to a common graph limit---the graphon. In this talk, I discuss how graphons can be used to deepen our understanding of machine learning on large-scale graphs.

3 Mean-Field Analysis for Load Balancing on Spatial Graphs
Daan Rutten[1], Debankur Mukherjee[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA
The analysis of large-scale, parallel-server load balancing systems has relied heavily on mean-field analysis. A pivotal assumption for this framework is that servers are exchangeable. However, modern data-centers have data locality constraints, such that tasks of a particular type can only be routed to a small subset of servers. An emerging line of research, therefore, considers load balancing algorithms on bipartite graphs where vertices represent task types and servers, respectively. In this talk, I will present a novel coupling-based approach to establish mean-field approximation for a large class of graphs which includes spatial graphs. The method extends the scope of mean-field analysis far beyond the classical full-flexibility setup.

4 Attributed Random Networks: Local Weak Limits, Pagerank and Sampling
Sayan Banerjee, University of North Carolina-Chapel Hill, Chapel Hill, NC
We investigate growing random networks, comprising nodes with different attribute types (communities), which evolve under the combined effect of node popularity (graph degree) and interaction between attributes (some attribute propensity kernel). Using stochastic approximation techniques, we show that local neighborhoods of typical nodes in large networks approach limiting random graphs given in terms of randomly stopped multi-type branching processes. This is used to obtain detailed information on the limiting distributions of centrality scores like degree and PageRank. We also see how our theoretical results shed light on sampling schemes ensuring prescribed representation of minorities, and on competition between majority and minority communities in the growing network. Based on joint work with Nelson Antunes, Shankar Bhamidi and Vladas Pipiras.

Monday, October 16, 12:45 PM - 2:00 PM

MC11

CC-North 124A
Large Deviations and Global Dynamics of Heavy-Tailed Systems
Community Committee Choice Session
Session Chair: Chang-Han Rhee, Northwestern University, Chicago, IL

1 Large Deviations for Scale-Free Random Graphs
Bert Zwart, Centrum Wiskunde Informatica, Amsterdam, Netherlands. Contact: bert.zwart@cwi.nl
We provide large deviations estimates for the upper tail of the number of triangles in scale-free inhomogeneous random graphs where the degrees have power law tails with index −[illegible],[illegible] (1,2). We show that upper tail probabilities for triangles undergo a phase transition at the point 4/3.
Our proofs are based on various concentration bounds, including a novel concentration bound well-suited to study large deviations of U-statistics.
[illegible]<4/3. Our proofs are partly based on various concentration inequalities. In particular, we tailor concentration bounds for empirical processes to make them well-suited for analyzing heavy-tailed phenomena in nonlinear settings.
Joint work with Clara Stegehuis (UT)

2 Sample Path Large Deviations for Levy Processes and Random Walks with Log-Normal Increments
Zhe Su, Chang-Han Rhee, Northwestern University, Chicago, IL
In the past two decades, the understanding of rare event asymptotics has greatly expanded, acknowledging both single and multiple jump principles. Recent works have characterized the ‘catastrophe principle’ with sample path large deviations for regularly varying and Weibull uncertainties. This leaves the log-normal case, one of the

three main classes of distributions for modeling heavy-tailed phenomena, unexplored. In this presentation, we delve into this open issue, establishing the sample path large deviations for random walks and Lévy processes, and characterizing the catastrophe principle for the log-normal case. We also discuss implications for tail asymptotics of queueing systems with log-normal job sizes.

3 Eliminating Sharp Minima from SGD with Truncated Heavy-Tailed Noise

Xingyu Wang[1], Sewoong Oh[2], Chang-Han Rhee[1], [1]Northwestern University, Evanston, IL, [2]University of Washington, Seattle, WA, Contact: xingyuwang2017@u.northwestern.edu

Recently, there have been discourses in machine learning literature that heavy-tailed noises in deep learning tasks enable SGDs to efficiently escape from sharp minima, which are known to lead to poor generalization. In this work, we show that by truncating the stochastic gradients in SGD under heavy-tailed noises, we can achieve a much stronger notion of the (almost) complete elimination of sharp local minima from the training trajectories of SGD. First, we establish an Eyring-Kramers type first exit time formula for truncated heavy-tailed SGD. Moreover, under appropriate structural conditions, we prove that the path-wise dynamics of truncated heavy-tailed SGD converge to a continuous-time Markov chain that never visits sharp minima. Our deep learning experiments confirm that truncated heavy-tailed SGD finds "flatter" minima with better generalization.

4 Theoretical Framework for Global Dynamics and Metastability Analysis of Heavy-Tailed Systems

Chang-Han Rhee[1], Xingyu Wang[2], [1]Northwestern University, Chicago, IL, [2]Northwestern University, Evanston, IL, Contact: chang-han.rhee@northwestern.edu

Stochastic dynamical systems often exhibit local stability (metastability) and phase transition between the domains of local stability. Understanding such phenomena is crucial in characterizing the global behaviors of dynamical systems. In this talk, we propose a new local uniform formulation of the heavy-tailed large deviations and show that one can transform such a large deviations formulation into local stability analysis. This machinery provides a streamlined framework for the heavy-tailed counterpart of the Freidlin-Wentzel theory and Eyring-Kramers formula. Moreover, we show that this can be further elevated to a crisp characterization of the global dynamics of the stochastic systems. We illustrate this in the context of heavy-tailed SGDs and show that it successfully captures intricate mathematical structures that are unique to the heavy-tailed SGDs.

Monday, October 16, 12:45 PM - 2:00 PM

MC12

CC-North 124B

Simulation Modeling and Applications

Community Committee Choice Session

Session Chair: Yuan Zhou, University of Texas at Arlington, Arlington, TX

1 Sustainable Blood Donor Recruitment and Retention via Social and Mobile App Campaigns

Lin Li[1], Robert Keyser[2], [1]Kennesaw State University, Marietta, GA, [2]Kennesaw State University, Marietta, GA, Contact: lli19@kennesaw.edu

The aging baby boomer blood donor base, coupled with decreases from younger age groups, is an ongoing public health concern and impacts all people in need of blood transfusions regardless of gender, age, racial, or ethnic background. There is an urgent need to expand the blood donor pool to include more younger generations, first-time donors, and minorities. This project supports a larger study effort of recruiting and retaining young blood donors (age 18-39). Collaborating with Medic Regional Blood Center, our focus for this project is to create a framework that effectively recruits and sustains a younger, diverse generation of blood donors.

2 Calibrated Queueing Models as Low-Fidelity Controllable Representations for Discrete Event Simulations: An Application in Biomanufacturing

Danielle F. Morey[1], Giulia Pedrielli[2], Zelda B. Zabinsky[1], [1]University of Washington, Seattle, WA, [2]Arizona State University, Tempe, AZ, Contact: dmorey43@uw.edu

Simulation models are extremely useful tools for analyzing a system. It is often necessary, however, to develop a surrogate model for more efficient computation. Commonly used surrogate models (e.g., Gaussian process, neural network) can be difficult to interpret because they use hyperparameters with no real-world equivalent. For a biomanufacturing application, we construct a queueing model as a surrogate for a simulation. This surrogate queueing model has explainable parameters, such as arrival rate or service time, and can be solved analytically. In addition to the creation of a model that is easier to interpret, we can exploit the known structure of the queueing model for additional analyses not possible with traditional surrogates.

3 An Agent-Based Model for Simulating Covid-19 Transmissions on University Campus and Its Implications on Mitigation Interventions

Yuan Zhou[1], Lin Li[2], [1]University of Texas at Arlington, Arlington, TX, [2]Kennesaw State University, Marietta, GA, Contact: yuan.zhou@uta.edu

Universities across the USA are facing challenging decision-making problems amid the COVID-19 pandemic. The purpose of this study is to facilitate universities in planning disease mitigation interventions as they respond to the pandemic. An agent-based model is developed to mimic the virus transmission dynamics on campus. Scenario-based experiments are conducted to evaluate the effectiveness of various interventions including course modality shift (from face-to-face to online), social distancing, mask use and vaccination. A case study is performed for a typical US university. This study provides useful implications for supporting universities in mitigating transmissions on campus and planning operations for the upcoming semesters and future pandemics.

4 Nested Heteroscedastic Gaussian Process Metamodeling for High-Dimensional Large-Scale Datasets

Jin Zhao, Xi Chen, Virginia Tech, Blacksburg, VA, Contact: zjin20@vt.edu

We investigate the nested heteroscedastic Gaussian process (NHGP) metamodeling technique, a novel approach to tackling large-scale, high-dimensional heteroscedastic datasets. We analyze the asymptotic properties of NHGP and study the convergence rate of its mean squared error bound under various parameter configurations. Recognizing the challenges posed by high-dimensional problems, such as the stringent smoothness requirements mandated by the Sobolev embedding theorem, we devise a strategy that effectively mitigates the issues. Specifically, we employ sparse grid designs using Smolyak's algorithm and separable Matérn kernels, proving more effective for high-dimensional problems. This research significantly advances simulation metamodeling with large-scale heteroscedastic datasets, particularly in high-dimensional contexts.

Monday, October 16, 12:45 PM - 2:00 PM

MC13

CC-North 125A

Teaching Decision Analysis

Panel Session

1 Moderating the Session of Teaching Decision Analysis

Jun Zhuang, University at Buffalo, Buffalo, NY

I will moderating the session of teaching DA. I have already secured the speakers for this session.

Session Chair: Jun Zhuang, University at Buffalo, Buffalo, NY

2 Panelist

Emanuele Borgonovo, Bocconi University, Milano, Italy

3 Panelist

Sasa Zorc, University of Virginia, Darden School of Business, Charlottesville, VA

4 Panelist

Gregory S. Parnell, University of Arkansas, Fayetteville, AR

5 Panelist

Stefan Creemers, 1</sup

6 Panelist

Behnam Malmir, Virginia Tech, Charlottesville, VA

7 Panelist

Belleh Fontem, 1</sup

Monday, October 16, 12:45 PM - 2:00 PM

MC14

CC-North 125B

Leveraging Data Analytics and AI to Manage Complex Value Chains and Natural Resources

Community Committee Choice Session

Session Chair: Dan Andrei Iancu, Stanford University, Stanford, CA

1 Managing Forests for Profit and Carbon Sequestration

Zhuoyang Liu, Dan Andrei Iancu, Erica Plambeck, Stanford University, Stanford, CA, Contact: zyliu@stanford.edu

How should policymakers better incentivize the private sector to profitably manage working forests in ways that align with social welfare and carbon-neutral goals? To study this question, we build a Markov decision process model to capture the stochastic evolution of forest stands

and investigate how forestry companies should optimally adjust their forest management (thinning, harvesting, and restoration) strategies to cope with natural disturbances and uncertainties associated with the timber and carbon offset markets. We derive structural results on the optimal timber management policies and use these to examine how various carbon accounting and crediting policies would impact the companies' profits as well as the long-run carbon stock on working forest stands. We leverage these results to generate insights for policymakers.

2 Optimal Control of Multiclass Fluid Queueing Networks: A Machine Learning Approach

Cheol Woo Kim[1], Dimitris Bertsimas[2], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: acwkim@mit.edu

We propose a machine learning approach to the optimal control of multiclass fluid queueing networks (MFQNETs). MFQNETs are continuous, deterministic approximations of multiclass queueing networks (MQNETs) that offer tractable approaches for the analysis and control of MQNETs.
We prove that a threshold type optimal policy exists for MFQNET control problems, where the threshold curves are hyperplanes passing through the origin. Based on this result, we use Optimal Classification Trees with hyperplane splits (OCT-H) to learn an optimal control policy for MFQNETs. We use numerical solutions of MFQNET control problems as a training set and apply OCT-H to learn explicit control policies. Our experimental results demonstrate that the learned policies achieve 100% accuracy on the test set.

3 An Improved Diet You Could Follow: Combining Machine Learning and Optimization to Generate More Realistic Dietary Shifts

Felipe Vizzoto[1], Antoine Desir[1], Dan Andrei Iancu[2], [1]INSEAD, Fontainebleau, France; [2]Stanford University, Stanford, CA, Contact: felipe.vizzoto@insead.edu

A dietary shift is an imperative to fighting climate change and the epidemic of non-communicable diseases. This work combines machine learning techniques with optimization to build more accurate models of compliance with dietary recommendations and to optimize such recommendations in view of nutritional and environmental considerations. We calibrate our models using data from the Brazilian Dietary Survey and we compare our optimized diets that suitably account for compliance with other recommendations from the literature.

Monday, October 16, 12:45 PM - 2:00 PM

MC15

CC-North 126A

Non-Kinetic Grey-Zone Conflict and OR Techniques

Community Committee Choice Session

Session Chair: David Dewhurst, [1]</sup

1 Community/Committee'S Choice Submission

Casey King, Yale University, New Haven, CT

2 Approaches to Extending Game-Theoretic Analyses to Complex, Real-World Scenarios

Scott Neal Reilly, Charles River Analytics, Cambridge, MA, Contact: snealreilly@cra.com

I will present a novel methodology to describe and solve formal games that change some standard assumptions of game theory to make it easier to describe, solve, and analyze real-world adversarial scenarios. I will describe a software implementation of this methodology that helps analysts understand the various possible outcomes of these situations. Finally, I will describe some initial evaluations we have undertaken to demonstrate the usefulness of this approach to better understanding and reasoning about real-world scenarios.

3 Strategic Dimensions of Economic Resilience

Mark Flood, DARPA, Arlington, VA

An introduction an overview of several of DARPA's research efforts that model economic and financial systems with a view to monitoring and enhancing their resilience.

4 Frontiers in Non-Kinetic Grey Zone Conflict

David Rushing Dewhurst, D R Dewhurst, Inc., Wareham, MA, Contact: david@drdewhurst.com

Non-kinetic grey-zone (NKGZ) conflict is characterized by ambiguity, uncertainty, novelty, and adaptation: ambiguity of intentions and outcomes; uncertainty in state space; novelty in domain of conflict; and adaptation to operations in these new domains. This talk first provides a background on NKGZ conflict, including historical and recent examples, and then outlines multiple frontiers in NKGZ conflict: (a) details of newly important operational domains (e.g., financial, economic, and supply chain); (b) strategic models of NKGZ conflict; and (c) emergent operations research, statistical, and artificial intelligence techniques with direct applications to NKGZ operations.

5 Financial Cartography In The Gray Zone

Corey L. Lofdahl, Leidos, Inc., Arlington, VA, Contact: corey.lofdahl@leidos.com

Modern strategic competition among nations centers less on the military than the diplomatic, informational, and economic elements of national power. This trend is captured by the term “gray zone” in which great power competition takes place in the continuum between the poles of peace and war. Instead of defeating a country militarily, today it is preferable to do so economically. In the gray zone, economies and markets are not attacked quickly and directly. Instead, they are compromised in a more nuanced, pervasive, and temporally extended manner such as with crime. This study uses Russian money laundering through European banks as an example and discusses the use of cartographic mapping techniques that allows analysts to conceptualize these normally opaque transactions.

Monday, October 16, 12:45 PM - 2:00 PM

MC16

CC-North 126B

People-Centric Operations: Teams

Community Committee Choice Session

Session Chair: Guillaume Roels, INSEAD, Fontainebleau, France

1 Fairness Concerns in Heterogeneous Teams: Optimal Team Composition and Contract

Lin Chen[1], Antoine Desir[2], Guillaume Roels[1], [1]INSEAD, Fontainebleau, France; [2]INSEAD, 263 Avenue Daumesnil, France. Contact: lin.chen@insead.edu

In homogeneous teams, inequality aversion increases team output. However, in heterogeneous teams, uneven profit distribution may cause guilt or envy, potentially affecting output. In such cases, is there a fairness-efficiency tradeoff? We consider a principal multi-agent model in which heterogeneous agents are subject to envy and guilt among each other. We show that when agents are highly inequality-averse but not too heterogeneous, it is optimal to involve a team and offer an envy- and guilt-free contract, leading to higher team output than if agents were inequality-neutral. Thus, heterogeneity in abilities combined with endogenous fairness concerns does not necessarily create a fairness-efficiency trade-off. Instead, stimulating inequality aversion may be beneficial for both the principal and the agents in providing a fairer and more efficient solution.

2 Physician Discretion and Patient Pick-Up: How Familiarity Encourages Multitasking in the Emergency Department

Robert Niewoehner[1], Diwas S. KC[2], Bradley R. Staats[3], [1]Indiana University Bloomington, Bloomington, IN, [2]Emory University, Atlanta, GA, [3]University of North Carolina at Chapel Hill, Chapel Hill, NC, Contact: bstaats@unc.edu

Emergency Department (ED) physicians generally respond to the rising demand by increasing the level of multitasking. What leads the physicians to select which patients, and how many patients, to treat? Using observations from two EDs, we explore whether familiarity alters patient pick-up behavior, we determine the effect of familiarity on multitasking, and we measure the combined impact of familiarity and multitasking on other ED outcomes. Among ED physicians, greater average familiarity leads to an increase in patient pick-up rate, observed multitasking, and shorter patient wait time, with no identifiable negative impact to patient processing time or length of stay. Moreover, the effects intensify at the end of a physician’s shift and for patients in severe condition. Within more familiar groups, physicians appear willing to exert more effort.

3 Sequential Selection of Candidates: An Experimental Investigation

Morvarid Rahmani, Karthik Ramachandran, Chris Green, Georgia Institute of Technology, Atlanta, GA, Contact: morvarid.rahmani@scheller.gatech.edu

In many settings, managers make sequential selection decisions where they are constrained by the number of selections and uncertainty about forthcoming candidates. We develop hypotheses based on the optimal solution to a theoretical model. We then conduct a set of experimental studies and evaluate the impact of pool size on selection decisions.

4 Incentives for Modular, Interdependent and Uncertain Projects

Jeremy Hutchison-Krupat[1], Antoine Feylessoufi[2], Stylianos Kavadias[1], [1]University of Cambridge, Cambrige, United Kingdom; [2]University College London, London, United Kingdom. Contact: a.feylessoufi@ucl.ac.uk

The role of modularity has received some attention at the product/service level and its link with organizational design, product quality and organizational performance is well established. There has been, however, much less theory to specifically guide the incentive design for the development of a modular system within an organization.

Monday, October 16, 12:45 PM - 2:00 PM

MC17

CC-North 127A

Human-Algorithm Interaction and the Future of Work

Community Committee Choice Session

Session Chair: Leon Valdes, University of Pittsburgh, Pittsburgh, PA

1 Improving Worker Learning in the Gig Economy

Shunan Jiang, Park Sinchaisri, University of California, Berkeley, Berkeley, CA, Contact: shunan_jiang@berkeley.edu

The gig economy is experiencing exponential growth, with an increasing number of workers engaging in on-demand platforms across various sectors, from grocery delivery to healthcare. These gig workers, often independent contractors, face unique challenges in their work environment as they lack structured training programs and supervision. Therefore, understanding how these workers learn and improve their performance becomes crucial. In collaboration with a grocery delivery platform, our work aims to explore the decision-making and learning processes employed by on-demand shoppers and inform the development of effective training and scheduling programs tailored to the unique needs of gig economy workers.

2 Designing Fundraising Campaign Mechanisms

Pramit Ghosh[1], Ignacio Rios[2], Anyan Qi[2], [1]The University of Texas at Dallas, Richardson, TX, [2]The University of Texas at Dallas, Richardson, TX

Charitable donations are a vital source of funding for non-profit organizations, enabling them to carry out their mission of addressing social issues and providing support to those in need. To enhance donations, non-profits employ various designs aimed at inducing pro-social behavior. This paper investigates the effectiveness of two specific design choices, i.e., matching funds and gift unlock, in the context of fundraising.

3 Nonfungible Tokens: How to Match Supply with Demand in the Metaverse

Dmitrii Sumkin[1], Pavel Kireyev[2], Serguei Netessine[3], [1]University of Illinois at Urbana-Champaign, Urbana-Champaign, IL, [2]INSEAD, Paris, France; [3]The Wharton School, Philadelphia, PA, Contact: dsumkin@illinois.edu

Organizations like Formula One, Hermitage Museum, and the NBA have started issuing digital collectibles (NFTs) on blockchain-enabled marketplaces. Digital collectible sales rose to $25bn in 2021 and $24.7bn in 2022. However, supply policies in these markets are not well understood. We analyze data from Decentraland, a metaverse platform, and build a structural model to study supply, demand, and price formation. Our findings reveal a trade-off between transaction frequency and market prices, influenced by supply policies, impacting platform revenues. Counterfactual analysis shows marketplace revenue is nonlinear with respect to the number of assets introduced, even if the minting cost is zero. Our framework highlights the importance of considering customers' incentives and can be utilized by marketplaces to measure potential effects of supply adjustments.

4 A Behavioral Study of Self-other Adoption Discrepancies in XAI

Fernanda Bravo[1], Zezhen (Dawn) He[2], Yaron Shaposhnik[2], Leon Valdes[3], [1]UCLA Anderson School of Management, Los Angeles, CA, [2]Simon Business School, University of Rochester, Rochester, NY, [3]Katz Graduate School of Business, University of Pittsburgh, Pittsburgh, PA, Contact: zezhen.he@simon.rochester.edu

Despite major recent developments in machine learning (ML), there is ample empirical evidence that users do not always follow ML recommendations. However, the question of whether the subject that is affected by the prediction impacts adherence is not well understood. This question is relevant as many ML applications, from medicine to the judicial system to lending decisions, are made by a user but affect a third party. In this work, we conduct behavioral experiments to study whether the party that is affected by a user's decision (the user, or another participant) impacts the adoption of ML recommendations. In addition, we explore whether the presence vs. absence of ML explanations moderates our results. We find no difference in adoption without explanations. In the presence of explanations, however, users are more willing to use ML when they are the affected party.

Monday, October 16, 12:45 PM - 2:00 PM

MC18

CC-North 127B

Privacy and Fairness in Optimization and Learning

Community Committee Choice Session

Session Chair: Rachel Cummings, Columbia University, New York, NY

1 Improving Communication with End Users About Differential Privacy

Rachel Cummings[1], Priyanka Nanayakkara[2], Mary Anne Smart[3], Gabriel Kaptchuk[4], Elissa Redmiles[5], [1]Columbia

University, New York, NY, [2]Northwestern University, Evanston, IL, [3]University of California San Diego, San Diego, CA, [4]Boston University, Boston, MA, [5]Georgetown University, Washington DC, DC

This talk will cover a series of user studies aimed at improving communication with non-technical end users about differential privacy (DP). Prior work (Cummings et al., 2019) found that the ways in which DP is described in-the-wild set users' privacy expectations haphazardly, which can be misleading depending on the deployment. In this work, we develop and evaluate prototype descriptions designed to help end users understand DP guarantees. These descriptions target two important technical details in DP deployments that are often poorly communicated to end users: the privacy parameter epsilon (which governs the level of privacy protections) and distinctions between the local and central models of DP (which governs who can access exact user data).

2 Thompson Sampling is Itself Differentially Private

Tingting Ou, Rachel Cummings, Marco Avella-Medina, Columbia University, New York, NY, Contact: to2372@columbia.edu

In this work we show that the classical Thompson sampling algorithm for multi-arm bandits is differentially private as-is, without any modification. We provide per-round privacy guarantees as a function of problem parameters and show composition over T rounds; since the algorithm is unchanged, existing $O((NT\log N)^{1/2})$ regret bounds still hold and there is no loss in performance due to privacy. We provide an intuitive explanation using a combination of existing and novel privacy analysis methods. We also show that simple modifications -- such as pre-pulling all arms a fixed number of times, increasing the sampling variance or using improved privacy composition methods -- can provide even tighter privacy guarantees.

3 Bayesian Approach to Measuring Algorithmic Fairness: A Case Study on Compas Recidivism Risk Score

Saeyoung Rho, Junzhe Zhang, Elias Bareinboim, Columbia University, New York, NY, Contact: s.rho@columbia.edu

Algorithmic fairness is receiving increasing attention due to the wide adoption of algorithms in critical areas with significant socioeconomic implications, such as criminal justice. Despite various definitions of algorithmic fairness proposed based on a counterfactual framework, the identification of counterfactual probabilities remains challenging without a concrete solution. In this paper, we propose a Bayesian approach to evaluate counterfactual fairness conditions, given a graphical structure and data. To demonstrate the process, we analyze COMPAS recidivism risk score to identify three variations of counterfactual fairness conditions for protected attributes (race, age, sex) on the algorithm's risk score. Our results indicate that the degree of fairness/discrimination varies depending on the choice of the fairness definition.

Monday, October 16, 12:45 PM - 2:00 PM

MC19

CC-North 127C

Recent Advancement of Organ Transplantation

Community Committee Choice Session

Session Chair: Yue Hu, 1</sup

1 A Data-Driven Approach for Identifying Candidates for Xenotransplant Human Clinical Trials

Baris Ata[1], Robert A. Montgomery[2], Jesse D. Schold[3], Y. Naz Yetimoglu[1], [1]The University of Chicago, Chicago, IL, [2]NYU Langone Health, New York, NY, [3]University of Colorado Anschutz Medical Campus, Aurora, CO, Contact: yyetimog@chicagobooth.edu

Xenotransplantation offers a potential solution to the scarcity of deceased-donor kidneys. The successful investigational transplants of genetically engineered pig kidneys to brain-dead patients suggest that the first human clinical trials are near. We use a data-driven approach to identify viable candidates for the first human clinical trials. Our method can flag patients with high statistical accuracy and suggest viable candidates for the first human clinical trials. That is, the great majority of the flagged patients have lower life expectancy under the status quo than with a xenotransplant. However, it has a relatively low capture rate, i.e., it doesn't flag every viable patient. This poses a challenge for the later stages of clinical trials. A bucketing approach for grouping patients alleviates this problem by identifying a larger fraction of viable candidates.

2 Using Machine Learning Predictions to Improve Utilization and Reduce Discards in Deceased Donor Organ Allocation

Nikhil Agarwal[1], Itai Ashlagi[2], Grace Guan[2], Paulo Somaini[3], Jiacheng Zou[2], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Stanford University, Stanford, CA, [3]Stanford Graduate School of Business, Stanford, CA, Contact: gzguan@stanford.edu

While there are over 100,000 patients waiting for a kidney transplant in the U.S., over 20% of procured deceased donor kidneys are discarded. It is important to identify when a kidney is at risk of being discarded, because organ procurement organizations can expedite the organ to a more accepting transplant center lower down on the waiting list to avoid discard. We develop a machine learning model to predict whether a donor will be at risk of being discarded, and we conduct randomized field experiments to evaluate the efficacy of this tool.

3 Targeted Priority Mechanisms in Organ Transplantation

Ruochen Wang[1], Sait Tunc[2], Matthew Ellis[3], Burhaneddin Sandıkçı[4], [1]Virginia Tech, Blacksburg, VA, [2]Virginia Tech, Blacksburg, VA, [3]Duke Health, Durham, NC, [4]Istanbul Technical University, Istanbul, Turkey. Contact: rcwangise@vt.edu

This paper designs and analyzes implementable voluntary nudge mechanisms that promote, but not enforce, higher utilization of organs as well as efficient matching between organs and patients without mandating a complete redesign of of the system. In particular, we study targeted priority mechanisms, which give priority to a target class of candidates on a pre-defined set of organs if they agree to limit their pool of organ offers to this targeted set. We then characterize the equilibrium behavior of the agents under such mechanisms, identify the impact of these mechanisms on several performance metrics, and investigate their optimal design.

4 Structural Estimation of Kidney Transplant Candidates' Quality of Life Scores

Baris Ata[1], John Friedewald[2], Yue Hu[3], A. Cem Randa[4], [1]University of Chicago, Chicago, IL, [2]Northwestern University, Evanston, IL, [3]Stanford University, Stanford, CA, [4]Uber, San Francisco, CA

We develop a framework for assessing the impact of changes to the deceased-donor kidney allocation policy taking into account transplant candidates' endogenous organ acceptance behavior. To be specific, we construct a dynamic structural model of transplant candidates' acceptance and rejection decisions for organ offers, and perform various counterfactual studies to assess policy changes.

Monday, October 16, 12:45 PM - 2:00 PM

MC20

CC-North 128A

HAS Job Market Lightning Session

Flash Session

Session Chair: Hussein El Hajj, Santa Clara University, Santa Clara, CA

Session Chair: Pooyan Kazemian, Case Western Reserve University, Cleveland, OH

Monday, October 16, 12:45 PM - 2:00 PM

MC21

CC-North 128B

Rethinking Healthcare and Pharmaceutical SCs

Community Committee Choice Session

Session Chair: Benjamin Grant, Clemson University, Greenville, SC

Session Chair: John Lowrey, Northeastern University, Boston, MA

1 E-Access versus Physical Access: An Examination of Telehealth Adoption

Eric Xu, [1</sup]

As interest in telehealth has expanded in recent years, it is more important than ever to understand the tradeoffs patients make when deciding about whether to use in-person services or telehealth services. Therefore, we examine the impact of telemedicine adoption on primary care use, specifically examining the conditions by which telehealth consultations become a substitute for in-person care or a compliment to in-person care. Using a unique dataset of insurance claims for primary care visits, we examine in-person, asynchronous, and synchronous primary care visits.

2 Place-Based Care Continuity and Childhood Obesity

John Lowrey[1], Ben Grant[2], [1]Northeastern University, Boston, MA, [2]Clemson University, Clemson, SC, Contact: j.lowrey@northeastern.edu

Primary care continuity has been linked to better health outcomes. Yet, higher continuity could also be the result of low healthcare access, since patients with low access may be forced to see the same provider. We account for differences in health access and outcomes using information on the patients' residence-based social determinants of health. Using a two-stage least squares approach, we find that care continuity improves health outcomes. While care continuity effect generally improves health for youth in more affluent areas, provider switching may be beneficial for youth in more deprived areas. Thus, place-based social determinants of health appear to condition the effect of operational interventions like continuity.

3 Balancing Speed-Safety Tradeoffs in the Drug Approval Process

Hanu Tyagi[1], Junghee Lee[2], Rachna Shah[1], [1]University of Minnesota, Minneapolis, MN, [2]University of Notre Dame, Notre Dame, IN

Getting new products to market fast is advantageous. However, increased speed could negatively impact product safety. We study the speed-safety tradeoff in the context of the US pharmaceutical industry. We compile a unique dataset of drugs approved by the FDA and find that speed negatively impacts safety.

Monday, October 16, 12:45 PM - 2:00 PM

MC22

CC-North 129A

Emerging Topics in Personalized Medicine

Community Committee Choice Session

Session Chair: Esmaeil Keyvanshokooh, Mays Business School, Texas A&M University, College Station, TX
Session Chair: Kyra Gan, Harvard University, Cambridge, MA

1 Resource-Constrained Optimal Dynamic Treatment Rules for HIV Treatment Success

Lina M. Montoya, University of North Carolina at Chapel Hill, Chapel Hill, NC

A recent sequential multiple assignment randomized trial (ADAPT-R) of HIV-positive patients in Kenya showed that, on average, conditional cash transfers (CCTs) for on-time clinic visits increased viral suppression (VS) compared to standard of care. We estimated an optimal dynamic treatment rule for CCT use; this rule would assign CCTs to all persons. In practice, however, resources may constrain the proportion of persons who can receive a CCT. One response is to selectively administer CCTs to only those most likely to benefit. Thus, we estimated the optimal stochastic allocation rule under a range of constraints on the proportion of patients who can receive a CCT. We then evaluated the counterfactual probability of VS under each resource-constrained optimal rule and contrast it with the counterfactual probability under the static rule in which everyone receives CCTs.

2 Practical Considerations when Designing an MRT for an App-Based mHealth Intervention

Madeline Abbott, Michael Dorsch, Xutong Zhang, Juan Arzac, Walter Dempsey, University of Michigan, Ann Arbor, MI, Contact: mrabbott@umich.edu

The ubiquitous nature of mobile health technology has expanded opportunities for integration of online learning into traditional clinical trial designs and thus allows researchers to learn individualized treatment policies using approaches such as micro-randomized trials (MRTs). In a trial aimed at reducing dietary sodium intake, we embed a Thompson sampler into an MRT to optimize delivery of an app-based intervention. We encountered various challenges during implementation, including how to: (i) define a relevant proximal outcome, (ii) specify a robust statistical model that allows for automation, (iii) balance model flexibility with computational cost, and (iv) address missing values in gradually collected data. In this work, we describe important factors to consider when developing solutions to these practical issues using this specific MRT as an example.

3 Contextual Reinforcement Learning Under Safe Exploration with Application to Type 2 Diabetes

Esmaeil Keyvanshokooh[1], Junyu Cao[2], [1]Mays Business School, Texas A&M University, College Station, TX, [2]The University of Texas at Austin, Austin, TX, Contact: keyvan@tamu.edu

Inspired by medical decision-making applications, this work formulates a Contextual Markov Decision Process under safety constraints. We develop a class of new reinforcement learning algorithms that accounts for personalization, safety, and general statistical models for modeling uncertainty. We prove that our algorithm admits a sublinear regret. We leverage clinical trial data on type 2 diabetes to evaluate the effectiveness of our algorithms in clinical practice.

4 Contextual Bandits with Budgeted Information Reveal

Kyra Gan[1], Esmaeil Keyvanshokooh[2], Xueqing Liu[3], Susan Murphy[4], [1]Cornell Tech, New York City, NY, [2]Mays Business School, Texas A&M University, College Station, TX, [3]Duke-NUS Medical School, Singapore, NA, Singapore; [4]Harvard University, Cambridge, MA, Contact: kyragan@cornell.edu

In digital health, to ensure the effectiveness of the treatments, patients are often requested to take actions that have no immediate benefit to them, which we refer to as pro-treatment actions. In practice, clinicians have a limited budget to encourage patients to take these actions and collect additional information. We introduce a novel optimization and learning algorithm to address this problem. This algorithm effectively combines the strengths of two algorithmic approaches in a seamless manner, including 1) an online primal-dual algorithm for deciding the optimal timing to reach out to patients, and 2) a contextual bandit learning algorithm to identify the best personalized treatment via the digital health interface. We prove that this algorithm admits a sub-linear regret bound. We illustrate the usefulness of this algorithm on both synthetic and real-world data.

Monday, October 16, 12:45 PM - 2:00 PM

MC23

CC-North 129B

Continuous Location Analysis II

Community Committee Choice Session

Session Chair: Zvi Drezner, California State University Fullerton, Fullerton, CA

1 Suboptimality of Hospital Locations in Southeastern USA

Joy Bhadury, Univ of North Carolina Greensboro, Greensboro, NC, Contact: joy-bhadury@uncg.edu

In this paper, we will study the impact ofsuboptimal locations of hospitals in four Southeastern states: North Carolina,South Carolina Virginia and Tennessee. Two different models will be proposedstudying inefficiencies engendered by the suboptimal locations and the impactof hospital closures on the same.

2 A Trajectory Based Heuristic for the Planar P-Median Problem

Zvi Drezner[1], Jack Brimberg[2], Anita Schoebel[3], [1]California State University Fullerton, Fullerton, CA, [2]The Royal Military College of Canada, Kingston, ON, Canada; [3]TU Kaiserslautern, Kaiserslautern, Germany. Contact: zdrezner@fullerton.edu

We present a novel approach for solving the planar p-median problem. A sub-class of the distributed p-median problem is identified that allows a continuous trajectory of local optima to be constructed as a parameter alpha decreases from 1 to 0. The trajectory converges to a local optimum of the planar p-median problem as alpha approaches 0. Computational results are very encouraging. For larger instances tested, the proposed trajectory method finds better solutions in a small fraction of the time taken by a conventional multi-start local search. The methodology is readily extended to continuous p-median problems in higher dimensional spaces.

3 Trade-Offs of Facility Location, Market Penetration and Long-Term Sustainability

Farhood Rismanchian[1], Mozart Menezes[2], Farzad Zaerpour[3], [1]The University of Winnipeg, Winnipeg, MB, Canada; [2]Area of Excellence The Complexity Advantage, NEOMA, Paris, France; [3]The university of winnipeg, Winnipeg, MB, Canada. Contact: f.rismanchian-ra@uwinnipeg.ca

The addition of new facilities, like sales points, to increase market share and sales is a common strategic decision. It assumes that higher market share leads to increased profit. Traditional facility location problems prioritize cost minimization, not profit maximization. However, incorporating new facilities may result in additional costs affecting overall profit. Our study explores the trade-off between profit, location, and design characteristics. We developed a flexible model considering sales revenue, inventory costs, setup costs, and market share to maximize system profitability. Additionally, we assess carbon emissions and profits in a sustainable, low-carbon supply chain network.

Monday, October 16, 12:45 PM - 2:00 PM

MC24

CC-North 130

Novel Revenue Management Approaches in Service Industries

Community Committee Choice Session

Session Chair: Metin Cakanyildirim, The University of Texas at Dallas, Richardson, TX

Session Chair: Milad Armaghan, Richardson, TX

4 Joint Optimization of Pricing and Personalized Recommendations in Online Retailing

Murray Lei[1], Zhong-Zhong Jiang[2], Dan Zhang[3], Rui Zhang[4], Yunwei Qi[5], [1]Queen’s University, Kingston, ON, Canada; [2]Northeastern University-China, Shenyang, China; [3]University of Colorado, Boulder, CO, [4]University of Colorado Boulder, Boulder, CO, [5]Alibaba, Hangzhou, China. Contact: rui.zhang@colorado.edu

We study the problem of pricing and personalized recommendations in online retailing. A set of products is offered to different types of customers. The prices can vary over time but must be consistent across customer groups. Also, customers’ decisions can be influenced by personalized product recommendations. But, there is a limit on the number of products that can be recommended to each customer. We formulate the problem as a finite-horizon stochastic dynamic program. We propose a solution strategy based on Lagrangian relaxation. We further obtain two sets of theoretical results. First, we show that the LP formulation of the Lagrangian relaxation admits a compact reformulation. Second, we prove a performance guarantee for a heuristic control method based on the solution. The policies and bounds are validated with data from a leading online retailer in China.

5 Buyout Price Optimization in the Rent-To-Own Business

Milad Armaghan, Metin Cakanyildirim, Andrew E. Frazelle, The University of Texas at Dallas, Richardson, TX, Contact: milad.armaghan@utdallas.edu

We study the multidimensional price optimization problem faced by a rent-to-own (RTO) firm, which rents a product for a periodic fee and offers it for sale at a sequence of prices during rental. RTO industry prices decrease steeply initially and gradually later. However, we prove for a special case that the optimal prices are in contrast concave decreasing. To overcome the nonconcavity of the profit, we formulate an equivalent bilevel optimization and transform the inner problem into a deterministic dynamic program to find the globally optimal price path. We also apply our methodology to jointly optimize prices and inventory. Applying our algorithm in a case study, we again find that optimal prices decrease gradually early in the agreement and steeply later. Moreover, our methodology yields approximately a 22% profit improvement relative to industry prices.

6 Luxury Brands' Fight Against Counterfeits, Public or Dark?

Lai Wei, Larisa Kovalenko, Boston College, Chestnut Hill, MA, Contact: weilx@bc.edu

Luxury products can face both deceptive and non-deceptive counterfeits at the same time. We characterize the optimal anti-counterfeit policies in generating higher revenues and policies that effectively decrease the volume of counterfeits sales, in a market consisting of two groups of customers, naive and sophisticated customers.

7 Managing Equipment Rentals: Unreliable Fleet, Impatient Customers, and Finite Commitment Capacity

Mohammad Firouz[1], Linda Li[2], Burcu B. Keskin[3], [1]The University of Alabama at Birmingham, Birmingham, AL, [2]Missouri State University, Springfield, MO, [3]University of Alabama, Tuscaloosa, AL

In this paper, we discuss fleet size decisions of an equipment rental firm. In our setting, we allow for partial backordering, reneging, and finite commitment capacity. Moreover, we explicitly consider the breakdown possibility of the available equipment fleet. We develop an efficient recursive algorithm to solve the underlying two-dimensional stochastic single-player model. Our algorithm determines the global optimal fleet size of the firm for the same reneging and equipment return rates. Extending our model to a two-player game, we propose an approximation heuristic to derive closed-form solutions to estimate equilibrium fleet sizes under complete information. Using our heuristic as the initial solution, we develop a simulation model to determine the exact equilibrium fleet sizes and draw a detailed comparison between the two-player and single-player models.

Monday, October 16, 12:45 PM - 2:00 PM

MC25

CC-North 131A

Healthcare Analytics

Community Committee Choice Session

Session Chair: Zhichao Zheng, Singapore Management University, Singapore, Singapore

1 Behavioral Responses to Kidney Allocation Priority: A Regression Discontinuity Analysis

Jiayi Liu[1], Diwas S. KC[2], [1]Virginia Tech, Blacksburg, VA, [2]Emory University, Atlanta, GA, Contact: jyliu@vt.edu

The severe shortage of deceased-donor kidneys has turned the allocation into a rationing problem. Prior research and policy guidance on the allocation system design often makes restrictive assumptions about patient behavior. This study provides quasi-experimental evidence on how patients respond to allocation rules. We exploit a national kidney allocation policy that assigns priority based on an exogenous cutoff. Allocation priority produces a positive supply shock: prioritized patients receive more frequent kidney donors with generally higher quality. We find that prioritized patients become more selective; they are much less likely to accept an organ donor of a given quality, which can lead to an increasing number of organs being discarded, further exacerbating the organ shortage. These findings have implications for kidney allocation policy making.

2 Small Area Estimation of Case Growths for Timely Covid-19 Outbreak Detection

Zhaowei She[1], Zilong Wang[2], Jagpreet Chhatwal[3], Turgay Ayer[4], [1]Singapore Management University, Singapore, Singapore; [2]Georgia Institute of Technology, Industrial Systems and Engineering, Atlanta, GA, [3]Harvard Medical

School, Mass General Hospital, Boston, MA, [4]Georgia Tech, Atlanta, GA

Rapid and accurate detection of local outbreaks is critical to tackle resurgent waves of COVID-19. A fundamental challenge in case growth rate estimation, a key epidemiological parameter, is balancing the accuracy vs. speed tradeoff for small sample sizes of counties. We develop an algorithm, Transfer Learning Generalized Random Forest (TLGRF), that balances this tradeoff. Through transfer learning, TLGRF can accurately estimate case growth rates for counties with small sample sizes based on relevant day and county-level features affecting the disease spread. TLGRF outperforms established growth rate estimation methods and demonstrated that it can greatly improve the timely detection of outbreaks. We thus developed a open source tool for timely detection of COVID-19 outbreaks in each U.S. county, which received substantial attention by policymakers.

3 Estimating Patient Health Transition from Data Censored by Treatment-Effect-Based Policies

Qian Luo[1], Yan He[2], Hai Wang[3], Zhichao Zheng[3], Haidong Luo[4], Oon Cheong Ooi[4], [1]Xi'an Jiaotong-Liverpool University, Suzhou, China; [2]Biofourmis, Singapore, Singapore; [3]Singapore Management University, Singapore, Singapore; [4]National University Hospital, Singapore, Singapore

Treatment-effect-based decision policies in healthcare can censor patient health transition observations and distort transition probability matrix (TPM) estimation. We introduce a structural model to recover true TPMs from censored data, proving consistency, asymptotic normality, and log-likelihood maximization. Using hypothetical data, we highlight our model's advantages over benchmarks ignoring censoring. Applied to extubation in ICU, our method, with more accurate TPMs accounting for policy censoring, reduces patient ICU stay compared to benchmarks.

4 A Two-Stage Stochastic Deceased-Donor Organ Allocation Model for Kidney Transplants

Daniela Cantarino, Jorge Andrés Acuna, Jose L. Zayas-Castro, University of South Florida, Tampa, FL, Contact: danieladuran@usf.edu

Chronic kidney disease (CKD) affects 1 in 7 adults in the United States, decreasing the duration and quality of life of 37 million individuals nationwide. Studies have shown that renal transplants in CKD patients add an average of 10 years to life compared to dialysis. However, the highest unsatisfied demand among all main organs is linked to the kidney, with over 70% of its registered patients still waiting for a renal replacement. We propose a two-stage stochastic deceased-donor organ allocation model considering pre- and post-transplant processes aimed at improving the quality and quantity of matches. Factors considered include waitlist mortality, expected survival, traveled distances, organ decay and biological compatibilities.

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MC26

CC-North 131B

Supply Chain Sustainability and Risk Analysis

Contributed Session

Session Chair: Qiang Qiang, Penn State, Malvern, PA

1 Non-Committed Cost Auditing in Supply Chain Contracts

Jing Li[1], Wanshan Zhu[1], Zhengping Wu[2], [1]Renmin University of China, Haidian District, Beijing, China; [2]Syracuse University, Syracuse, NY, Contact: rmbslijing@ruc.edu.cn

As a widely used means in supply chain practice, audit can be used as an auxiliary means to alleviate the supply chain incoordination problem under asymmetric information that cannot be solved by profit-sharing contract and other means. Although some studies have considered audit issues under supply chain contracts in the literature, few studies are conducted from the perspective of principal-agent theory, not to mention the situation where retailers do not commit to audit strategies under the principal-agent model. In this paper, under the principal-agent theory model, we consider the optimal audit strategy when the retailer makes no commitment to the audit mechanism. We explore the unique features of the audit strategy and the sensitivity of the optimal strategy to various factors.

2 Financing Risky Supplier: Green Technology Investment and Regulation

Yutian Li, University of Science and Technology of China, Hefei, China. Contact: liyutian@ustc.edu.cn

As sustainability plays a prominent role everywhere, supply chain disruption frequently occurs because of supplier's violation to environmental regulation. In a supply chain consist of a supplier and a manufacture, both of them try to invest in green technology to reduce the risk of regulation violation. However, this investment aggravates the supplier's financial problem which is a significant risk of supply disruption as well. In this paper, we explore how a manufacture financially subsidizes supplier to mitigate the disruption risk from regulation violation and bankruptcy. Meanwhile, we will show that an aggressive regulation is not always encouraging investment on green technology.

3 The Multi-Period Interactive CLSC Network
Qiang Qiang, Penn State, Malvern, PA, Contact: qzq10@psu.edu
Inspired by the recent business cases, we develop a coupled multi-period CLSC network model dealing with heterogeneous products facing different demand markets. The end-of-life product from the forward supply chain is collected, recycled and the raw material is extracted to be used as an input for the reverse supply chain which produces another type of product. In particular, interactions between the two supply chains with inventory cost and innovation competition are analyzed. An algorithm is introduced to study the network equilibrium. Numerical examples are used to illustrate the model.

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MC27

CC-North 131C
Novel Operational Strategies in Service
Community Committee Choice Session
Session Chair: Yang Li, Ivey Business School, Western University, London, ON, Canada

1 In-Queue Queueing: Gaining Utility Through Ancillary Service While Waiting
Yang Li[1], Baolong Liu[2], Rowan Wang[3], [1]Ivey Business School, Western University, London, ON, Canada; [2]ShanghaiTech University, Shanghai, China; [3]Southern University of Science and Technology, Shenzhen, China. Contact: liubl@shanghaitech.edu.cn
We examine a queueing system with the primary service provider also offering an ancillary service. The customers are categorized into two groups: the ones who exclusively come to the primary service (Type-P) and the ones who are also interested in the ancillary service (Type-A). While both types come for the primary service, Type-A customers line up in an embedded queue for the ancillary service which attracts more demand but increases the expected waiting time. Thus, there exists a trade-off between demand expansion and the queue congestion effect. With queueing models, the results show that not only does the ancillary service expand demand, but also improves welfare, although it may lead to a lower profit for providers compared to the primary queue without ancillary service and the primary priority queue, due to the cost of providing ancillary service.

2 To App or Not to App: Omnichannel Competition
Abhishek Ghosh[1], Achal Bassamboo[2], Martin Lariviere[2], [1]Freeman School of Business, Tulane University, New Orleans, LA, [2]Northwestern University, Evanston, IL, Contact: aghosh2@tulane.edu
We use a game theoretic model to study, from an operations perspective, why some omnichannel firms offer an app and others don't.

3 On the Social Loss from Balking
Guanling Yang, Ricky Roet-Green, Simon Business School, University of Rochester, Rochester, NY, Contact: gyang15@simon.rochester.edu
Empirical studies and observations have demonstrated that social loss due to balking is significant, yet this phenomenon has not been adequately addressed in canonical strategic queueing literature. In this study, we examine the individual equilibrium strategy and the socially optimal policy for both observable and unobservable fundamental M/M/1 queueing models, while taking into account social loss.

4 Sales Versus Subscription Business Models in Retail: Price and Assortment Competition
Mehmet Sekip Altug[1], Tolga Aydinliyim[2], Oben Ceryan[3], Aditya Jain[4], [1]George Mason University, Fairfax, VA, [2]Baruch College, CUNY, New York, NY, [3]City, University of London, London, United Kingdom; [4]Baruch College, Zicklin School of Business, New York, NY, Contact: aditya.jain@baruch.cuny.edu
Motivated by retailers' introduction of subscription services, we study consumers' self-selection between "buying from seller firms" versus "subscribing to renter firms." Modeling price and assortment competition among sellers and renters, we characterize a solution wherein the renter's large assortment at premium prices and the seller's limited assortment split equilibrium demand.

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MC28

CC-North 132A
Data Analytics in Operations Management
Community Committee Choice Session

Session Chair: Qi Annabelle Feng, Purdue University, West Lafayette, IN
Session Chair: Jian Wu, Purdue University, West Lafayette, IN

1 Vehicle Rebalancing in a Shared Micromobility System with Rider Crowdsourcing

Ziliang Jin[1], Yulan Amanda Wang[2], Yun Fong Lim[3], Kai Pan[2], Zuo-Jun Max Shen[4], [1]The Hong Kong Polytechnic University, Hong Kong, China; [2]The Hong Kong Polytechnic University, Hung Hom, Hong Kong; [3]Singapore Management University, Singapore, Singapore; [4]University of California Berkeley, Berkeley, CA, Contact: kai.pan@polyu.edu.hk

We consider a shared micromobility operator who can crowdsource individual riders with reward incentives in addition to engaging a third-party logistics provider (3PL) to relocate the vehicles. We construct a time-space network with multiple service regions and formulate a two-stage stochastic mixed-integer program considering uncertain customer demands. We develop an efficient solution approach that incorporates scenario-based and time-based decomposition techniques. We solve large-scale problem instances based on real data and provide extensive managerial implications. Introducing rider crowdsourcing to the 3PL can increase profit, reduce demand loss, and improve vehicle utilization rate without affecting existing 3PL commitments. The 3PL is more efficient for mass relocation, while rider crowdsourcing is more efficient for sporadic relocation.

2 Contextual Data-Integrated Newsvendor Solution with Operational Data Analytics (ODA)

Qi Annabelle Feng, J. George Shanthikumar, Jian Wu, Purdue University, West Lafayette, IN, Contact: wu1549@purdue.edu

We analyze the inventory decision for an unknown demand that may be learned from historical data of the demand and related covariates. We apply the operational data analytics (ODA) framework to formulate the data-integration model and the validation model. The ODA solution demonstrates superior performance with a finite sample size.

3 Federated Learning on Adaptively Weighted Nodes by Bilevel Optimization

Yankun Huang[1], Qihang Lin[1], Nick Street[1], Stephen Baek[2], [1]Tippie College of Business, The University of Iowa, Iowa City, IA, [2]School of Data Science, The University of Virginia, Charlottesville, VA, Contact: yankun-huang@uiowa.edu

We propose a federated learning method with weighted nodes in which the weights can be modified to optimize the model's performance on a separate validation set. The problem is formulated as a bilevel optimization where the inner problem is a federated learning problem with weighted nodes and the outer problem focuses on optimizing the weights based on the validation performance of the model returned from the inner problem. A communication-efficient federated optimization algorithm is designed to solve this bilevel optimization problem. Under an error-bound assumption, we analyze the generalization performance of the output model and identify scenarios when our method is in theory superior to training a model only locally and to federated learning with static and evenly distributed weights.

4 E-Commerce Order Fulfillment with Limited Time Window

Quan Zhou, Mehmet Gumus, Sentao Miao, McGill University, Montreal, QC, Canada. Contact: quan.zhou3@mail.mcgill.ca

We studied a multi-warehouse multi-location order fulfillment problem under limited logistic resources. Orders are fulfilled in batches, and each order has a fixed lifetime to be fulfilled before being lost. We formulate this problem as a finite-horizon dynamic program. We first characterize the structural properties of an optimal fulfillment policy and then utilize these properties to design effective heuristics. We proposed two heuristic policies based on Lagrangian relaxation. Both heuristics are asymptotically optimal when the number of locations becomes large. Our results suggest that allowing a multi-period fulfillment window is a solution to alleviate logistic capacity constraints and that incorporating this information into the decision-making process can bring additional benefits.

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MC29

CC-North 132B

Innovative Energy Operations: Empirical and Theoretical Studies

Community Committee Choice Session

Session Chair: Nil Karacaoglu, The Ohio State University, Columbus, OH
Session Chair: Nur Sunar, 1</sup

1 Electricity Pricing with Limited Consumer Response

Fariba Farajbakhsh Mamaghani[1], Saed Alizamir[2], Shouqiang Wang[3], [1]Tulane University, River Ridge, LA, [2]Yale University, New Haven, CT, [3]The University of Texas at Dallas, Richardson, TX, Contact: fariba@tulane.edu

Implementing demand response (DR) programs in the residential electricity market to reduce demand-supply mismatches has generated mixed results. As a distinctive feature of this market, the retail prices are typically set in advance and hence cannot incorporate the random demand shocks that may occur closer to the consumption point. In this paper, we construct a demand model to describe how consumers make consumption decisions in response to random external factors representing their ambient environment (e.g., outdoor temperature) for a given price. Analyzing their behavior under "rational inattention" identifies responsive and non-responsive regions to demand shocks. This research contributes to understanding DR programs and provides insights for designing effective pricing mechanisms.

2 Optimal Maintenance Scheduling on Power Plants

Abdullah Coskun, Omer Karaduman, Stanford University, STANFORD, CA, Contact: ACOSKUN@STANFORD.EDU

Using rich data on hourly physical productivity and maintenance schedules from US power plants, we study the effects of maintenance schedules on efficiency. Our research aimed to gain a comprehensive understanding of how different maintenance strategies impact the productivity and performance of power plants. Building upon the evidence derived from the empirical data, we developed a theoretical model to determine the optimal maintenance schedules. This model takes into account various factors, such as the frequency and duration of maintenance activities, the specific needs and characteristics of power plants, and the potential impact on efficiency.

3 IoT-Based Nudging for Energy Saving: More Can be Less for Organizations and Environment

Jacob Zijian Zeng[1], Serasu Duran[2], Nil Karacaoglu[3], Sunar Nur[1], [1]UNC Kenan-Flagler Business School, Chapel Hill, NC, [2]Haskayne School of Business, Calgary, AB, Canada; [3]The Ohio State University, Columbus, OH, Contact: jacob_zeng@kenan-flagler.unc.edu

We estimate the impact of IoT-based nudging on energy saving for organizations.

4 Ppas in the Context of Renewable Electricity

Subas Acharya[1], Roza Galeeva[1], Helyette Geman[2], [1]Johns Hopkins University, Baltimore, MD, [2]Johns Hopkins University, Baltimore, MD, Contact: sa.subas@gmail.com

The first part of the paper analyzes the shapes over the day of electricity prices and generation from renewables, particularly solar and wind. Using these factors as a foundation, our objective is to analyze the valuation of Power Purchase Agreements (PPAs) and the risks associated with electricity produced by renewable sources - thus enriching the Environmental, Social, and Governance (ESG) profile of the buyer. We further present a methodology for determining optimal hedge ratios to minimize risk for buyers or sellers of renewable facilities. We focus on the two regions: Texas (Electric Reliability Council of Texas (ERCOT)) and California.

Monday, October 16, 12:45 PM - 2:00 PM

MC30

CC-North 132C

Technology and Innovation Management

Community Committee Choice Session

Session Chair: Wenli Xiao, University of San Diego, San Diego, CA

Session Chair: Qiong Chen, Southwestern University of Finance and Economics, Chengdu

1 Does Network Help? Innovation During Distressed Times

Pankaj Kumar[1], Xiaojin Liu[2], Anant Mishra[3], [1]Virginia Polytechnic Institute and State University, Blacksburg, VA, [2]Virginia Commonwealth University, Richmond, VA, [3]Carlson School of Management, University of Minnesota, Minneapolis, MN, Contact: xliu22@vcu.edu

Collaboration is generally viewed as a strategic resource to augment innovation output. In this study, we empirically investigate how an employee's network of relationships within a firm affects their creativity and innovation productivity during times of distress.

2 Technological Resource Reconfiguration in Declining Firms

Yang Ye, Southwestern University of Finance and Economics, Chengdu, China

Most firms face declining problems, but handling organizational decline through technological resource reconfiguration is not well studied. Previous studies have extensively investigated how innovation strategies can help declining firms turn around, but technological resource reconfiguration is different from broad innovation strategies as it focuses on a processed examination of resource flows and stocks. This study examines the content and timing requirements of technological resource reconfiguration by analyzing patent reassignments of declining firms. It also investigates how different causes of decline and firms' technological and distress experiences play a role in initiatives to reconfigure with technological resources.

3 Achieving Performance in Innovative Projects: Strategies for Planning and Adapting

Gulru Ozkan-Seely[1], Surya D. Pathak[1], Mohan V. Tatikonda[2], P.V. Balakrishnan[1], [1]University of Washington, Bothell, WA, [2]Indiana University, Indianapolis, IN, Contact: gulru@uw.edu

We investigate adaptive mechanisms and planning strategies for innovative projects with characteristics such as complexity, uncertainty, ambiguity, novelty and scale. Data is collected from sixteen NPD projects from one high-tech organization, and an analytical optimal control model is developed to capture adaptation and planning strategies that maximize performance at project completion. We show that initial levels of project structuring, uncertainty resolution and performance potential result in wide range of strategies, varying from focusing on expending high rate of efforts early in the project to extending peak efforts to later in the project. Also, we show that adaptive range widely, from taking no action to modifying ultimate goals.

4 Innovation Investments Of Firms, Efficiency Enhancement And Spillover Effect In Supply Chain

Shucheng MIAO[1], Andy Yeung[2], [1]The Hong Kong Polytechnic University, Kowloon, Hong Kong; [2]The Hong Kong Polytechnic University, Kowloon, Hong Kong. Contact: jason.miao@connect.polyu.hk

Although innovation applications have been frequently studied, it is unclear whether and when innovation investments lead to true improvement of operational efficiency, which is a key factor in operations management. Specifically, we apply SFA and GMM techniques to examine this impact and relevant moderators. By using innovation investment data from Lightcast, we show the positive impact of innovation investments, and this impact is stronger for firms with higher R&D intensity or in complex environments. Moreover, we illustrate the spillover effect of innovation investments in supply chain networks. Drawing on the social network perspective, we show this relationship is continuous and stronger for more concentrated and complex networks. These findings highlight strategies that make innovation capability a more crucial asset in the supply chain network.

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MC31

CC-North 221A

Amazon Supply Chain Optimization

Community Committee Choice Session

Session Chair: Garrett J. van Ryzin, Amazon, New York, NY

1 Configurable Simulation-Based Search for Heterogeneous Opportunity Costs of Capacity

Michael Bloem, Amazon, Bellevue, WA

In recent years, the Amazon Fulfillment Network (AFN) has grown in scale and evolved into multiple layers. This creates new challenges for inbound and placement optimization under labor, transportation, and storage capacity constraints. Inbound and placement optimization models penalize capacity consumption with opportunity costs. Appropriate opportunity costs are found using a high-fidelity AFN simulator. This talk will describe a configurable cost search approach that enables simultaneous search for heterogenous costs of capacity. The approach decomposes costs into groups based on constraint type, topology, or other considerations. Group cost updates are independent and can use different first- or second-order sub-gradient-based algorithms. We demonstrate how this approach allows us to find acceptable costs for thousands of heterogenous constraints.

2 Simulation-Based Storage Fullness Control and Optimization

Nanjing Jian[1], Garrett J. van Ryzin[2], Lee Dicker[2], Yan Xia[1], [1]Amazon.com, Bellevue, WA, [2]Amazon.com, New York, NY, Contact: nanjjian@amazon.com

Amazon, being "the everything store", sells hundreds of millions of products. The products share the warehouse storage capacity across multiple weeks before peak. High storage fullness negatively impacts the labor throughput, increasing the variable cost for processing inventory. While the current inventory management systems treat those costs as constants, this leads to high operational inefficiency around peak. We propose to incorporate nonlinear labor costs as functions of storage fullness into the existing large-scale, simulation-based capacity control system. The algorithm is inspired by multi-agent distributed optimization. It searches for the primal storage fullness target and dual capacity cost over iterations of stochastic simulations, and at convergence, outputs storage fullness targets that optimize the end-to-end supply chain costs.

3 Order Fulfillment Optimization at Amazon

Weihong Hu[1], Yash Kanoria[2], Andrea Qualizza[3], Jikai Zou[4], [1]Amazon, Bellevue, WA, [2]Columbia University, Cambridge,

MA, [3]Amazon.com, McLean, VA, [4]Amazon Web Service, Seattle, WA

We will discuss how Amazon makes order assignment decisions at scale for tens of millions of orders daily. Order assignment decisions take into account several customer experience and network objectives to determine how to consolidate demand, where, when and how to fulfill each shipment. Historically our models encoded the various objectives as different cost components at the unit or shipment levels. As we recently transitioned the U.S. fulfillment network to a regionalized model, we pivoted away from shipment level optimization and towards an approach where we explicitly optimize for and trade-off network level objectives without sacrificing customer experience.

4 Consensus Planning Protocol

Garrett J. van Ryzin, Amazon, New York, NY

Consensus Planning Protocol (CPP) is a methodology developed to coordinate decision-making among distributed agents. While initially created for the Amazon supply chain, it has broad applications in distributed optimization settings. This talk provides a practical introduction to CPP, focusing on key concepts, features, and intuition without excessive technicalities. We examine three Amazon applications to provide practical examples of CPP and describe optimization and software tools for implementing it.

Monday, October 16, 12:45 PM - 2:00 PM

MC32

CC-North 221B

Behavior-Informed Operation of Urban Transportation Systems

Community Committee Choice Session

Session Chair: Tianming Liu, University of Michigan, Ann Arbor, MI

1 Understanding The Dwelling Behavior Of Ride-sourcing Drivers At Transportation Hubs From Behavioral Queuing Perspective

Tianming Liu[1], Zhengtian Xu[2], Yafeng Yin[1], Jussi Keppo[3], [1]University of Michigan, Ann Arbor, MI, [2]The George Washington University, Washington, [3]National University of Singapore, Singapore, Singapore. Contact: tianmliu@umich.edu

Urban transportation hubs, such as airports and railway stations, serve as major locations for ride-hailing services, where drivers frequently wait to pick up passengers. This waiting often leads to the formation of driver queues, resulting in increased fleet idleness and decreased system efficiency. This study aims to the dwelling behavior of ride-sourcing drivers at transportation hubs from a behavioral queueing perspective. Through an analysis of a comprehensive dataset of idle drivers during a natural experiment at a large city airport, valuable insights are generated regarding drivers' strategies and behavioral biases in the dwelling process, along with corresponding management strategies.

2 Is Free Transit Just? Quantifying the Impact of Ethical Principles on Transit Design and Finance

Tianxing Dai, Hongyu Zheng, Marco Nie, Northwestern University, Evanston, IL, Contact: tianxingdai2025@u.northwestern.edu

This study investigates the impact of ethical principles on transit design and finance. We develop a stylized, accessibility-based transit design model that finances transit operations from fixed subsidy, farebox revenue, and supplementary taxation. Our results confirm egalitarian designs prioritize carless population, whereas utilitarian designs favor drivers. We also find free public transit is desirable only when accompanied with aggressive tax schemes dedicated to improving transit services, even when the design is guided by an egalitarian principle.

3 Understanding Multi-Homing and Switching by Platform Drivers

Xiaotong Guo[1], Andy Haupt[1], Hai Wang[2], Jinhua Zhao[1], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Singapore Management University, Singapore, Singapore. Contact: xtguo@mit.edu

Freelance drivers in the shared mobility market frequently switch or work for multiple platforms, affecting driver labor supply. Due to the importance of driver labor supply for the shared mobility market, understanding drivers' switching and multi-homing behavior is vital to managing service quality on---and effective regulation of---mobility platforms. However, a lack of individual-level data on driver behavior has thus far impeded a deeper understanding. This paper taxonomizes and estimates perceived switching and multi-homing frictions on mobility platforms. Based on a structural model of driver labor supply, we estimate switching and multi-homing costs in a platform duopoly using public and limited high-level survey data in a shared mobility market with a transportation network company duopoly.

4 Planning, Policy, and Operational Implications of Post-Pandemic Travel Patterns on Urban Transportation Systems

Michael Leong, Massachusetts Institute of Technology, Cambridge, MA, Contact: mleong1@mit.edu

The emerging structure of post-pandemic travel behavior has widespread implications on the long-range planning, policy, and operations of transportation systems and city form. Using anonymized mobile phone data from the Washington DC Metropolitan Area in partnership with WMATA, this study creates a replicable framework to quantify these post-pandemic mobility changes with a focus on the future of work, public transit adaptation, and achieving the climate goals of the century. Key findings include that there are wide divergences by mode, built environment, activity type, and spatial distribution of activity, where suburban centers and downtowns exhibit different roles than pre-pandemic times. Consequently, we articulate infrastructural and operational frameworks to make public transportation, transportation systems, and cities more resilient to the future.

5 Evaluating Service Reliability Of Electrified Freight Networks Using Multi-agent Reinforcement Learning

Aron Brenner[1], Ting Bai[2], Karl H. Johansson[2], Saurabh Amin[3], [1]MIT, Cambridge, MA, [2]KTH, Stockholm, Sweden; [3]MIT, Cambridge, MA, Contact: abrenner@mit.edu

Decarbonizing the freight transportation sector requires strategic allocation of fast charging infrastructure for heavy duty vehicles along major freight corridors. Importantly, this investment in charging infrastructure must be made with consideration towards consequent freight routing and charging behaviors emerging from both inter-fleet competition resulting from public charging resource constraints and cooperation induced by cross-fleet platooning. To this end, we propose a multi-agent reinforcement learning framework for evaluating fleet costs, station revenues, and system reliability under different charging infrastructure allocations and apply our framework to a case study on the Stockholm-Malmö freight corridor.

Monday, October 16, 12:45 PM - 2:00 PM

MC33

CC-North 221C

Discrete Optimization for Trustworthy Machine Learning

Community Committee Choice Session

Session Chair: Connor Lawless, Cornell University, Oakville, ON, Canada

1 Learning Optimal Classification Trees Robust to Distribution Shifts

Nathan Justin[1], sina Aghaei[2], Andres Gomez[1], Phebe Vayanos[1], [1]University of Southern California, Los Angeles, CA, [2]USC, Los Angeles, CA, Contact: njustin@usc.edu

We consider the problem of learning classification trees that are robust to distribution shifts between training and testing/deployment data. This problem arises frequently in high stakes settings such as public health and social work where survey data is highly sensitive to distribution shifts. We demonstrate that the problem of learning an optimal robust classification tree can be cast as a single-stage mixed-integer robust optimization problem with a highly nonlinear and discontinuous objective. We reformulate this problem equivalently as a two-stage linear robust optimization problem for which we devise a tailored solution method. We show an increase of up to 14.16% in worst-case accuracy and of up to 4.72% in average-case accuracy across several datasets and distribution shifts from using our robust tree in comparison to a regularized, non-robust optimal tree.

2 Screening Rules for L0-L2 Regression

Anna Deza, Alper Atamturk, IEOR, UC Berkeley, Berkeley, CA, Contact: annadeza@berkeley.edu

Logistic regression with a large number of features compared to available labels presents numerous challenges for learning. We present screening rules that safely remove features from the sparse logistic regression with L0-L2 regularization before solving the problem. The screening rules are based on the Fenchel dual of strong conic relaxations of the sparse logistic regression problem. Numerical experiments with real and synthetic data suggest that a high percentage of the features can be effectively and safely removed apriori, leading to substantial speed-up in the computations.

3 Shattering Inequalities for Learning Optimal Decision Trees

Zachary Zhou, Justin J. Boutilier, Carla Michini, University of Wisconsin-Madison, Madison, WI, Contact: zzhou246@wisc.edu

Recently, mixed-integer programming (MIP) techniques have been applied to learn optimal decision trees. Empirical research has shown that optimal trees typically have better out-of-sample performance than heuristic approaches such as CART. However, the underlying MIP formulations often suffer from weak linear programming relaxations. We introduce a class of valid inequalities for learning optimal multivariate decision trees, called shattering inequalities. We propose a separation procedure for shattering inequalities and show how to use them as part of the solution process. Numerical experiments show that in most instances, our approach outperforms other approaches from the literature. Theoretical results show that under mild assumptions on the dataset, a well-defined subset of the shattering inequalities are facet-defining.

4 Learning to Branch with Interpretable Machine Learning Models

Selin Bayramoglu[1], George L. Nemhauser[2], Nikolaos Sahinidis[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, Contact: sbayramoglu3@gatech.edu

Machine learning is being increasingly used in improving decisions made within branch-and-bound algorithms for solving mixed integer programming (MIP) problems. In this work, we build simple and interpretable models to approximate strong branching scores, a costly expert branching rule. Our method selects important features for a given problem domain and produces statistically significant models for the MIPs studied. We compare our models with built-in branching rules of SCIP, a state-of-the-art solver, and other ML-based rules.

Monday, October 16, 12:45 PM - 2:00 PM

MC34

CC-North 222A

Machine Learning and Mean Field Games

Community Committee Choice Session

Session Chair: Gokce Dayanikli, University of Illinois Urbana-Champaign, Urbana-Champaign, IL

Session Chair: Mathieu Lauriere, New York University Shanghai, Shanghai, China

1 Model-Free Mean-Field Reinforcement Learning: Mean-Field MDP and Mean-Field Q-Learning

Rene A. Carmona, Princeton University, Princeton, NJ

We study infinite horizon discounted Mean Field Control (MFC) problems with common noise through the lens of Mean Field Markov Decision Processes (MFMDP). We allow the agents to use actions that are randomized not only at the individual level but also at the level of the population. This common randomization allows us to establish connections between both closed-loop and open-loop policies for MFC and Markov policies for the MFMDP. In particular, we show that there exists an optimal closed-loop policy for the original MFC. Building on this framework and the notion of state-action value function, we then propose reinforcement learning (RL) methods for such problems, by adapting existing tabular and deep RL methods to the mean-field setting. The main difficulty is the treatment of the population state, which is an input of the policy and the value function. We provide convergence guarantees for tabular algorithms based on discretizations of the simplex. We also show that neural network based algorithms are more suitable for continuous spaces as they allow us to avoid discretizing the mean field state space. Numerical examples are provided.

2 Mean-field Singular Control Problem: Regularitiy And Related Mean-field Reflected Diffusion

Jiacheng Zhang, UC berkeley, Berkeley, CA

We study a class of mean-field control problems with singular controls. Such a model represents the limit of the control problems in which a controller can adjust, through a bounded variation process, an underlying diffusion, which in turn affects an n-particle system. Adopting appropriate notions of convexities, we are able to establish the regularity of the value function of the problem and to show the existence of the optimal control. The regularity of the value function allows to characterize the solution of the problem in terms of a related mean-field Skorokhod problem. This consists in keeping the optimally controlled state process in a region prescribed by the derivative of the value function, by using the optimal control in order to reflect the state at its boundary.

3 Multi Scale Deep Reinforcement Learning for Mean Field Problems in Continuous Spaces

Andrea Angiuli[1], Jean-Pierre Fouque[2], Alan Raydan[3], [1]Amazon Prime Science, Santa Barbara, CA, [2]University of California-Santa Barbara, Santa Barbara, CA, [3]UC Santa Barbara, Santa Barbara, CA

We present how to solve Mean Field (MF) problems in continuous spaces based on model free deep Reinforcement Learning (RL). MF problems consist in games with infinity symmetric players. We can distinguish cooperative (MF control), non-cooperative (MF game) and mixed frameworks (MF control game). Each is characterized by a different solution. Our algorithms are characterized by multi scale learning rules. The first two are inherited from the actor critic paradigm, a classic RL method to solve Markov decision processes by coordinate learning of the optimal strategy (actor) and the value function (critic). The other ones relate to the parametric representation of MF distributions through score function and Langevin dynamics. Numerical results on linear quadratic examples show the crucial role of calibrating the learning rates in the converge to different solutions.

Monday, October 16, 12:45 PM - 2:00 PM

MC35

CC-North 222B

Recent Advances in Policy Optimization and Reinforcement Learning - Part II

Community Committee Choice Session

Session Chair: Yan Li, Georgia Tech, Atlanta, GA
Session Chair: Guanghui Lan, Georgia Institute of Technology, Atlanta, GA

1 Federated Methods to Speedup Reinforcement Learning

sajad Khodadadian, Georgia Institute of Technology, Atlanta, GA, Contact: skhodadadian3@gatech.edu

It is known that Reinforcement Learning (RL) algorithms are data-intensive, and require a large set of data to train. In this talk, we consider a federated RL framework where multiple agents collaboratively learn a global model, without sharing their sensitive individual data and policies. Although having N agents enables the sampling of N times more data, it is not clear if it leads to proportional convergence speedup. We consider federated versions of on-policy TD, off-policy TD and Q-learning, and establish that there is a speedup in learning that is linear in the number of agents. In particular, we show this even in the presence of Markovian noise and multiple local updates. We do this by developing a federated stochastic approximation algorithm with Markovian noise (FedSAM) and establishing linear speedup under a very general framework.

2 A Model-Free First-Order Method for Linear Quadratic Regulator

Caleb Ju[1], Georgios Kotsalis[2], Guanghui Lan[3], [1]Georgia Institute of Technology, Atlanta, GA, [2]Amazon, Seattle, WA, [3]Georgia Institute of Technology, Atlanta, GA, Contact: cju33@gatech.edu

We consider the classic stochastic linear quadratic regulator (LQR) problem under an infinite horizon average stage cost. Leveraging policy gradient methods from reinforcement learning, we obtain a first-order method with a sampling complexity that seems to have the best dependence on the error term for the model-free case without assuming the generated policies are stable. Our proposed method is an actor-critic algorithm. The actor involves a variational inequality formulation of the stochastic LQR, while in the critic we utilize a shrinking multi-epoch conditional stochastic primal-dual method to obtain the optimal rate of convergence.

3 Robust Average-Reward Markov Decision Process

Yue Wang[1], Alvaro Velasquez[2], George Atia[3], Ashley Prater-Bennette[4], Shaofeng Zou[5], [1]University at Buffalo, The State University of New York, Buffalo, NY, [2]CU Boulder, Boulder, CO, [3]UCF, orlando, FL, [4]AFRL, Rome, NY, [5]University at Buffalo, the State University of New York, Buffalo, NY

In robust Markov decision processes (MDPs), the uncertainty in the transition kernel is addressed by finding a policy that optimizes the worst-case performance over an uncertainty set of MDPs. In this paper, we focus on robust average-reward MDPs, where the goal is to find a policy that optimizes the worst-case average reward over an uncertainty set. We first take an approach that approximates average-reward MDPs using discounted MDPs. We design a robust dynamic programming approach, and theoretically characterize its convergence to the optimum. Then, we investigate robust average-reward MDPs directly. We derive the robust Bellman equation, prove that the optimal policy can be derived from its solution, and further design a robust relative value iteration algorithm that provably finds its solution, or equivalently, the optimal robust policy.

4 Offline Policy Learning Under The F-sensitivity Model

Jingyuan Wang[1], Ruohan Zhan[2], Zhimei Ren[3], Zhengyuan Zhou[1], [1]Stern School of Business, New York University, New York City, NY, [2]Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong; [3]University of Chicago, Chicago, IL

Offline learning uses observational data (from employing an unknown policy) to make better decisions, which is a crucial application if online experiments are not available. However, such learning process is very sensitive to distribution shifts, i.e., the discrepancies between the data-generating and the policy-deploying environment. Whereas the current literature commonly assumes such distributional shifts to be KL-divergence, we propose the first offline learning algorithm, adopting empirical risk minimization (ERM) techniques, under the f-sensitivity model which includes the violation of unconfoundedness and assumes the selection bias due to unmeasured confounding is bounded “on average”. By finding the worst-case performance of any policy under environment shifts, our algorithm is able to maximize this value in order to establish the optimal policy.

Monday, October 16, 12:45 PM - 2:00 PM

MC36

CC-North 222C

Recent Progress in Optimization Software II

Community Committee Choice Session

Session Chair: Hans Mittelmann, Arizona State University, Tempe, AZ

1 What is New in Xpress Solver

Michael Perregaard, FICO, Birmingham, United Kingdom

We will present on the latest developments in the Xpress Solver. Emphasis will be on the new Global Solver for solving general mixed integer non-linear optimization problems to global optimality, and how it extends the high performance MIP engine of Xpress.

2 Heuristics for Global Optimization with Artelys Knitro

Richard Waltz, Artelys, Los Angeles, CA

Artelys Knitro is a solver focused on large-scale, nonlinear (potentially non-convex) optimization problems. Knitro offers both interior-point and active-set algorithms for continuous models, as well as tools for handling problems with integer variables and other discrete structures. By default, Knitro applies fast local optimization techniques to non-convex problems converging to locally optimal solutions. However, Knitro also offers heuristics to search for global (or improved local) solutions at a cost that is often not much more than the cost of a single local solve. This talk will highlight some of the latest developments in Knitro for finding global (or improved local) solutions on non-convex problems. In particular, we will focus on new multi-start initial point heuristics applied to non-convex QPs/QCQPs.

3 Recent Developments in Optimization with MATLAB

Steve Grikschat, MathWorks, Natick, MA

MATLAB has solvers for continuous and discrete optimization problems. They can solve both analytical and black-box models, including those with multiple objectives and those black-box models with discrete variables where relaxations do not exist. Recent enhancements to these solvers and the capabilities for modeling optimization problems will be presented.

4 The SAS Optimization Solvers: Recent Improvements and Future Developments

Philipp M. Christophel[1], Menal Guzelsoy[2], Amar Kumar Narisetty[3], Laszlo Ladanyi[2], Rob Pratt[4], [1]SAS Institute GmbH, Heidelberg, Germany; [2]SAS, Cary, NC, [3]SAS Institute Inc, Youngstown, NY, [4]SAS Institute, Inc., Cary, NC, Contact: philipp.christophel@sas.com

In this talk we present the recent improvements to the SAS linear and mixed-integer optimization solvers and discuss future developments. Topics include simplex, crossover, presolve, and cuts.

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MC37

CC-North 223

Healthcare Applications in Long-term Sequential Decision-making Under Uncertainty

Community Committee Choice Session

Session Chair: Zeyu Liu, West Virginia University, Morgantown, WV

1 Personalized and Interpretable Diabetic Retinopathy Screening Recommendations

Soroush Akbarijokar[1], Poria Dorali[2], Christina Weng[3], Taewoo Lee[4], [1]University of Pittsburgh, Pittsburgh, PA, [2]University of Houston - Cullen College of Engineering, Houston, TX, [3]University of Houston, Houston, TX, [4]University of Pittsburgh, Pittsburgh, PA

Diabetic retinopathy (DR) is the leading cause of blindness among working-age Americans. Teleretinal imaging (TRI) has emerged as an affordable tool that has the potential to increase screening rates among patients with limited access to care, yet little is known how TRI-based screening should be recommended in conjunction with traditional screening exams. We develop a POMDP model that determines personalized screening policies that take into account patient-specific characteristics such as age, A1C level, cost savings preferences, and adherence behavior. We then use statistical learning techniques to translate the POMDP-based policy into a more interpretable policy.

2 Optimizing Pre-Positioning and Transportation of Medical Supplies Under the Uncertainty of Epidemic Outbreaks

Zeyu Liu, West Virginia University, Morgantown, WV

The Covid-19 pandemic has inflicted tremendous economic. To alleviate the impact, it is vital to establish a robust relief system for medical supplies under demand and supply uncertainties. We utilize a novel sequential decision-making framework to optimize facility locations, inventory management, and distribution of medical supplies in an extended planning horizon. To address the computational challenge of multistage stochastic programming (MSP) in prolonged horizons, we adopt a worst-case robust approach to reduce the scenario tree. Our approach optimizes the future recourse to ensure minimized risks, expanding the modeling capability of current MSP methods. Theoretical analyses are conducted to facilitate algorithm design that solves large-scale instances. We also conduct numerical experiments to validate model performances and draw insights.

3 Optimal Prioritization and Discharge Policies for Medicaid Waiver Services

Yuqing Chen[1], Qiushi Chen[2], Can Zhang[3], [1]The Pennsylvania State University, University Park, PA, [2]Penn State University, University Park, PA, [3]Duke University, Durham, NC, Contact: ykc5346@psu.edu

Medicaid waiver programs provide critical services for patients with developmental disabilities to support the care in home and community-based settings. Due to both rapid increase in demand and limited resources for such services, the current waiting time is extensive and detrimental to the patients. Prior studies have focused on identifying either optimal prioritization or discharge policies in managing the waitlist. We propose a Markov Decision Process (MDP) model to examine jointly optimal prioritization and discharge decisions in the single server setting and study how the option of early discharge can lead to different structures of prioritization decisions. The policies of the same structure also achieve good performance when generalized in multi-server settings.

4 Adaptive Robust Radiotherapy Planning to Manage Radioresistance

Arkajyoti Roy[1], Shaunak Dabadghao[2], Ahmadreza Marandi[3], [1]The University of Texas at San Antonio, San Antonio, TX, [2]Eindhoven University of Technology, Eindhoven, Netherlands; [3]Eindhoven University of Technology, Tilburg, Netherlands. Contact: arkajyoti.roy@utsa.edu

Managing uncertainties in radiotherapy is crucial towards the success of the treatment and improving the patient's quality of life. We develop robust radiotherapy planning models that can account for radioresistance, which is often caused by tumor hypoxia. While standard robust treatment planning can overcome this, it can also produce overly conservative or suboptimal decisions, especially when there are changes during the treatment as often caused by reoxygenation of hypoxic cells. To overcome this, an adaptive framework is proposed that can adapt to updated information during the treatment. Using this framework, we explore the value of multiple diagnostics to update the treatment.

Monday, October 16, 12:45 PM - 2:00 PM

MC38

CC-North 224A

Data-driven Decision Making: Robustness, Learning, and Optimization

Community Committee Choice Session

Session Chair: Andrew E.B. Lim, National University of Singapore, Singapore, Singapore

1 Bayesian Risk-Averse Q-Learning with Streaming Data

Yuhao Wang[1], Enlu Zhou[2], [1]georgia institute of technology, atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA, Contact: yuhaowang@gatech.edu

We consider an off-policy reinforcement learning problem with streaming data, where we need to solve a discounted infinite-horizon Markov decision process (MDP) with an unknown transition model. We adopt a Bayesian risk MDP (BRMDP) formulation, which uses Bayesian posterior to estimate the transition model and imposes a risk functional on rewards at each stage with respect to the posterior distribution to account for the mis-specification of the transition model. We develop a multi-stage Bayesian risk-averse Q-learning algorithm by solving BRMDP with dynamically updated Bayesian posterior on the transition model. The proposed algorithm learns a risk-averse policy that is optimal conditional on all the observed data. In particular, the learned policy converges to the true optimal policy if we have an infinite number of observed data for each state-action pair.

2 Target-Oriented Regret Minimization for Satisficing Monopolists

Napat Rujeerapaiboon, Yize Wei, Yilin Xue, NUS, Singapore, Singapore. Contact: napat.rujeerapaiboon@nus.edu.sg

We study a robust monopoly pricing problem where a seller aspires to sell an item to a buyer. We assume that the seller ambitiously optimizes over a space of all individually rational and incentive compatible mechanisms with a regret-type objective criterion. Using robust optimization, a mechanism that minimizes the worst-case regret has been previously derived. In this paper, we alternatively adopt robust satisficing which minimizes the excess regret that is above the predetermined target level. We analytically show that the optimal mechanism involves the seller offering an infinite menu of lotteries. Additionally, we consider two other analytically-solvable variants of the problem where the seller restricts her attention to a class of only deterministic posted price mechanisms and where the seller is relieved from specifying the target regret in advance.

3 Bayesian Metric Learning for Cold-Start Item Recommendations with User Preference Drifts

Viet Anh Nguyen, Chinese University of Hong Kong, Hong Kong, Hong Kong

Recommending new items without prior interactions with existing users remains a challenge for today's recommender systems. While content-based filtering can initialize new items' embeddings for cold-start recommendations, it may fail structurally when the user's taste in new items drifts away from that in existing items. We model this drift through a user-specific perturbation of the local metric on the embedding space, which results in the shift in the distance evaluation and rankings between the user's and the new item's embeddings. We identify this local metric using a Bayesian learning model that acquires the user's feedback on a few new items in a personalized manner and updates our belief on the user-specific preference metric. This learning framework leads to empirical improvement in recommendation quality, demonstrated through popular performance criteria.

4 Optimal Trade Execution With Learning

Andrew Lim[1], Galvin Ng[2], [1]National University of Singapore, Singapore, Singapore; [2]Ecole Polytechnique, Paris, France

A trader would like to maximize expected revenue from selling an inventory of stocks by a specified terminal time, in a market where expected returns are linear in the trading rate but with unknown but constant intercept (drift) and slope (price impact). Since the trading rate affects the learning data, this is intrinsically a problem of exploration and exploitation and we wish to understand this tradeoff under the optimal policy. To sidestep the challenges of solving the dynamic programming equation, which is high-dimensional and has no explicit solution even when the prior is multivariate Gaussian, we consider a high-noise asymptotic regime and use a Taylor Series expansion to extract the exploration component of the optimal policy. Exploration is shown to depend, in a complex but intuitive way, on the time horizon, inventory level, and level of parameter uncertainty.

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MC39

CC-North 224B

TSL and TS Best Paper Award Session

Award Session

Session Chair: Vikrant Vaze, Dartmouth College, Hanover, NH

1 **TSL and TS Best Paper Award Session**

Vikrant Vaze, Dartmouth College, Hanover, NH

oTSL Best Paper PresentationoTS Best Paper Presentation

Monday, October 16, 12:45 PM - 2:00 PM

MC40

CC-North 225A

Advances in Optimization for Logistics Network Design

Community Committee Choice Session

Session Chair: Lacy Greening, Georgia Institute of Technology, Atlanta, GA

1 Optimization-Based Learning for Tactical Load Plan Modification in Trucking Service Networks

Ritesh Ojha[1], Wenbo Chen[1], Hanyu Zhang[1], Reem Khir[2], Pascal Van Hentenryck[3], Alan Erera[4], [1]Georgia Institute of Technology, Atlanta, GA, [2]Purdue University, West Lafayette, IN, [3]ISyE Georgia Tech, Atlanta, GA, [4]Georgia Tech, Atlanta, GA, Contact: riteshojha8@gatech.edu

A critical service network design challenge for package carriers is the so-called load planning problem. Load planning refers to decisions about how many trailers or container loads (perhaps of different types) to plan for dispatch over time between pairs of terminals. Such planned loads are the transportation capacity of the network. Another key component to the consolidation transportation plan are the decisions regarding which package volumes to assign into planned loads. This work considers dynamic optimization of load plans given fixed primary and alternate flow planning decisions. An extensive computational study on real-life instances, provided by our industry partner, including few of their largest terminals in their network, reports an average of 8-12\% potential improvement in trailer capacity utilization at the respective terminals.

2 The Service Network Design Problem with Fleet and Emissions Management

Mike Hewitt[1], Christian Truden[2], [1]Loyola University Chicago Quinlan School of Business, Glen Ellyn, IL,

[2]University of Klagenfurt, Klagenfurt, Austria. Contact: christian.truden@aau.at

While hydrogen fuel cell and battery-electric vehicles present opportunities to reduce emissions, effectively integrating their use into operations given range limitations, recharging (refueling) times, and sparse infrastructure requires careful planning. A recognition that the emissions associated with energy production can vary from one region to another is critical. This is also true with respect to the price of both energy and diesel fuel. In this work, we consider fleet management decisions regarding how many vehicles of each type (diesel, battery-electric, hydrogen) a carrier should acquire as well as in what regions they should operate. The impact of these fleet-level decisions on customer service is captured by explicitly modeling the routing of shipments and vehicles while recognizing the consumption of limited onboard resources.

3 Design Efficient Train Service Network with Cross-Network Synchronization

Peiheng Li, Gunnar Feldmann, Clark Cheng, Norfolk Southern Corporation, Atlanta, GA, Contact: peiheng.li2@nscorp.com

Train service network design is one of the fundamental decisions in railroad planning. It involves synchronization across large-scale physical, railcar blocking, and train crew networks to comply with various business rules. The problem itself is extremely complicated and the development is largely resorted to manual processes. At Norfolk Southern, we have developed a hierarchical approach, which considers it as a vehicle routing problem with pickup and delivery (VRPPD) and breaks the limitations of existing column generation methods in addressing business requirements and the need for cross-network synchronization. Numerical experiments against real-life operating plans have verified its effectiveness in delivering reliable service and driving productivity.

4 Solving Choice-Based Competitive Facility Location Problems Using Simulation and Submodularity

Robin Legault[1], Emma Frejinger[2], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Université de Montreal, Montreal, QC, Canada. Contact: legault@mit.edu

We introduce a novel framework for solving competitive facility location problems under any discrete choice model. Our approach approximates a deterministic equivalent reformulation of the problem by simulation. The problem is solved by a branch-and-cut method in which aggregated simulated customers are partitioned into two groups. The first is explicitly represented in the model, and the second is replaced by a single decision variable, which is bounded by submodular cuts. Our method reduces the computing time of the standard sample average approximation approach by orders of magnitude. When the entropy of the customers' behavior is low, it leads to near-optimal solutions in a fraction of the time required by model-specific algorithms.

5 Guided Large Neighborhood Search for Middle-Mile Consolidation Network Design

Lacy Greening, Alan Erera, Georgia Tech, Atlanta, GA

We study a middle-mile network design optimization problem with fixed origins and destinations to build load consolidation plans that minimize cost and satisfy customer shipment lead-time constraints. To solve real world instances, we develop a machine learning guided, integer programming based large neighborhood search approach.

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MC41

CC-North 225B

On Facility Location Problems

Contributed Session

Session Chair: Paulo Moreira, Faculty of Sciences of the University of Lisbon, Lisbon, Portugal

1 A Branch and Price Algorithm for the Angular Set Covering Problem

Fredy Barrriga-Gallegos, Gabriel Gutiérrez-Jarpa, Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile. Contact: fredy.barriga@pucv.cl

The Set Covering Problem (SCP) is a well-known location problem with many applications. Its main objective is to determine the minimum cost set of facilities from a finite and discrete set of options, covering all the demand points 360° around a given geographic area. We propose a mathematical formulation and a model for the angular covering problem, which considers establishing the coverage at specific angles guaranteeing covering angular zones where the demand points are located, and avoiding covering unnecessary space where there are no demand points. This covering structure has several applications, such as the location of surveillance security cameras. We propose a branch and price algorithm to solve large instances for the angular covering problem. We realize computational experiments to show the computational effectiveness of the solution method.

2 Location-Allocation of Cooling Shelters with the Varying Capacity and Demand Depending on the Temperature-Humidity Index

Sang Jin Kweon, Seokho Yoon, Yu Seon Yun, Yujin Song, Ulsan National Institute of Science and Technology, Ulsan, Korea, Republic of

During heat waves, the capacity and demand for cooling shelters can change depending on the temperature-humidity index. In this presentation, we explore the application of the temperature-humidity index to estimate both the capacity and demand for cooling shelters. Using these estimates, we propose a bi-objective integer linear programming model to allocate heat-vulnerable residents to cooling shelters. Our model is validated with a case study in Ulsan Metropolitan City, South Korea. We prioritize heat-vulnerable residents based on the temperature-humidity index, and assign them to cooling shelters with the objectives of maximizing coverage and minimizing the total operating cost. Our approach can improve the efficiency and effectiveness of cooling shelter allocation during heat waves.

3 Time Horizons for Multi-Period FLP, Under Uncertainty

Paulo Moreira[1,2], Francisco Saldanha-da-Gama[3], [1]Faculty of Sciences of the University of Lisbon, Lisbon, Portugal; [2]CMAFcIO - Center of Mathematics, Fundamental Applications and Operations Research), Lisbon, Portugal; [3]Sheffield University Management School, Sheffield, United Kingdom

The problem consists of deciding where to have facilities operating in each time period so that the demand of a set of customers can be satisfied. The objective is to minimize the total cost throughout the planning horizon, which is divided into the cost of operating the facilities and of supplying the customers. Additionally, a set of potential locations exists where new facilities can be installed during the planning horizon. However, it is assumed that is a phase-in/out problem. The work targets large (possibly infinite) planning horizons. A discount factor is assumed for the monetary values. Uncertainty is assumed for costs and demands. The resulting problem can be formulated as a multi-stage stochastic programming problem. Computational tests are reported on to assess the contribution provided by this work.

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CC-North 226A

Roundtable Session of RAS II

Panel Session

1 Roundtable Session of RAS II

Shuai Su, 1</sup

Session Chair: Andrew Straatveit, 1</sup

Session Chair: Jay Baillargeon, 1</sup

2 Panelist

Yihui Wang, 1</sup

3 Panelist

Fan Pu, 1</sup

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MC43

CC-North 226B

Air Traffic Management and Flight Delays

Community Committee Choice Session

Session Chair: Ke Liu, 1</sup

1 Data-Driven Aircraft Assignment to Minimize Delay Propagation

Vinayak V. Deshpande[1], Vidyadhar Kulkarni[2], Wei Liu[3], [1]University of North Carolina at Chapel Hill, Chapel Hill, NC, [2]University of North Carolina-Chapel Hill, Chapel Hill, NC, [3]Purdue University, West Lafayette, IN, Contact: liuweimsor@gmail.com

We propose a new approach to reduce the delay propagation by optimizing the assignment between incoming and outgoing flights flown by an airline at a given airport. Specifically, we provide a data-driven approach to estimate the arrival delay distribution, and then derive several assignment policies based on the estimated distribution. We show that the assignments derived from the data-driven approach can offer a verifiable improvement compared to the optimal assignment (FIFO) derived in the deterministic setting by using the real data of Delta Airlines at Atlanta airport.

2 Modeling Flight Interarrival Times

Ke Liu, the University of California Berkeley, Berkeley, CA

Runway capacity is a critical limiting factor in airport and air traffic network efficiency. Understanding the behavior of controlled interarrival time (CIT) and the operational conditions is important. This work presents an empirical study of CIT at landing runway threshold. A mathematical model is designed to fit the distribution of observed runway crossing time interval (RCTI) for arrival pairs by a conditional probability with uniform distribution for estimated time of arrival (ETA) and normal distribution for CIT. Behavior of CIT is further explained by variables relating to weather, runway and aircraft. This conditional probability model captures the situation when arrival demand is low and time gaps between arrivals are constrained by ETAs, and also ideally approximates the left-hand side of RCTI when short-term arrival demand exceeds capacity.

3 Benefits of Shifting Passenger Traffic from Air to High-speed Rail

Kaijing Ding, University of California Berkeley, Berkeley, CA

This study provides a method to quantify the benefit of shifting passenger traffic from air to high-speed rail (HSR) from the perspective of flight delay cost reduction. We first estimate the number of flight reductions for airport origin and destination pairs based on the HSR ridership forecast provided in the California High-Speed Rail 2020 Business Plan, and then distribute these flight reductions to quarter hours. After that, Lasso models are applied to estimate the impact of the reduced queuing delay of SFO, LAX and SAN on the arrival delay of national Core 29 airports. Finally, these delay reductions are monetized and we ultimately arrive at delay cost savings of $71-123 million in 2029 and $370-618 million in 2033.

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MC44

CC-North 226C

AI, Quantum Computing, and Recommender Systems

Community Committee Choice Session

Session Chair: Xiang (Shawn) Wan, [1</sup]

1 Hierarchical Reinforcement Learning for Modeling User Novelty-Seeking Intent in Recommender Systems

Pan Li, New York University, Stern School of Business, New York, NY, Contact: pli2@stern.nyu.edu

We propose a novel hierarchical reinforcement learning-based method to model the hierarchical user novelty-seeking intent, and to adapt the recommendation policy accordingly based on the extracted user novelty-seeking propensity. We further incorporate diversity and novelty-related measurement in the reward function of the hierarchical RL (HRL) agent to encourage user exploration. We demonstrate the benefits of explicitly modeling hierarchical user novelty-seeking intent in recommendations through extensive experiments on simulated and real-world datasets. In particular, we demonstrate that the effectiveness of our proposed hierarchical RL-based method lies in its ability to capture such hierarchically-structured intent. As a result, the proposed model achieves superior performance on several public datasets, compared with state-of-art baselines.

2 Potential Energy Supremacy in Quantum Economy

Junyu Liu[1], Hansheng Jiang[2], Zuo-Jun Max Shen[3], [1]The University of Chicago, Chicago, IL, [2]University of California, Berkeley, Berkeley, CA, [3]University of California Berkeley, Berkeley, CA, Contact: junyuliucaltech@gmail.com

Energy cost is crucial in the modern computing industry. Governments prefer low energy consumption for computing providers' market development. This paper explores potential energy advantages of quantum computing over classical counterparts without considering computational complexity. By employing duopoly models with energy constraints for quantum and classical companies, we demonstrate that quantum firms may achieve higher profits within given energy limits and be more energy-efficient in the Nash equilibrium, regardless of computational efficiency assumptions for quantum and classical algorithms. Consequently, quantum computing could offer a more sustainable approach to the computing industry.

3 The Impact of Bifurcation on Platform Outcomes in a Knowledge Sharing Community

Xiaomeng Chen, [1</sup]

While some platforms remain one united community that includes all subcommunities, others bifurcate subcommunities into spin-off platforms. Such bifurcation breaks the community in the original platform and forces users to reallocate between the home platform and the spin-off platform. In this paper, we investigate the impact of bifurcation on platform outcomes. We exploit the introduction of spin-off platforms in an online platform incubator, where users can propose to start a new spin-off platform, to identify the effects of bifurcation using a DID approach. We find that the bifurcation decreases user contribution in the home subcommunity. However, the two bifurcation communities generate more total user contribution and attract more new users, compared to a single united community.

4 Asymmetric Impact of AI Matching on Influencer Marketing: Implications for Platform Revenue

Yi Liu[1], Z. Jessie Liu[2], [1]University of Wisconsin - Madison, Madison, WI, [2]Johns Hopkins University, Baltimore, MD

This paper explores the impact of using artificial intelligence (AI) to connect marketers with influencers. We develop a theoretical model to examine how AI accuracy affects the competition between influencers and the profitability of a social media platform. We find that improving AI accuracy may not always benefit the platform, which is due to the asymmetric nature of such matching technology: the matching outcome for influencers with a narrower audience is more sensitive to AI accuracy than that for those with a broader audience. Additionally, we find that adjusting commission rates in response to AI improvements could help the platform mitigate the negative impact, although it may not be eliminated entirely.

Monday, October 16, 12:45 PM - 2:00 PM

MC45

CC-North 227A

Machine Learning for Discrete and Global Optimization 2

Community Committee Choice Session

Session Chair: Rohit Kannan, Los Alamos National Laboratory, Los Alamos, NM

Session Chair: Can Li, 1</sup

1 Learning When and How to Decompose via Machine Learning

Ilias Mitrai, Prodromos Daoutidis, University of Minnesota, Minneapolis, MN

Decomposition-based solution algorithms have been widely used for the solution of large-scale optimization problems by exploiting the underlying structure. However, the efficiency of such algorithms over monolithic ones is not known a priori and the underlying structure is not always apparent. We present an automated framework that determines when and how to decompose an optimization problem. First, a graph classification approach is developed to determine a priori if a decomposition-based solution should be implemented over a monolithic one based on an appropriate graph representation of an optimization problem. Secondly, Bayesian inference and Stochastic Blockmodeling are used to “learn” the underlying structure of an optimization problem which can subsequently be used as the basis for the application of decomposition-based solution algorithms.

2 DNN-Based Learning Approaches to Accelerate Globally Optimal Solutions to the ACOPF Problem

Fatih Cengil[1], Harsha Nagarajan[2], Russell Bent[2], Sandra D. Eksioglu[3], Burak Eksioglu[3], [1]University of Arkansas, Fayetteville, AR, [2]Los Alamos National Laboratory, Los Alamos, NM, [3]University of Arkansas, Fayetteville, AR, Contact: mfcengil@uark.edu

We propose machine learning techniques to speed up the convergence to global solutions for the AC Optimal Power Flow (ACOPF) problem. The Optimality-Based Bound Tightening (OBBT) algorithm iteratively tightens variable domains and provides near-global optimum solutions for ACOPF problems, but it is computationally expensive. To accelerate OBBT, we propose two DNN-based learning maps between a load profile and a variable subset. Subsets are selected in static or iteration-specific dynamic ways, where tightening the variable bounds in the subset still contributes to improving the ACOPF problem’s relaxation. Both approaches are efficient in finding near-global optimal solutions, resulting in up to 14 times faster convergence on different-scale instances (up to 2,000 buses).

3 Learning to Select Convex Relaxations in a Branch and Bound Algorithm

Can Li, Purdue University, West Lafayette, IN

SDP type of relaxations provides tight bounds for Quadratic Unconstrained Binary Optimization(QUBO) but are more expensive to solve than most LP relaxations. We propose a branch and bound framework for solving QUBOs. By default, only the LP relaxation is solved at each node of the branch-and-bound algorithm. SDP relaxations are solved parsimoniously, i.e., we only wish to solve the SDP relaxations if there is a high chance that it can fathom a given node. To predict whether a node can be fathomed by SDP bound, we propose a method that combines machine learning with solving a convex quadratic program. Our proposed approach is shown to save the number of SDP solves and computational time in a number of maxcut instances we tested.

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MC46

CC-North 227B

Fairness and Equity: Interpretation and Intervention

Community Committee Choice Session

Session Chair: Violet (Xinying) Chen, Stevens Institute of Technology, Hoboken, NJ
Session Chair: Wenting Li, 1</sup

4 Structural Properties of Fair Solutions

John Hooker, Ozgun Elci, Peter Zhang, Carnegie Mellon University, Pittsburgh, PA, Contact: jh38@andrew.cmu.edu

An optimization model can ensure a fair distribution of costs or benefits across stakeholders by incorporating an appropriate social welfare function (SWF). The choice of SWF has historically been guided by showing how it follows from certain axiomatic or bargaining arguments. We show how SWFs can be characterized by the structure of optimal solutions they actually deliver. We study utilitarian, maximin, leximax, proportional fairness, alpha fairness, Kalai-Smorodinsky, and threshold-based SWFs from this perspective. We also examine their behavior in hierarchical distribution networks, and their ability to incentivize efficiency improvements and sharing.

5 Fairness For Small And Medium Sized Enterprises (SMEs) Through Trade Credit Distribution

Wenting Li[1], Violet (Xinying) Chen[2], Rui Yin[1], [1]Arizona State University, Tempe, AZ, [2]Stevens Institute of Technology, Hoboken, NJ, Contact: wentingl@asu.edu

With over 95% of supply chain participants being small to medium-sized enterprises (SMEs), their development is pivotal for overall stability. We explore the SMEs' development with uneven trade credit distribution along supply chains. As SMEs usually lack bargaining power, they are forced to accept unfair payment terms, hampering their development. Our research prioritizes fair trade credit distribution to foster SME development. In a multi-period supply chain framework, we assess the impact of trade credit distribution on SMEs' development and supply chain performance. Our findings are useful for guiding long-term strategies for supply chain managers and policymakers to foster balanced and sustainable growth.

6 A Framework for Fair Decision-Making over Time with Time-Invariant Utilities

Guanyi Wang[1], Andrea Lodi[2], Sriram Sankaranarayanan[3], [1]National University of Singapore, Singapore, Singapore; [2]Cornell Tech, New York, NY, [3]IIM Ahmedabad, Ahmedabad, India. Contact: guanyi.w@nus.edu.sg

Fairness is a major concern in contemporary decision problems. Its objective is to maximize fairness while preserving the efficacy of the underlying decision-making (DM) problem. This paper examines repeated decisions on problems involving multiple stakeholders and a central decision-maker. Repetition provides additional opportunities to promote fairness while increasing complexity. This paper presents a general framework for the proposed fairness-over-time (FOT) DM problem. The framework includes an abstraction of the aggregation for utilities over time. We demonstrate that: under some conditions for the aggregation, a strong FOT-DM reformulation is amenable to branch-and-cut solvers. Finally, we propose a relaxation of this reformulation for computing high-quality approximate solutions via simultaneous row and column generation techniques.

7 Bridging Two Fairness Perspectives: Group Parity Metrics and Social Welfare Functions

Violet (Xinying) Chen[1], John Hooker[2], Derek Leben[2], [1]Stevens Institute of Technology, Hoboken, NJ, [2]Carnegie Mellon University, Pittsburgh, PA

Statistical parity metrics have been endorsed as a means of achieving group fairness, but they present both technical and philosophical issues. We explore whether a broader conception of social justice, based on a social welfare function (SWF), can address these issues. We propose two models to derive implications of the well-known alpha fairness SWF for demographic parity, equalized odds, and predictive rate parity. We find that alpha fairness can justify demographic parity and equalized odds under fairly weak conditions, while it provides no justification for predictive rate parity. Proportional fairness (Nash bargaining), a special case of alpha fairness, achieves demographic parity and equalized odds across all groups simultaneously under certain conditions.

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MC47

CC-North 227C

Recent Advances in Cyber-Physical Security - Part II

Community Committee Choice Session

Session Chair: Dan Li, Clemson University, Clemson, SC
Session Chair: Akash Tiwari, Texas A&M University, College Station, TX

1 Integrating Incremental Learning and Blockchain to Better Protect Data Security in Cyber-Manufacturing

Boris Oskolkov, Oklahoma State University, Stillwater, OK,

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The study aims to integrate incremental machine learning and blockchain technology to improve data security in cyber-manufacturing. The proposed approach is expected to make the data in a manufacturing system immutable and traceable, protecting manufacturers from a variety of data security threats, such as data tampering and data loss. As the blockchain is able to track the provenance of data, meaning that it can be traced back to its original source ensuring the authenticity of products and services. With the integration of machine learning, the authentication of the new coming data will also be contributed by the automatic data-driven quality check, further improving the efficiency and effectiveness of data security and protection.

2 Taxonomy-Driven Graph-Theoretic Approach for Manufacturing Cybersecurity Risk Modeling and Assessment

Md Habibor Rahman[1], Young-Jun Son[2], Mohammed Shafae[1], [1]The University of Arizona, Tucson, AZ, [2]Purdue University, West Lafayette, IN, Contact: habiborrahman@email.arizona.edu
This talk introduces a graph-theoretic cybersecurity risk modeling and assessment framework for smart manufacturing systems. Leveraging taxonomical classifications and attack graph formalism, first, it offers a cohesive and structured representation of threat attributes in manufacturing systems. Second, cyberattack propagation through the manufacturing value chain is analyzed, identifying which manufacturing assets are susceptible to compromise and calculating the cybersecurity risk associated with potential attack paths. Finally, the attack path with the maximum likelihood of success and minimum attack detection probability is identified. The proposed approach can aid practitioners in identifying the critical connections and manufacturing assets requiring prioritized security controls and deploying appropriate defense measures accordingly.

3 Security Assurance via PLC Fuzzing

Nicholas Heinrich-Barna, TX
Programmable Logic Controllers (PLC) Fuzzing applies conventional hardware and firmware fuzzing techniques to validate proper peripheral functionality within a PLC. By systematically testing and covering the design, PLC Fuzzing reduces potential attack vectors and strengthens system security, thus PLC Fuzzing ensures the safety and security of subsystems in industrial control systems. We demonstrate a peripheral fuzzing method that enhances the security of associated industrial control systems. Our evaluation involves using custom firmware on a Beagle Bone Black device and a Codesys runtime environment.

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MC48

CC-North 228A

Data Analytics in Cybermanufacturing Systems

Community Committee Choice Session

Session Chair: Xiaoyu Chen, University of Louisville, Louisville, KY

Session Chair: Chenang Liu, Oklahoma State University, Stillwater

1 Point Cloud-Based Prediction of Mechanical Behavior for Additively Manufactured Mechanical Metamaterials

Zehao Ye[1], Chen Kan[1], Xin Liu[1], Bo Peng[2], [1]University of Texas-Arlington, Arlington, TX, [2]Dassault Systemes Simulia Corporation, West Lafayette, IN, Contact: zehao.ye@mavs.uta.edu
Mechanical metamaterials have been widely applied in industries such as aerospace, defense, and healthcare. Additive manufacturing (AM) offers advantages in producing mechanical metamaterials for its ability of fabricating complex geometries. However, geometric imperfections induced by AM processes can significantly compromise mechanical behaviors of metamaterials. Current approaches for mechanical behavior assessment rely on destructive tests and finite element modeling, which are costly and time-consuming. This project proposed a novel machine-learning framework to predict the mechanical behaviors of AM-fabricated metamaterials based on their as-built geometries represented by point clouds. Through a case study using auxetic mechanical metamaterials, the effectiveness of the proposed framework is experimentally validated.

2 Width Control of Direct Ink Writing via Offline Reinforcement Learning

Zebin Li[1], Wuyang Chen[2], Chi Zhou[1], Hongyue Sun[3], [1]University at Buffalo, SUNY, Buffalo, NY, [2]University of Georgia, Athen, GA, [3]University at Buffalo, Buffalo, NY, Contact: zebinli@buffalo.edu
The extrusion speed and the motion speed are two critical process parameters for direct ink writing (DIW). However, due to the potential issue of the material properties being inconsistent, the printing process can be unstable even under the constant extrusion speed and motion speed. Besides, the real-time control of the extrusion speed is difficult due to the system delay caused by the material properties (e.g., viscosity). Therefore, a RL-based method is proposed for real-

time motion speed control to realize better printing quality. Specifically, an offline-training-online-tuning framework is developed in which the trained control policy can adapt to a new material with limited efforts. The results suggest the effectiveness of real-time width control for better printing quality and the ability of adapting the control policy to other materials economically.

3 Diffusion Generative Model-Based Self-Supervised Learning for Smart Monitoring of Additive Manufacturing

Emmanuel Yangue, Chenang Liu, Oklahoma State University, Stillwater, OK, Contact: chenang.liu@okstate.edu

Despite the rapid adoption of deep learning models to additive manufacturing, quality assurance issues continue to be addressed for this technology, with the limited availability of sampling objects for advanced studies. Thus, this study leverages the emerging diffusion generative model, notably an improved denoising diffusion implicit models, for layer-wise image generation in AM. The proposed model demonstrates great potential for similarity image synthesis generation addressing sampling issues while maintaining diversity to explore possible new process variations.

4 Ful-Field Thermal History Sensing in Additive Manufacturing

Xiaoyu Chen[1], Chenang Liu[2], Li Yang[1], [1]University of Louisville, Louisville, KY, [2]Oklahoma State University, Stillwater, Contact: xiaoyu.chen@louisville.edu

Full-field thermal history sensing is a challenging yet important problem to characterize thermal cracking problem in multi-source laser powder bed fusion (LPBF) additive manufacturing system. Motivated by the limitations of the co-axial and off-axial IR imaging system, we propose a full-field sensing method to integrate both IR imaging systems for LPBF process. By formulating a sparse irregularly shaped matrix completion problem, a semidefinite programming method is developed to efficiently complete such matrix to provide real-time full-field thermal history sensing. A finite element simulation study is conducted to evaluate the proposed hybrid sensing method to demonstrate its effectiveness, efficiency, and generalizability.

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MC49

CC-North 228B

Regression Modeling and Online Monitoring of Complex Data

Community Committee Choice Session

Session Chair: Kai Yang, Medical College of Wisconsin, Milwaukee, WI

1 Nonparametric Online Monitoring of Dynamic Networks

Yipeng Wang, University of Florida, Gainesville, FL, Contact: yipeng.wang1@ufl.edu

Online monitoring of a network sequence is important for detecting temporal structural changes of the system. To this end, there have been some discussions in the statistical process control (SPC) literature to first extract some features from the observed networks and then apply an SPC chart to monitor the extracted features sequentially over time. In this paper, we suggest using four specific features to describe the structure of an observed network, and their combination can reflect most network structural changes that we are interested in various applications. After the four features are extracted from the observed networks, we suggest using a multivariate nonparametric control chart to monitor the extracted features online. Numerical studies show that our proposed network monitoring method is more reliable and effective than some existing methods.

2 Joint Modeling of Multivariate Nonparametric Longitudinal Data and Survival Data - A Local Smoothing Approach

Lu You[1], Peihua Qiu[2], [1]University of South Florida, Tampa, FL, [2]University of Florida - Department of Biostatistics, Gainesville, FL, Contact: luyou@usf.edu

In many clinical studies, evaluating the association between longitudinal and survival outcomes is of primary concern. For analyzing data from such studies, joint modeling of longitudinal and survival data becomes an appealing approach. In some applications, there are multiple longitudinal outcomes whose longitudinal pattern is difficult to describe in a parametric form. In this paper, we develop a novel joint modeling method to fill the gap. In the new method, a local polynomial mixed-effects model is used for describing the nonparametric longitudinal pattern of the multiple longitudinal outcomes. Practical guidelines for choosing tuning parameters and for variable selection are provided. The new method is justified by some theoretical arguments and numerical studies.

3 Design Variable-Sampling Control Charts Using Covariate Information

Kai Yang[1], Peihua Qiu[2], [1]Medical College of Wisconsin, Milwaukee, WI, [2]University of Florida - Department of

Biostatistics, Gainesville, FL, Contact: kayang@mcw.edu
Statistical process control charts are widely used for monitoring sequential processes over time. A common practice in using a control chart is to first collect data of quality variables at equally spaced sampling times, and then make decisions about the process status based on the data. In some applications, however, the quality variables are associated with certain covariates, and it should improve the performance of a chart if the covariate information can be used properly. Intuitively, if the covariate information indicates that process shifts occur, then the next process observation should be collected sooner than usual to achieve quick shift detection. Motivated by this idea, we propose a variable-sampling control chart by using covariate information. It is a self-starting control chart that can well accommodate stationary short-range serial data correlation.

4 Spatio-Temporal Process Monitoring Using Exponentially Weighted Spatial Lasso

Peihua Qiu[1], Kai Yang[2], [1]University of Florida - Department of Biostatistics, Gainesville, FL, [2]Medical College of Wisconsin, Milwaukee, WI, Contact: pqiu@ufl.edu

In practice, if a spatio-temporal process has a distributional shift (e.g., mean shift) started at a specific time point, then the spatial locations with the shift are usually clustered in small regions. This kind of spatial feature of the shift has not been considered in the existing spatio-temporal process monitoring (STPM) literature yet. In this paper, we develop a new STPM method that takes into account the spatial feature of the shift in its construction. The new method combines the ideas of exponentially weighted moving average in the temporal domain for online process monitoring and spatial LASSO in the spatial domain for accommodating the spatial feature of a future shift. It can also accommodate the complicated spatio-temporal data structure well.

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MC50

CC-North 229A

Multi-Objective Decision Making Under Uncertainty

Community Committee Choice Session

Session Chair: Jacqueline Dowling, California Institute of Technology, Pasadena, CA

Session Chair: Aleksander Grochowicz, 1</sup

Session Chair: Tyler Ruggles, Carnegie Science, Stanford, CA

1 Exploring Zero-Carbon Electricity System Planning Under Different Non-Carbon Co-Priorities in California

Brian Tarroja[1], Rebecca Peer[2], Emily Grubert[3], [1]University of California, Irvine, CA, [2]University of Canterbury, Christchurch, New Zealand; [3]University of Norte Dame, Norte Dame, IN, Contact: bjt@apep.uci.edu

Developing a zero-carbon electricity system is a critical enabler for transitioning away from fossil fuel dependence. Such systems are typically explored with the co-priority of minimizing monetary cost, but this approach can cause resulting systems to potentially have significant contributions to environmental impacts that are not adequately captured by cost inputs. Here, we explore what the composition of zero-carbon electricity systems in California can be when planned to minimize impacts other than cost, such as regional water consumption, land use, solid construction materials, and critical metals mass, and compare these to a system planned to minimize monetary cost. We highlight the importance of explicitly considering non-cost co-priorities in zero-carbon electricity planning.

2 Improving Trade-Offs Between Climate Policy Objectives via Robust and Self-Adaptive Decision-Making Approaches

Angelo Carlino[1], Paolo Gazzotti[2], Massimo Tavoni[3], Andrea Castelletti[2], [1]Carnegie Institution for Science, Stanford, CA, [2]Politecnico di Milano, Milano, Italy; [3]RFF-CMCC-EIEE, Milano, Italy. Contact: acarlino@carnegiescience.edu

Integrated assessment models represent how the global economy and climate are connected. Via cost-benefit or cost-effective analysis, emission trajectories balance the cost of reducing emissions with their economic damages or with given policy targets. Yet, uncertainty and trade-offs between economic, social, and climatic objectives challenge this traditional approach. To this aim, we design self-adaptive multi-objective climate policies and evaluate the improvement using the Dynamic Integrated Climate Economy (DICE) model. The conflicts between objectives are reduced by maintaining optionality and adjusting decisions as uncertainties realize over time. We extend the methodology to multiple agents in RICE, the regionalized version of the DICE model, to examine the differences between robust and self-adaptive decision-making.

3 Intersecting Near-Optimal Spaces for Policy Information

Aleksander Grochowicz[1], Koen van Greevenbroek[2], Fred Espen Benth[1], Marianne Zeyringer[3], [1]University of Oslo, Oslo, Norway; [2]UiT The Arctic University of Norway, Tromsø, Norway; [3]University of Oslo, Kjeller, Norway.

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We present the value of near-optimal solutions in quantifying uncertainties and depicting trade-offs between different decisions. By marginally deviating from the paradigm of cost optimality, we can find designs that are robust to perturbation and offer significant flexibility in investment decisons.
We explicitly describe the near-optimal space of an energy system optimisation model for Europe (with the open-source model PyPSA-Eur), formulated as an LP, thus visualizing the flexibility allowed by relaxing cost optimality.
With this methodology we show the importance of multi-decadal weather variability and how to obtain a robust solution in a highly parallelised manner. We also showcase regional trade-offs in an integrated system, identifying decisions that enable flexibility for others.

4 A Computationally Efficient Benders Decomposition for Energy Systems Planning Problems with Detailed Operations and Time-Coupling Constraints

Anna Jacobson[1], Filippo Pecci[1], Nestor Andres Sepulveda[2], Qingyu Xu[3], Jesse D. Jenkins[4], [1]Princeton University, Princeton, NJ, [2]Massachusetts Institute of Technology, Cambridge, MA, [3]Tsinghua University, Beijing, China; [4]ZERO Lab, Princeton University, Princeton, NJ, Contact: annafj@princeton.edu
We introduce a novel energy systems model (ESM) formulated with Benders decomposition. Our algorithm incorporates investment decisions and budgeting variables for policy constraints in a Benders master problem to decouple operational timesteps. Separated timesteps can be parallelized without need for a nested decomposition, allowing for inclusion of multiple Benders cuts per iteration. Runtime of our ESM scales linearly with temporal resolution, out-competing large scale monolithic mixed integer linear programming models. Several systems that successfully terminate under our algorithm are intractable under conventional schemes. Our model eases the need for abstraction in system representation in the temporal, spatial, and operational dimensions. This decreased abstraction mitigates structural uncertainty, increasing ESMs' policy relevance.

5 Coal Power Plant Decommissioning Strategy and Repurposing Opportunities in China

Ziting Huang, Johns Hopkins University, Baltimore, MD, Contact: zhuang51@jhu.edu
In China, over 100 GW existing coal power is to be retired in the next 30 years. The study aims to provide policy implications for coal power industry amid energy transition by optimizing retrofitting and decommissioning strategies at both plant and system levels.
Five strategies are identified for future coal power: (1) demolishing, (2) retiring for other use, (3) mothballing, (4) repurposing with renewable energy and storage, and (5) retrofitting with carbon capture systems. To achieve financial, social, and environmental goals, a multi-attribute rating analysis is first applied to optimize the decision at the plant level. Then, a least-cost capacity expansion model is performed to optimize the coal decommissioning scale or additional investment plan in the system. The study will also discuss the decision difference between government/ market-oriented systems.

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MC51

CC-North 229B

Predictive and Prescriptive Modeling for the Energy Transition: Electricity, Buildings, Transportation, Industry, and More

Community Committee Choice Session

Session Chair: Erick Jones, University of Texas at Arlington, Arlington, TX

1 Accounting for Reliability Criteria in Long Term Planning of Power Systems

Raziye Aghapour[1], Erick Jones[2], [1]The University of Texas at Arlington, ARLINGTON, TX, [2]The University of Texas at Arlington, ARLINGTON, TX, Contact: rxa5674@mavs.uta.edu
The ever-increasing demand for electricity necessitates expanding power infrastructure to keep up with demand. Energy system planning is driven by the demand forecast, being prone to demand estimation error. Taking the effect of uncertainty in demand prediction into account, this research will model energy system planning as a stochastic problem. Supplying reliable power to customers is another crucial aspect of power system planning that will be considered via meeting predetermined power system reliability indices.

2 Risk-averse Three-stage Investment Optimization To Improve Power System Resilience To Winter Storms

Brent Austgen[1], Manuel Joseph Garcia[2], Bryan Arguello[3], Erhan Kutanoglu[4], John Hasenbein[5], [1]The University of Texas at Austin, Lowell, IN, [2]Sandia National Laboratories, Austin, TX, [3]Sandia National Labs, Albuquerque, NM,

[4]University of Texas-Austin, Austin, TX, [5]The University of Texas at Austin, Austin, TX

We present a three-stage scenario-based stochastic optimization model for determining power grid investments for winter storm resilience. First stage decisions pertain to generator winterization and mobile battery energy storage system (MBESS) acquisition, second stage to MBESS deployments, and third stage to operational response. We incorporate conditional value-at-risk (CVaR) as the risk measure to target high-impact, low-frequency events. Applying the model to a Texas-focused case study, we discuss not only how the optimal investments are affected by parameters like cost and risk aversion, but also how effectively the CVaR risk measure mitigates the severe outcomes in the tail of the loss distribution.

3 Disaggregating Errors in the Cumulative Experience and Learning Rate for Energy Technology Forecasts

Christian Hernandez-Negron[1], Erin Baker[2], [1]University of Massachusetts-Amherst, Amherst, MA, [2]Univ of Massachusetts-Amherst, Amherst, MA

As renewable technologies evolve, we investigate in more detail data underlying learning curves. Combining technological change analyses and modeling to analyze data on previous projections and actual trends, we decompose the error between these projections and the actual change in price, to determine how much came from increase in production and how much from learning per production. For the disaggregation, we use actual observed data, projections based on reliable reports, and forecasts based on an error using historical data. The decomposition analyses would tell us how much of a surprise in cost is due to higher or lower than expected capacity increases; or higher or lower than expected learning per unit capacity.

4 Sustainable Building Design Using Design and Analysis of Computer Experiments

Victoria C. P. Chen[1], Shirish Rao[2], Vishnu Sharma[1], Erick Jones[3], Jay Michael Rosenberger[2], [1]The University of Texas at Arlington, Arlington, TX, [2]University of Texas-Arlington, Arlington, TX, [3]University of Texas at Arlington, Arlington, TX, Contact: vchen@uta.edu

The construction industry is one of the largest consumers of natural resources, including water, materials, and energy. Towards the goal of more sustainable building design, we present a “tiny home” case study that demonstrates a design and analysis of computer experiments (DACE) approach for conducting a comprehensive study of potential building designs. Typical DACE methods are intended for purely numerical factor variables. Due to the high number of categorical factors (e.g., window type, roof color) and the nonlinear nature of relationships in building design, a new DACE framework appropriately integrates machine learning algorithms to address this complexity.

5 Energy Transition Supply Chains

Erick Jones, University of Texas at Arlington, Arlington, TX

Supply chains have traditionally focused on costs (e.g., acquisition and transportation), reliability, and delivery times. However, due to the pandemic, new geopolitical alignments, and new industrial policy (e.g., CHIPS Act and the Inflation Reduction Act) traditional supply chain models and metrics like Just-In-Time no longer suffice. The new supply chains, in addition to considering traditional supply chain metrics, must also balance geopolitical risk, sustainability, and workforce availability. These new metrics are especially important for critical supply chains identified by Executive Order 14017 which includes critical minerals like lithium and for the *Lithium based Battery Supply Chain.*We propose investigating how sustainable the new energy supply chain is.

Monday, October 16, 12:45 PM - 2:00 PM

MC52

CC-North 230

Learning-Augmented Decision-Making In Cyber-Physical Systems

Community Committee Choice Session

Session Chair: Tongxin Li, Caltech, Alhambra, CA

1 Learning-Augmented Control via Online Adaptive Policy Selection

Yiheng Lin, California Institute of Technology, Pasadena, CA

We present algorithms for a general class of online policy selection problem under time-varying dynamics and costs. In this setting, the decision maker seeks to minimize the total cost incurred over a finite horizon by selecting a parameter for a given policy class at each time step. We propose the Gradient-based Adaptive Policy Selection (GAPS) algorithm that achieves the optimal policy regret and is efficient to implement. Further, we establish a connection between online policy selection and a class of learning-augmented control problems. This connection, in turn, leads to novel algorithm designs for learning-augmented control with strong adaptive regret guarantees in time-varying environments.

2 Learning-Augmented Online Decision-Making with Anytime Constraints

Jianyi Yang, University of California, Riverside, Riverside, CA, Contact: jyang239@ucr.edu

Exploiting available statistical information, Machine Learning (ML) algorithms have been developed for online decision-making problems to improve the performance. However, to be deployed in real mission-critical systems, ML algorithms are required to have guaranteed performance at each decision round in in terms of some important metrics. This requirement can be modeled as an online decision-making problem with anytime constraints which is challenging due to the uncertainly in online settings. In this talk, I will present learning-augmented algorithms to provably guarantee the anytime constraints while achieving a good average performance for both settings with known and unknown dynamic models. In addition, I will present some application examples on sustainable AI workload scheduling and battery management in EV charging.

3 Online Peak-Aware Energy Scheduling with Untrusted Advice

Russell Lee, UMass Amherst, Amherst, MA, Contact: rclee@cs.umass.edu

This talk covers the online energy scheduling problem in a hybrid model where the cost of energy is proportional to both the volume and peak usage. Inspired by recent advances in learning-augmented online algorithms, we discuss deterministic and randomized algorithms for this problem such that the decision-making can be adjusted by a trust parameter. We then analyze the proposed algorithms using two performance metrics: *robustness* which measures the competitive ratio as a function of the trust parameter when the advice is inaccurate, and *consistency* for the competitive ratio when the advice is accurate. Our large-scale empirical evaluations using real traces of energy demand, prices, and renewable generations highlight that the proposed algorithms outperform worst-case optimized algorithms and fully data-driven algorithms.

4 Reinforcement Learning for Sustainability Applications: Challenges and Opportunities

Christopher Yeh, California Institute of Technology, CA

The lack of standardized benchmarks for reinforcement learning (RL) in sustainability applications has made it difficult to both track progress on specific domains and identify bottlenecks for researchers to focus their efforts on. We have built a suite of RL environments, called SustainGym, designed to test the performance of RL algorithms on realistic sustainability tasks. These multi-agent environments range from adaptive EV charging scheduling to carbon-aware data center job scheduling. We find that off-the-shelf standard RL algorithms tend to struggle in these environments, with traditional controllers often outperforming RL agents. Our findings provide important challenges to address before RL is ready for wide deployment.

Monday, October 16, 12:45 PM - 2:00 PM

MC53

CC-North 231A

Flexible and Efficient Power System Operations: New Models and Frameworks for Demand Response

Community Committee Choice Session

Session Chair: Bahareh Kargar, New Jersey Institute of Technology, Harrison, NJ

Session Chair: SangWoo Park, New Jersey Institute of Technology (NJIT), North Bergen, NJ

1 Offline Reinforcement Learning for Price-Based Demand Response Program Design

Ce Xu[1], Bo Liu[2], Yue Zhao[1], [1]Stony Brook University, Stony Brook, NY, [2]Amazon, Seattle, WA, Contact: ce.xu@stonybrook.edu

In this paper, price-based demand response (DR) program design by offline Reinforcement Learning (RL) with data collected from smart meters is studied. Offline RL does not need to interact with consumers in the real world and thus has great cost-effectiveness and safety advantages. A sequential decision-making process with a Markov Decision Process (MDP) framework is formulated. A novel data augmentation method based on bootstrapping is developed. Deep Q-network (DQN)-based offline RL and policy evaluation algorithms are developed to design high-performance DR pricing policies. The developed offline learning methods are evaluated on both a real-world data set and simulation environments, and are demonstrated to achieve excellent performance that is very close to the ideal performance bound provided by the state-of-the-art online RL algorithms.

2 Learning Heterogeneous Elasticity Values for Incentive Based Demand Response

Bahareh Kargar, SangWoo Park, New Jersey Institute of Technology, Newark, NJ, Contact: bk349@njit.edu

Residential electricity consumption constitutes over 38% of total U.S. electricity consumption, forming a large pool of flexibility that we can exploit. One of the reasons why DR has been unsuccessful in the residential sector is because there is a lack of understanding of consumer-specific behavior patterns. In this research, we establish a framework for understanding the heterogeneous elasticity of electricity consumption in the face of monetary rewards, and utilize that information for the dynamic pricing of rewards. We aim to predict the elasticity of electricity demand specific to each consumer and appliance given external factors such as time of day, temperature, building characteristics. Then, these elasticity information will be used to design a reward pricing mechanism that will dynamically change the amount of reward based on the current state of the system.

3 Online Learning for Incentive-Based Demand Response

Deepan Raj Prabakar Muthirayan, [1</sup]

In this presentation, we consider the problem of learning online to estimate the baseline and to optimize the operating costs over a period of time for Demand Response (DR) programs. We propose an online learning scheme that employs least-squares for estimation with a perturbation to the reward price (for the DR services or load curtailment) that is designed to balance the exploration and exploitation trade-off that arises with online learning. We show that, our proposed scheme is able to achieve a very low regret of O(log(T))^2 with respect to the optimal operating cost over T days of the DR program with full knowledge of the baseline, and is individually rational for the consumers to participate. Our scheme is significantly better than the averaging type approach, which only fetches O(T^(1/3)) regret.

4 A Two-Stage Mechanism for Demand Response Markets

Mardavij Roozbehani[1], Bharadwaj Satchidanandan[2], [1]Massachusetts Institue of Technology, Cambridge, MA, [2]Massachusetts Institute of Technology, Cambridge, MA

Demand response mechanisms incentivize electricity consumers to adjust their consumption during supply shortages. However, estimating customers' counterfactual consumption baselines is susceptible to errors. Moreover, customers' optimal responses depend on their private costs of curtailment, which are subject to strategic misreporting. The two-stage mechanism proposed here addresses these issues. In the day-ahead market, participating loads only provide a probabilistic description of their anticipated consumption and associated costs for the following day, thus, enabling day-ahead planning. In real-time, if summoned for demand response, they report their baselines and costs and receive credits for reductions below their reported baselines. The credit calculation mechanism guarantees incentive compatibility of truthful reporting in both stages.

5 Demand Response for a Novel Decentralized Power-To-Methanol Process

Max Kollmer[1], Markus Vogelbacher[1], Francisco Vidal-Vazquez[2], Jörg Matthes[1], [1]Karlsruhe Institute of Technology, Karlsruhe, Germany; [2]Karlsruhe Institute of Technology, Karlsruhe, Germany. Contact: max.kollmer@kit.edu

Due to the increasing share of renewable energies, the role of demand response and production planning is becoming more important. Green methanol production is one promising process to use surplus renewable electricity to produce methanol through flexible operation. In this work, an optimization model for the flexibilization of a novel power to methanol process that uses decentralized CO_2 point sources is developed. Based on simulation data of a stationary power to methanol process, a MILP-model with buffer storages, an electrolyser and a power to methanol plant is constructed. The optimal operation is determined considering variable electricity costs, varying renewable electricity supply and various production constraints.

Monday, October 16, 12:45 PM - 2:00 PM

MC54

CC-North 231B

Advancements in Bridging the Gap between ML and OR

Community Committee Choice Session

Session Chair: Brandon Alston, Rice University, Houston, TX

1 Graph and Hopfield Neural Networks: Perspectives from the Machine Learning and Operations Research Communities

Haimonti Dutta, University at Buffalo, Buffalo, NY, Contact: haimonti@buffalo.edu

In Operations Research, the Hopfield Neural Network (HNN) has been used to solve optimization problems dynamically by characterizing the behavior of the network using an energy or Lyapunov function.
In Computer Science, Graph Neural Networks have been proposed, for processing data represented as graphs. GNN models use information diffusion and relaxation mechanisms for processing structured data.
So, how similar are Graph Neural Networks to Hopfield Neural Networks?
In this talk, we explore this possibility and discuss the

hypothesis that GNNs are more general than Hopfield Networks since they can be used for processing more general kinds of graphs and can adapt more general diffusion mechanisms.
Finally, we discuss an application -- finding care pathways for patients admitted to a hospital using a Graph Neural Network but using it to solve an optimization problem.

2 Learning Mdps from Features: Predict-Then-Optimize for Sequential Decision Problems by Reinforcement Learning

Kai Wang, Harvard University, Cambridge, MA, Contact: kaiwang@g.harvard.edu

In the predict-then-optimize framework, the objective is to train a predictive model, mapping from the environment features to parameters of an optimization problem to solve subsequently. Recent work on decision-focused learning shows that embedding the optimization problem in the training pipeline can improve decision quality and help generalize better to unseen tasks compared to training based on intermediate loss functions. We study the predict-then-optimize framework in the context of sequential decision problems (formulated as MDPs) via understanding the differentiability of MDPs. We use features and a set of trajectories to train a model to predict MDP parameters. Our method learns a model that generates predictions with better decision quality in sequential decision problems with applications in public health and wildlife conservation.

3 Optimal Multivariate Binary Decision Trees

Brandon Alston, Rice University, Houston, TX

Multivariate decision trees are powerful machine learning tools for classification and regression that attract many researchers and industry professionals. An optimal binary tree can be obtained by solving a biobjective optimization problem that seeking to maximize the number of correctly classified datapoints and minimize the number of branching vertices. We propose two cut-based mixed integer linear optimization (MILO) formulations for designing optimal binary classification trees (leaf vertices assign discrete classes). Our models leverage an on-the-fly subprocess testing for irreducible infeasible subsystems (IIS) which we make feasible through cutting planes that hold the form of packing constraints. We conduct experiments on publicly available datasets to show our models' ability to scale and robustness in out-of-sample test performance.

Monday, October 16, 12:45 PM - 2:00 PM

MC55

CC-North 231C

Operations of Online Marketplaces

Community Committee Choice Session

Session Chair: Sebastien Martin, Kellogg School of Management, Northwestern University, Evanston, IL

1 Trading Flexibility for Adoption: From Dynamic to Static Walking in Ridesharing

Sebastien Martin[1], Julia Y. Yan[2], [1]Kellogg School of Management, Northwestern University, Evanston, IL, [2]University of British Columbia, Vancouver, BC, Canada

On-demand ridesharing aims to fulfill riders' transportation needs anytime and anywhere. Although this is appealing for riders, overall system efficiency can improve substantially if riders can be flexible. We explore riders' flexibility in space via walking to better pickup locations. Ridesharing platforms traditionally use dynamic walking, which jointly optimizes rider-driver assignment with pickup locations. We instead propose static walking, which presents a fixed pickup location to the rider, then optimizes assignment. We study characteristics of networks that make static walking viable, propose algorithms for static walking, and apply our algorithms to Lyft data in Manhattan.

2 Implications of Worker Classification in On-Demand Economy

Ming Hu[1], Zhoupeng (Jack) Zhang[2], Jianfu Wang[3], [1]University of Toronto, Minneapolis, MN, [2]Rotman School of Management, University of Toronto, Toronto, ON, Canada; [3]College of Business, City University of Hong Kong, Kowloon, Hong Kong. Contact: zhoupeng.zhang@rotman.utoronto.ca

How should gig workers be classified? We study this policy question focusing on the welfare of full-timers, who depend on gig jobs as primary income sources. We identify two issues with uniform regulations: when all workers (full- and part-timers) are reclassified as employees, a profit-maximizing company may *undercut* full-timers, which result in lower welfare; when all are reclassified as contractors+, which offers incomplete employee benefits but allows flexibility, workers can *overjoin* such that full-timers' welfare may not be enhanced due to extra congestion in the marketplace. We show that differentiated approaches such as to classify gig workers according to their labor input or to operationally prioritize full-timers can improve over uniform classifications. We empirically calibrate the model and apply our insights to the ride-hailing market in California.

3 Recent Developments in Reinforcement Learning for Ridesharing

Zhiwei (Tony) Qin, Lyft, San Francisco, CA

Online rideshare platforms allow idle vehicle vacancy to be more effectively utilized to meet the growing need of on-demand transportation, by connecting potential mobility requests to eligible drivers. In this presentation, we talk about recent developments in rideshare matching which shift toward online on-policy methods. We will also discuss learning the value functions for individual market participating units (both supply and demand) while making sure that they collectively approximate the system values well.

4 Complexity Conundrum: Balancing Efficiency and Innovation for Sustainable Success

Yudi Huang, Northwestern university, Evanston, IL, Contact: yudi.huang@kellogg.northwestern.edu

The proliferation of advanced analytical tools and processes in the tech industry has resulted in significant efficiency gains and profit improvements. However, this adoption has also led to greater system complexity, which may pose long-term maintenance and improvement challenges. This study proposes a dynamic model to quantify the magnitude of complexity-related losses and provide strategies to mitigate the hidden cost of complexity. Leveraging additional data, the model can evaluate a company's current position and suggest development strategies. The findings of this study highlight the importance of balancing efficiency gains with the long-term implications of increased system complexity in the tech industry.

Monday, October 16, 12:45 PM - 2:00 PM

MC56

CC-North 232A

Quadratic Optimization and Convexification

Community Committee Choice Session

Session Chair: Hao Hu, Clemson University, Clemson, SC

Session Chair: Boshi Yang, Clemson University, Clemson, SC

1 MILP Approximations for QCQP

Shiyi Jiang[1], Kai Pan[2], Boshi Yang[3], Jianqiang Cheng[4], [1]The Hong Kong Polytechnic University, Hong Kong, China; [2]The Hong Kong Polytechnic University, Hung Hom, Hong Kong; [3]Clemson University, Clemson, SC, [4]University of Arizona, Tucson, AZ

This talk discusses a new method to solve general quadratically constrained quadratic programs (QCQPs). We use an eigenvalue based decomposition to rewrite nonconvex quadratic functions as the difference of two convex ones. A new variable is introduced to partition each nonconvex quadratic constraint to an SOC constraint and the complement of an SOC constraint. We linearly approximate the former constraint and approximate the latter one by linear constraints and a complementarity constraint. We show that the optimal value of the linear program with complementarity constraint relaxation converges to that of the QCQP asymptotically. Numerical experiments are conducted to show the effectiveness of the reformulation.

2 Convexification of Bilinear Terms over Network Polytopes

Seyed Erfan Khademnia, Danial Davarnia, Iowa State University, Ames, IA, Contact: erfank@iastate.edu

The McCormick relaxation for bilinear constraint z=xy gives the convex hull over box domains. In network problems, the McCormick relaxation often leads to poor dual bounds. We study the convex hull of sets containing bilinear constraints $z_{ij}=x_i y_j$, where x_i is the network arc-flow variable, and y_j is in a simplex. For the case with a single y variable in the simplex, we introduce a systematic procedure to obtain the convex hull in the original space of variables and show that all facet-defining inequalities of the convex hull can be obtained explicitly by identifying a tree structure in the network. For the general case with multiple y variables in the simplex, we design a constructive procedure to obtain a class of facet-defining inequalities for the convex hull that is characterized by a special forest structure. Computational results are presented to evaluate both methods.

3 Solution of Disjoint Bilinear Programs Using Simplicial Branch-And-Bound

Hyun-Ju Oh[1], Mohit Tawarmalani[2], [1]Clemson Univerity, Clemson, SC, [2]Purdue University, West Lafayette, IN

In this paper, we propose a branch-and-bound algorithm for disjoint bilinear programs (DBPs). The feasible region of each sub-problem is derived by exploiting the reformulation-linearization technique and a variant of the double-description method. We demonstrate that our algorithm converges to an optimal solution of DBP finitely by carrying out the simplicial branch-and-bound scheme, which splits the feasible region of a variable into sub-simplices at the branching step. We also show that our algorithm outperforms competing methods on large-scale problems.

4 Solution Existence Of Quadratically Constrained Quadratic Programs

Alexander Joyce[1], Boshi Yang[2], [1]Florida Polytechnic University, Lakeland, FL, [2]Clemson University, Clemson, SC, Contact: ajoyce@floridapoly.edu

The Frank-Wolfe Theorem provides conditions for when a problem defined by a quadratic objective function over affine linear constraints has an optimal solution. Over time, this theorem has been extended to cover cases involving convex quadratic constraints. We discuss more current results through the lens of the asymptotic cone of a set defined by a single quadratic constraint. This discussion expands current results and provides sufficient conditions for when a quadratically constrained quadratic program with one quadratic constraint with an indefinite Hessian has an optimal solution.

Monday, October 16, 12:45 PM - 2:00 PM

MC57

CC-North 232B

Emerging Technologies in Transportation Systems I

Community Committee Choice Session

Session Chair: Si Liu, McMaster University, Hamilton, ON, Canada

1 DCA: Delayed Charging Attack on the Electric Shared Mobility System

Shuocheng Guo[1], Hanlin Chen[2], Mizanur Rahman[1], Xinwu Qian[3], [1]The University of Alabama, Tuscaloosa, AL, [2]Purdue University, West Lafayette, IN, [3]University of Alabama, Tuscaloosa, AL, Contact: sguo18@crimson.ua.edu

This study investigates the Delayed Charge Attack (DCA) on electric shared mobility systems (ESMS), which can delay charging services by exploiting vulnerabilities in shared electric vehicles (SEV), electric vehicle supply equipment (EVSE), and the grid, leading to a long-term degradation of the ESMS. We begin by the ESMS threat model with the assets, information flow, and access points, forming a linked sequence for a viable attack vector. Using a Susceptible-Infectious-Removed-Susceptible process, the DCA model is tested against various anomaly detection algorithms using real-world taxi trip data and EVSE locations in New York City. Results show that a 10-min delay leads to a 10.7% ($311.7) weekly revenue loss per driver and the DCA is robust against the AD. Increased repair costs of $36,000 are required to prevent at least 3.8% ($111.8) of weekly revenue loss.

2 Deep Reinforcement Learning Based Stealthy Attack Modeling in Mixed Traffic Flow

Yangjiao Chen, Chaojie Wang, Srinivas Peeta, Georgia Institute of Technology, Atlanta, GA, Contact: ychen3254@gatech.edu

This study leverages deep reinforcement learning (DRL) to understand the behavior and impact of stealthy attacks on traffic flow in a mixed traffic environment consisting of human-driven vehicles (HDVs), normal connected autonomous vehicles (CAVs), and compromised CAVs controlled by stealthy attackers. The results show that compromised CAVs can significantly disrupt traffic flow, weakening the efforts of normal CAVs to smoothen traffic flow.

3 Selective Two-Echelon Orienteering Problem Using UAM and Drones in Urban Logistics

DongKyun Kim, Hyungjoo Cha, Cheong Taesu, Korea University, Seoul, Korea, Republic of. Contact: dongkyun_kim@korea.ac.kr

Urban Air Mobility (UAM) has emerged as a potential solution to urban traffic congestion in logistics zones. This study proposes the Selective Two-Echelon Orienteering Problem using UAM (StOP-U), where UAM selectively visits stations in the first echelon and drones or customers complete last mile delivery in the second echelon according to station types. A mixed-integer linear programming (MILP) formulation is presented to solve the StOP-U problem. Due to the problem's complexity, a two-phase Variable Neighborhood Search (VNS) heuristic algorithm is also proposed. Computational analysis shows that the MILP outperforms the conventional traveling salesman problem (TSP), while the VNS heuristic algorithm generates near-optimal solutions for small-sized instances.

4 Exploring Private-Public Partnership for Innovative Last Mile Deliveries

Si Liu, Elkafi Hassini, McMaster University, Hamilton, ON, Canada. Contact: lius278@mcmaster.ca

We present a pioneering exploration of Private-Public Partnerships (PPPs) in the context of the platform that integrates smart parcel lockers with city bus systems. Implementing such a solution requires the resolution of complex issues, including allocating costs, benefits, and risks among the stakeholders. We propose a game-theoretic framework that models the strategic interactions between the public (city bus operators) and private entities (digital platform operators and e-commerce companies) involved in this PPP. The model, built on non-cooperative and cooperative game theory, analyses the potential outcomes under different partnership scenarios and strategic decisions.

It helps to identify the conditions under which a stable and mutually beneficial partnership can be established and how the benefits and costs can be fairly allocated.

Monday, October 16, 12:45 PM - 2:00 PM

MC58

CC-North 232C

spORts Panel: The Next Frontier in Sport Analytics

Panel Session

1 **Moderator**

Liz Wanless, Ohio University, Athens, OH

Monday, October 16, 12:45 PM - 2:00 PM

MC59

CC-West 101A

COVID-19 Response

Community Committee Choice Session

Session Chair: Peter Frazier, Cornell / Uber, Ithaca, NY

Session Chair: Shane Henderson, Cornell University, Ithaca, NY

Session Chair: David B. Shmoys, Cornell University, Ithaca, NY

1 Responding to the COVID-19 Pandemic: The Central Role of Computing and AI

Madhav Marathe, University of Virginia, Charlottesville, VA

The COVID-19 pandemic serves as a grim reminder of our collective inability to control pandemics. Globalization, anti-microbial resistance, urbanization, climate change, social media and ecological pressures threaten to upend the progress we have made in fighting infectious diseases. In this talk, we will argue that pandemics is a complex systems problem that is intricately tied to the social, behavioral, political and economic issues that go beyond human health. We will describe how scalable computing, AI and data science played an important role in supporting COVID-19 pandemic response. Computational challenges and directions for future research will be discussed.

2 Designing Safe Classrooms at Cornell During the COVID-19 Pandemic

Peter Frazier, Cornell / Uber, Ithaca, NY

We describe a model of SARS-CoV-2 transmission in classrooms that accounts for masking, seating density, ventilation, vaccination rates, and the type of classroom activity. This model was used during the pandemic to safely increase the student density in classrooms at Cornell University to support in-person teaching with limited classroom capacity. We then use data from weekly mandatory testing for COVID-19 at Cornell to estimate the risk of transmitting SARS-CoV-2 in classrooms at Cornell during the Fall 2021 semester. By avoiding all classes with COVID-positive classmates, we estimate that a typical student would reduce their chance of testing positive for SARS-CoV-2 over that semester from 13.8% to 13.6%, a 0.2 percentage point decrease.

3 Analytics Saves Lives During the Covid-19 Crisis in Chile

Leonardo J. Basso, Instituto Sistemas Complejos de Ingenieria (ISCI) & Universidad de Chile, Santiago, Chile

During the COVID-19 crisis, the Chilean Ministries of Health and Science partnered with Instituto Sistemas Complejos de Ingeniería (ISCI) and telecom ENTEL, to develop innovations that placed OR and analytics at the battlefront during the pandemic. Innovations included tools that (1) provided data on the actual effects of lockdowns in different municipalities and over time; (2) helped allocate limited intensive care unit capacity; (3) significantly increased testing and provided on-the-ground strategies for active screening of asymptomatic cases; and (4) implemented a nationwide serology surveillance program that significantly influenced Chile’s decisions regarding booster doses. According to conservative estimates, the initiatives saved about 3,000 lives, roughly 5% of the total death toll in Chile, while saved resources amount to more than 300 million USD.

Monday, October 16, 12:45 PM - 2:00 PM

MC60

CC-West 101B

Applications of Optimization

Community Committee Choice Session

Session Chair: Alexandra M. Newman, Colorado School of Mines, Golden, CO

1 Modeling Heavy Machinery in an Underground Mine to Optimize Ventilation

Aaron Swift, Colorado School of Mines, Golden, CO

An underground mine ventilation system provides fresh ambient air, and dilutes dust and gases produced by equipment and blasting activity. It is also is one of the largest ongoing costs of an underground mining operation. We investigate impacts from the operation of an electric equipment fleet in order to determine optimal airflow.

2 Ventilation Considerations in Medium- and Short-Term Underground Mine Planning

John Ayaburi, Colorado School of Mines, Golden, CO

Underground mines may face schedule disruptions due to the accumulation of heat. Ventilation systems serve as the primary source of fresh air. We develop an integer program to determine the airspeed within a ventilation system that maximizes mine productivity in the medium term, accounting for equipment heat output. We correspondingly provide a mixed-integer quadratically constrained program that minimizes schedule deviation between medium- and short-term plans and determines the distribution of air across operating mine levels.

3 A Specialized Heuristic for Solving the Open-Pit Resource-Constrained Project Scheduling Problem

Nicholas F. Parham, Air Force, Las Vegas, NV

A critical capability for strategic mine planning is the ability to solve the resource-constrained project scheduling problem to optimality, and to do so quickly. However, generalized optimization techniques do not scale well. A specialized heuristic using value propagation allows near-optimal schedules to be found and remains scalable for practical use cases. We verify the heuristic with instances from MineLib, a public mining library, and validate it with active commercial instances.

4 Optimizing Buildings for Energy Efficiency

Chase Robinson, Colorado School of Mines, Golden, CO

Buildings are one of the most significant contributors to greenhouse gas emissions. The high emissions levels are due to the poor energy efficiency of the buildings. To improve energy efficiency, the way facilities produce and use energy must change. Renewable energies can be used along with better materials and construction methods to reduce emissions. At Southern University, a research house is being installed with solar panels, and an air-to-water filtration system is being used to supply the water. A thermal simulation was performed to research different building methods and materials to help improve thermal efficiency. A single-walled construction house was modeled, and a steady thermal simulation was performed using the model.

Monday, October 16, 12:45 PM - 2:00 PM

MC61

CC-West 101C

Diversity in Public Sector Service Operations

Community Committee Choice Session

Session Chair: Vanitha Virudachalam, Gies College of Business, UIUC, Champaign, IL

Session Chair: Dawson Kaaua, McDonough School of Business, Georgetown University, Washington

1 Block Power: Building Health, Wealth, and Power

Karthik Balasubramanian, Harvard Business School, Boston

Block Power partners with non-profit organizations who help their constituents build networks of family members, friends and neighbors to build health, wealth, and power in traditionally marginalized communities. As elections approach, these networks are activated to expand voter outreach and increase civic engagement.

2 Impact of Women in the Invention Team on Product Development Outcomes

Nagarajan Sethuraman[1], Deepak Jena[2], Rachna Shah[3], Shashikant Kumawat[2], [1]University of Kansas, Lawrence, KS, [2]Indian School of Business, Hyderabad, India; [3]University of Minnesota, Minneapolis, MN, Contact: nagarajan@ku.edu

Does having additional women participate in research and product development teams result in more successful products downstream? We examine this question in the context of the pharmaceutical industry which has suffered from historically low women participation in the patent invention teams, leading US congress to act.

3 Female Decision Makers in Public Health Supply Chains

Dwaipayan Roy[1], Amir Karimi[2], [1]University of Virginia Darden School of Business, Charlottesville, VA, [2]The University of Texas at San Antonio, San Antonio, TX

In resource constrained settings, such as low and middle income countries, reproductive health issues do not receive adequate priority from national governments. We examine the relationship between female decision makers in national governments and operational outcomes associated with reproductive health supply chains. Findings from this study contribute to the literature on public health supply chains, highlighting the role that the identity of decision makers play in these supply chains.

4 Going the Distance: The Impact of Commute on Gender Diversity in Public Service

Dawson Kaaua[1], Vanitha Virudachalam[2], [1]McDonough School of Business, Georgetown University, Washington, [2]Gies College of Business, UIUC, Champaign, IL

We analyze the extent to which high commute distances deter female political participation and whether this effect is mitigated by the availability of part-time work. Leveraging differences in distance to the state capitol among state house districts, we use a sharp regression discontinuity design to show that state house districts located further from the state capitol have a lower percentage of female candidates, but this effect disappears in part-time state legislatures. Then, we conduct a conjoint survey experiment administered to a pool of college students to understand how a variety of policies could help to close the gender gap in politics. We find that paid parental leave is the policy most likely to temper the differential effect of a longer commute distance on women entering politics.

Monday, October 16, 12:45 PM - 2:00 PM

MC62

CC-West 102A

Data Analytics and Optimization for Manufacture-Circulation Industrial System

Community Committee Choice Session

Session Chair: Lixin Tang, Shenyang, China

1 A Row Generation-Lagrangian Relaxation-Based Profit Sharing Method for Cooperative Game

Miao Chang[1,2], Shengnan Zhao[1,2], Lixin Tang[1], [1]National Frontiers Science Center for Industrial Intelligence and Systems Optimization, Northeastern University, Shenyang, China; [2]Key Laboratory of Data Analytics and Optimization for Smart Industry, Northeastern University, Ministry of Education, Shenyang, China

In manufacture-circulation industrial system, there are many industrial enterprises which collaborate to conduct the organized manufacturing. To facilitate the stability of the collaboration, it is crucial but challenging to enhance the profits of participants. In this work, we formulate the profit-sharing problem as a cooperative game model, and design multiple profit-sharing mechanisms to obtain profit-sharing schemes that satisfy the core. We then propose a row generation-Lagrangian relaxation algorithm to determine the core allocation of the profit-sharing game. The effectiveness of the proposed algorithm is demonstrated through numerical experiments, and the characteristics of different profit-sharing mechanisms are analyzed.

2 Interface Connection and Logistics Optimization Management of the Manufacture-Circulation Industrial System

Nengmin Wang, Qi Jiang, School of Management, Xi'an Jiaotong University, Xi'an, China. Contact: jiangqiq@foxmail.com

Interface connection and logistics optimization management are important to ensure smooth, high-quality, low-carbon logistics in Manufacture-Circulation Industrial System (MCIS). This project focuses on the heavy logistics manufacturing industry in China. (1) It studies the influence mechanisms of logistics on MCIS by exploring the evolution patterns when manufacture integrates with logistics. (2) It investigates the operation rules and management mechanisms of the interface connection in manufacturing enterprises. (3) It develops logistics decision model, extends, and innovates solution and optimization methods in MCIS according to the characteristics of complex dynamics and high uncertainty. (4) It researches into the way of improving logistics efficiency and provides policy suggestions to promote the integration of manufacture and logistics.

3 The Production Planning Problem of Steel Enterprise Driven by Manufacture Circulation

Gongshu Wang[1,2], Yang Yang[3], Lijie Su[4], Lixin Tang[1], [1]National Frontiers Science Center for Industrial Intelligence and Systems Optimization, Northeastern University, Shenyang, China; [2]Key Laboratory of Data Analytics and Optimization for Smart Industry (Northeastern University), Ministry of Education, Shenyang, China; [3]Liaoning Engineering Laboratory of Data Analytics and Optimization for Smart Industry, Shenyang, China; [4]Liaoning Key Laboratory of Manufacturing System and Logistics Optimization, Shenyang, China. Contact: wanggongshu@ise.neu.edu.cn

This talk presents a study of a steel production planning problem driven by manufacture circulation. The problem is unique in that it comprehensively considers batch production mode, product substitution, and demand uncertainty. For the deterministic scenario, we formulate the problem as a mixed integer programming model. For uncertain scenarios, we develop a two-level robust optimization model. We propose an enhanced Benders decomposition algorithm that incorporates a problem-specific method for generating valid inequalities to strengthen the master problem, and a hybrid strategy that combines approximate and exact methods to solve the non-convex slave problem. We have performed a large number of computational experiments on synthetic examples to verify the performance of the proposed method, and the results demonstrate its efficiency and effectiveness.

4 Relax-And-Fix Based Heuristics to Solve Production Planning Problem in Steel Industry

Yuming Zhao[1], Gongshu Wang[2], Lixin Tang[1], [1]National Frontiers Science Center for Industrial Intelligence and Systems Optimization, Shenyang, China; [2]Key Laboratory of Data Analytics and Optimization for Smart Industry (Northeastern University), Ministry of Education, Shenyang, China

In this work we study production planning problem inspired by real-world steel industry continuous galvanizing process in aiming to improve production management and efficiency. A formulation of the model with setup carryover is introduced and a minimum cost network flow reformulation of the model is demonstrated. We regroup the items of different product families according to their available time window to improve the solving efficiency, and propose heuristic algorithms based on relax-and-fix method with different variable partition strategies to solve the different formulations. Experimental results of generated problem instances indicate the algorithm's efficiency in practical application.

Monday, October 16, 12:45 PM - 2:00 PM

MC63

CC-West 102B

Service Science Best Student Paper Award Competition (II)

Award Session

1 Waiting Online versus In-Person in Outpatient Clinics: An Empirical Study on Visit Incompletion

Jimmy Qin[1], Carri Chan[1], Jing Dong[2], Shunichi Homma[3], Siqin Ye[3], [1]Columbia Business School, New York, NY, [2]Columbia University, New York, NY, [3]Columbia University Irving Medical Center, New York, NY

To better manage telemedicine visits and effectively integrate them with in-person visits, we need to better understand patient behaviors under the two modalities of visits. Utilizing data from two large outpatient clinics, we take an empirical approach to study service incompletion for in-person versus telemedicine appointments. Our estimation results show that intra-day delay increases the telemedicine service incompletion rate by 7.40%, but it does not have a significant effect on the in-person service incompletion rate. We conduct counterfactual experiments to optimize the intra-day sequencing rule when having both telemedicine and in-person patients. Our analysis indicates that not correctly differentiating the types of incompletions due to intra-day delays from no-show can lead to highly suboptimal patient sequencing decisions.

2 Fair Markovian Search

Mohammad Reza Aminian[1], Vahideh Manshadi[2], Rad Niazadeh[1], [1]The University of Chicago, Booth School of Business, Chicago, IL, [2]Yale University, New Haven, CT

We study the problem of optimal search (with costly information acquisition) for the best alternative among a pool of candidates that belong to different societal groups. Due to baked-in biases in the prior data, group-unaware comparisons of candidates may lead to unfair treatment of certain groups. As such, a socially-aware decision-maker aims to achieve fairness by imposing constraints on ex-ante outcomes in various stages of the search. We start with the classic Pandora's box model of Weitzman (1979) under demographic parity constraints. Candidates belong to two demographic groups and we constrain the policy to equalize the probability of selection or the expected number of opportunities (inspected candidates) across these groups. For each case, we show that optimal fair policy retains the index-based structure of the optimal unfair policy, but potentially randomizes between two policies that are dual-based adjustments of the unfair problem - thus they are easy to compute and economically interpretable. Building on these constructs, we consider richer search processes, such as search with rejection and multi-stage search, that can be modeled by joint Markov scheduling (JMS) (Dumitriu et al., 2003; Gittins, 1979). Imposing general affine and convex ex-ante fairness constraints - that encompass various notions such as the 4/5 rule or minimum guaranteed welfare - across an arbitrary number of groups or even individuals, we give a primal-dual algorithm to find the almost fair and optimal policy. This algorithm, too, randomizes over index-based policies; this time, over a polynomial number of policies whose indices are dual-based adjustments to the Gittins indices of the unfair JMS. Our algorithmic developments, while involving many intricacies, rely on a simple yet powerful observation: there exists a relaxation to the Lagrange dual function of these constrained optimization problems that admit index-based policies akin to the original unconstrained ones.

3 A Data-driven Approach To Improve Artisans' Productivity In Distributed Supply Chains

Divya Singhvi[1], Somya Singhvi[2], Xinyu Zhang[3], [1]New York University, New York, NY, [2]USC Marshall School of Business, Los Angeles, CA, [3]New York University Stern School of Business, New York, NY, Contact: xz1151@stern.nyu.edu

Despite their vital role in rural economy, artisanal supply chains continue to be plagued by low productivity and the highly fragmented nature of their upstream. This study presents research conducted in close collaboration with a leading exporter of handmade rugs in India, aimed at improving artisans' productivity in distributed supply chains. We provide robust empirical evidence that frequent supervisor visits can play a crucial role in improving artisans' productivity. Our analysis also suggests that this impact is heterogeneous, with visits to more complex rugs, and visits that are more consistent, leading to maximum productivity gains. To capitalize on these insights, we propose a novel predict-then-optimize framework for optimizing supervisor visits in the supply chain and we see significant productivity improvement from extensive numerical analysis.

4 Stopping The Revolving Door: MDP-based Decision Support For Community Corrections Placement

Xiaoquan Gao, Pengyi Shi, Nan Kong, Purdue University, West Lafayette, IN

We study the incarceration-diversion decision problem to reduce jail overcrowding and recidivism rates by leveraging community corrections. We build a large-scale Markov decision process (MDP) model to balance the tradeoffs among congestion, recidivism, and violation. The salient features of the criminal justice setting, including deterministic service times and occupancy-dependent costs, present significant theoretical and algorithmic challenges. We propose a unified approach with system coupling and policy deviation bounding to compare value functions. We establish the convexity of the value function, which provides a theoretical basis for developing an efficient algorithm based on a separation of time scales. We showcase the effectiveness of our algorithm in solving real-world problems through a case study using data from our community partner.

Monday, October 16, 12:45 PM - 2:00 PM

MC64

CC-West 102C

Harnessing Social Media Intelligence

Community Committee Choice Session

Session Chair: Xunyu Chen, University of Arizona, Tucson, AZ

Session Chair: Yeongin Kim, Virginia Commonwealth University, Glen Allen

1 The Effect of Emoji and Social Influence on Intervention for Misinformation on Social Media

Seonjun Kang, Victoria Yoon, Yeongin Kim, Virginia Commonwealth University, Richmond, VA, Contact: kangs10@vcu.edu

Misinformation has spread rapidly through social media and has recently become a concern. Therefore, social media platforms have intervened to prevent the spread of misinformation, such as labeling photos or videos of misleading articles (i.e., flag) and displaying links to fact-checking. Although the development of various interventions can reduce the consumption of misinformation, it has yet not fully effectively controlled the spread of misinformation. In particular, a factor that influences individual decisions, such as emojis accompanying articles on social media, has received little attention in the context of misinformation intervention. We study the effect of emojis on the article's believability and user engagement with the article. Drawing on emotions as social information theory, we build a research model and validate it using online experiments.

2 Meta-Voicing for Social Good: Unpacking the Influence of Social Media Engagement in Corporate Philanthropy Communication

Yan Shi[1], Ying Liu[1], Yi (Zoe) Zou[2], [1]University of Massachusetts Amherst, Amherst, MA, [2]University of Western Ontario, London, ON, Canada. Contact: yanshi@umass.edu

Social media has become a viable channel for firms to communicate corporate social responsibility. Nevertheless, little is known about how the online diffusion of a firm's philanthropic announcement unfolds over time and how such diffusion can influence consumer behavior. To address these questions, we drew on the attribution theory and utilized an online natural experiment that took place during the disaster relief period of 2021 Henan floods in China. Preliminary results reveal that both the intensity and content of meta-voicing responses towards a firm's charitable donation announcement can influence consumers' online livestreaming purchases of the firm's products. More importantly, the initial meta-voicing reactions towards a firm's philanthropic announcement can have both immediate and enduring impacts on purchase behavior.

3 Seeing is Believing? Utilizing Multi-Modal Features and Inter-Modal Inconsistency of Ceo Interviews to Predict Financial Risk

Cuibing Wu[1], Xunyu Chen[2], Julie Zhang[3], Xiaobai Li[1], [1]University of Massachusetts Lowell, Lowell, MA, [2]University of Arizona, Tucson, AZ, [3]University of Massachusetts, Lowell, Lowell, MA, Contact: cuibing_wu@student.uml.edu

Multimedia content of business executives holds a potential to influence financial markets. This study introduces a deep learning approach to forecasting stock volatility by analyzing CEO interviews circulated on YouTube. We extend existing research by incorporating not just the CEO's multi-modal features (i.e., verbal, vocal, and visual) but also the inter-modal inconsistency among these channels, which has been evidenced to shape audience perception, within a deep learning framework, as key factors affecting a firm's stock volatility. Our work contributes to communication, finance, and deep learning literature by demonstrating the impact of CEO interviews on financial markets, highlighting the predictive power of behavioral inconsistency, and proposing a hierarchical fusion framework that effectively leverages multi-modal signals.

Monday, October 16, 12:45 PM - 2:00 PM

MC65

CC-West 103A

TIMES Best Working Paper Award

Award Session

Session Chair: Onesun Steve Yoo, UCL School Of Management, University College London, London, United Kingdom

Session Chair: Zhaohui Jiang, Carnegie Mellon University, Pittsburgh, PA

Monday, October 16, 12:45 PM - 2:00 PM

MC66

CC-West 103B

NSF Proposal Writing Workshop

Community Committee Choice Session

Session Chair: Georgia-Ann Klutke, National Science Foundation, Alexandria, VA

Session Chair: Reha Uzsoy, National Science Foundation, Alexandria, VA

1 NSF Proposal Writing

Reha Uzsoy, National Science Foundation, Alexandria, VA

An overview of NSF funding mechanisms, review process and helpful suggestions for writing successful proposals to the National Science Foundation.

2 NSF Proposal Writing Workshop

Georgia-Ann Klutke, National Science Foundation, Alexandria, VA

An overview of NSF funding mechanisms, review process and helpful suggestions for writing successful proposals to the National Science Foundation.

3 NSF Proposal Writing

Janis Terpenny, National Science Foundation, Alexandria, VA

An overview of NSF funding mechanisms, review process and helpful suggestions for writing successful proposals to the National Science Foundation.

Monday, October 16, 12:45 PM - 2:00 PM

MC67

CC-West 104A

Text Analytics for Social Good

Community Committee Choice Session

Session Chair: Ozgur Turetken, 1</sup

1 Social Media, Sentiments and Political Discourse

Hiba M. Noor[1], Mehmet Akgul[2], Ozgur Turetken[1], [1]Toronto Metropolitan University, Toronto, ON, Canada; [2]McMaster University, Hamilton, ON, Canada. Contact: akgulm@mcmaster.ca

Social media is widely used for online political discourse, and opinions shared on social media have different sentiments associated with them. Moreover, opinions expressed on social media affect the sentiments of those who are exposed to them. Therefore, understanding the factors related to the sentiments expressed in messages can help policymakers to take actions that align with voter needs and priorities. In this talk, we will discuss the application of sentiment analysis to tweets related to the political elections. We will provide how key drivers of the sentiments could be extracted from the tweets and discuss the relationship between tweet sentiments and tweet virality, i.e., how much a tweet spreads. In addition, we will provide how text clustering, along with tweet virality, could be applied in reflecting election outcomes.

2 Unpacking the Relation Between Media Sentiment and House Prices: A Topic Modelling Approach

Ernest N. Biktimirov, Tatyana Sokolyk, Anteneh Ayanso, Brock University, St Catharines, ON, Canada

This study uses a topic modelling approach to investigate the relation between news media sentiment and house price movements. By examining real estate related articles published in local newspapers of 16 major cities in Canada and Australia, we identify the specific topics discussed and report differences in their themes and media sentiment's predictive power between Canada and Australia. This analysis presents novel inferences of qualitative information related to the housing market. The findings indicate that more transparent housing markets have more efficient prices, suggesting that regulators should strive to improve information transparency in housing markets.

3 Combating Disinformation Warfare with Artificial Intelligence

Richard Frank, Barry Cartwright, Simon Fraser University, Burnaby, BC, Canada. Contact: rfrank@sfu.ca

This project aims to develop an AI tool that will permit the detection of disinformation attacks mounted on social media by hostile foreign actors. The process starts with the manual discovery of sources of dis-, mis-, and real-information on various social media platforms, after which the content is scraped to form the "truth" on which the machine-learning models are built. These, and additional, feeds are then continuously crawled for new content. The AI tool is comprised of 6 underlying machine-learning algorithms to avoid algorithmic bias, each of which, for each new post, "vote" as to whether the post is dis-, mis-, or real- information. Finally, the aggregated (weighted) votes are used to identify new dis-information attacks, which can be analyzed using keywords and topic detection to help understand the thrust and source of the attack.

4 Large Language Models and Conspiracy Theory

Yisheng Li, Toronto Metropolitan University, Torronta, ON, Canada

In the post-truth era, the rise of large language models (LLMs) like ChatGPT, an emerging general-purpose technology in artificial intelligence (AI), has significant implications for the mass production and diffusion of conspiracy theories. The repercussions include the decline of social capital and the erosion of democratic institutions. However, information systems (IS) research on this area is in its infancy. This study aims to identify outstanding research problems such as designing experiments to test the persuasiveness/sophistication of AI-generated conspiracy theories. Of particular analytical interest is to extract the linguistic/rhetoric features of AI-generated conspiracy theories by conducting sentiment analysis and topic modeling. We also discuss the challenges for content moderation and fact-checking. Our study enriches the understanding of potential harms incurred by LLMs and contributes to IS research on misinformation/disinformation.

Monday, October 16, 12:45 PM - 2:00 PM

MC68

CC-West 104B

Data Envelopment Analysis: Recent Advances in Methodologies and Applications

Contributed Session

Session Chair: Sonia Valeria Aviles-Sacoto, Universidad San Francisco de Quito, Quito, Ecuador

1 Counting Operations in Data Envelopment Analysis

Dulá H. José H[1], Gregory Koronakos[2], Dimitris Despotis[2], [1]University of Alabama, Tuscaloosa, AL, [2]University of Piraeus, Piraeus, Greece

Algorithms and computations are an important aspect of DEA. Current practices when introducing a computational procedure for DEA consist of describing the approach and comparing its performance based on execution times. The preponderant operation in DEA is solving linear programs; therefore, an operation count for DEA procedures can be limited to the "LP workload" based on the number and size of LPs solved. Operation counts provides a common ground for analyzing and comparing DEA procedures. They are independent of hardware, LP solvers, and platform. We discuss the use of machine-independent operations count to analyze and compare DEA procedures. We make the case for the use of operation counts in DEA procedures that claim substantial speedups as part of the analysis and comparison with competing approaches. We provide a taxonomy for DEA procedures.

2 A Study on the Improvement Targets of Data Envelopment Analysis Models

Xu Wang, Waseda University, Tokyo, Japan

DEA is a mathematical programming methodology for the relative efficiency evaluation of decision making units (DMUs) with multiple inputs and outputs. Besides the efficiency score, DEA model can provide an improvement target for each inefficient DMU to achieve efficiency, which is the attractive point of DEA. Thus, the idea of least-distance DEA has been proposed for finding the closest efficient target that is similar to the DMU under evaluation and can be achieved easily. We make a comparison between improvement targets provided by the conventional additive(ADD) model and least-distance DEA model using a time-series data set of 86 retail businesses in Japan. The results of numerical experiments suggests the superiority of the improvement target provided by the least-distance DEA model on the realization of efficiency for those inefficient DMUs.

3 Parallelizing DEA Procedures

Gregory Koronakos[1], José Dulá[2], [1]Department of Informatics, University of Piraeus, Piraeus, Greece; [2]The Culverhouse College of Business, University of Alabama, Alabama, AL

There has been an interest since the early days of DEA to explore the parallelization of its procedures. The traditional approach along with innovations that followed such as Reduced Basis Entry (Ali, 1993), Hierarchical Decomposition (Barr & Durchholz, 1997) and its variants are highly parallelizable. Others, such as BuildHull (Dula, 2011), less so. We show how to parallelize BuildHull to attain speedups for DEA computations that make it competitive setting new performance standards.

4 Shared Inputs and Multicriteria Grouping in DEA

Sonia V. Aviles-Sacoto[1], Estefania C. Aviles-Sacoto[2], Wade D. Cook[3], David Güemes-Castorena[4], [1]Universidad San Francisco de Quito, Quito, Ecuador; [2]Universidad Politécnica Salesiana, Cuenca, Ecuador; [3]York University, Toronto, ON, Canada; [4]Tec de Monterrey, Monterrey, Mexico. Contact: svaviless@usfq.edu.ec

DEA is a methodology for evaluating the efficiencies of DMUs, with each unit having its own set of inputs and outputs. However, in certain situations, the DMUs can share inputs or outputs. An example of this is one where a set of university departments, grouped according to the faculties to which they belong, share a faculty-level resource. Furthermore, it is assumed that the shared resource cannot be split up and allocated to the group members. Unlike previous studies, the situation herein can involve multiple criteria upon which DMUs can be grouped and as well can have multiple stages with different DMU groupings in one stage than in another. This paper analyzes a situation wherein a DEA-like methodology is developed to derive efficiency scores in a two-stage setting and in the presence of multiple criteria. We demonstrate the new methodology using the Mexican tourism sector

A Team-Based Approach for Design and Implementation of Artificial Intelligence Applications and Its Impact on Workforce Development

Houshang Darabi, University of Illinois-Chicago, Chicago, IL, Contact: hdarabi@uic.edu

A false assumption made by industry professionals is that artificial intelligence (AI) systems are software codes, and their development is solely dependent on people with programming skills in machine learning (ML) and data processing. This presentation outlines a team-based approach for design and implementation of AI applications. It shows that a successful AI project requires several skillsets and a framework through which ML model developers and application experts/users not familiar with coding and ML model development can communicate/advance the project. Real world examples of this approach in healthcare and occupational safety projects are presented. It is argued that the approach must be considered as the education core of any AI workforce development effort that is meant to train industry professionals who are not computer savvy.

Learning to Make Adherence-Aware Advice

Guanting Chen[1], Xiaocheng Li[2], Chunlin Sun[3], Hanzhao Wang[4], [1]University of North Carolina at Chapel Hill, Chapel Hill, NC, [2]Imperial College Business School, London, United Kingdom; [3]Stanford University, Stanford, CA, [4]Imperial College London, London, United Kingdom

As AI systems continue to contribute to human decision-making, it is frequently observed that human agents sometimes disregard the advice provided by AI. The probability that the human agent follows the AI's advice is called the agent's adherence level. Although the optimal advice is the best action for the agent when the adherence level is 1, when the adherence level is less than 1, it might become suboptimal for the AI system to provide the same advice. We propose a decision-making model that aims to provide optimal adherence-aware advice, accounting for the varying levels of adherence exhibited by human agents across different states and actions. In addition to the model, we introduce accountable and near-optimal reinforcement learning algorithms specifically designed to address adherence-aware advice.

Monday, October 16, 12:45 PM - 2:00 PM

MC69

CC-West 105A

Advanced Machine Learning for Complex Physical Systems

Community Committee Choice Session

Session Chair: Yinan Wang, Rensselaer Polytechnic Institute, Troy, NY

1 Physics-Informed Data-Driven Degradation and Prognostic for Hydropower System

Mucun Sun, Idaho National Laboratory, Idaho Falls, ID, Contact: Mucun.Sun@inl.gov

The hydropower system is a cyber-physical system, and the industry is experiencing high operation and maintenance (O&M) costs along with increasing unplanned outages, primarily due to aging equipment and new asset loading patterns. Current (O&M) practices in asset management are predominantly reactive rather than predictive and systematic. To address these challenges, a proposed physics-informed data-driven degradation model aims to simulate the health of components in various environments. Its purpose is to accurately characterize wear and fatigue in the pilot components of hydropower systems. Additionally, the model provides informed confidence in prognostic predictions concerning asset degradation and remaining life.

2 Detonate: Nonlinear Dynamic Evolution Modeling of Time-Dependent 3-Dimensional Point Cloud Profiles

Michael Biehler[1], Daniel Lin[2], Jianjun Shi[3], [1]Georgia Institute of Technology, Atlanta, GA, [2]Walton High School, Atlanta, GA, [3]ISyE Georgia Tech, Atlanta, GA

Modeling the evolution of a 3D profile over time as a function of heterogeneous input data and the previous time steps 3D shape is a challenging, yet fundamental problem in many applications. We introduce a novel methodology for the nonlinear modeling of dynamically evolving 3D shape profiles. Our model integrates heterogeneous, multimodal inputs that may affect the evolvement of the 3D shape profiles. We leverage the forward and backward temporal dynamics to preserve the underlying temporal physical structures. We leverage the theoretical Koopman framework to develop a deep learning-based framework for nonlinear, dynamic 3D modeling with consistent temporal dynamics. We evaluate our method on multiple high-dimensional and short-term dependent problems, and it achieves accurate estimates, while also being robust to noise.

3 ADs: Active Data-Sharing for Data Quality Assurance in Advanced Manufacturing System

Yue Zhao[1], Yuxuan Li[2], Chenang Liu[2], Yinan Wang[1], [1]Rensselaer Polytechnic Institute, Troy, NY, [2]Oklahoma State University, Stillwater, OK, Contact: zhaoy23@rpi.edu

The Data-sharing framework is enabled among multiple machines with similar functionality to augment the dataset for building ML models. It is needed to ensure only high-quality data to improve the performance of ML methods. There are two main challenges: (1) the labeling information usually cannot distinguish data points from different distributions; (2) it is hard to evaluate the "quality of information" in each data point. We proposed an Active Data-sharing (ADs) framework to ensure the quality of the shared data among multiple machines. It is designed as a self-supervised learning framework by integrating the architecture of contrastive learning and active learning. The results of our ADs framework are very promising that data-sharing is conducted between similar machines, and the ML methods can receive better performance with the high-quality augmented dataset.

4 Augmenting Generative Adversarial Network (GAN) to Enable Effective Longitudinal Data for Imbalanced Classification

Ziyang Zhang[1], Chenang Liu[2], [1]Oklahoma State University, Stillwater, OK, [2]Oklahoma State University, Stillwater, Contact: jan.zhang@okstate.edu

This study aims to extend the Generative Adversarial Networks (GAN) for longitudinal data augmentation in imbalanced classification. The proposed approach first extends the generator by involving a new filter layer with a longitudinal data-oriented distance metric, which can identify the qualified generated samples for discrimination. Afterwards, it also explores a collaboration mechanism among multiple discriminators for training, enabling more effective discrimination. This approach is validated on a Diabetic Retinopathy (DR) dataset which contains imbalanced and non-equally spaced longitudinal data.

Monday, October 16, 12:45 PM - 2:00 PM

MC70

CC-West 105B

Crowdsourcing and eBusiness

Community Committee Choice Session

Session Chair: Jiahui Mo, Clemson University, Clemson, SC

1 Is AI a Panacea? An Investigation of the Impact of AI-Related Competitive Actions on Firm Performance

Yuanyuan Chen[1], Annie Tian[1], Danish Hasnain Saifee[2], [1]University of Alabama Culverhouse College of Commerce, Tuscaloosa, AL, [2]University of Alabama, Tuscaloosa, AL, Contact: ychen200@cba.ua.edu

Organizations are striving to take various competitive actions to embrace Artificial intelligence (AI) technology. Drawing on the Functional and Symbolic Framework (FSF) and related literature on competitive action repertoires and IT innovation, and assembling a large longitudinal dataset spanning 12 years, we examine the impact of four competitive repertoire characteristics-presence, total volume, novelty (new action types), and diversity-on a firm's financial performance and stock valuation. Our results show that while firms' engagement in AI-related competitive actions can increase a firm's symbolic value, which is reflected in higher stock market valuation, the impact on functional value is more mixed, reflected only in higher revenues but not in profitability.

2 Examining the Impact of Situational Factors on Performance in Crowdsourcing Competitions

Indika Dissanayake[1], Mahmut Yasar[2], Sridhar P. Nerur[3], Mahyar Sharif Vaghefi[2], [1]University of North Carolina at Greensboro, Greensboro, NC, [2]University of Texas at Arlington, Arlington, TX, [3]University of Texas-Arlington, Arlington, TX, Contact: i_dissan@uncg.edu

Organizations seek innovation and competitive advantage through crowdsourcing platforms, relying on the wisdom of the crowds. Solvers participate in contests hosted by seekers on these platforms for monetary incentives, learning opportunities, and reputation enhancement. While the collective intelligence of the crowds generates creative solutions, the impact of contest incentives, the number of solvers, and contest complexity on solution quality remain unclear. To address this gap, we explore the direct effects of the number of solvers and monetary prizes on performance while considering the moderating effects of task complexity. Additionally, we examine how these direct effects vary based on solver performance levels. This research has important implications for academia, platform designers, and seekers.

3 Do Digital Platforms Make Nonbinding Contracts More Enforceable? Evidence from the Amazon Freight Platform

Ali Shirzadibabakan, William J. Kettinger, He Li, Clemson University, Clemson, SC, Contact: ashirza@clemson.edu

This study examines how spot markets enabled by digital platforms improve the enforcement of nonbinding contracts. The simultaneous use of *nonbinding contracts* and *spot markets* is prevalent in industries with high uncertainties in supply and demand, making the enforcement of nonbinding contracts challenging. Leveraging the entry of the Amazon Freight platform, we demonstrate that a digital platform-enabled spot market reduces suppliers' refusals of nonbinding contracts by increasing supply capacity and reducing spot prices. Also, the platform-enabled spot market has a stronger impact on reducing refusals in markets with high demand volatility. This research contributes to understanding the role of digital platforms in enforcing nonbinding contracts and improving operational efficiency in uncertain industries.

4 Effects of Perceived Fairness of Work Assignment Algorithms on Crowdsourcing Performance

Hansol Lee, Texas Tech University, Lubbock, TX

Many crowdsourcing platforms have employed artificial intelligence (AI) based algorithms to assist the work assignment and worker allocation systems, in order to optimize worker resources and improve worker performance on tasks. However, as many of such algorithms are "black boxes" and platforms usually provide insufficient information about the algorithms' working mechanisms, workers may perceive unfairness with their work assignments, leading to a negative impact on their performance. In this study, we conduct an online experiment to investigate how a platform's information provision regarding the AI algorithmic decision making influences workers' performance by affecting workers' perceived fairness of the work assignment system.

Monday, October 16, 12:45 PM - 2:00 PM

MC71

CC-West 105C

Centralized and Decentralized Platforms

Community Committee Choice Session

Session Chair: Wael Jabr, Pennsylvania State University, University Park, PA

1 Leveraging The Digital Tracing Alert In Virus Fight: The Impact Of Covid-19 Cell Broadcast On Population Movement

Heeseung Andrew Lee, University of Texas at Dallas, Dallas, TX, Contact: andrewlee@utdallas.edu

Digital tracing alerts have emerged as effective means to share information with agility in responding to disaster outbreaks. We examine the extent to which instant digital tracing alerts and the information included in the alerts affect people's actions toward disaster management in the context of South Korea. We leverage 4,029,696 sub-district and hour level dataset, including population movement and digital tracing alert transmission information. Our results show that digital tracing alerts are effective in inducing population movement out of the infected area and decreasing the population density. Furthermore, the effectiveness of digital tracing alerts hinges on the inclusion of different private information of individuals on case confirmation.

2 Impact of Platform Privacy Governance on Mobile App Cross-Promotion Strategies: Evidence from Apple's App Tracking Transparency

Shivan Bhatt, He Li, William J. Kettinger, Pranith Abbaraju, Clemson University, Clemson, SC, Contact: hl3@clemson.edu

This research examines how platform privacy policy affects mobile apps' *cross-promotion*, i.e., an app advertises on another app. We exploit Apple's implementation of app tracking transparency on April 26, 2021—i.e., a privacy feature that requires apps to obtain permission to track users across apps and websites owned by other firms. We conduct a longitudinal analysis of the top downloaded game apps on iOS and Android platforms. We found that in response to new app tracking transparency, advertising apps decrease ad content creatives and ad platform integrations. After implementing the app tracking transparency policy, ad content creatives are negatively associated with app revenue, but more ad platforms generate higher app revenue. This research provides implications for mobile apps' cross-promotion strategies in the presence of stricter privacy policies.

3 Democratizing AI Innovation with Open Data: Evidence from Imagenet

Jing Tian, Penn State University, University Park, PA

The increasing concentration of AI innovation has raised concern that AI innovation may endow the leading firms with dominant market power that prevents others from harnessing the benefits and squeezes social welfare. Against this background, there is a growing number of open data initiatives in which data are purposefully collected, curated, and made freely available to the public. Leveraging the release of ImageNet as the empirical setting, our study investigates the concentration of AI innovations among platform and non-platform firms, as well as the role of open data in countering the data advantages of platform firms, thereby facilitating the democratization of AI innovation.

4 Examining the Impact of AI-Supported Recommendations on Judicial Fairness

Wael Jabr[1], Ian Ho[2], Yifan Zhang[3], [1]Pennsylvania State University, University Park, PA, [2]Pennsylvania State University, State College, PA, [3]Kennesaw State University, Kennesaw, GA, Contact: wjabr@psu.edu

The judicial system grants judges a great degree of subjectivity when making criminal sentencing decisions. While those sentences, in theory, should be based on crime severity, offenders' criminal history and their reoffending likelihood, judges, in practice, have little to no constraints on how they decide cases. To promote fairness, several state's judicial systems have adopted AI to support judges in their bailing and sentencing decisions. This research answers the following questions: (1) Do AI-supported recommendations affect individual judges' sentencing decisions? (2) If so, how do judges respond to those recommendations? (3) Do judges make "better" decisions with AI's support regarding overall recidivism and public safety? (4) How does such impact evolve over time? We answer these questions in the context sentencing in the United States.

Monday, October 16, 12:45 PM - 2:00 PM

MC72

CC-West 106A

Responsible AI

Community Committee Choice Session

Session Chair: Shweta Singh, University of Warwick, Coventry, United Kingdom

1 Hiring Biases and Responsible Artificial Intelligence

Shweta Singh, [1</sup]

In order to mitigate algorithmic AI biases, there has been ample research to develop 'de-biased' AI solutions. However, researchers also acknowledge that technological fixes of AI bias and a mathematical notion of AI fairness is hard to come by. Thus, we propose a unique and novel technique to understand biases from the AI models and argue to integrate this knowledge in our society, in order to have bias free community, society and humanity!

2 Selecting Social Influencers And Managing Influencer-brand Collaboration

Mengjie (Magie) Cheng, Shunyuan Zhang, Harvard Business School, Cambridge, MA, Contact: macheng@hbs.edu

The growth of the influencer marketing industry warrants an empirical examination of the effect of sponsored videos on an influencer's reputation. We collect user-generated YouTube videos created by prominent English-speaking influencers, extract a rich set of theory-driven video features, and use reweighting to construct comparable treatment and control influencer-video pairs. A difference-in-differences analysis on the matched sample finds a reputation-burning effect: posting a sponsored video, compared to posting an equivalent organic video, costs the influencer 0.17% of their reputation. The reputation-burning effect is stronger among influencers with larger audiences, and it s mitigated when there is high fit between the sponsored content and the influencer's "usual" content and when the promoted brand is less well-known.

3 When Systemic Biases Taint Algorithms: A Path to More Equitable Access in Healthcare

Ozgur Aksoy[1], Mehmet U.S. Ayvaci[1], Asunur Cezar[2], Srinivasan Raghunathan[1], [1]The University of Texas at Dallas, Richardson, TX, [2]Bogazici Universitesi, Istanbul, Turkey. Contact: ozgur@utdallas.edu

Predictive algorithms can sift through vast amounts of past data and assist in critical decisions in healthcare. For example, health insurers commonly use algorithms to identify beneficiaries likely to generate high costs and offer interventions to reduce the associated risks. Despite their potential for efficiency gains, such cost predictions can reflect systemic inequities in historical data, which we refer to as social bias. Explicitly measuring this social bias and adjusting the decision-making process can help mitigate the unintended consequences of social bias. In this research, we formulate a bias-aware algorithmic decision-making framework that factors in the origins of the social bias while also considering fairness outcomes. Besides analyzing this problem structurally, we use Medicare claims and U.S. Census data to validate our approach empirically.

Monday, October 16, 12:45 PM - 2:00 PM

MC73

CC-West 106B

Finance Student Awards

Award Session

Session Chair: Steven Kou, Boston University, Boston, MA

1 Asset-Pricing Factors with Economic Targets

Sicong Li[1], Svetlana Bryzgalova[1], Victor DeMiguel[1], Markus Pelger[2], [1]London Business School, London, United Kingdom; [2]Stanford University, Stanford, CA

We propose a method to estimate latent asset-pricing factors that incorporates economically motivated targets for both cross-sectional and time-series properties of the factors. Cross-sectional targets may capture the shape of loadings (monotonicity of expected returns across characteristic-sorted portfolios) or the pricing span of exogenous state variables (macroeconomic innovations or intermediary-based risk factors). Time-series targets may capture overall expected returns or mispricing relative to a benchmark reduced-form model. Using a large-scale set of assets, we show that these targets nudge risk factors to better span the pricing kernel, leading to substantially higher Sharpe ratios and lower pricing errors than conventional approaches.

2 The Merton Model Re-visited: Design of Optimal Incentives for Traders in Copy Trading

Kai Sun[1], Mingwen Yang[2], Vijay S. Mookerjee[3], [1]University of Texas at Dallas, Richardson, TX, [2]University of Washington, Seattle, WA, [3]University of Texas- Dallas, Richardson, TX

Copy trading allows retail investors (followers) to automatically copy the trades of experts (traders) in real time after paying the following fees to the platform. By allowing others to replicate the trading, traders who get copied will earn following fees through the compensation contract with the platform. The compensation scheme is crucial in aligning the interests of all parties involved, including traders, followers, and the platform. We propose a model that compensates the trader in a way that his trading behavior will not be altered.

3 Randomized Policy Optimization For Optimal Stopping

Xinyi Guan, Velibor Misic, UCLA Anderson School of Management, Los Angeles, CA

Optimal stopping is the problem of determining when to stop a stochastic system in order to maximize reward, which is of practical importance in domains such as finance, operations management and healthcare. Existing methods for high-dimensional optimal stopping that are popular in practice produce deterministic linear policies -- policies that deterministically stop based on the sign of a weighted sum of basis functions -- but are not guaranteed to find the optimal policy within this policy class given a fixed basis function

architecture. In this paper, we propose a methodology for optimal stopping based on randomized linear policies, which choose to stop with a probability that is determined by a weighted sum of basis functions. We motivate these policies by establishing that under mild conditions, given a fixed basis function architecture, optimizing over randomized linear policies is equivalent to optimizing over deterministic linear policies. We formulate the problem of learning randomized linear policies from data as a smooth non-convex sample average approximation (SAA) problem. We theoretically prove the almost sure convergence of our randomized policy SAA problem and establish bounds on the out-of-sample performance of randomized policies obtained from our SAA problem based on Rademacher complexity. We also show that the SAA problem is in general NP-Hard, and consequently develop a practical heuristic for solving our randomized policy problem. Through numerical experiments on a benchmark family of option pricing problem instances, we show that our approach can substantially outperform state-of-the-art methods.

Monday, October 16, 12:45 PM - 2:00 PM

MC74

CC-West 106C

Market Design in the Field

Community Committee Choice Session

Session Chair: Apostolos Filippas, Fordham University, New York, NY

1 Treasury Auction Format

Aleksandrs Smilgins[1], Sasa Pekec[2], [1]Copenhagen Business School, Frederiksberg, Denmark; [2]Duke University, Durham, NC

The choice of auction format for government bond auctions varies by country, with uniform or discriminatory sealed-bid auctions with preapproved bidders (Primary Dealers) being the most prevalent. We compare bidding in Danish and Swedish government bond auctions, and how it relates to the auction pricing rule: Denmark uses uniform pricing, while Sweden uses discriminatory pricing.

2 Advertising as Coordination: Evidence from a Field Experiment

Apostolos Filippas, Fordham University, New York, NY

Paid advertising can increase market efficiency by directing buyers to sellers with greater capacity. We show this with a field experiment in a large marketplace, where all sellers could choose to buy advertising but buyers were randomized into seeing the advertising. Contrary to concerns that buyers might infer advertising sellers were adversely selected, treated buyers sought out advertising sellers. Consistent with this buyer preference, advertising sellers were better on every measurable dimension, particularly in their capacity to take on more work. This shift in buyer attention to higher-capacity sellers increased market transaction volume by around 2%. Costly advertising was necessary to facilitate this coordination, as mere statements about capacity had become uninformative.

3 Reducing Interference Bias in Online Marketplace Experiments Using Cluster Randomization

David Holtz[1], Felipe Lobel[2], Ruben Lobel[3], Inessa Liskovich[3], Sinan Aral[4], [1]UC Berkeley Haas School of Business, Berkeley, CA, [2]UC Berkeley, Berkeley, CA, [3]Airbnb, San Francisco, CA, [4]MIT Sloan School of Management, Cambridge, MA, Contact: dholtz@haas.berkeley.edu

Online marketplace designers frequently run randomized experiments to measure the impact of proposed product changes. However total average treatment effect (TATE) estimates obtained through individual-level randomized experiments may be biased due to SUTVA violations, a phenomenon we refer to as “interference bias.” The practice of randomizing treatment assignment at the level of “clusters” of similar individuals is an established experiment design technique for countering interference bias in social networks, but it is unclear ex ante if it will be effective in marketplace settings. In this paper, we use an “experiment over experiments” conducted on Airbnb to provide empirical evidence of interference bias in online market settings and assess the viability of cluster randomization as a tool for reducing interference bias in TATE estimates.

4 Dueling Contests and Platform’s Coordinating Role

Sanjiv Erat[1], Konstantinos Stouras[2], Casey Lichtendahl[3], [1]University of California-San Diego, La Jolla, CA, [2]University College Dublin, Dublin, Ireland; [3]Google, Data Science, Charlottesville, VA, Contact: serat@ucsd.edu

We study equilibria in prize allocations among competing contests. We extend our results to heterogeneous contests.

Monday, October 16, 12:45 PM - 2:00 PM

MC75

Session.Location:CC-West 208A

Bidding-based Markets

Contributed Session

Session Chair: Meixi Wu, National University of Singapore, Singapore, Singapore

1 Optimal Bidding Strategy for Sponsored Advertising on Ecommerce

Biyi Fang, Phaniram Sayapaneni, Xinzi Sun, Chaowen Zheng, Darren Xu, Kuang-chih Lee, Walmart, Sunnyvale, CA

Real-time bidding (RTB) is a widely used mechanism in online sponsored advertising, where advertisers compete to show their ads to relevant customers through real-time auctions. However, deriving the optimal bidding strategy can be challenging due to the complexity and volatility of the auction environment. In this talk, we will discuss two main bidding strategies that are driven by constrained optimization and reinforcement learning, to help maximize advertiser's objective(s) in 2nd price auction environment on Walmart eCommerce. We will discuss the algorithm and formulation in details, and share the challenges and insights when applying them in real-world scenario. At the end, our experiments demonstrate the effectiveness and efficiency of the proposed bidding strategies through auction simulation in terms of optimizing ad campaign performance.

2 Low Revenue in Display Ad Auctions: Algorithmic Collusion vs. Non-Quasilinear Preferences

Martin Bichler[1], Oberlechner Matthias[1], Laura Mathews[1], Alok Gupta[2], [1]Technical University of Munich, Garching B. München, Germany; [2]University of Minnesota, Minneapolis, MN, Contact: bichler@in.tum.de

Most display ad exchanges moved from second- to first-price auctions in recent years. The effect on revenue is difficult to evaluate empirically. Recent literature on algorithmic collusion finds that, in contrast to the second-price auction, first-price auctions can induce Q-learning agents to bid below the Nash equilibrium in a repeated complete-information version of the auction. We analyze a variety of online learning algorithms and show that they all converge to equilibrium in both, the complete and incomplete information model. We also compute equilibrium for ROI-optimizing agents and show that their revenue in the first-price auction is lower than in the second-price auction in equilibrium.

3 Course Selection Under Social Network Effects

Meixi Wu, Jussi Keppo, Zhenyu Hu, National University of Singapore, Singapore, Singapore. Contact: meixi@u.nus.edu

We consider a course selection model that matches a continuum of students to a finite number of courses. Students' valuations for the courses are subject to their individual level social network effects. We adopt a pseudo-market allocation mechanism for course selection that takes the students' reported valuations for the courses as input and then outputs the students' bid-price vector for each course and the corresponding allocations. We show the existence of equilibrium prices and allocations under any distribution of students' reported preferences for the courses, and show that one such equilibrium can be solved by a linear program. Simulations suggest that the welfare is non-increasing in the strength of the network effects.

Monday, October 16, 12:45 PM - 2:00 PM

MC76

Session.Location:CC-West 208B

Design and Optimization for Transit Systems

Contributed Session

Session Chair: Sanaz Kazemzadehazad, Illinois Institute of Technology, Chicago, IL

1 Smart Public Transportation: Designing To Improve Welfare

Pooria Choobchian[1], Ali Shamshiripour[2], Ali Mohammadi[3], Abolfazl (Kouros) Mohammadian[1], [1]University of Illinois Chicago, Chicago, IL, [2]University of Arizona, Tucson, AZ, [3]Independent Researcher, Tehran, Iran, Islamic Republic of

This paper proposes a smart, auction-based public transportation platform to address information asymmetry and sparse demand in suburban areas. The platform elicits potential demand and ensures profitability for the service provider. The auction is designed to be truthful, budget-balanced, customer sovereign, and individually rational. The service provided by the proposed platform provides an inclusive, on-demand public transportation access to residents who are underserved under the conventional, fixed-route public transportation.

2 Anticipatory Vehicle Repositioning and Routing in Autonomous Mobility-On-Demand Systems

Monika Filipovska, Haimanti Bala, University of Connecticut, Storrs, CT, Contact: monika.filipovska@uconn.edu

In the context of an autonomous mobility-on-demand (AMOD) system, this study focuses on the problem of effective vehicle repositioning in anticipation of future demand. A major challenge of AMOD operations is the integration of vehicle matching and repositioning decisions, as well as vehicles' routes as they perform the assigned tasks. We propose a hierarchical multi-scale approach for anticipatory vehicle repositioning that integrates routing guidance for the vehicles from the perspective of a single operator. The vehicles' routes during repositioning determine the times and locations at which vehicles are available to be matched and serve new arising demand, thus determining the effectiveness of the repositioning strategy.

3 Managing Capacity for Curb Spaces in Urban Transportation System

Armagan Bayram[1], Yuchi Guo[2], [1]University of Michigan Dearborn, Livonia, MI, [2]University of Michigan - Dearborn, Dearborn, MI, Contact: armagan@umich.edu

The management of curb spaces in the urban transportation system becomes increasingly challenging and it becomes more important to allocate the curb space effectively to improve the overall traffic system. In this study, the various uses of the curb space (such as parking, pick-up/drop-off, and loading/unloading) are taken into account as we first construct an open migration network to analyze the flow of the vehicles. Then, using a news-vendor model, the capacity needed for different users is allocated with the objective of maximizing cities' profits. We derive optimal capacity allocation policies and implement numerical experiments. With the model developed, capacity allocation decisions for various curb uses can be made more systematically and can result in improvements in the overall traffic system.

4 Capacity-Based Heuristic Optimization of Signal Timings and Vehicle Trajectories Within a Connected Vehicle Environment

Paul Rieger[1], Arturo Crespo[1], Andreas Oetting[2], [1]TU Darmstadt, Darmstadt, Germany; [2]TU Darmstadt, Darmstadt, Germany. Contact: rieger@verkehr.tu-darmstadt.de

The increasing volume of personal motorized vehicles (PMVs) in cities has become a serious issue leading to congestion, noise and air pollution. However, the current technological development of Vehicle-to-everything (V2X) communication allows the possibility to enhance traffic flow, especially at road intersections. With these new technological possibilities in mind, we suggest a heuristic to simultaneously optimize traffic signals and vehicle trajectories such that available capacities are efficiently utilized. Our method is based on state-of-the-art signal control enhanced by the V2X-enabled possibilities to simultaneously determine additional green times adapted trajectories of arriving vehicles.

5 Pandemic Aftermath: How Do Travel Patterns Change After Covid-19?

Sanaz Kazemzadehazad[1], Mohammad Miralinaghi[2], Ramin Shabanpour[3], Mohammad Hossein Pourgholamali Davarani[4], Samuel Labi[5], [1]Illinois Institute of Technology, chicago, IL, [2]Illinois Institute of Technology, Chicago, IL, [3]University of North Florida, Jacksonville, FL, [4]Purdue, West Lafayette, IN, [5]Purdue University, West Lafayette, IN, Contact: skazemzadehazad@hawk.iit.edu

The COVID-19 pandemic has changed many facets of human life, including travel behaviors. The repercussions of these changes have persisted into the post-COVID period. By considering both attitude (perception of risk) and mode utility factors (sociodemographic, car ownership, employment status, and travel distance and time), we developed a hybrid model using a stated preference survey to analyze how commuters' travel habits changed before and after the COVID pandemic. The results indicate that people are reluctant to use public transit, still prefer to work remotely and shop online, and if not possible, they choose their private car for long distances and active modes for short distances. This research can be used by transit agencies with a vested interest in reviving public transit ridership after future pandemics.

6 Dynamic Routing, Confirmation And Compensation For Combined Urban Transportation Of Passengers And Goods

Yilun wang, ?, ?, AL

Transporting goods with passengers on board has the potential to increase profits for Mobility-on-demand companies, while reducing travel experience to passengers due to detours caused by making deliveries along the way. To approach this, we studied offering compensation as incentives in dynamic and stochastic scenarios, where the requests arrive dynamically and the passenger's acceptance of detour is unknown. We design an anticipatory policy which is based on a new value function approximation (VFA) with slide memory and makes integrated routing, confirmation, and compensation decisions for CUT. The anticipatory policy shows significant effectiveness in the numerical experiments, which can improve the total profit by 20% than the mode that delivers goods without passengers on board alone. When compared to the benchmark policies, it achieves up to 17% more profits.

Monday, October 16, 12:45 PM - 2:00 PM

MC77

Session.Location:CC-West Lecture Hall

Deep Learning/ Machine Learning Applications and Algorithms

Contributed Session

Session Chair: Dzung Phan, IBM Research, Yorktown Heights, NY

1 Natural Language Processing (NLP)-Based Neural Network Architecture to Process the G, E, and APSIM Inputs and Their Interactions for Yield Prediction

Zahra Khalilzadeh, Lizhi Wang, Iowa State University, Ames, IA, Contact: zahrakh@iastate.edu

This study proposes a Natural Language Processing (NLP)-based neural network architecture for yield prediction by processing the genotype(G), environment(E), and APSIM inputs along with their interactions. The proposed model utilizes a combination of NLP techniques and neural network architectures to process temporal and textual information and extract useful features for yield prediction. The study uses a publicly available dataset containing G, E, and APSIM inputs along with corresponding yield values to evaluate the proposed model. The experimental results demonstrate that the proposed approach achieves superior performance compared to existing state-of-the-art models. The proposed model not only captures the complex interactions between the input variables but also provides insights into the underlying factors influencing crop yield prediction.

2 Time Series Perturbation Based on Gradient of Deep Learning Models

Juheon Kwak, Dongil Kim, Ewha Womans University, Seoul, Korea, Republic of. Contact: juhun2005@ewhain.net

Perturbation refers to a tiny change designed to degrade the performance of deep learning models. Perturbation is usually made once by weights of trained model, which has drawbacks: time complexity is relatively high, and perturbation is limited to the last gradient of trained model. In this paper, we propose a new method can make the perturbation to time series with deep learning model. Prediction model is trained for original purpose, and an additional perturbation model is trained for attack of prediction model. The perturbation model uses original time series and gradient of prediction model as input data and label, and derives the changing perturbation to attack the prediction model. The experimental results showed that with 4 real-world dataset, the proposed method outperformed other benchmark methods in terms of performance degradation of the prediction model.

3 Generating Diverse Solutions for Vehicle Routing Problems via Reinforcement Learning

André Hottung, Kevin Tierney, Bielefeld University, Bielefeld, Germany

Deep reinforcement learning methods have shown significant promise at generating solutions to vehicle routing problems in a sequential decision process. At test time, these methods usually sample multiple solutions per instance from a trained model to search for high-quality solutions. However, it has been observed that trained models can suffer from overconfidence in their actions during the sequential construction process which can lead to low solution variety and hence an impaired search performance. We evaluate existing techniques that allow to increase solution diversity and their impact on the overall search performance. Furthermore, we present a novel approach that significantly increases the solution diversity and evaluate it on the vehicle routing problem and the vehicle routing problem with time windows.

4 Optimal Control of Dynamical Systems via Linearizable Deep Learning

Dzung Phan[1], Vinicius Lima[2], [1]IBM Research, Yorktown Heights, NY, [2]University of Pennsylvania, Philadelphia, PA, Contact: phandu@us.ibm.com

Deep learning models are frequently used to capture relations between inputs and outputs and to predict operation costs in dynamical systems. Computing optimal control policies based on the resulting regression models, however, is a challenging task because of the nonlinearity and nonconvexity of the models. We propose a linearizable approach to design optimal control policies based on deep learning models for handling both continuous and discrete action spaces. When using ReLU activation functions, one can construct an equivalent representation of recurrent neural networks by a set of mixed-integer linear constraints. The optimal control problem reduces to a mixed-integer linear program (MILP), which can be solved using MILP solvers. Numerical experiments on standard reinforcement learning benchmarks show the good performance of the proposed approach.

Monday, October 16, 12:45 PM - 2:00 PM

MC78

Session.Location:CC-West 211A

Games and Their Applications

Contributed Session

1 Computing an Equilibrium of Competition Among Sharing Platform Operators Modeled as an M-N Stackelberg Game

Jaeyeon Jo[1], Jihwan Yu[1], Jinkyoo Park[2], [1]KAIST, Daejeon, Korea, Republic of; [2]Korea Advanced Institute of Science and Technology, Daejeon, Korea, Republic of. Contact: robin512@kaist.ac.kr

The M-N Stackelberg game, consisting of multiple leaders and followers, is intricately intertwined with the hierarchical interaction between leaders and followers, as well as the simultaneous interaction among leaders and among followers. This game is essential for modeling competitive sharing platform markets with multiple platform operators. However, due to the intricate interactions between leaders and followers, finding optimal solutions for leaders is challenging. In this study, we propose a general methodology to find the Stackelberg equilibrium of the M-N Stackelberg game. We apply our algorithm to analyze the competition in sharing platform markets, such as sharing energy storage system platforms and car-sharing platforms.

2 Measuring Decentralized Network Efficiency : A Pre-Mortem Stackelberg Game

Minkeon Song[1], Dong-Joon Lim[2], [1]Sungkyunkwan University, Suwon, Korea, Republic of; [2]Sungkyunkwan University, Gyeonggi-do, Korea, Republic of. Contact: mksong0925@naver.com

In this research, we present the 'pre-mortem Stackelberg game model' as a non-cooperative game approach that can serve as an alternative to the conventional decentralized network DEA(Data Envelopment Analysis) model which suffers from infeasibility. We have identified the circumstances that give rise to the issue and recommended the use of non-radial slacks as a remedy. Our findings show that the proposed model provides an alternative efficiency measure for the follower and enables an optimal adjustment of intermediate products, for which feasible solutions do not exist under the conventional model. The proposed model provides equivalent efficiency measures to the traditional model when feasible solutions exist. It is expected to facilitate the use of non-cooperative games in network DEA when the VRS assumption is appropriate for performance evaluation.

3 Differential Game Theoretic Models for Designing Conservation Incentives

Behnam Momeni[1], Shima Mohebbi[2,1], [1]George Mason University, Fairfax, VA, [2]George Mason University, Fairfax, VA, Contact: bmomeni@gmu.edu

The efficient management of water resources is crucial for addressing a range of environmental challenges. This study applies differential game theoretic models to design incentive schemes for farmers, geographically distributed across a river network. Three main players considered are Non-Governmental Organizations (NGOs), upstream farmers, and downstream farmers while environmental and social feedback loops are captured. The proposed approach allows for analyzing the strategic behavior of farmers in their decision-making process related to water consumption and the NGOs in allocating incentives. The proposed model is parameterized for the Red River, the second-largest basin in the south-central United States, and demonstrates optimal incentive allocations balancing the economic and environmental efficiency among farmers.

5 Partition-Based Stability of Coalitional Games

Jian Yang, Rutgers University, Newark, NJ, Contact: jyang@business.rutgers.edu

We are concerned with the stability of a coalitional game. First, the concept of core can be weakened so that the blocking of changes is limited to only those with multilateral backings. This principle of consensual blocking along with others can be applied to partition-allocation pairs. Each such pair is made up of a partition of the grand coalition and a corresponding allocation vector whose components are individually rational and efficient for the various constituent coalitions of the given partition. The resulting stability concepts are compatible with core-related concepts. Probably more importantly, two of them are universal meaning that any game, no matter how ``poor'' it is, has its fair share of stable solutions. There is also a steepest ascent method to guide the convergence process to a stable partition-allocation pair from any starting partition.

Session Chair: Jian Yang, Rutgers University, Newark, NJ

Monday, October 16, 12:45 PM - 2:00 PM

MC79

Session.Location:CC-West 211B

Daniel H. Wagner Prize III

Award Session

Session Chair: James J. Cochran, The University of Alabama, Tuscaloosa, AL

Monday, October 16, 12:45 PM - 2:00 PM

MC80

Session.Location:CC-West 212A

Recent Advances in Stochastic Optimization

Contributed Session

Session Chair: Evgeny Shindin, IBM Research - Haifa, Haifa, Israel

1 Data Valuation from Data-Driven Optimization

Robert Mieth[1,2], Juan M. Morales[3], H. Vincent Poor[2], [1]Rutgers University, New Brunswick, NJ, [2]Princeton University, Princeton, NJ, [3]University of Malaga, Malaga, Spain

In this talk we show how Distributionally Robust Optimization (DRO) offers a natural framework to both (i) account for data quality in data-driven stochastic optimization and (ii) directly value data sets according to their contribution to the decision cost. For this purpose, we first discuss the usefulness of the Wasserstein metric to quantify data quality and then construct a novel Wasserstein DRO formulation that accommodates data from multiple sources with individual transport budgets. We illustrate the proposed framework using an application from power system operations, where we show how the resulting optimization problem implicitly computes the value of data given its quality and the context of the physics-constrained decision-making problem at hand.

2 Personalized Learning in Partially Observable Environments

Anas Abdelhakmi[1], Jussi Keppo[2], Hong Ming Tan[1], [1]National University of Singapore, Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore. Contact: a.anas@u.nus.edu

Personalized Learning (PL) aims to improve learning outcomes by adapting to learners' unique needs. Existing work on PL typically faces a trade-off between adapting to partially observable environments and maintaining tractability. In this paper, we propose a data-driven approach to estimate learners' skill levels by utilizing multiple information sources such as instant skills' assessment and instructors' forward-looking views. We formulate the problem as a constrained Markov Decision Process and then propose a model-free Deep Reinforcement Learning algorithm to approximate the solution. We show that our approach can handle such environments by using real world data.

3 An Efficient Algorithm to Find Optimal Control for Robust Fluid Processing Networks

Evgeny Shindin, Roi Ben Gigi, Odellia Boni, IBM Research - Israel, Haifa, Israel

Multiclass Processing Networks are used in various applicative domains. The tractable way to find an optimal control for such a network is to approximate it by a fluid model resulting in a Separated Continuous Linear Programs (SCLP). To deal with uncertainty in the network models robust optimization (RO) approach for SCLP recently developed. However robust counterpart (RC) of SCLP often enlarge SCLP problem dimensions and reduces scalability and stability of Revised SCLP-simplex algorithm that developed to solve large SCLPs. To overcome this issue we examined RO theory for LP problems and developed new algorithm, that does not require to build full RC in order to find its optimal solution of uncertain SCLP problems.

Monday, October 16, 12:45 PM - 2:00 PM

MC81

Session.Location:CC-West 212B

Innovative Approaches to Analytics Knowledge Transfer

Contributed Session

Session Chair: Alessandro Hill, Cal Poly, San Luis Obispo, CA

1 Analytics Course Project

Marcy Jance, Indiana University East, Richmond, IN

A course assignment/project that can be used for learning and assessment purposes in a statistics or analytics class will be presented.

2 Effect of Gamification on Knowledge Transfer in Stack Overflow (SO)

Orcun Temizkan[1], Ram Kumar[2], [1]Ozyegin University, Istanbul, Turkey; [2]University of North Carolina, Charlotte, NC, Contact: orcun.temizkan@ozyegin.edu.tr

Stack Overflow (SO) is a popular Question and Answer community for software development. Gamification in SO takes the form of badges and bounties earned by users. Badges are designed to encourage participation. Users can get different levels of badges (gold, silver, bronze). Bounties are reputation points offered by users who want answers to questions. While these gamification mechanisms are popular, there is limited research on whether badges and bounties are effective and existing research is inconclusive. We develop and empirically test models of knowledge transfer that include the effects of gamification and explore the effectiveness of these two forms of gamification mechanisms on knowledge transfer in SO.

3 Expanding Students' Social Networks via Optimized Seating Assignments

Alessandro Hill[1], Steffen Peuker[2], David Hom[1], [1]California Polytechnic State University, San Luis Obispo, CA, [2]California Polytechnic State University, San Luis Obispo, CA

A strong and diverse peer network is important for students' educational, personal, and professional success. We present a novel method for assigning students to seats using social network analysis and optimization. We aim at augmenting students' ties through optimized seating, and suggest a processes for surveying existing connections and representing arbitrary classroom layouts. We show that the underlying difficult combinatorial problem, a variant of the assignment problem, can be formulated as an integer program and solved to optimality using mathematical optimization. We also account for classroom balancing and various student needs. In a case study including more than 240 students, we analyze potential and impact. Compared to self-selection, the new ties can clearly be increased. Student and instructor feedback support the usefulness of our approach.

Monday, October 16, 12:45 PM - 2:00 PM

MC82

Session.Location:CC-West 212C

Evaluating Quality of Care for Healthcare Systems

Contributed Session

Session Chair: Weifen Zhuang, Xiamen University, Xiamen, China

1 Exploring the Impact of Health It Features on Quality of Hospital Care

Raluca Cobzaru[1], Roy Welsch[1], Stan Finkelstein[1], Zach Shahn[2], Kenney Ng[3], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]CUNY School of Public Health, New York, NY, [3]IBM Research, Cambridge, MA, Contact: rcobzaru@mit.edu

As policies with staggered adoption - such as Medicaid expansion across states - have been gaining traction in the public health sector, so has the topic of difference-in-differences (DiD) methods which allow for time-varying treatment strategies. We utilize a novel adjustment framework for time-dependent covariates in the DiD setting to study the causal effect of implementing certain EHR system features (e.g. clinical decision support, care coordination across departments, automated drug interaction checks, etc.) on hospital performance metrics (e.g. 30-day mortality and readmission rates) over time. Our results help inform Health IT adoption policies and ease the operational burden on hospitals by identifying a sufficient set of EHR features associated with improved quality of care.

2 The Impact of Provider Coaching on Patient Satisfaction in Emergency Department

Sara Nourazari[1], Samuel Davis[2], Joshua Joseph[3], Leon Sanchez[2], [1]California State University, Long Beach, Long Beach, CA, [2]Harvard Medical School, Cambrdige, MA, [3]Harvard Medical School, Cambridge, MA, Contact: sara.nourazari@csulb.edu

Patient experience and satisfaction are crucial factors in healthcare, as they correlate with better health outcomes and financial incentives. Emergency departments (EDs) face unique challenges in achieving high patient satisfaction due to fragmented interactions and limited time for providers to build trust. This study aims to investigate the influence of professional coaching on patient experience and satisfaction in EDs, considering patient, provider, and visit characteristics. The research questions address the impact of these factors on patient satisfaction scores and the effectiveness of provider coaching. By understanding the role of professional coaching, this study aims to help healthcare providers improve patient experience, population health, and financial performance.

3 Evidence on the Validity of the Healthcare Quality Competency Framework

Xinyu Wei[1], Heng Xie[2], Richard (Xianghui) Peng[3], Victor R. Prybutok[4], [1]California State University, Chico, Chico, CA, [2]California State University, Sacramento, Sacramento, CA, [3]Penn State Erie, The Behrend College, Erie, PA, [4]University of North Texas, Denton, TX, Contact: xwei1@csuchico.edu

Assessment of healthcare quality is vital for enhancing patient outcomes and achieving organizational excellence. As such, assessment is of interest to healthcare professionals and scholars. This research investigates an industry framework of healthcare quality competencies to explore relevant measurements arising from the dynamic nature of today's healthcare quality landscape. We integrate healthcare quality practices and results to develop a research model and validate its effectiveness using survey data.

4 Impacts of Staff Collaborations on the Service Time for Inpatient Stays: An Analysis Using EHR Audit Logs and Dynamic Graphs

He Zhang[1], Gaurav Jetley[2], [1]University of South Florida,

Tampa, FL, [2]Colorado State University, Fort Collins, CO, Contact: hezhang@usf.edu

In this study, we investigate the impacts of collaboration between teams of care providers in healthcare organizations on the service time for inpatient stays. Using data from EHR audit logs, we first develop a temporal data mining algorithm to obtain a dynamic graph representing the strengths of collaboration between care providers, which is used with econometric models to find the impact of collaboration between care providers on the service time. We find a curvilinear impact (inverted-U) of staff collaborations on service time of inpatient stays. It suggests a learning curve; when care providers with little to no experience in working together collaborate, they initially have a negative impact on service time for inpatient stays. However, as the collaborations strengthen over time, they start to make a positive impact by decreasing the service time for inpatient stays.

5 Where is the Value of Information Sharing in the Regional Collaborative Emergency Care System-Evidence from a Regional Chest Pain Center

Weifen Zhuang[1], Yao Li[2], Jian Chen[3], Hong Chen[4], Changqing Zhong[5], [1]Xiamen University, Xiamen, China; [2]Southern University of Science and Technology, West Lafayette, IN, [3]Tsinghua University, Beijing, China; [4]Cheung Kong Graduate School of Business, Shanghai, China; [5]Hunan People's Privincial Hospital, Changsha, China. Contact: wfzhuang@xmu.edu.cn

Timely access to a specialized and systematic care is important for patients with time-sensitive and life-critical conditions. We empirically investigate effects of pre-hospital information sharing within a regional collaborative emergency care system, for inter-hospital transferred patients with the most severe type of heart attack, from a regional chest pain center. Our results show that pre-hospital information sharing not only significantly improves operational efficiency of the receiving hospital and the whole coordinated system by reducing 27.7% in-hospital delay and 12.1% system delay, but also exerts significant effect on reducing duplicate electrocardiogram tests by 17.6% and emergency department utilization by 30.7%. We further explore the underlying mechanism of operational efficiency improvements.

Monday, October 16, 12:45 PM - 2:00 PM

MC83

Session.Location:CC-West 213A

Advances in Time Series Modeling

Contributed Session

Session Chair: Yu An, Peking University, Beijing, China

1 Improving the Forecast Accuracy of Protected Data Using Time Series Features

Cameron Bale[1], Matthew Schneider[2], Jinwook Lee[2], [1]Drexel University, Philadelphia, PA, [2]Drexel University, Philadelphia, PA, Contact: cdb327@drexel.edu

Existing data privacy methods degrade forecast accuracy to unusable levels. To overcome this problem, we investigate the similarity between time series features that are predictive of forecast accuracy. We develop a matrix-based privacy method called k-nearest time series + (k-nTS+) swapping tailored to maintain forecast accuracy. We apply our privacy method to a forecasting competition data set where the identities of the time series are hidden but an adversary seeks to identify them. Using only six time series features, we find that k-nTS+ swapping maintains forecast accuracy and preserves the distribution of time series features much better than competitor methods at similar privacy levels. The k-nTS+ protected time series are also more representative of the original data, potentially leading to increased trust between data owners and forecasters.

2 Predicting the Price of Gold in the Financial Markets Using Hybrid Models

Mohammadhossein Rashidi, University of Massachusetts, Amherst, MA, Contact: mrashidi@umass.edu

Forecasting accurate prices in financial markets is one of the most challenging issues for market participants and researchers. The use of time-series forecasting models such as ARIMA, technical analysis variables indicating trader behavior, and psychological factors can help to create a more accurate model. By combining these factors with a stepwise regression and neural network, a hybrid model can be created for predicting the price of gold in international financial markets. This hybrid model, called "ARIMA-Stepwise Regression-Neural Network," could be used to forecast stocks, commodities, currency pairs, and other financial market instruments. The hybrid model outperforms time-series, regression, and stepwise regression models in terms of accuracy. The study could help traders in financial markets make better decisions based on accurate price predictions.

1 Anomaly Detection in Time Series Using a Hybrid Deep Learning One Class Algorithm

Waldyn Martinez, Miami University, Oxford, OH, Contact: martinwg@miamioh.edu

Detecting anomalies in time series data is an important area of research with applications in a wide variety of fields including finance, transportation, health monitoring, etc. In this work we present a hybrid algorithm consisting of a Auto-Encoder architecture as a feature extractor and a one-class peeling (OCP) support vector machine (SVM) algorithm as a discriminator to detect potential novel and anomalous observations. We find that the proposed hybrid algorithm performs favorably against other competing deep learning, statistical and machine learning methodologies.

5 TCP-ARMA: A Tensor-Variate Time Series Forecasting Method

Yu An[1], Di Wang[2], Lili Chen[3], Xi Zhang[1], [1]Peking University, Beijing, China; [2]Shanghai Jiao Tong University, Shanghai, China; [3]Beijing Academy of Blockchain and Edge Computing, Beijing, China. Contact: yu.an@pku.edu.cn

Time series forecasting based on complex high-order historical tensor data poses significant challenges due to the high-dimensional nature of these data that exhibit complex structures. Traditional time series models, designed for scalar or vector data, are insufficient for handling such data, necessitating the development of novel techniques to tackle these challenges. To address this issue, we propose a TCP-ARMA model for time series forecasting, which integrates a smoothed mean and a tensor-variate ARMA model with a parameter reduction technique. To efficiently solve the optimization problem, a tailored BCD-PALM algorithm is designed. A real-world case study was employed to validate the proposed approach, and the results demonstrate its effectiveness in addressing the challenges associated with high-dimensional tensor data.

Monday, October 16, 12:45 PM - 2:00 PM

MC84

Session.Location:CC-West 213B

Global Supply Chains

Contributed Session

Session Chair: Carlos Paternina-Arboleda, San Diego State University, San Diego, CA

1 Benefits of Extreme Political Stability and Instability of Suppliers Countries for Focal Firms: The U-Shaped Relationship

Jafar Namdar[1], Sachin B. Modi[2], Arash Azadegan[3], Milad Baghersad[4], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Villanova University, Villanova, PA, [3]Rutgers University, newark, NJ, [4]Florida Atlantic University, fort lauderdale, FL

Using a large-scale panel dataset, we investigate the relationship between a firm's performance and its suppliers' exposure to political instability. The empirical evidence suggests a U-shaped relationship between a focal firm's performance and the political instability of its suppliers' countries, indicating that the firm experiences the highest benefits when its suppliers are located in highly stable or unstable political environments. Furthermore, we discovered that the relationship varies depending on the industry category of the firm.

2 Financial Hedging Incentive Contracts in Global Supply Chains:A Distributionally Robust Approach

Xiaoyi Li, Hui YU, Chongqing University, Chongqing, China. Contact: 20200201013@cqu.edu.cn

This paper considers global sourcing decisions under exchange rate and demand uncertainties,proposes financial hedging incentive contracts to explore the characteristics of exchange rate risk mitigation policies for global supply chains. The distributionally robust Stackelberg game model is designed to solve the problem. Our results show that in the distributionally robust setting, the correlation between the exchange rate and demand does not affect the retailer's order decision. Additionally, the variance of the exchange rate and demand fluctuation has an impact on the retailer's order decision, which mainly depends on the mean value of the exchange rate. Moreover, financial hedging incentive contracts make wholesale price constraints looser, increasing the scope for upstream and downstream cooperation and enabling higher order quantity.

3 Exchange Rates and International Trade: Insights from Spatial Price Equilibrium Modeling with Policy Instruments via Variational Inequalities

Anna B. Nagurney[1], Dana Hassani[1], Oleg Nivievskyi[2], Pavlo Martyshev[2], [1]University of Massachusetts Amherst, Amherst, MA, [2]Kyiv School of Economics, Kyiv, Ukraine. Contact: dhassani@umass.edu

This paper presents a multicommodity international trade spatial price equilibrium model with exchange rates and policy instruments. The model allows for multiple trade routes, different modes of transportation, and transport through distinct countries. We identify the governing equilibrium conditions as a variational inequality problem in product path flows. A case study inspired by the impacts of the war against Ukraine on agricultural trade flows and product prices is presented. The modeling and algorithmic framework allows for quantifying the effects of exchange rates, various trade policies, and the availability of routes on supply and demand market prices and the volume of trade flows with implications for food security.

4 Capacity Investment and Pricing Strategies Across International Markets Under Currency Exchange Rate and Tariff Uncertainty

Murat Erkoc[1], Huaqing Wang[2], Chunlin Wang[3], Yu Xia[4], [1]University of Miami, Coral Gables, FL, [2]Palm Beach Atlantic University, West Palm Beach, FL, [3]University of New Mexico, Albuquerque, NM, [4]College of William and Mary, Williamsburg, VA, Contact: cwang17@unm.edu

This paper analyzes capacity investment and pricing strategies for a multinational manufacturer to hedge against exchange rate and tariff uncertainties in the competitive global market. Because of long-lead times, the capacity investment must be done before the selling season begins when the exchange rate between the two countries is uncertain. We consider a duopoly competition in the foreign country. We model the exchange rate as a random variable. An analytic model is built to study the duopoly competition in a foreign market with both currency exchange rate and tariff rate as exogenous variables. We find the optimal capacity investment and pricing strategy given various exchange rate and different tariff policy statuses. Some penetrating managerial insights are generated. Case discussion and numerical tests confirm our findings.

5 Smart Information Systems for Real-Time AI-Driven Decision Support in Ports

Carlos D. Paternina-Arboleda[1], Jesus M. Velasquez-bermudez[2], Danilo Abril[3], [1]San Diego State University, San Diego, CA, [2]Hypothalamus Ai, Miami, FL, [3]Hyphotalamus Ai, Miami, FL, Contact: cpaternina@sdsu.edu

The ongoing issues in global supply chain disruptions have raised many concerns on ports productivity among which port congestion is a key issue. This article implements an integrated tactical-operational optimization framework which raises the capabilities of port information systems to deliver smarter decision-making processes in ports. To this end, we have developed a library of multiple smart models for the optimization of ports operations, independently engaged in parallel but mathematically coordinated to achieve Autonomous Real-Time Distributed Optimization, using a novel event-driven structure to enable future implementations using digital twins. The framework has been tested to benchmark different commercial solvers on several real instances for the port under study. The results show a strong improvement in Port's operational planning.

Monday, October 16, 12:45 PM - 2:00 PM

MC88

CC-North Exhibit Hall

Monday Poster Session

Poster Session

Session Chair: Adolfo Raphael Escobedo, Arizona State University, Tempe, AZ

Session Chair: Bjorn Berg, University of Minnesota, Minneapolis, MN

Session Chair: Hrayer Aprahamian, Texas A&M University, College Station, TX

1 Are We Gaming Students Evaluations And Does It Matter?

Philip M. Goldfeder[1], James A. DiLellio[2]; [1]Northwestern University, USA, [2]Pepperdine University, USA

The utility and predictive reliability of Student Evaluations of Teaching (SET) are a controversial topic in higher education. At many schools they are a primary metric used in promotion and tenure decisions. The ideas that have been frequently researched are whether SET measure teaching effectiveness and if these evaluations can be gamed by inflating student grades. This paper will address the latter question by comparing grades and evaluations from a graduate level Data Science course taught by the same instructor over a 10-year period. Further questions investigated include what other metrics might be better correlated to student grades and any conclusions which can be drawn from this.

2 More Online Search By Investors, Less Blame On Managers?evidence From Insurance Markets

Hua Cheng[1], Luying Wang[2]; [1]University of Texas at Austin, USA, [2]Singapore Management University, Singapore

There has been limited investigation into the impact of online search on insurance markets such as Directors' and Officers' liability insurance (D&O insurance), which provides an ideal setting to examine information asymmetry. This study investigates how online search activities influence the purchase of D&O insurance among Chinese listed firms. Our analysis reveals that higher online search is associated with reduced purchases of D&O insurance, and these findings remain robust after addressing potential endogeneity concerns. Additionally, we found that the reduced D&O insurance purchases induced by online search on D&O insurance improve firm value.

3 How Empowering Leadership Affects Employee Creativity? Moderated-Mediation Analysis

Nosheen Amjad; Xian Jiaotong University, China
Results from 172 repondent from Pakistani firms confirm that empowering leadership postively affect perceived job autonomy. Moreover, job autonomy is found to mediate the association between empowering leadership and employee creativity. In addition, the study demonstrates that supervisors' creativity expectations moderates the relationship between job autonomy and employee creativity. Finally, the moderating effect of supervisor's creativity expectations in the conditional indirect association of empowering leadership with employee creativity through perceived job autonomy.

4 Long-term Mortality Prediction In Patients With Cirrhosis Using Machine Learning

Mohsen Mohammadi[1], Alexander Huang[1], Bima Hasjim[1], Praneet Polineni[1], Mitchell Paukner[1], Sydney Olson[1], Alexandra Harris[1], Julianna Doll[1], Therese Banea[1], Lisa VanWagner[2], Lihui Zhao[1], Sanjay Mehrotra[1], Daniela Ladner[1]; [1]Northwestern University, USA, [2]University of Texas Southwestern Medical Center, USA
MELD-Na is a strong predictor for 30-day mortality in patients with cirrhosis and high MELD-Na, but is less predictive of long-term outcomes. We assess the accuracy of machine-learning models that leverage additional laboratory data in predicting 1-year mortality and compare them to MELD-Na.

5 Explainable FinBERT: Extending Explanations In Sentiment Analysis Of Financial Texts Via Shapley

Yoshihiro Nishi, Hiroshi Takahashi; Keio University, Japan
Financial sentiment analysis can help investors make more efficient decisions. FinBERT has been pre-trained on a financial-specific dataset and is highly accurate in the sentiment analysis of financial documents. However, FinBERT has the disadvantage of sometimes requiring assistance to interpret or explain output results, which may make it difficult to use for critical decision-making. In this study, we propose Explainable FinBERT, which supplements the output results of FinBERT with those of SHAP and explicitly shows the impact of each word in the body of analyzed data on the results of financial sentiment analysis using FinBERT. A more detailed analysis will be conducted in the future.

6 How Does Selective Incivility Undermine Diversity In Supply Chains?

Iman Nosoohi; Dalhousie University, Canada
In this research, we introduce *selective incivility* as a behavioral risk to diversity in supply chains. We develop a conceptual model to describe how selective incivility may influence supply chain decision making, buyer-supplier relationship, and employee recruitment and retention in ways that undermine supply chain diversity.

7 Interpreting Characteristics Behaviors In Empirical Asset Pricing

Zequn Li, Ying Wu, Steve Y. Yang; Stevens Institute of Technology, USA
We propose a novel approach for interpreting machine learning models in measuring risk premium, which infers global model interpretations through local interpretable model-agnostic explanation (LIME). This method helps us understand the different behaviors in explaining the influence of the existing firm characteristics in asset pricing whether it was linear, independent, interacting, or insignificant. Our study advances the asset pricing literature by introducing a novel approach to interpreting the contribution of firm characteristics through local interpretations when using advanced machine learning methods in asset pricing.

8 Bringing Data Into Dynamic Models: Guidelines For Advanced Estimation Methods

Jose Lopez; MIT, USA
Dynamic, non-linear models require customized methods for formal estimation. Increasing data availability and computational power provide opportunities, though many audiences remain unfamiliar. Synthesizing across literatures, we develop a pragmatic workflow to guide decision making and identify promising approaches for addressing recurring problems. Additionally, we provide detailed examples through different models.

9 A Two-stage Approach To Minimize Number Of Material Movements In A Warehouse

Andrea Esposito[1], Ryme Kabak[2]; [1]MIT, USA, [2]Johnson & Johnson, USA
We propose a new approach that redefines the material categories and their placement within a fully automated warehouse. The strategy proposed is to forecast the movements of materials using deep learning, and then to optimize their storage. By doing so, we aim to streamline warehouse operations, improving efficiency and cost-effectiveness.

10 Analyzing Trends In Battery Electric Vehicles(Bev) And Hybrid Electric Vehicles (Hev) Through Patent Data With Structural Topic Modeling

Yong suk Hong[1], Hyunhong Choi[2]; [1]Kyunghee university, Korea, Republic of, [2]Kyung Hee University, Korea, Republic of

This research explores distinctions between Battery Electric Vehicles (BEV) and Hybrid Electric Vehicles (HEV) through patent data via Structural Topic Modeling (STM). Integrating time as covariate in STM, we established a trend analysis, highlighting the possible evolution in BEV and HEV related themes over time. From 1980 to 1990, the main focus in patent discussions was on HEV-related topic. Then, from 1990 to 2000, BEV topic took the lead. Between 2000 and 2010, there was a mix of common and HEV theme. Lastly, from 2010 to 2020, common topic prominently featured in latent topics

11 Analyzing Masking And Quarantine Interventions During The Covid-19 Emergency: Insights From Seir Models

Diego Hernandez; The University of Oklahoma, USA

The COVID-19 pandemic required diverse public health interventions, such as masking and quarantine, to mitigate virus transmission. This study employs SEIR models incorporating COVID-19 variants, vaccination rates, mortality rates, herd immunity, and the effects of masking/quarantine. By referencing initial reproduction numbers (Ro) for each variant, we assess the impact of interventions by comparing observed data with SEIR simulations. Our findings offer valuable insights into the effectiveness of these measures, aiding evidence-based decision-making and informing future public health strategies for similar epidemics.

12 DEMONETIZATION, FINANCIAL INCLUSION AND BANK EFFICIENCY

keyur thaker[1], Vinceint Charles[2], Abhay Pant[3]; [1]INDIAN INSTITUTE OF MANAGEMENT INDORE, India, [2]University of Bradford, United Kingdom, [3]Indian Institute of Technology Gawhati, India

The impact of Demonetization and Financial Inclusion on Indian Bank Efficiency using three measures namely, New Profit, New Cost, and New Technical, across Size and Ownership groups is examined. The impact across groups, using Repeated ANOVA is examined. Uniform impact across groups, events, and efficiency types was not found. The number of frontier banks increased. SBI, largest bank, with significant role had positive impact on cost and profit efficiency while foreign banks saw muted impact. The study unique to examine demonetization and Financial Inclusion impact on banking sector and two-stage estimation that combines DEA with repeated ANOVA.

13 Social Particles In The Open Medium: Open Collaboration In Github

Shiyang Lai; University of Chicago, USA

Drawing from sociophysics, this study posits a method to enhance structured and holistic modeling of online collaboration. By viewing individuals, teams, and collaborative surroundings as social atoms, molecules, and medium, this study employs tools and principles from physics to illustrate human interactions. This study proposes an analytical framework that adheres to the key principles of select traditional instruments from physics, while concurrently integrating more probabilistic and fluid elements to harmonize discrepancies between the two systems. This framework is tested on a dataset sourced from GitHub, including 416 thousands of users and their associated collaboration data.

14 Time Heals - A Trust Game Experiment Of Anger

Kamyar Kamyar[1], Marco Palma[2], Ian Krajbich[1]; [1]The Ohio State University, USA, [2]Texas A&M University, USA

Psychological literature has shown that emotions calm down as time passes. However, few studies have tried to apply this phenomenon to cases where economic decisions are involved. Do people remain angry at each other over time when treated unfairly in cases involving monetary stakes? To figure out, we have designed trust game experiments with monetary stakes. Specifically, we are studying the effect of time on anger in economic decision making.

15 An Empirical Study Of Daily Commuting And Employees' Work And Well-being

Vivien Lim, Thompson Teo; National University of Singapore, Singapore

This study examined the commute stress and enjoyment experienced by employees during their morning and evening commute. Data were collected from 174 employees who utilized public transportation in their morning (home to work) and evening (work to home) commute in Singapore. Results suggest that the morning and evening commutes are different in terms of the stress and enjoyment they engender, as well as in the extent to which different types of activities are carried out. The evening commute was related with higher levels of recovery. These findings hold some practical implications for commuters and public transportation service providers.

16 Content Promotion For Online Content Platforms With The Diffusion Effect

Yunduan Lin[1], Mengxin Wang[1], Zuo-Jun Max Shen[2], Heng Zhang[3], Renyu Zhang[4]; [1]University of California, Berkeley, USA, [2]University of California Berkeley, USA, [3]Arizona State University, USA, [4]The Chinese University of Hong Kong, China

In this paper, we tackle the candidate generation and promotion optimization (CGPO) problem in online content platforms, incorporating the diffusion effect neglected by traditional promotion policies. We introduce a diffusion model to characterize content adoption, leading to an NP-hard CGPO problem. To estimate model parameters from platform data, we propose Double Ordinary Least Squares (D-OLS) estimators. Our CGPO solution demonstrates submodularity, permitting an efficient approximation. In a video-sharing platform case study, our promotion policy increased total adoption by 49.90% over the existing policy, underlining diffusion's importance in online content promotion.

17 Cooperative Connected Automated Vehicle Control: Strategies For Speed Harmonization In Mixed Autonomy Traffic

Zhe Fu, Abdul Rahman Kreidieh, Alexandre Bayen; University of California, Berkeley, USA

We explore methods for generating traffic-regulating behaviors by automated driving systems through feedback control and imitation learning. We construct an expert policy that exploits knowledge of global states of traffic to homogenize the movement of vehicles towards their desirable uniform-flow equilibrium. We then demonstrate that imitation learning techniques can successfully capture such behaviors using only local observations and relatively few interactions with the environment. The proposed expert strategy that served as part of the "speed planner" was deployed on 103 automated vehicles in a massive traffic experiment conducted on Nashville's I-24 highway in November 2022.

18 Competitive Landscape Analysis On College, Academic Program And Student Levels

Krystie Dickson[1], Vladimir Zlatev[2]; [1]Boston University, USA, [2]Boston University Metropolitan College, USA

The Competitive Landscape Analysis Framework (CLA) was developed to gain insights into the performance of programs offered at Boston University Metropolitan College. The framework seeks to analyze data of competing universities by rating and ranking them to determine the competitive positioning of our programs based on various key differentiating factors.

19 Durability Design Of Conspicuous Products

Jiacheng Guo[1], Lai Wei[2]; [1]Princeton University, USA, [2]Boston College, USA

For conspicuous consumption good, durability not only have a direct impact on the second-hand market, but also affects consumers' utilities of status from it. The latter is due to a diluted exclusivity value of the product when there is an increase in sales, whether on the first-hand or second-hand market. In this context, we examine the ideal durability decisions for conspicuous goods, particularly in cases of competition between two products.

20 Study Of Influencing Factors Of Trust Formation In Digital Economy

Cong Cao, Yangbin Xu, Jinyang Zhou; Zhejiang University of Technology, China

This research study investigates online trust as a breakthrough point aiming at consumers in the digital economy; as such, it examines specific factors that influence consumers' online trust. Based on a literature review and existing research results in relevant fields, with the TPB as the theoretical underpinning, this study proposes a three-dimensional integrated trust model and identifies three factors that impact consumers' trust: personal attitude, online reviews and TTPs. The required experimental data were obtained using random sampling and online questionnaires. Moreover, the study investigated the mechanism and impact of different factors on consumers' trusting behaviours.

21 Pricing Strategies For Profitability And Market Opportunities: A Case Study

Xilin Zhang; Binghamton University, USA

This study analyzes the impact of pricing strategies on profitability across sectors. We evaluate cost-based, competition-based, and value-based pricing approaches and their influence on profitability and market opportunities. To maximize profit margins and sales, companies must carefully consider pricing approaches. We explore the benefits of value-based pricing, implementation barriers requiring change, and recommend its strategic adoption to leverage market advantages. Also, we analyze the benefits of cost-based and competition-based pricing in achieving specific goals. Our proposed pricing model integrates these approaches, offering flexibility for diverse objectives.

22 Crafting A Compelling Narrative: How Self-presentation Influences The Success Of Online Medical Crowdfunding Campaigns

Shuaishuai Yang; University College London, United Kingdom

Like in daily life, most people want to create a positive image by selectively providing information based on others' preferences. Online medical crowdfunding fundraisers also aim to manage donors' perceptions of their campaigns to achieve their fundraising goals. The fundraisers usually present their situations differently. Different pictures and writing styles will give donors different impressions of patients and their campaigns. Moreover, the impressions could significantly affect donors' intention to donate. Therefore, the objective of this research is to investigate the impact of various self-presentation styles on the efficacy of medical crowdfunding campaigns.

23 Modeling The Spread Of Circulating Vaccine-derived Poliovirus Type 2 Outbreaks And Interventions

Yuming Sun[1], Pinar Keskinocak[1], Lauren N. Steimle[1], Stephanie Kovacs[2], Steven Wassilak[2]; [1]ISyE Georgia Tech, USA, [2]CDC, USA

Despite the successes of the Global Polio Eradication Initiative, there are circulating vaccine-derived poliovirus outbreaks that require improved interventions. We built a compartmental model to simulate the spread of polio and evaluate interventions. We validated the model and tested the impact of interventions that varied in the number of vaccination rounds, the target regions, and the start dates. Results indicated to stop the outbreaks, stakeholders should conduct aggressive interventions with more rounds, shorter delays from detection to vaccination, and broader coverage compared to the current practice.

24 Breaking The Law, Or Breaking Even? The Factors Affecting SVoD Password Sharing Piracy In The Context Of Digital Piracy Neutralization

Jaehyun Lee[1], Yeolib Kim[2], Yoonhyuk Jung[3]; [1]Ulsan National Institute of Science and Technology (UNIST), Ulsan, Korea, Republic of, Korea, Republic of, [2]Ulsan National Institute of Science and Technology (UNIST), Korea, Republic of, [3]Korea University, Korea, Republic of

Subscription Video on Demand (SVoD) platforms are experiencing a new type of digital piracy: password sharing. Our research analyzes piracy neutralization, password borrowing/lending, and moderating factors to explore password-sharing piracy preconditions. We conducted a survey on Amazon Mechanical Turk to identify the nature of password sharing. We found that piracy neutralization has a significant impact on password-sharing piracy. Moreover, privacy concern, fashion involvement, and network dynamics moderates the main effects. The study contributes to the digital piracy literature and offers practical insights for SVoD services to better understand password sharing.

25 Statistical Teleodynamics Analysis Of Emergent Equilibria In The Schelling Game

Jessica Shi; Columbia University, USA

The behavior of a Schelling type agent-based model is studied. The space is divided into blocks, and agents move between blocks to maximize their utility. The agent utility function is dependent on block density and parameters. At equilibrium, all agents have equal utility and the system could exhibit segregation in which agents cluster in certain blocks. We programmed the agent-based simulation with NetLogo. We identify the parameter ranges for non-monotone utility functions which are necessary for segregation, and we show the asymptotic behavior of the system given initial conditions and verify it through simulation. The model emulates socioeconomic segregation occurring in many urban areas.

26 Shared Parking And Charging Management In Multi-unit Dwellings

Ruolin Zhang, Eleftheria Kontou; University of Illinois at Urbana-Champaign, USA

In urban areas, the search for parking and charging results in vehicle cruising and congestion. However, private parking spaces and charging infrastructure in multi-unit dwellings (MUDs) could be available during daytime, when MUD residents drive their vehicles to work. We design a shared parking and charging system for MUD charging hubs and public users to provide accessible parking and charging services to the general public. A binary integer linear programming (BILP) model is formulated for the supply side. Counterfactual analysis is conducted to model users' charging behavior. Results from a numerical experiment in Chicago, Illinois using real-world data will be presented.

27 Keeping The Lights On: Optimizing Gas Allocation For Extreme Winter Energy Demands

Ashish Radhakrishnan; The Pennsylvania State University, USA

The growing interdependence of natural gas and electricity infrastructure in the U.S. has caused reliability concerns during extreme winter weather events such as the 2014 Polar Vortex and 2021 Winter Storm Uri. Lack of natural gas fuel supply was found to be a major contributor behind the power outages experienced during these events. The primary driver behind the fuel supply delivery risk is rooted in the way gas is currently allocated to the various end users. This study builds an optimization modeling framework that endogenously models the fuel supply delivery risk to allocate gas amongst various end users. The benefits of the optimal allocation are analyzed for the Northeastern part of U.S.

28 Waiting Together: How To Infer Response Time When Customers Wait In Groups

Yanting Li[1], Ricky Roet-Green[2]; [1]University of Rochester, Simon business school, USA, [2]Simon Business School, University of Rochester, USA

In this work, we relax two fundamental assumptions in the strategic queuing literature: (1) customers arrive one after the other and (2) the service provider serves customers one by one. We study customers' strategies under Bayesian updating in the case of uncertainty for the demand ratio where customers are either single or in a group. We find that providing group information to customers is not always beneficial regarding revenue maximization. When the demand ratio is at a specific range, it is better not to disclose any information to customers.

29 Dynamic Vehicle Yard Operations Under Uncertainty

Katja Meuche[1], Mathieu Dahan[1], Benoit Montreuil[2]; [1]Georgia Institute of Technology, USA, [2]Georgia Tech, USA

A vehicle yard is a set of parking lots between which groups of vehicles are moved. The movements are executed by multiple assigned teams of relocators who themselves are transported in vans. We propose a Markov decision process to determine the dynamic operations of the vehicle yard while accounting for travel time and vehicle demand uncertainty. We leverage the problem structure to propose two solution approaches based on a cost function approximation policy and an approximate dynamic programming policy. We compare their performance on a test instance to minimize relocator idle time and late vehicle movements.

30 Food Transportation Safety And Food Recalls

Bukola Bakare[1], Sarah Campbell-Sengupta[2]; [1]Western Carolina University, USA, [2]St. Cloud State University, USA

Contaminated food is the number one cause of food recalls in the United States. The CDC reported 7,659 illnesses, 2,044 hospitalizations, and 41 deaths from 2017-2020 foodborne outbreaks in produce alone. The USDA has continually strengthened sampling programs to understand relative risks in food contamination. Food safety inspections are done on local and imported produce. Thus, annual sampling in food transportation has had a significant impact. Safety regulations are closely monitored, yet, there is an unexplained gap between the number of food related recalls and food safety inspections. This study uses data from USDA and CDC to track food recalls and the implemented food security.

31 The Impact Of Construal Level On Planning Fallacy: Programmers' Construal Level And Their Estimations On Workload

Hongyu Gao[1], Mark Keil[1], Yi Yang[1], Jong Seok Lee[2]; [1]Georgia State University, USA, [2]University of Tennessee, Knoxville, USA

The planning fallacy has long been recognized as a prevalent phenomenon in IT project management. Construal Level Theory (CLT) suggests that individuals with distal or proximal psychological distance perceive things abstractly or concretely, respectively. This study aims to investigate the impact of construal level on the planning fallacy. Specifically, we propose that when individuals focus on the similarities between projects, they tend to underestimate the workload of the specific project. When individuals concentrate on a project's distinctive aspects, they are inclined to overestimate its workload. A preliminary study with professional programmers lends support to the hypotheses.

32 Stochastic Dominant Resource Allocation Fairness With A Cloud Computing Application

Jiaqi Lei, Sanjay Mehrotra; Northwestern University, USA

Allocation of limited resources across different operational areas requires consideration of fairness. In this paper, we introduce the concept of stochastic dominant resource fairness for multi-resource allocation. We demonstrate that the proposed model is amenable to approximation using Sample Average Approximation, which is second-order cone representable and satisfies key properties of Stochastic Pareto-efficiency, Stochastic sharing incentive, and Stochastic envy-freeness under suitable conditions. A cloud computing application with real-world data shows that consideration of stochasticity is important when the desired resources have greater variance.

33 Advertising Pricing: The Impact Of The Integration Of E-commerce On Social Media Platforms

Jiayu Fan, Subodha Kumar; Temple University, USA

Several multi-sided platforms, including TikTok and Instagram, have recently introduced in-app shopping capabilities, meanwhile, TikTok built connections with third-party suppliers or manufacturers. This integration with eCommerce is set to revolutionize the revenue ecosystem of these platforms, prompting changes in ad pricing strategies and revenue-sharing policies. Users can now conveniently browse products and make purchases directly within the app. In addition to generating revenue through advertisements, these platforms also earn commissions on each purchase. This poses new questions regarding the pricing of two distinct ad types: traditional ads and shoppable ads.

34 A Systematic Modeling Framework For Sustainable From-farm-to-fork Logistics Network Design And Planning

Chao Lei, Waiyanet Phuwadon; Shanghai Maritime University, China

The distribution of perishable goods throughout the world has been largely restricted to short distances because of their perishability; however, poor transportation planning has contributed to a substantial amount of supply chain costs. A sophisticated long-haul food network design is depicted as a challenging task in an optimization model. We present a mathematical model for "farm-to-fork" logistics networks involving the export of perishable products from regional farms to an overseas country. A case study based on the fresh food logistics system between Thailand and China is undertaken to demonstrate the relevance of the proposed approach to accelerating sustainable development.

45 Local Acceptance Of Hydrogen Power Plant Project: The Case Of South Korea.

Seungyeon Lee; Korea University, Korea, Republic of

This study aims to determine the willingness-to-accept (WTA) of local residents regarding the construction of a fuel cell power plant (FCPP) using the contingent valuation method (CVM) and the marginal-willingness-to-accept (MWTA) of the factors affecting acceptance using the discrete choice experiment (DCE) method. Combining the two methods, a simulation was conducted to determine the subsidy level based on FCPP attributes. The results showed that constructing a 5MW FCPP with a storage tank, supplying hot water to households, could secure acceptance with a WTA of 7.8 million KRW/year (USD 6,037/year). This study provides practical evidence for policymakers to promote H_2 economy expansion.

35 Quantifying The Impact Of Energy Storage In PJM Interconnection

Shailesh Wasti[1], Anthony Giacomoni[2], Sushant Varghese[1], Aravind Retna Kumar[1], Mort David Webster[1]; [1]Pennsylvania State University, USA, [2]PJM Interconnection, USA

In this study, we model the interaction of energy storage resources (ESRs) in the Day-Ahead and Real-Time Markets of PJM Interconnection to assess their impacts under system uncertainties such as real-time net-load variability and random outages. The results show integrating ESRs reduces the total online capacity of coal generators in the day-ahead market at the expense of worsening overall system reliability by increasing unserved energy and reserve capacity shortages. We propose a multi-interval real-time market and stochastic fast-start unit commitment as market enhancements and demonstrate that system reliability and bid production cost improve while reducing the coal capacity online.

36 Using Etl And Data Visualization Tools To Enhance Career Services For Analytics Master Program Student

Putranegara Riauwindu, Vladimir Zlatev; Boston University, USA

This poster proposes an ETL framework & Data Visualization method to provide tailored occupation information for analytics graduates, specifically for Boston University Metropolitan College (BU MET) Applied Business Analytics students. The data is extracted from various sources, manipulated using MS Power Query and Excel, and stored in MS SharePoint. Interactive visualizations are created in MS Power BI, resulting in two dashboards: Analytics Career Prospect and Job Market Consultation. These dashboards offer comprehensive information on occupations, salary, job posting trends, required skills, industries, and more. They serve as a convenient and efficient resource for career research.

37 Using Extract, Transform, And Load Framework And Data Visualization Tools To Enhance Career Services For Analytics Master's Program Student

Putranegara Riauwindu, Vladimir Zlatev; Boston University, USA

This poster proposes an ETL framework & Data Visualization method to provide tailored occupation information for analytics graduates, specifically for Boston University Metropolitan College (BU MET) Applied Business Analytics students. The data is extracted from various sources, manipulated using MS Power Query and Excel, and stored in MS SharePoint. Interactive visualizations are created in MS Power BI, resulting in two dashboards: Analytics Career Prospect and Job Market Consultation. These dashboards offer comprehensive information on occupations, salary, job posting trends, required skills, industries, and more. They serve as a convenient and efficient resource for career research.

38 The Nexus Of Crisis Perception: Unraveling The Link Between Covid-19 And Climate Change Concerns

Sabrina Tang[1], Dennis Cui[2]; [1]Northwood High, USA, [2]Wayzata High School, USA

Our study examines the relationship between individuals' perceptions of the COVID-19 pandemic and their subsequent attitudes towards climate change, and finds that concern about COVID-19 correlates with stronger attitudes towards climate change. Our findings shed light on the interconnectedness of crisis perception and highlight the potential for combating climate change.

39 Student Initiated Management Science-based Projects In An MBA Course

David G. Hollingworth, Tara Stiles-Rath; University of North Dakota, USA

MBA students typically have lower levels of training, experience, and comfort with quantitative methods. In addition, they are usually more interested in practical use, rather than technical detail. This poster describes the use of student-initiated Management Science-based projects in an MBA course to enhance student motivation and learning by solving problems that they identify as personally relevant. The projects facilitate higher impact learning by taking concepts out of the classroom and encouraging hands-on learning-by-doing. Key aspects of project are identified, a sampling of projects that students have initiated and completed, and a detailed example of a recent project is provided.

40 Spectral Bundle Methods For Primal And Dual Semidefinite Programs

Feng-Yi Liao[1], Yang Zheng[2], Lijun Ding[3]; [1]University of California, San Diego, USA, [2]University of California San Diego, USA, [3]University of Washington and University of Wisconsin - Madison, USA

We present an overview and comparison of Spectral Bundle Methods (SBMs) for solving both *primal* and *dual* semidefinite programs (SDPs). In particular, we introduce a new family of SBMs for solving SDPs in the *primal* form. The algorithm developments are parallel to those by Helmberg and Rendl, mirroring the elegant duality between primal and dual SDPs. The new family of SBMs achieves linear convergence rates for primal feasibility, dual feasibility, and duality gap when the algorithm captures the *rank of the dual solutions*. The original SBM by Helmberg and Rendl is well-suited for SDPs with low-rank primal solutions, while our new spectral bundle method works well for SDPs with low-rank dual solutions.

41 Robust Screening And Partitioning For Feature Selection

Ethan Houser, Sara Shashaani; North Carolina State University, USA

Feature selection (FS) is the process of eliminating irrelevant or redundant covariates in a dataset to construct interpretable prediction models. Solving FS with optimization is often done greedily and inefficiently. We propose a stochastic search with optimality guarantees for FS using a partitioning structure informed by an initial screening phase.

42 Link Prediction Models For Organ Illicit Networks

Hasini Balasuriya, Monica Gentili; University of Louisville, USA

Link prediction models are vital for analyzing complex networks by predicting missing or future connections and are particularly significant in understanding and combating illicit organ trafficking networks. This preliminary study compares different models experimentally to solve the static link prediction problem and employs multiple evaluation metrics to assess their accuracy. The findings contribute to enhancing our understanding of link prediction models' performance in this domain.

43 An Integrated RSM-ANN Technique To Predict The Optimal Pricing Strategy

Moddassir Khan Nayeem[1], Shahriar Tanvir Alam[2], Omar Abbaas[1]; [1]University of Texas at San Antonio, USA, [2]University of Southern California, USA

It is deemed pertinent to have knowledge of product demand and pricing strategies to achieve the economics of scale and profitability of a product. The price, salvage value, and cost of the product have a significant influence on the expected profit, overstock, and understock of an order. Therefore, in this study, the price, salvage value, and cost of a product along with the mean and standard deviation of demand are considered deciding factors in controlling the expected overstock and understock. This study combines the Response Surface Methodology (RSM) and Artificial Neural Network (ANN) to determine the combination of optimum deciding factors to find the maximum expected profit from an order.

44 Learning Fixed Points In Recurrent Neural Networks

Vicky Zhu[1], Robert Rosenbaum[2]; [1]Babson College, USA, [2]University of Notre Dame, USA

Fixed points of recurrent neural networks are commonly used to model neural responses to static or slowly changing inputs. These applications raise the question of how to train the weights in a recurrent neural network to minimize a loss function evaluated on fixed points. A natural approach is to use gradient descent on the Euclidean space of recurrent weights. However, this approach can lead to poor learning performance. Under a re-parameterization of the network, we derive two alternative learning rules that produce more robust learning dynamics and show that one of the learning rules can be interpreted as gradient descent under a non-Euclidean geometry on the space of recurrent weights.

45 A New Upper Bound Of The Euclidean Tsp Constant

Yue Yu, John Gunnar Carlsson; University of Southern California, USA

Let $X_1, X_2, \ldots, X_n$ be n independent and uniformly distributed random points in a compact planar region *R* of area 1. Let $TSP(X_1, \ldots, X_n)$ denote the length of the optimal Euclidean traveling salesman tour that traverses all these points. The classical Beardwood-Halton-Hammersley theorem (1959) proved the existence of a universal constant β_2 whose best bounds are $0.625 \leq \beta_2 \leq 0.92116$. Building upon an approach proposed by Steinerberger (2015), we present a computer-aided proof that improves its upper bound to $\beta_2 < 0.90304$.

46 A Machine Learning Embedded Dijkstra's Algorithm For Shortest-path Problems

Weiheng Zhong, Hadi Meidani; University of Illinois Urbana Champaign, USA

The shortest path computation in dynamic graphs is crucial in a variety of applications, including internet routing services and product recommendations. To achieve the efficiency requirements for these applications, machine-learning-based solutions are proposed. However, these methods cannot overcome the barrier of graph topology generalization. Hence, we proposed a novel class of methods for solving shortest-path problems by embedding machine-learned components into a Dijkstra-based algorithm. By combining a purely heuristic method and a purely data-driven model, our algorithm achieved satisfactory performance and could be directly applied to unseen graph topologies in multiple fields without re-training.

47 Projection-free Methods For Solving Nonconvex-concave Saddle Point Problems

Morteza Boroun, Erfan Yazdandoost Hamedani, Afrooz Jalilzadeh; The University of Arizona, USA

In this study, we investigate a class of constrained saddle point optimization problems where the objective function is nonconvex-(strongly) concave and smooth. This class of problems has wide applicability in machine learning, including robust multi-class classification and dictionary learning. Several methods have been developed for tackling this problem when the projection onto the constraint set is easy to compute, however, the availability of methods with projection-free oracles remains limited. To address this gap, we propose efficient single-loop projection-free methods reliant on first-order information.

48 Stochastic Sustainable Supply Chain Network Design For Reusable Products

Amir Hossein Sadeghi, Robert Handfield; North Carolina State University, USA

This project addresses the problem of supply chain network design for reusable products in a single-vendor, multi-product, multi-retailer, with a focus on economic and environmental sustainability. The objective is to efficiently manage product reuse and recovery, considering various constraints such as budget limitations, storage capacity, and the number of orders. To capture the uncertainty associated with these constraints, a stochastic formulation is adopted to provide a more realistic representation of the problem.

49 A Unified Machine Learning Framework For Optimization Under Uncertainty

Justin Dumouchelle; University of Toronto, Canada

Stochastic programming and robust optimization are powerful modeling frameworks for decision-making under uncertainty. Typically, algorithms in these domains are limited to a class of problems or are even problem specific. This work presents a unified machine-learning framework for computing high-quality solutions within various problems in both domains. By approximating the intractable aspects of these optimization problems with machine learning models, we can formulate easy-to-solve surrogate optimization problems that can be solved efficiently with off-the-shelf libraries.

50 Optimal Diagonal Preconditioning

Zhaonan Qu[1], Wenzhi Gao[1], Oliver Hinder[2], Yinyu Ye[1], Zhengyuan Zhou[3]; [1]Stanford University, USA, [2]University of Pittsburgh, USA, [3]Stern School of Business, New York University, USA

Preconditioning has long been a staple technique in optimization. In this paper, we study the problem of optimal diagonal preconditioning, that achieves maximal reduction in the condition number of any full-rank matrix. We first reformulate the problem as a quasi-convex optimization problem and provide a bisection and an interior point method. Next, we specialize to one-sided optimal diagonal preconditioning problems, and demonstrate that they can be formulated as standard dual SDP problems. Our findings suggest that optimal diagonal preconditioners can significantly improve upon existing heuristics-based diagonal preconditioners at reducing condition numbers.

51 Bayesian Feasibility Determination With Multiple Constraints

Tingnan Gong[1], Liu Di[2], Yao Xie[1], Seong-Hee Kim[1]; [1]Georgia Institute of Technology, USA, [2]Google, USA

We aim to efficiently determine a feasible region of a group of unknown black box functions that assign real numbers to discrete alternatives. Unlike existing binary classifications that primarily develop a classifier trained on a fixed number of data, we optimize the order of alternative sampling to achieve high accuracy in feasibility determination with few observations. To achieve this, we utilize the Gaussian process as the surrogate model and introduce a novel value-of-information acquisition function to perform adaptive sampling under multiple constraints. We thoroughly analyze the convergence of our proposed scheme and demonstrate its effectiveness through numerical experiments.

52 A Proactive/reactive Mass Screening Approach With Uncertain Symptomatic Cases

Jiayi Lin[1], Hrayer Aprahamian[1], George Golovko[2]; [1]Texas A&M University, USA, [2]The University of Texas Medical Branch, USA

This work employs population-level risk data to optimize the allocation of limited testing resources between proactive screening of specific groups and reactive screening of symptomatic cases, integrating individual and Dorfman group testing. By analyzing the optimization problem, efficient solutions are devised. A case study using geographically-based COVID-19 data in the US reveals up to 52% reduction in total misclassifications compared to conventional strategies, and provides valuable managerial insights regarding the allocation of proactive/reactive measures and budget across regions.

53 A Streamlined Heuristic For The Problem Of Min-Time Coverage In Constricted Environments

Young In Kim[1], Spiridon Reveliotis[2]; [1]Georgia Institute of Technology, USA, [2]ISyE Georgia Tech, USA

We consider the employment of networked robotic fleets for the support of inspection tasks taking place in constricted environments, like subterranean utility networks or pipelines, in an expedient manner. We provide a taxonomy regarding the formal positioning of this problem, analytical characterizations for some members of this taxonomy in the form of mixed integer programs, a formal analysis of the worst-case computational complexity, and additional structural results that eventually enable the development of an efficient heuristic for the considered variates of the addressed problem.

54 Optimizing Electric Vehicle Charging Station Locations: Exploring Grover's Quantum Searching Algorithm

Tina Radvand[1], Alireza Talebpour[2]; [1]University of Illinois at Urbana- Champaign, USA, [2]University of Illinois at Urbana-Champaign, USA

Electric Vehicles (EVs) offer sustainable solutions for environmental concerns. However, limited charging station infrastructure impedes their widespread adoption. Determining optimal charging station locations is an NP-hard combinatorial optimization problem. Recent quantum computing breakthroughs address the computational power needed.This poster presents a novel approach using Grover's Quantum Searching Algorithm to optimize charging stations for long-distance trips. Grover's algorithm exhibits exponential speedup for solving combinatorial optimization problems. Employing a 433-qubit Osprey processor, this research showcases its capabilities on a sample graph.

55 Facilitating The Movement Emergency Response Vehicles In A Transportation Network: A Two-level Routing Framework

Jamal Nahofti Kohneh, Pamela Murray-Tuite; Clemson University, USA

This study presents a two-level routing framework to facilitate the movement of emergency response vehicles (ERVs) in a transportation network. In the first level, the framework utilizes mixed-integer programming (MIP) models to generate optimized micro-paths for multiple ERVs in different road types. In the second level, a dynamic routing approach employs the traffic simulation tool SUMO to execute Dijkstra's algorithm, integrating the optimization results from the first level to assist ERVs in selecting the shortest travel-time path across the network. The findings demonstrate improved ERVs' travel time compared to static routing with lights and sirens.

56 Patient-Centric Early-Stage Clinical Trial Design

Hanwen Liu, Amin Khademi, Qi Luo; Clemson University, USA

We propose an innovative patient-centric design for early-stage clinical trials, wherein patients actively determine therapy times and dose selection by solving an optimal stopping problem. This approach balances the exploration of the dose-response curve and maximization of patients' utility. Our findings indicate that involving patients' preferences in the decision-making process of clinical trials not only boosts patient recruitment but also accelerates the drug development process.

57 Can Multiple Offers Achieve Higher Profits? Ride-Hailing Platform

Amir Zamani[1], Subodha Kumar[2]; [1]Fox Business School, USA, [2]Fox School of Business, Temple University, USA

This paper examines a novel feature on the driver's side of a ride-hailing application using a game-theoretic model that aims to determine the optimal pricing strategy for the platforms in scenarios involving price-sensitive riders. The feature entails sending two ride requests simultaneously to each driver, in contrast to the conventional practice of drivers receiving a single request. Through an evaluation of its impact and a comparison with the traditional approach, valuable insights can be gained regarding the benefits and drawbacks of this feature. We consider both the 1-offer and 2-offer settings and extend our model to incorporate the behavior of impatient riders.

58 Adaptive Strategies For Flooding Risk Management Under Climate Change: A Reinforcement Learning Application For Nyc

kairui feng, ning Lin, Oppenheimer Michael; Princeton University, USA

The escalating threat of storm-induced flooding, driven by climate change, rapid coastal development, and sea-level rise, highlights the urgent need for advancements in coastal flood risk management. This study introduces a reinforcement learning-based strategy for adaptive seawall design, allowing for regular adjustments based on observed data to better address the deep uncertainties associated with climate change impacts. Our findings reveal that implementing the dynamic, reinforcement learning strategy results in a substantial reduction in total life-cycle costs by 20% to 40% compared to conventional approaches.

59 Electric Stampede: A Robust Solution To The Challenging Task Of Us Power Grid Optimization

Hussein Sharadga[1], Javad Mohammadi[1], Constance Crozier[2], Kyri Baker[2]; [1]The University of Texas at Austin, USA, [2]University of Colorado, USA

Our team actively participates in the US Department of Energy's Power Grid Optimization Competition, solving the intricate challenge of optimizing the US power grid. This competition poses a significant challenge due to the complicated nature of the problem, involving millions of variables and constraints, including binary variables and nonconvex, nonlinear characteristics. To overcome these complexities, we employ techniques like constraint relaxation, linearization, and problem reformulation. By leveraging these methods, we efficiently solve complex problems while maintaining optimality and meeting time constraints. Our proposed model excels above all others for its robustness.

60 Pivotal Uncertainties To Resolve - Optimal Information Gathering In Supply Chain Design

Austin I. Saragih[1], Milena Janjevic[1], Matthias Winkenbach[1], Jarrod D. Goentzel[1], Gilberto Montibeller[2]; [1]Massachusetts Institute of Technology, USA, [2]Loughborough University, United Kingdom

In this paper, we formulate an optimal information gathering strategy (IGS) to identify which uncertainties in the supply chain network drive our decisions. Existing approaches consider uncertainties, but do not consider the benefit of resolving them. Based on stylized, numerical, and case study results, we show a significant value of optimal IGS. As a non-monotone non-submodular minimization problem, we solve the problem with an algorithm which achieves a constant approximation guarantee.

61 Impacts Of Natural Gas Ordinances On Long-term Energy Investment Decisions

Stephanie Wilcox[1], Ozge Kaplan[2], Ben Hobbs[1]; [1]Johns Hopkins University, USA, [2]U.S. Environmental Protection Agency, USA

Several cities in the U.S. have enacted GHG-limiting ordinances to reduce on-site building sector emissions. However, analyses of the ordinances' long-term impacts on natural gas and power system infrastructure investment are missing from the literature. In this study, we extend the U.S. EPA's City-Based Optimization Model for Energy Technology to model long-term minimum cost energy and building sector investment decisions of NYC's GHG-limiting ordinance. Our results show that the cost-optimal investment decisions depend heavily on the inclusion of necessary system upgrades such as natural gas main replacements and future costs of "clean" natural gas substitutes.

62 Multi-objective Ship Schedule Recovery With Voluntary Ship Speed Reduction Zones And Emission Control Areas

Zeinab Elmi, Bokang Li, Maxim A. Dulebenets; Florida A&M University-Florida State University, USA

In order to reduce ship emissions in the vicinity of ports, some ports provide dockage fee refunds for ships sailing below a particular speed threshold near these ports. Such programs are expected to substantially improve environmental sustainability but impose limitations on ship schedule recovery in response to disruptions where ship speeding-up is viewed as a common option. Furthermore, emission control areas within the vicinity of ports impose additional restrictions. This study presents a new multi-objective optimization model for ship schedule recovery that directly captures voluntary speed reduction programs and emission control areas in order to facilitate the analysis of tradeoffs.

63 Remanufacturing And Recycling Decisions For Critical Parts And Materials

K Jo Min, Samantha Bradley, Alexander Hoffmeister, Mohammad Ahnaf Sadat, John Jackman; Iowa State University, USA

We construct and analyze remanufacturing and recycling facility decisions when the price of high valued parts and materials follows a geometric Brownian motion process.

By stochastic optimal control, we find the optimal price thresholds and timings. Illustrative example is given in the case of Nickel.

64 Autonomous Drone Delivery Problem

Zahra Gharibi[1], Mojtaba Gharibi[2], Steven Waslander[3], Raouf Boutaba[4]; [1]California Satie University San Marcos, USA, [2]University of Texas at Austin, USA, [3]University of Toronto, Canada, [4]University of Waterloo, Canada

We introduce the Vehicle Scheduling Problem (VSP) to minimize late vehicles in a transportation network while meeting safety, deadline, and speed requirements. VSP is NP-hard for common job shop scheduling objectives, but we present a heuristic algorithm and MIP formulation. Our motivation is to create a framework for scheduling Unmanned Aerial Vehicles (UAVs) in the airspace, a problem not naturally addressed in existing scheduling literature.

65 Living Together For The Future!exploring The Willingness Of Functional Restricted Groups To Use New Public Infrastructure Under The Integration Of Virtual And Real Worlds

Zhenyang Shen[1], Cong Cao[2]; [1]Zhejiang University of Technology, China, [2]Zhejiang university of Technology, China

The United Nations will establish sustainable cities and communities as one of its sustainable development goals. With the advancement of digital technology, physical space gradually intersects and integrates with virtual space based on digital technology. Functional restricted groups have obstacles when using new public infrastructure in the field of virtual and real integration. Identify the various sources of factors that affect functional restricted groups' intention to use of new public infrastructure. Analyze and verify the impact of the above factors on functional restricted groups on the concept to use of new public infrastructure.

66 Adaptive Batching For Order Picking In Warehouses

Jelmer Pier Van der Gaast; Fudan University, China

In this research, a new order batching method used in the order picking process called adaptive order batching is presented. In adaptive order batching, incoming customer orders are dynamically batched, and a pick batch can be modified in real-time even when the pick tour has already started. We develop a mathematical model for adaptive batching that minimizes the order throughput time and show when adaptive order batching outperforms other conventional batching methods.

67 Creating Majority-minority Districts In Alabama: A Column Generation Heuristic

Julia R. Allen[1],[2], Wes Gurnee[1], David B. Shmoys[2]; [1]MIT, USA, [2]Cornell University, USA

Redistricting in the US plays a crucial role in determining political representation, but it often exacerbates existing inequalities. This study proposes a two-stage approach that can be scaled effectively to optimize for various fairness criteria. In the first, a randomized divide-and-conquer column generation heuristic generates many potential districts. In the second, a master selection problem determines which districts will be included in the final plan. This work focuses on Alabama due to a recent Supreme Court case mandating the creation of new districts, with specific emphasis on creating two majority-minority districts and preserving the cohesive Black Belt community.

68 Enhancing Supply Chain Resilience Through Inventory, Process And Volume Flexibility

Fangyuan Li, Stephan Biller; Purdue University, USA

Enhancing supply chain resilience has become a prevalent research topic following the widespread product shortages during the pandemic. Different mitigation strategies have been proposed using inventory, process, and volume flexibility. Inventory is effective in dealing with short-term fluctuations, process flexibility lessens product mix mismatches while volume flexibility can effectively handle long-term and systematic demand disparities. This study will investigate how to utilize the interplay of these three strategies to achieve supply chain resilience in an uncertain environment.

69 Simulation Is All You Need

Akshit Kumar[1], Omar Besbes[2], Yash Kanoria[1], Yilun Chen[3], Wenxin Zhang[2]; [1]Columbia Business School, USA, [2]Columbia University, USA, [3]CUHK Shenzhen, USA

Motivated by online matching markets and NRM problems with many types (e.g., fulfillment optimization), we study dynamic spatial matching (DSM) in which supply and demand live in d dimensional space and need to be matched with each other dynamically. If demand and supply have different spatial distributions, the matching constraint has bite and greedy matching fails. We introduce a unifying and practical algorithmic principle for NRM and DSM dubbed SOAR: Simulate, Optimize, Assign, Repeat, which repeatedly simulates the future to enable good matching decisions. For particularly challenging NRM and DSM models, SOAR with multiple simulated sample paths at each stage achieves near optimal regret.

70 Evacuation Planning Under Traffic Congestion And Network Disruption Uncertainty

Aura Jalal, Valérie Bélanger; HEC Montreal, Canada

This study addresses evacuation planning under traffic congestion and network disruption uncertainty. We propose mathematical formulations to decide the shelter location and the flow and route definition for evacuees in a multi-period planning horizon, aiming to minimize the expected evacuation time and risk.

71 Optimal Channel Selection Considering Price Competition And Information Sharing Under Demand Uncertainty

Nan Chen[1], Jianfeng Cai[1], Devika Kannan[2], Kannan Govindan[2]; [1]Northwestern Polytechnical University, China, [2]Southern Denmark University, Denmark

The rapid development of Internet technology has led to an increasingly significant role for e-commerce platforms in economic growth. To explore how the green supply chain operates on different marketing channels with demand uncertainty, we develop a model to analyze a manufacturer's channel selection decision among the traditional offline channel, E-commerce online channel (resell mode, agency mode), and further consider the traditional retailers and E-tailer whether or not to share the demand information with the manufacturer.

72 A Nationwide Analysis Of An Oilseed Supply Chain For Sustainable Aviation Fuel

Juliana Pin; North Carolina State University, USA

This research project evaluates the Sustainable Aviation Fuel (SAF) targets established by U.S. Administration, aiming for 3 billion gallons by 2030, 17 billion gallons by 2040, and 35 billion gallons by 2050. Using oilseeds like pennycress, carinata, and camelina as feedstocks, simulations demonstrate that their combined estimated production would be sufficient to meet the 2030 SAF target at a cost of $0.20 per pound. However, relying solely on oilseeds beyond 2030 has limitations, as increasing their market price only results in an increase of less than half a billion gallons in SAF production, revealing the need of alternative feedstocks to achieve the desired goals.

73 The Bilevel Optimization Of Decentralized Multiple Projects Scheduling With Flexible Resources Supply

Xinyu Lin; Renmin University of China, China

In project scheduling, the resource supply plan is as important as the task scheduling plan, and there is a mutual influence relation between them. However, in the existing studies, these two decisions are usually separated. The focus of decentralized multi-project scheduling is how to solve the resource conflicts among projects, which can be reduced by a good resource supply plan. The paper addressed the resource competition from both the demand supply side. With the prevailing of flexible employment mode, the paper considered two ways of flexible supply of global resources, internal supply and external supply, established a bilevel optimization model, and designed a new negotiation mechanism.

74 Robust Auction Design With Support Information

Jerry Anunrojwong, Santiago R. Balseiro, Omar Besbes; Columbia Business School, USA

The seller wants to sell an item to n i.i.d. buyers and only the support [a,b] is known; a/b quantifies relative support information (RSI). The seller either minimizes worst-case regret or maximizes worst-case approximation ratio. We show that i) with low RSI, second-price auctions (SPA) is optimal; ii) with high RSI, SPA is not optimal, and we introduce a new mechanism, the "pooling auction" (POOL), which is optimal; iii) with moderate RSI, a combination of SPA and POOL is optimal. Under POOL, whenever the highest value is above a threshold, the mechanism still allocates to the highest bidder (just like SPA), but otherwise the mechanism allocates to a uniformly random buyer, i.e., pools low types.

75 Win-curves In Real-time Bidding: A Micro-foundation

Shailender Joseph[1], Ganesh Janakiraman[2], Milind Dawande[3], Vijay S. Mookerjee[2]; [1]University of Texas at Dallas, USA, [2]University of Texas- Dallas, USA, [3]The University of Texas at Dallas, USA

In this work, we show the existence of a consistent win-curve in a dynamic model of economically rational bidders who participate in a first-price auction in a real-time bidding set-up. We show this with a minimal set of assumptions and provide ways to compute the win curve numerically.

76 Scheduling Multi-skill Technicians And Reassignable Tasks In A Cloud Computing Company

SHUANG JIN[1], JIAMING TAO[2], QIAN HU[1], MINGHUI LAI[3]; [1]Nanjing University, China, [2]Meituan, China, [3]Southeast University, China

We investigate a multi-skill technician and reassignable task scheduling problem in a cloud computing company. Multi-skill technicians are assigned to process tasks from customers in a horizon. The tasks are allowed to be reassigned to others multiple times, and one technician can process in parallel. We characterize the feasible solutions and introduce a weighted objective containing three metrics, processing efficiency, response delay, and workload balance. An effective two-stage hierarchical optimization method embedded in a greedy randomized adaptive search procedure framework is proposed. Computational experiments are conducted to evaluate the effectiveness of our algorithm.

77 An Iterative Approach To Optimizing Repair Part Inventory Policies Using Simheuristics

Ruthairut Wootisarn[1], Liying Zhang[2], Xueying Wang[1]; [1]Boston University, USA, [2]Bonston University, USA

Simheuristics is an approach that allows the modeler to use a simulation and a heuristic to solve a stochastic combinatorial optimization problem. MBTA, the transportation authority in Boston, maintains an inventory of over 3 million parts used for repairs that have intermittent demand and long supplier lead times. The simheuristics approach searches for an optimal amount of parts in inventory that minimize holding, delay, and setup costs. Initial reordered points and order-to-to levels (s, S) are provided by a simple deterministic model. The heuristic is based on the slope for the total cost equation for each potential policy change.

78 Dynamic Chance Constraints For Stochastic Capacitated Lot Sizing Problems

Azadeh Farsi[1], Jianqiang Cheng[1], Boshi Yang[2]; [1]University of Arizona, USA, [2]Clemson University, USA

The economic lot-sizing problem aims to find the most cost-effective production plan to meet uncertain future demands over a specified period. In this presentation, we focus on the dynamic capacitated lot-sizing problem, which ensures demand satisfaction by imposing individual and joint chance constraint cases respectively. We develop deterministic reformulations and approximations for the chance constraints, and develop a sequential convex approximation algorithm to solve the obtained mixed-integer nonlinear approximations. Numerical tests demonstrate that the proposed dynamic model is more cost-effective than the static model while meeting the demand satisfaction requirements.

79 Task Allocation And Path Planning For Multiple Tethered Autonomous Underwater Vehicles

Abhishek Patil, Jung Yun Bae, Myoungkuk Park; Michigan Technological University, USA

This work presents a heuristic approach to efficiently solve the task allocation and path planning problem for multiple Tethered Autonomous Underwater Vehicles (T-AUVs). The proposed heuristic ensures workload balance and accounts for the entanglement-free constraint imposed by vehicle tethers. By formulating the problem as an integer programming problem with a min-max objective and entanglement-free constraints, we address the complexity arising from nonlinearity. The heuristic produces a feasible solution within a reasonable computation time, enabling its practical application in real-time operations. Simulation-based validation further confirms its effectiveness.

80 Optimization Model For Technology Investment In Steel Industry: The Case Of Korea

Woojin Son; Korea university, Korea, Republic of

The industrial sector is the largest emission source in Korea where the steel industry takes up to 39% of the sectoral emission. The goal of this work is to provide a novel approach for decision-making in the implementation of greenhouse gas reduction technology in the steel industry.A solution model elaborates a bottom-up approach for cost optimization using GAMS. The yearly investment of newly developed steel production technologies is demonstrated for existing steel production facilities in Korea. The result indicates that the model provides an optimal investment decision with reduced cost and greenhouse gas emissions.

81 A Novel Approach To Hospital Selection For Stroke Patients With Ais And Lvo

Yu-Chun Cheng, Yu-Ching Lee; National Tsing Hua University, Taiwan

Timely treatment is vital for stroke patients, especially those with AIS and LVO. Past studies on hospital selection strategies have only focused on expected treatment time. We propose a new approach that factors in the risk of not receiving definitive treatment within the therapeutic time window. By comparing the likelihood of receiving definitive treatment under various strategies, we identify the one with the least risk. The optimal strategy varies with different therapeutic time window settings and the presence of LVO. With more data, this approach could offer better hospital recommendations for stroke patients.

82 Integrated Bioenergy Network Design Under Pricing Flexibility And Uncertainty In Supply And Demand

Leyla Sadat Tavassoli, Halit Üster; Southern Methodist University (SMU), USA

We study profit-maximizing strategic bioenergy network design in an integrated fashion by considering variability in biomass (supply) as a reaction to price set as well as uncertainty in biomass yield in addition to uncertainty in biofuel demand. A stochastic model that integrates network design and inventory decisions in a multiperiod planning horizon setting is presented along with an efficient solution approach based on decomposition. The model is tested on both randomly generated instances and a real case study with data from Midwest US using GIS.

83 Inventory Distribution Planning and Optimization for Flipkart's Large Supply Chain

Shobhit Bhatnagar, Gowtham Bellala, Apoorva Agrawal, Vikas Goel, Sai Anjani Kumar KVN; Flipkart, India

We study the problem of supplier inbound (IB) planning in different fulfillment centers (FCs) for a large e-commerce company in India. Inefficient planning of inbound quantities could lead to idle manpower at FCs and loss of in-stock and speed. We propose integer programming models that maximize the IB allocation across multiple FCs and product categories subject to various constraints such as storage space, manpower and other business requirements. The proposed solution resulted in an annual savings of over $1 Million.

84 Column Generation For Multistage Stochastic Mixed-integer Nonlinear Programs With Discrete State Variables

Tushar Rathi[1], Benjamin P. Riley[1], Angela Flores-Quiroz[2], Qi Zhang[1]; [1]University of Minnesota, Twin Cities, USA, [2]Universidad de Chile, Chile

Although stochastic programming provides a natural framework for modeling sequential optimization problems under uncertainty, efficient solution of large-scale multistage stochastic programs remains a challenge, particularly in the presence of discrete decisions and nonlinearities, as well as long planning horizons and a large number of scenarios. In this work, we propose an exact decomposition approach based on column generation that takes advantage of the specific structure of multistage stochastic mixed-integer nonlinear programs with discrete state variables. Several real-world case studies are used to demonstrate the effectiveness of the proposed decomposition algorithm.

85 A Model And Method For Optimization Problems With Decision-dependent Uncertainty

Zhichao Ma[1], Jeffrey T. Linderoth[2], Jim R. Luedtke[2]; [1]University of Wisconsin Madison, USA, [2]University of Wisconsin-Madison, USA

We focus on stochastic programs with endogenous uncertainty in which decisions can affect the time of realization of uncertainty. We provide a three-stage stochastic program with binary decision variables in the first stage that can determine the realization time of uncertainty, whether in the second stage or in the third stage. We develop methods to estimate the upper and lower bounds of this problem. Additionally, we present a branch and bound algorithm to efficiently solve the problem, which can significantly reduce computation time compared to the extensive form.

86 Investigating The Impact Of Telemedicine On Service Times

Yupu Sun[1], Ersin Korpeoglu[1], Lina (Dahye) Song[2]; [1]University College London, United Kingdom, [2]University College London School of Management, United Kingdom

More people than ever needed telemedicine in response to the COVID-19 pandemic. To understand how telemedicine works across different specialties, we investigate the impact of telemedicine on service times. We find that telemedicine adoption is related to longer psychology therapies while it is associated with shorter outpatient services, compared with in-person care.

87 Free-Flow Optimal Blocking Model

Mehmet Kolcu, Clark Clark Cheng, Gunnar Feldmann; Norfolk Southern Corp., USA

A railroad blocking problem (RBP) is a routing problem grouping the shipments to minimize the shipment cost by considering various factors, such as network constraints, and the available yard resources. RBP focus on handling and distance cost, making it a multi-objective problem. Our Free-Flow Model approach initially finds an optimal trade-off between handling and distance costs for the specific shipment set by using our Optimal Blocking Model tool. Then, it lets the traffic to flow freely. Free-Flow Model brings new blocking opportunities that we do not see in the existing model and improves the current plan's quality. It supports the business by running a zero-base plan to learn new opportunities.

88 A Nonlinear Wiener Process Based Degradation Model With Damage Resistance For Reliability Analysis

Yuhan Hu, Mengmeng Zhu; NC State University, USA

The degrees of damage caused by random shocks may affect system degradation differently. In this paper, we consider a damage-resistant system, which can resist shock damage to a certain level. Contemplating the system's damage resistance, we first propose a new shock classification based on shock magnitude, and discuss the damage resistance level accordingly. Further, considering system vulnerability after multiple significant shocks, we develop two-stage degradation models using a nonlinear Wiener process incorporating the new shock classification. Lastly, the closed-form system reliability functions are derived, and numerical examples are conducted to predict system reliability.

89 Quantifying The Benefits Of Customized Vaccination Strategies: A Network-based Optimization Approach

Su Li, Hrayer Aprahamian; Texas A&M University, USA

We study the problem of designing vaccine distribution strategies through a multi-period optimization-based framework that embeds important subject-specific risk and contact information into the decision making process. By analyzing the structure of the resulting optimization problem, we identify key structural properties and two heuristic schemes. We demonstrate the benefits of the considered framework through a case study on COVID-19 in Texas. Our results highlight the importance of considering risk and contact information as doing so substantially reduces the total expected number of fatalities over conventional compartmental-based approaches.

90 Capacity Planning For Services With Customers Having Time-dependent Priorities

Jae Yoon Hwang, Tianyu Xu, Xinran Yu; Boston University, USA

The increase in product or service complexity and time-dependent urgencies can cause difficulties in determining priorities among customer needs. This poster details a capacity planning framework that is based on a discrete-event simulation, programmed in Python, to determine how priorities should be set in real time for customers waiting in queue. These systems exist for nurse dispatching, transportation deployment, police response, repair technician and call center. Dynamic urgencies increase over time until the need is addressed. An example is presented from a hospital cardiac unit that compares four different nurse dispatching rules.

91 Supply Chain Risk Response Analysis Using Utility Functions

Hanyi Zheng, Jingyi Wu, Zhilin Liu, Yucheng Yao; Boston University, USA

In response to the increasing frequency and severity of climate-related disruptions, supply chain managers can no longer rely solely on accepting a risk or transferring the risk through insurance. Decision makers must consider two alternative approaches by investing in either risk mitigation or risk avoidance. This presentation explores the integration of the analytical hierarchy process method with a color-coded decision aid that quantifies their utility function, and is consistent with the decision tree of the four alternative decisions. The proposed methodology results in a ranking of the four options with weights representing their respective preferences.

92 Existence And Uniqueness Of Bayesian Nash Equilibrium Under Multinomial Logit Demand

Jian LIU; The Chinese University of Hong Kong, Hong Kong

This paper examines the pricing problem of an individual firm using the classical Multinomial Logit (MNL) model to estimate market demand. We assume that the marginal cost of each product offered by distinct firms is private information and construct a Bayesian Nash equilibrium (BNE) model to identify the optimal pricing strategy. We prove the existence and uniqueness of the equilibrium and propose a decomposition algorithm based on the Progressive Hedging algorithm to solve the BNE. Our algorithm improves the efficiency of finding the optimal solution.

93 Social Optimal Freight Routing Pricing Considering The Ordering Behavior Of Receivers

Oriana Calderon, José Holguín-Veras; Rensselaer Polytechnic Institute, USA

The ordering decisions of the receivers of supplies play a significant role in creating freight externalities. This research develops an analytical formulation, i.e., the Social Optimal Routing and Ordering Problem (SOROP) to compute the optimal charges to induce receivers to implement socially optimal inventory management procedures. The SOROP considers: (i) the profit-maximizing behavior of receivers in decisions concerning floorspace allocation, (ii) externality charges to account for the externalities produced by their ordering decisions, and (iii) the effect of these decisions on the routing and the corresponding cost structure.

94 Mip-based Scheduling For Welding T-beams In Shipbuilding

Yeonho Kang, Minseok Song, Duksang Lee; Pohang University of Science and Technology, Korea, Republic of

During the production of T-beams for ship manufacturing, a bottleneck arose during the welding process. To minimize waste time and delays, an optimization algorithm was utilized. By applying MIP models, the welding was efficiently completed within the designated working time, resulting in increased daily production, reduced weekend work, and meeting T-beam deadlines.

95 Earned Value Measurement In Project Buffers Management

Pawel Blaszczyk; University of Silesia, Poland

The aim of this research was the trial of modelling and optimizing the time-cost trade-offs in project planning problem. The base of the problem description contains both safe and reasonable amounts of time and cost estimations and the influence factors matrix. We assumed also the pricing opportunity of performance improving. Finally we try to combine that method with Earned Value Analysis (EVA) method - one of the most popular project audit method.

96 Optimal Dynamic Pricing In The Presence Of Strategic Consumers: A Game-theoretic View

Ziqi Zhang, Zelin Zhang, Guoqing Guo; Renmin University of China, China

The current research explores a monopolist's dynamic pricing decisions facing strategic consumers under limited capacity. While previous literature has proved the existence of a unique Nash equilibrium in a seller-consumer game, we challenge this finding and show there may exist multiple Nash equilibria under such pricing policies. We highlight the interdependency (implicit collusion) and mix strategies of customers' decision-making, resulting in the inefficiency of seller's pricing policy. To address this issue, we propose a maximum-matching dynamic pricing strategy that can lead to a unique pure Nash equilibrium while generating significant profits and examine it with a lab experiment.

97 Distributionally Ambiguous Multistage Stochastic Integer And Disjunctive Programs: Applications To Multistage Two-player Interdiction Games

Sumin Kang[1], Manish Bansal[2]; [1]Virginia Tech, USA, [2]Virginia Tech., USA

This paper studies the generalizations of multistage stochastic mixed-integer programs (MSIPs) with distributional ambiguity, namely distributionally risk-receptive and risk-averse multistage stochastic mixed-integer programs (denoted by DRR- and DRA-MSIPs). These frameworks have applications in non-cooperative games involving two players with uncertainty in the impact of the decisions made by a player. We present cutting plane-based and reformulation-based approaches for DRR- and DRA-MSIPs. We also introduce generalizations of MSIPs by considering multistage stochastic disjunctive programs with(out) distributional ambiguity and present algorithms for solving them.

98 Multi-stage Models For Dynamic Ride-sharing Pairing In Taxi Services: A Case Study In Chicago

Min-Ci Sun, Cheng Zhang, Luca Quadrifoglio, Dahye Lee; Texas A&M University, USA

Ridesharing has been regarded as an effective way to mitigate traffic congestion. This study intends to propose a practical and solvable model to reduce the total travel distance. We formulate the ride-sharing problem as multi-stage models to consider multiple riders in a match, and various permutations are examined to identify the best pick-up/ drop-off sequence. Furthermore, user-centric factors, including riders' waiting time and detour tolerance, are integrated. The multi-stage optimization model is verified by the taxi data from the city of Chicago, and the result indicates that the proposed model can effectively reduce the total travel distance.

Monday, October 16, 2:15 PM - 3:30 PM

MD01

CC-North 120A

Supply-Chain-Centric View of Working Capital, Hedging and Risk Management: Integrated Supply Chain Finance (iSCF) Tutorial

Tutorial Session

Session Chair: Hari Balasubramanian, University of Massachusetts, Amherst, Amherst, MA

1 Supply-Chain-Centric View of Working Capital, Hedging and Risk Management: Integrated Supply Chain Finance (iSCF) Tutorial

Panagiotis Kouvelis, Washington University in St. Louis, Clayton, MO

Integrated Supply Chain Finance (iSCF) is a portfolio of effective operating, financial and risk mitigating practices and techniques within supply chains, which reflect strategic concerns of participating firm agents (decision makers) within the chain, and optimize not only the management of the working capital for liquidity, but also make effective use of assets for firm profitability and risk control. The main theory and research areas within iSCF are: Financing Working Capital in Supply Chains; Financial Hedging in support of Supply Chain Operations; Integrated Risk Management (IRM) in Supply Chains; Supply Chain Contracts and Risk Management. This tutorial chapter will dedicate a section in each of the above topics, and it will elucidate the foundational models and the key results in each of these areas. It will conclude with thoughts on future research topics, and how emerging technologies may be shaping the future of iSCF decision making.

Monday, October 16, 2:15 PM - 3:30 PM

MD03

CC-North 120D

Responsive Learning Technologies/FICO

Technology Tutorial

1 Littlefield 2.0 -- A New Version of the Online Game for Operations Management Courses

Samuel C. Wood, Responsive Learning Techologies, Los

Altos, CA, Contact: wood@responsive.net
After 24 years there is a new version of Littlefield! Littlefield is a competitive online simulation of either a factory or a medical laboratory that has been by more than half a million students in 500+ universities in 60+ countries to excite and engage students in operations management topics like process analysis and inventory control. This presentation will introduce a newly updated version 2 of the game that will go into production in 2024.

2 End-to-End FICO® Xpress Insight Tutorial: From Data to Decisions for Non-Technical Business Users

Jeff Day, FICO, Durham, NC, Contact: jeffday@fico.com

Monday, October 16, 2:15 PM - 3:30 PM

MD04

CC-North 121A

New Directions in the Online Allocation of Reusable Resources

Community Committee Choice Session

Session Chair: Will Ma, Columbia University, New York, NY
Session Chair: Wenxin Zhang, New York
Session Chair: Santiago Balseiro, Columbia University, Armonk, NY

1 Dynamic Pricing for Reusable Resources: The Power of Two Prices

Santiago Balseiro[1], Will Ma[2], Wenxin Zhang[3], [1]Columbia University, Armonk, NY, [2]Columbia University, New York, NY, [3]Columbia University, New York, NY, Contact: wz2574@columbia.edu
Motivated by real-world applications such as cloud computing services, we study pricing for reusable resources where system states include how many units are in use and for how long. As the system states grow exponentially, we propose a class of stock-dependent (SD) policies that adjust prices solely based on the number of available stocks. We introduce a convex optimization problem to obtain the optimal policy in this class. We provide a tight characterization of the regret of the optimal SD policy, where the local shape of the reward function is the key driver of performance. Our results demonstrate that the optimal SD policy can significantly outperform the fluid policy w.r.t. the convergence rate of regret. Interestingly, we show that a simple two-price policy that increases prices when the stock is below a certain threshold achieves the same regret as the optimal SD policy.

2 The Power of Static Pricing for Reusable Resources

Adam N. Elmachtoub[1], Jiaqi Shi[2], [1]Columbia University, New York, NY, [2]Columbia University, New York, NY
We consider the problem of pricing a reusable resource service system. Potential customers arrive according to a Poisson process and purchase the service if their valuation exceeds the price. If no units are available, customers immediately leave. Serving a customer corresponds to using one unit for an exponential service time. The objective is to maximize the steady-state revenue rate.
Although an optimal policy is fully dynamic, we provide two main results that show a simple static policy is universally near-optimal for any service rate, arrival rate, and number of units in the system. When there is one class of customers who have a monotone hazard rate (MHR) valuation distribution, we prove that a static pricing policy guarantees 90.2% of the optimal policy. When there are multiple classes of customers, we prove that static pricing guarantees 78.9% of the optimal policy.

3 Online Reusable Resource Assortment Planning with Customer-Dependent Usage Durations

Tianming Huo, Wang Chi Cheung, National University of Singapore, Singapore, Singapore. Contact: e0007875@u.nus.edu
We consider an online setting, where a revenue-maximizing decision maker offers assortments of reusable resources to a sequence of online customers. Our setting allows each customer to have a different usage duration on a reusable resource, departing from existing research works that focus on customer-homogenous usage duration models. We first consider the linear revenue case, where the revenue earned is linear in a customer's usage duration. We propose a novel online algorithm featuring the notion of rejection durations, which serve to reserve capacities for future customers. When the capacities are sufficiently large, our online algorithms achieve a competitive ratio within a constant factor from the best possible one. Our framework can be generalized from the linear revenue case to the cases of affine or constant revenue.

4 Leveraging Reusability: Improved Competitive Ratio of Greedy for Reusable Resources

Jackie W. Baek[1], Shixin Wang[2], [1]NYU Stern School of Business, Berkeley, CA, [2]The Chinese University of Hong Kong, Hong Kong, China. Contact: shixinwang@

cuhk.edu.hk

We study online weighted bipartite matching of reusable resources with adversarial requests. Matched resources are used for random durations. We examine the greedy policy, previously known to be 1/2 competitive against a clairvoyant benchmark. We improve this result by introducing a parameter that quantifies the degree of reusability. If p is the smallest probability of a matched resource returning in one step, the greedy policy achieves a competitive ratio of 1/(2-p). For geometric usage distributions, we establish a (1+p)/2 ratio, shown to be tight. Our results are robust to greedy policy approximations. Our work demonstrates that reusability enhances performance of the online algorithm, with simple greedy policies sufficing in high reusability settings.

Monday, October 16, 2:15 PM - 3:30 PM

MD05

CC-North 121B

Sequential Learning Problems in Operations Management

Community Committee Choice Session

Session Chair: Dohyun Ahn, The Chinese University of Hong Kong

Session Chair: Dongwook Shin, HKUST Business School, Clear Water Bay, Hong Kong

1 Online Resource Allocation for Reusable Resources with Many Customer Types

Xilin Zhang[1], Wang Chi Cheung[2], [1]National University of Singapore, Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore. Contact: isecwc@nus.edu.sg

We consider reusable resource allocation under uncertainty. Customers with different types arrive sequentially. The decision maker (DM) selects allocations based on observed types. Each resource unit is occupied for a random duration and becomes available again. Our model covers applications such as admission control and assortment planning. The DM aims to maximize multiple rewards, satisfy resource constraints, and handle uncertain customer arrivals. We present a near-optimal algorithm that balances rewards, resources, and durations using a novel adaptation of the Multiplicative Weight Update algorithm. Importantly, the performance guarantee remains invariant even with increasing customer types, making our algorithm applicable to machine learning driven model that involves many customer types.

2 Recommendation Policies in the Presence of Social Learning

Wen Yun[1], Assaf Zeevi[2], [1]Columbia University, New York, NY, [2]Columbia University, New York, NY

We study the interaction between recommendation policies and social learning whereby customers make purchase decisions using product reviews. A key feature is that demands keep evolving as reviews accumulate over time. A monopolist uses a recommender system to sell a single product with product reviews over a finite selling horizon. The monopolist seeks to maximize the expected total profit via a recommendation policy that determines the customer type and the amount to recommend. In the fluid approximation, we quantify effects on immediate revenues and future demands, and show how their relative importance varies with the extent of social learning. The gain of accounting for social learning, compared to benchmark policies oblivious of social learning, grows linearly or sublinearly in the selling horizon. Lastly, we propose asymptotically (near)-optimal policies.

3 Feature Misspecification in Sequential Learning Problems

Dohyun Ahn[1], Dongwook Shin[2], Assaf Zeevi[3], [1]The Chinese University of Hong Kong, Shatin, Hong Kong; [2]HKUST Business School, Clear Water Bay, Hong Kong; [3]Columbia University, New York, NY, Contact: dohyun.ahn@cuhk.edu.hk

We consider a class of sequential learning problems, where a decision maker must learn the unknown statistical characteristics of a finite set of systems using sequential sampling to ultimately select a subset of "good" systems. A salient feature of our problem is that system performance is governed by a set of features. The decision maker postulates the dependence on these features to be linear, but this model may not precisely represent the true underlying system structure. We show that this misspecification can lead to suboptimal performance, and propose a prospective sampling principle that eliminates the adverse effects of misspecification as the number of samples grows large. The proposed principle applies across a general class of widely used sampling policies, enjoys strong asymptotic performance guarantees, and exhibits effective finite-sample performance.

4 Information-Directed Selection for Pure Exploration

Wei You[1], Chao Qin[2], [1]Hong Kong University of Science

and Technology, Hong Kong, Hong Kong; [2]Columbia University, New York, NY, Contact: weiyou@ust.hk
In this study, we address pure exploration in stochastic bandits and propose an optimal algorithm framework based on problem complexity. Our conditions extend the top-two algorithm principle (Russo, 2020) for unstructured bandits and introduce an effective selection rule, information-directed selection (IDS). This selects top candidates based on information gain. We prove that integrating IDS with top-two Thompson sampling is optimal for Gaussian best-arm identification. We further illustrate instances where beta-tuning for the top-two algorithm and top-two algorithms for linear bandits are suboptimal, and propose simple algorithms to address these issues. Our IDS-integrated algorithms outperform those without adaptive selection, as shown in numerical experiments.

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MD06

CC-North 121C

Submodularity in OR: New Approaches and Applications

Community Committee Choice Session

Session Chair: Rajan Udwani, UC Berkeley, Berkeley, CA

1 Coordinated Inventory Stocking and Assortment Personalization

Yicheng Bai[1], Omar El Housni[2], Paat Rusmevichientong[3], Huseyin Topaloglu[2], [1]Cornell University, New York, NY, [2]Cornell Tech, New York, NY, [3]USC Marshall School of Business, Los Angeles, CA, Contact: oe46@cornell.edu

We study a joint inventory stocking and assortment personalization problem. We have access to a set of products that can be used to stock a facility with limited capacity. At the beginning of the selling horizon, we decide how many units of each product to stock. Over the selling horizon, customers arrive into the system and depending on the remaining inventories and the arriving customer type preferences, we offer a personalized assortment of products. Our goal is to choose the stocking quantities at the beginning of the selling horizon and to find a policy to offer a personalized assortment to each customer so that we maximize the total expected revenue over the selling horizon. We develop an approximation framework that gives the first theoretical guarantees for this class of problems. Our framework builds on techniques from submodular optimization and dynamic programming.

2 Approximate Submodularity in Network Optimization

Levi DeValve, University of Chicago, Chicago, IL

Recent work on network design problems has identified an approximately submodular structural property, called cover modularity, that leads to algorithms with strong performance guarantees. This structural property has been shown to hold in a wide range of problems whose objectives can be expressed as the solution of a linear program. We review this work and identify further applications of cover modularity to an even wider range of problems, including applications in e-commerce fulfillment.

3 Fast Algorithm for Dynamic Assortment Planning for Multinomial Logit Choice Model

Shuo Sun, Rajan Udwani, Zuo-Jun Max Shen, UC Berkeley, Berkeley, CA, Contact: shuo_sun@berkeley.edu

In this work, we consider a dynamic assortment planning problem under the Multinomial Logit choice model (MNL). Customers arrive sequentially and each customer independently chooses at most one item. Items may stock out over time and our goal is to decide on the initial stocking quantities of each item subject to a constraint on the total inventory (such as a cardinality constraint or a capacity constraint), to maximize the total expected revenue. We propose a fast and scalable approximation algorithm with a constant-factor performance guarantee that improves upon the state-of-the-art algorithms in several variants of the problem.

4 MNL-Prophet: Sequential Assortment Selection Under Uncertainty

Vineet Goyal[1], Salal Humair[2], Orestis Papadigenopoulos[3], Assaf Zeevi[1], [1]Columbia University, New York, NY, [2]Amazon, Inc., Sammamish, WA, [3]Columbia University, New York, NY

We consider a stochastic variant of the assortment selection problem under the MNL choice model, where the parameters of each item (price and attraction) are drawn from some known distribution. The realized parameters of each item are observed sequentially in an arbitrary and unknown order. Upon observing each item, we must decide irrevocably whether to include it in the constructed assortment, or forfeit it forever. The above model applies in many real-life scenarios where retailers have to make deals with wholesalers without having accurate knowledge of the characteristics of other potential products, nor the ability to control the order those are observed. We provide simple optimal online selection policies for both unconstrained and cardinality-constrained versions of the above setting under the objective of maximizing the expected revenue.

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MD07

CC-North 122A

Data, Platforms, and Algorithms

Community Committee Choice Session

Session Chair: Ali Makhdoumi, Duke University

Session Chair: Alireza Fallah, Massachusetts Institute of Technology, Cambridge, MA

1 Learning to Rank for Limited Attention Users

Arpit Agarwal[1], Rad Niazadeh[2], Prathamesh Patil[3], [1]Columbia University, New York, NY, [2]Chicago Booth School of Business, CHICAGO, IL, [3]University of Pennsylvania, Philadelphia, PA, Contact: pprath@seas.upenn.edu

Inspired by the challenge of incentivizing exploration in recommendation systems, we study the problem of Ranking with Limited-Attention Users. In our model, a platform displays a ranked list of items in an online fashion to a sequence of T arriving users. At each time, the user selects an item by first considering a prefix window, and then picking the most preferred item in that prefix. The user preferences are assumed to be known beforehand, but the payoffs are unknown and need to be learned. In this model, we study two settings: (a) adversarial prefix sizes and stochastic payoffs, and (b) stochastic prefix sizes and adversarial payoffs. We design combinatorial algorithms that achieve (a) an instance-dependent regret of O(log T) in the former, and (b) a worst-case regret of \sqrt{T} in the latter. We complement our algorithmic results with matching regret lower-bounds.

2 Artificial Intelligence Algorithms And Spontaneous Collusion

Martino Banchio, Giacomo Mantegazza, Graduate School of Business Stanford University, Stanford, CA

In this paper we characterize a new collusion scheme between Artificial Intelligence algorithms in market environments. The behavior we identify relies on a statistical linkage between independent AI algorithms, called spontaneous coupling, and it does not require monitoring one's opponent. Using a fluid approximation, we explain why coupling arises and how it prevents convergence to Nash equilibrium and even dominant strategies. We show that unequal learning speeds are responsible for coupling and the collusive behavior that ensues: with equal learning speed collusion disappears. Finally, we show how the collusive scheme we identify generates novel patterns of collusion in an online auction market, and we apply our findings to design strategy-proof mechanisms robust to the presence of players that use learning algorithms to determine their optimal strategy.

3 Incentivizing Compliance with Algorithmic Instruments

Daniel Ngo[1], Logan Stapleton[1], Vasilis Syrgkanis[2], Steven Wu[3], Keegan Harris[3], Anish Agarwal[4], [1]University of Minnesota, Minneapolis, MN, [2]Stanford University, Stanford, CA, [3]Carnegie Mellon University, Pittsburgh, PA, [4]Columbia University, New York City, NY, Contact: ngo00054@umn.edu

While existing work has studied compliance as static behavior, we propose a game-theoretic model to study compliance as dynamic behavior that changes over time. In rounds, a social planner interacts with a sequence of agents whose private type determines their prior preferences and baseline rewards. The planner gives each agent a recommendation that may alter their beliefs and action selection. We develop a novel recommendation mechanism that views the planner's recommendation as an instrumental variable that only affects an agent's action by mapping the history to a recommendation. While the initial agents may be completely non-compliant, our mechanism can incentivize compliance over time and enable the estimation of the treatment effect.

4 Bridging Central and Local Differential Privacy in Data Acquisition Mechanisms

Alireza Fallah[1], Ali Makhdoumi[2], Azarakhsh Malekian[3], Asuman Ozdaglar[4], [1]Simons Laufer Mathematical Sciences Institute/UC Berkeley, Berkeley, CA, [2]Duke University, Durham, NC, [3]University of Toronto Joseph L Rotman School of Management, Toronto, ON, Canada; [4]Massachusetts Institute of Technology, Cambridge, MA

We study the design of optimal data acquisition mechanisms for a platform interested in estimating the mean of a distribution by collecting data from privacy-conscious users. Users have heterogeneous sensitivities for two types of privacy losses corresponding to local and central privacy measures, and they are compensated in exchange for their data. The platform designs a mechanism to solicit users' preferences and then delivers both local and central privacy guarantees while minimizing the estimation error and the expected payment to users. We formulate the design of such mechanisms as a nonconvex optimization problem, and, using a primal-dual argument, we develop an algorithm to efficiently solve it in polynomial time.

Monday, October 16, 2:15

PM - 3:30 PM

MD08

CC-North 122B

Market Design for Electricity Markets

Community Committee Choice Session

Session Chair: Cheng Guo, Clemson University, Clemson, SC

1 Modeling, Equilibrium and Market Power for Electricity Capacity Markets

Cheng Guo[1], Christian Kroer[2], Daniel Bienstock[2], Yury Dvorkin[3], [1]Clemson University, Clemson, SC, [2]Columbia University, New York, NY, [3]New York University, Brooklyn, NY, Contact: cguo2@clemson.edu

The capacity market is a marketplace for trading generation capacity, and is viewed by its proponents as a mechanism to ensure power system reliability. It also provides an important revenue stream for generators. Based on current practice at NYISO, we propose optimization models for capacity markets and analyze outcomes. Our results show the influence of the capacity market on generator revenues, and the impact of market power. More specifically, we find that when there is no market power, the outcome of the capacity market does not affect electricity sales in the energy market. Also, with the capacity market, more generators become profitable, especially the generators with a lower net cost of new entry. In addition, it is possible for a generator to earn more revenue by exercising market power. We conduct case studies on NYISO datasets.

2 Auction Designs to Increase Incentive Compatibility and Reduce Self-Scheduling in Electricity Markets

Conleigh Byers[1], Brent Eldridge[2], [1]Harvard University, Cambridge, MA, [2]Pacific Northwest National Laboratory, Richland, WA

The system operator's scheduling problem in electricity markets is a non-convex mixed-integer program. We simulate bidder behavior to show that market power can be exercised by self-scheduling. Agents can learn to increase their profits via a reinforcement learning algorithm without explicit knowledge of the costs or strategies of other agents. Over a multi-period commitment window simulating the day-ahead market, we show that convex hull pricing can reduce producer incentives to deviate from the central dispatch decision. In a realistic test system, we find strategic bidding under conventional marginal pricing can increase total producer profits and decrease lost opportunity costs. While the cost to consumers with convex hull pricing is higher at the competitive solution, the cost to consumers is higher with the restricted convex model after strategic bidding.

3 Uncertainty-Informed Renewable Energy Scheduling: A Scalable Bilevel Framework

Dongwei Zhao[1], Vladimir Dvorkin[2], Stefanos Delikaraoglou[2], Alberto Lamadrid[3], Audun Botterud[2], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Massachusetts Institute of Technology, Cambridge, MA, [3]Lehigh University, Bethlehem, PA, Contact: zhaodw@mit.edu

This work proposes a bilevel framework for accommodating variable renewable energy sources (VRES) in electricity markets. The mechanism computes the optimal VRES day-ahead bids based on the bilevel model, which minimizes expected system costs across day-ahead and real-time stages. However, solving the bilevel problem is computationally challenging for large-scale systems. We introduce a novel technique based on strong duality and McCormick envelope, which relaxes the problem to a linear program, enabling large-scale applications. The framework is applied to the 1576-bus NYISO system and benchmarked against a myopic strategy, where VRES bid is at the mean value of probabilistic forecasts. The results show that, under high VRES levels, our framework can significantly reduce system costs, by optimizing VRES quantities efficiently in the day-ahead market.

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MD09

CC-North 122C

Frontiers in Queueing (in Honor of Daryl Daley)

Community Committee Choice Session

Session Chair: Jalani Williams, Carnegie Mellon University, Pittsburgh, PA

Session Chair: Weina Wang, Carnegie Mellon University, Pittsburgh, PA

1 Stability and Functional Limit Theorems for Queues Fed by Scheduled Traffic

Peter W. Glynn, Stanford University, Stanford, CA, Contact: glynn@stanford.edu

A scheduled traffic model is one in which customer n is scheduled to arrive at time nh, but actually arrives at time nh + □_n, where the □_i's are iid. In this talk, we compare the behavior of these arrival models to renewal traffic. In particular, a queue fed by scheduled traffic can be stable even at the same time that the queue fed by the time-reversed scheduled traffic model is unstable. We also discuss functional limit theorems for scheduled traffic models as the ?_i's become successively more and more heavy-tailed, with limit processes that transition from fractional Brownian motion with H < 1/2 into the realm of Brownian motion as the tail gets heavier.

2 Uniform Bounds for Size Estimate Hedging

Douglas Down[1], Ziv Scully[2], [1]McMaster University, Hamilton, ON, Canada; [2]Cornell University, Ithaca, NY, Contact: downd@mcmaster.ca

The Size Estimate Hedging (SEH) policy, recently introduced by Down and Akbari-Moghaddam, is an index-based policy for scheduling in M/G/1 queues, where only service time estimates are available for scheduling decisions. Simulation results have suggested that it performs well for a wide range of service time distributions. To date, analytic results for SEH are lacking. In this work, we apply methodology developed by Scully et al. to derive performance bounds when jobs with true service time s have estimated size [bs,as]. Based on these bounds, SEH is compared with several policies that have been proposed for queues with service time estimates.

3 The Reset and Marc Techniques, with Application to Multiserver-Job Analysis

Isaac Grosof[1], Yige Hong[2], Mor Harchol-Balter[2], Alan Scheller-Wolf[3], [1]Georgia Tech, Atlanta, GA, [2]Carnegie Mellon University, Pittsburgh, PA, [3]Tepper School of Business, Pittsburgh, PA, Contact: isaacbg227@gmail.com

Multiserver-job (MSJ) systems, where jobs need to run concurrently across many servers, are increasingly common in practice. The default service ordering in many settings is First-Come First-Served (FCFS) service. Virtually all theoretical work on MSJ FCFS models focuses on the stability region, with almost nothing known about mean response time.
We derive the first explicit characterization of mean response time in the MSJ FCFS system. We characterize mean response time up to an additive constant, which becomes negligible as arrival rate approaches throughput.
We first use our novel RESET technique to reduce to a M/M/1 with Markovian Service Rate, with service process controlled by the saturated system, a simpler closed system which is more analytically tractable. We then use our novel MARC technique to characterize mean response time in that system.

4 The M/M/k with Deterministic Setup Times

Jalani Williams, Weina Wang, Mor Harchol-Balter, Carnegie Mellon University, Pittsburgh, PA

Capacity management, whether it involves servers in a data center, or human staff in a call center, or doctors in a hospital, is largely about balancing a resource-delay tradeoff. On the one hand, one would like to turn off servers when not in use (or send home staff that are idle) to save on resources. On the other hand, one wants to avoid the considerable setup time required to turn an off server back on. In this talk, we describe recent work focused on understanding the delay component of this tradeoff. In particular, we discuss new, tight bounds on the average delay in the M/M/k with Deterministic setup times.

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MD10

CC-North 123

Sequential Learning and Decision-Making

Community Committee Choice Session

Session Chair: Lin Fan, Stanford University, Stanford, CA

1 A Definition for Non-Stationary Bandits

Yueyang Liu[1], Benjamin Van Roy[1], Kuang Xu[2], [1]Stanford University, Stanford, CA, [2]Stanford Graduate School of Business, Stanford, CA, Contact: yueyl@stanford.edu

The subject of non-stationary bandit learning has attracted much recent attention, but lacks a formal definition. Non-stationary bandits have typically been characterized in the literature as those for which the reward distribution changes over time. We demonstrate that this informal definition is ambiguous. Further, a widely-used notion of regret---the dynamic regret---is motivated by this ambiguous definition and thus problematic. In particular, even for an optimal agent, dynamic regret can suggest poor performance.
The ambiguous definition also motivates a measure of the degree of non-stationarity experienced by a bandit, which often overestimates and can give rise to extremely loose regret bounds. This paper proposes a formal definition. This definition motivates a new regret measure, and a tighter regret analysis for non-stationary bandit learning.

2 Optimal Adaptive Experimental Design of Inference of Average Treatment Effect

Vikas Deep[1], Achal Bassamboo[1], Sandeep Juneja[2], [1]Northwestern University, Evanston, IL, [2]TIFR, MUMBAI, India. Contact: vikas.deep@kellogg.northwestern.edu

In this paper, our objective is to develop an adaptive experimentation policy with the objective of constructing a confidence interval (CI) of a pre-specified width $\

epsilon$, and with a coverage guarantee that the average treatment effect (ATE) lies in the CI with probability at least $1-\delta$. The novelty of our analysis is the derivation of asymptotic lower bound on the number of samples required by any adaptive policy and an optimal policy that matches lower bound. Existing literature talks about the optimal adaptive policy in the Best arm identification (BAI) problem. We observe that optimal policy in our set-up chooses assignment probabilities proportional to variance of the distribution of that particular arm. In contrast, in the case of the BAI problem, assignment probabilities decrease with an increment to variance of the distribution of that particular arm.

3 Smooth Non-Stationary Bandits

Su Jia[1], Qian Xie[1], Nathan Kallus[2], Peter Frazier[3], [1]Cornell, Ithaca, NY, [2]Cornell University, Long Island City, NY, [3]Cornell / Uber, Ithaca, NY

In many applications of online decision making, the environment is non-stationary and it is therefore crucial to use bandit algorithms that handle changes. Most existing approaches are designed to protect against non-smooth changes, constrained only by total variation or Lipschitzness over time, where they guarantee T^2/3 regret. However, in practice environments are often changing *smoothly*, so such algorithms may incur higher-than-necessary regret and do not leverage information on the rate of change. We study a non-stationary MAB problem where each arm's mean reward is a □-Holder function over time, i.e., (□ − 1)-times Lipschitz-continuously differentiable. We show the first separation between the smooth and non-smooth regimes by presenting a policy with an optimal T^3/5 regret for □ = 2. We complement this result by a T^{(□+1)/(2□+1)} lower bound for any □ ≥ 1.

4 The (Surprising) Rate Optimality of Greedy Procedures for Large-Scale Ranking and Selection

Zaile Li[1], Weiwei Fan[2], Jeff Hong[3], [1]Fudan University, Shanghai, China; [2]Tongji University, Shanghai, China; [3]Fudan University, Shanghai, China. Contact: zaileli21@m.fudan.edu.cn

Ranking and selection (R&S) aims to select the best alternative with the largest mean performance from a finite set of alternatives. Ideal large-scale R&S procedures should be rate optimal, i.e., the total sample size required for an asymptotically non-zero probability of correct selection (PCS) grows linearly in the number of alternatives. Surprisingly, we find that the naïve greedy procedure that keeps sampling the alternative with the largest running average appears rate optimal. We develop a boundary-crossing perspective and prove the greedy procedure's rate optimality. We further show that the derived PCS lower bound is asymptotically tight. Moreover, we propose explore-first greedy procedures to overcome the greedy procedure's inconsistency. Last, we conduct numerical studies to show our greedy procedures' performance in solving large-scale R&S problems.

5 Adaptivity and Confounding in Multi-Armed Bandit Experiments

Chao Qin, Columbia University

We explore a new model of bandit experiments where a potentially nonstationary sequence of contexts influences arms' performance. Context-unaware algorithms risk confounding while those that perform correct inference face information delays. Our main insight is that an algorithm we call deconfounted Thompson sampling strikes a delicate balance between adaptivity and robustness. Its adaptivity leads to optimal efficiency properties in easy stationary instances, but it displays surprising resilience in hard nonstationary ones which cause other adaptive algorithms to fail.

Monday, October 16, 2:15 PM - 3:30 PM

MD11

CC-North 124A

Queueing Control

Community Committee Choice Session

Session Chair: Vahid Sarhangian, University of Toronto, Toronto, ON, Canada

1 Optimal Control of Supervisors Balancing Individual and Joint Responsibilities

Zhuoting Yu, Sigrun Andradottir, Hayriye Ayhan, ISyE Georgia Tech, Atlanta, GA, Contact: zhuoting@gatech.edu

We consider a two-stage service system with two types of servers, subordinates who perform the first-stage service and supervisors who have their own responsibilities in addition to working with the subordinates on the second-stage service. Rewards are earned when first or second-stage service is completed and when supervisors finish their own responsibilities. Costs are incurred when customers abandon without completing the second-stage service. Our problem is to determine how the supervisors should distribute their time between their joint work with the subordinates and their own responsibilities in order to maximize the long run average profit.

2 Parallel Server Systems Under Extended Heavy Traffic

Eyal Castiel, Georgia Tech, Atlanta, GA

The standard setting for studying parallel server systems (PSS) at the diffusion scale is based on the heavy traffic condition (HTC), which assumes that the underlying static allocation linear program (LP) is critical and has a unique solution. This solution determines the graph of basic activities, which identifies the set of activities (i.e., class-server pairs) that are operational. In this talk we explore the extended HTC, where the LP is merely assumed to be critical in a simple setting where we are able to describe an asymptotically optimal policy. The scaling limit for the control problem associated with the model is given by a so called workload control problem (WCP) in which a cost associated with a diffusion process is to be minimized by dynamically switching between control modes.

3 Expanding Service Capabilities Through an On-Demand Workforce

Xu Sun[1], Weiliang Liu[2], [1]University of Florida, Gainesville, FL, [2]National Univerisity of Singapore, Singapore, Singapore. Contact: weiliangliu@u.nus.edu

An on-demand workforce can greatly benefit a traditional call center by allowing it to adjust its service capacity on demand quickly. To operationalize this process, we develop a two-stage decision model in which the first stage seeks the optimal mix of permanent and on-call staff, and the second stage seeks a joint on-demand staffing and call scheduling policy to minimize the associated cost given a mix. In a suitable asymptotic regime, we characterize the system dynamics and derive an optimal joint staffing and call scheduling policy for the second-stage problem, which in turn is used to find an approximate solution to the first-stage problem. Interestingly, the call scheduling rule shows an unusual pattern due to the interplay between staffing and scheduling decisions. Extensive numerical studies show that our proposed approach can achieve significant cost savings.

4 Service Anatomy: Balancing Acute and Post-Acute Care

Noa Zychlinski[1], Itai Gurvich[2], [1]Technion - Israel Institute of Technology, Haifa, Israel; [2]Northwestern University, Kellogg School of Management, Evanston, IL, Contact: noazy@technion.ac.il

Motivated by recent healthcare trends, we study the integration of Acute Care (AC) and Post-Acute Care (PAC). We develop an integrative modeling approach that captures the system's dynamics as it emerges through the evolution of individual patients' health conditions. Patients' outcomes depend, through their characteristics, on both AC and PAC efforts. The suggested modeling yields a tractable analysis while moving beyond common assumptions on service times being independent and fixed. We characterize the optimal AC-PAC effort integration and its dependencies according to (i) the extent to which AC and PAC complement/substitute for each other, (ii) the operational severity, which measures the ratio of PAC to AC marginal costs for the given health condition, and (iii) the relationship between the operational severity and the marginal AC cost within the patient group.

Monday, October 16, 2:15 PM - 3:30 PM

MD12

CC-North 124B

Variance Reduction

Community Committee Choice Session

Session Chair: Sara Shashaani, North Carolina State University, Raleigh, NC

Session Chair: Pranav Jain, North Carolina State University, RALEIGH, NC

1 Distributionally Robust Stratified Sampling for Stochastic Simulations with Multiple Uncertain Input Models

Seung Min Baik[1], Young Myoung Ko[1], Eunshin Byon[2], [1]Pohang University of Science and Technology, Pohang, Korea, Republic of; [2]University of Michigan, Ann Arbor, MI, Contact: seungmin.baik@lstlab.org

This paper presents a robust version of stratified sampling for stochastic simulation with multiple uncertain input models. Traditional variance reduction techniques often assume a single, fixed input model, and thus pose a risk of having limited applicability under model uncertainties. Our distributionally robust (DR) stratified sampling approach minimizes the maximum of worst-case estimator variances among plausible input models, such as nonstationary wind conditions in wind turbine reliability assessment. We propose a bi-level optimization framework with various uncertainty set designs and use Bayesian optimization to solve the min-max problem. Numerical experiments and a wind turbine case study demonstrate the robustness of our method.

2 Simulation Optimization with Adaptive Stratification

Sara Shashaani[1], Pranav Jain[2], [1]North Carolina State University, Raleigh, NC, [2]North Carolina State University, RALEIGH, NC

To increase the robustness and efficiency of a class of simulation optimization algorithms called ASTRO-DF (adaptive sampling trust-region optimization -- derivative-free), we use concomitant (auxiliary) variables in simulation to approximate the boundaries of the optimal strata at each visited solution during the optimization procedure.

3 A Stochastic Variance-Reduced Acceleratedprimal-Dual Method for Finite-Sum Saddle-Pointproblems

Afrooz Jalilzadeh[1], Erfan Yazdandoost Hamedani[2], [1]The University of Arizona, Tucson, AZ, [2]University of Arizona, Tucson, AZ, Contact: afrooz@email.arizona.edu

In this paper, we propose a variance-reduced primal-dual algorithm with Bregman distance for solving convex-concave saddle-point problems with finite-sum structure and nonbilinear coupling function. This type of problems typically arises in machine learning and game theory. Based on some standard assumptions, the algorithm is proved to converge with oracle complexity of $O(\sqrt(n)/\epsilon)$ and $O(n/\sqrt{\epsilon}+1/\epsilon^{1.5})$ using constant and non-constant parameters, respectively where n is the number of function components. Compared with existing methods, our framework yields a significant improvement over the number of required primal-dual gradient samples to achieve -accuracy of the primal-dual gap. We tested our method for solving a distributionally robust optimization problem to show the effectiveness of the algorithm.

4 Cgpt: A Conditional Gaussian Process Tree for Grey-Box Bayesian Optimization

Mengrui (Mina) Jiang, Arizona State University, Tempe, AZ

In black-box optimization problems, Bayesian optimization algorithms are often applied to discover hidden structure and determine where to sample sequentially. However, information about system properties can be available, such as the trajectory of a dynamical system. We consider the case where the objective function can be encoded as a tree, each node performs input computation and the outcome directs the child branch. We propose the new Conditional Gaussian Process tree (CGPT) model for “tree functions” to embed the function structure and improving the prediction power of the Gaussian process. We utilize the intermediate information made available at the tree nodes, to formulate a novel likelihood for the CGPT parameter estimation under different levels of knowledge of the structure. Our study shows that CGPT always outperforms a single Gaussian process model.

5 Monte-Carlo Estimation of Covar

Nifei Lin[1], Jeff Hong[1], Weihuan Huang[2], [1]Fudan University, Shanghai, China; [2]Nanjing University, Nanjing, China. Contact: nflin19@fudan.edu.cn

CoVaR is one of the most important measures of financial systemic risks. It is defined as the risk of a financial portfolio conditional on another financial portfolio being at risk. In this paper we first develop a Monte-Carlo simulation-based batching estimator of CoVaR and study its consistency and asymptotic normality. We show that the best rate of convergence of the batching estimator can achieve $n^{-1/3}$, where n is the sample size. We then develop an importance-sampling inspired estimator under the delta-gamma approximations to the portfolio losses, and we show that the best rate of convergence of the estimator can achieve $n^{-1/2}$. Numerical experiments support our theoretical findings and show that both estimators work well.

Monday, October 16, 2:15 PM - 3:30 PM

MD13

CC-North 125A

Decision Models for Network Security and Resilience

Community Committee Choice Session

Session Chair: Mathieu Dahan, Georgia Institute of Technology, Atlanta, GA

1 Strategic Network Inspection with Location-Specific Detection Capabilities

Bastián Bahamondes, Mathieu Dahan, Georgia Institute of Technology, Atlanta, GA

We consider a network inspection game, in which a defender randomly positions a limited number of detectors in a network to detect attacks caused by an attacker, who randomly targets a subset of network components. Each detector location is associated with a probability of detecting attacks within its set of monitored network components. The objective of the defender (resp. attacker) is to minimize (resp. maximize) the expected number of undetected attacks. We formulate an integer program for the defender’s best response and use it within a multiplicative weights algorithm to compute approximate Nash equilibria. To handle the dimensionality of the attacker’s strategies, we add a projection step on the space of unidimensional marginal distributions. We compare the resulting inspection strategies with the optimal ones generated via a column generation approach.

2 Infrastructure Network Security With Imperfect Detection Technology

J. Haden Boone, Mathieu Dahan, Georgia Institute of Technology, Atlanta, GA, Contact: jboone31@gatech.edu

We consider a two-player zero-sum hide-and-seek game, in which a defender coordinates sensors according to a probability distribution to detect faults or strategic attacks on a critical infrastructure network. Detector performance is assumed to be imperfect, and is modeled with a probability that a fault in or attack on the network is successfully detected by a detector placed in its vicinity. This probability is determined from the detection technology utilized and the properties of the network, faults, or attacks. We analytically characterize Nash equilibria of the game in which the defender attempts to minimize the number of undetected attacks, and provide empirical evaluation of our methods on real networks.

3 Hyperconnected Relay-Based Network Design with Stochastic Demand

Onkar Kulkarni[1], Mathieu Dahan[2], Benoit Montreuil[3], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, [3]Georgia Tech, Atlanta, GA, Contact: onkar.kulkarni@gatech.edu

In this work, we study a bi-level stochastic program to design relay-based transportation network. In the first stage, we position the relay-hubs and size them and schedule trucks for transporting commodities upon realization of commodity demand uncertainty in the second stage. Due to commodity consolidation considerations, second stage consists of general integer decision variables which makes the problem challenging to solve. To alleviate the issue, we propose algorithm(s) based on Benders-decomposition to provide good quality solutions. In order to test our approach, we apply the developed methodology to design relay-hub network for a major car manufacturing company to be used for car deliveries.

4 Modeling a Military Campaign as a Stochastic Game Through Application of a Network Graph

Joseph McCarthy, Georgia Institute of Technology, Atlanta, GA, Contact: jmccarthy@gatech.edu

We model a military campaign as a zero-sum stochastic game which we solve through Shapley value iteration. We develop a heuristic to provide good value estimates that reduce solving time. To portray the campaign, we represent military objectives as nodes and integrate the military concept of lines of communication to express our operational state space as a directed acyclic graph, permitting expansive representations of armed conflict. We propose a parallel network graph that separates commanders who together create a combined, operational action.

5 Designing Resilient Short-Haul Logistics Networks Using K-Shortest Paths

Onkar Kulkarni[1], Mathieu Dahan[1], Benoit Montreuil[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Tech, Atlanta, GA, Contact: mathieu.dahan@isye.gatech.edu

We consider the problem of designing resilient short-haul logistics networks by selecting hub locations to minimize the total demand-weighted distance of the k-shortest paths between each origin-destination pair. We model this problem using a path-based integer-programing formulation and leverage its structure to devise two tailored scalable solution methodologies based on Benders decomposition and branch-and-price. To showcase the applicability of the developed model and solution methodologies, we design large-scale intercity parcel-delivery networks across Central China and compare their resilience to disruptions with respect to traditional cost-optimized logistics networks.

Monday, October 16, 2:15 PM - 3:30 PM

MD14

CC-North 125B

The Role of Transparency in Social Operations

Community Committee Choice Session

Session Chair: Lei Hua, University of Texas at Tyler, Tyler, TX

Session Chair: Karen Zheng, MA

1 Media Controversies and Supply Chain Labor Transparency in the Fashion Industry: The Need for a Fresh, Diverse Corporate Board

Veronica H. Villena[1], Li Cheng[2], [1]Arizona State University, Tempe, AZ, [2]Michigan State University, Leansing, MI, Contact: vhvillena@asu.edu

The fashion industry's labor scandals, with incidents such as the Rana Plaza and Boohoo, have drawn wide attention. Stakeholders have called for more transparency in the efforts of fashion brands to address their supply chains' labor issues. We draw attention to a less-studied institutional force: the media. Brands can react to media controversies—negative news coverage about the labor-related controversial activities in a firm's supply chain—differently; some take actions to ameliorate the consequences whereas others are defensive when their supply chain labor scandals are exposed. We investigate whether media exposure might prompt a fashion brand to publicly disclose data regarding its suppliers' working and labor conditions and, more importantly, *when* this pressure would be more effective depending on the board's composition.

2 Stories vs. Numbers: Enhancing Consumer Adoption of Socially Responsible Products

Lei Hua[1], Tim Kraft[2], Doug Thomas[3], Yanchong Zheng[4], [1]University of Texas at Tyler, Tyler, TX, [2]NC State - Poole College of Management, Raleigh, NC, [3]University of Virginia, Charlottesville, VA, [4]Massachusetts Institute of Technology, Cambridge, MA

Our study examines consumers' valuations of sustainability communication and the impact of different social responsibility topics and message formats on these valuations. Our research is based on collaboration with Goodio, a Helsinki-based craft chocolate maker that promotes positive social change. Our survey studies reveal that fair pricing information presented with fact-based messaging is more effective among U.S. participants, indicating a preference for educational attachment and information effects in societies with stronger 'masculine' characteristics, while Finnish participants are more receptive to story-based messaging, highlighting the importance of inducing emotional attachment in societies with stronger 'feminine' characteristics. Further studies establish causal evidence and generalize our findings to different products and prices.

3 Ex-Post Equilibrium Market Recommendations

Shai Vardi, Purdue University, West Lafayette, IN

New business models help sellers make better decisions by communicating information about market prices. However, sellers' inability to coordinate greatly reduces the efficacy of this information and can lead to market failures. We study the feasibility and benefits of providing equilibria as recommendations in economies where sellers face price uncertainty, information scarcity, and an inability to coordinate.

We describe a general model in which sellers wish to sell some good at one of several markets, and provide an algorithmic framework that a market planner can use to recommend ex-post equilibria to sellers. Using both synthetic data and real data on India's agricultural markets, we show that the recommended equilibria typically outperform other natural strategies in terms of seller welfare, geographic price dispersion, and market volume concentration.

Monday, October 16, 2:15 PM - 3:30 PM

MD15

CC-North 126A

Automation in Military Test & Evaluation

Community Committee Choice Session

Session Chair: Robert Newton, Penn State, University Park, PA

1 Build up Approach: Using RPAs as Scalable Autonomy Test Beds

Megan E. L. Burk[1], Aubrey Olson[2], [1]U.S. Air Force, Pentagon, VA, [2]U.S. Air Force, Edwards AFB, CA

The purpose of this presentation is to summarize a potential avenue to create an AI test bed developed by the team during the MIT/AIA Ideation course. The team surveyed the current efforts, engaged with the teams working on those efforts, and identified where a small group of motivated individuals could get a "5-yard win." The team proposed a possible AI/autonomy test bed, the benefits of this test bed, and required resources to accomplish the goal of a useful, accessible, and long-lasting AI-test bed.

2 Uncertainty Quantification: Artificial Intelligence and Machine Learning in Military Systems

Ayla Reed[1,2], [1]Maui High Performance Computing Center, Kihei, HI, [2]15th Space Surveillance Squadron, Kihei, HI

Instituting a military standard for quantified uncertainty metadata represents a solution to the problems inherent in using artificial intelligence/machine learning (AI/ML) for military advantage. By provisioning for metadata now, the Department of Defense can continue to determine the best policy for using AI/ML in parallel with capability development. This coordination will prevent delays in solving difficult technical problems associated with implementing AI/ML in warfighting systems. Uncertainty quantification can enable a practical digital implementation of the observe, orient, decide, and act loop, addressing ethical issues with employing AI/ML in war and optimizing investment in research and development.

3 Integrating Developmental Flight Testing and Crew Served Weapons Using Image Classification

James Mackey, Michael Zeihen, 413th Flight Test Squadron, Hurlburt Field, FL, Contact: james.mackey.14@us.af.mil

The MH-139A, fleet replacement for the UH-1N, is undergoing developmental testing to include integrating crew served weapons. Calculating safe trajectories and limitations on weapons use is time consuming and was not practical for the compressed testing timeline. Integrating high-speed camera photography with calibration measures and image classification techniques the data analysis team developed a rapid methodology to map rotor blade position during handling quality testing to determine blade location during typical engagement profiles. This approach enabled the team to rapidly model the safe employment envelope for the MH-139A crew served weapons and thereby compress the test schedule to meet delivery timelines.

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MD16

CC-North 126B

Panel Discussion on Design and Algorithmic-Biases and Fairness Solutions

Panel Session

Session Chair: Wilkistar Otieno, 1</sup

1 Panel Discussion on Design and Algorithmic-Biases and Fairness Solutions

Wilkistar Otieno, 1</sup

2 Panelist

Michael Johnson, University of Massachusetts Boston

3 Panelist

Anahita Khojandi, University of Tennessee, Knoxville, TN

4 Panelist

Angelika Leskovskaya, SMU Cox School of Business, Dallas, TX

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MD17

CC-North 127A

Judgment and Algorithms

Community Committee Choice Session

Session Chair: Enno Siemsen, University of Wisconsin-Madison, Madison, WI

1 Automation or Collaboration? Comparing Integrated Learning Methods with Machine Learning in Demand Planning

Rebekah I. Brau[1], Finnegan McKinley[2], John Aloysius[2], Heilbronn Enno Siemsen[3], [1]Brigham Young University, Provo, UT, [2]University of Arkansas, Fayetteville, AR, [3]University of Wisconsin-Madison, Madison, WI, Contact: bekki_brau@byu.edu

Our research compares integrated forecasts (human judgment and algorithms) with machine learning forecasts without human input. We propose a novel method of integrating the three main components of demand forecasting analytics: technology (data, statistics, information technology), people, and processes. We test the individual components using field data and find that the novel method improves on each component. We also find that, overall, the novel approach is more accurate when compared to unsupervised machine learning.

2 Algorithm-Human-Algorithm: A New Classification Approach to Integrating Judgemental Adjustments

Christopher J. Chen[1], Nitish Jain[2], Varun Karamshetty[3], [1]Indiana University Kelley School of Business, Bloomington, IN, [2]London Business School, London, United Kingdom; [3]National University of Singapore, Singapore, Singapore. Contact: varun.karamshetty@nus.edu.sg

Firms often elicit judgemental adjustments to an algorithm-generated demand forecast. This process aims to utilize humans' private information that is inaccessible to the algorithm. However, humans are vulnerable to systematic biases when making such adjustments. Thus, it is challenging to integrate these adjustments with algorithm-generated forecasts to improve forecast accuracy. We propose a novel classification-based solution to address this challenge. First, we predict an adjustment's quality using predictors of humans' private information advantage (eg, product and store characteristics) and systematic biases (eg, recent forecast errors and adjustment characteristics). Next, we apply a simple heuristic--based on the predicted quality--to classify (accept/reject) each adjustment integration in the final forecast.

3 Forecast vs. Order Adjustments in Inventory Systems

Enno Siemsen[1], Eirini Spiliotopoulou[2], [1]University of Wisconsin-Madison, Madison, WI, [2]Tilburg University, GH Amsterdam, Netherlands. Contact: esiemsen@wisc.edu

Inventory order systems could allow human decision-makers to override forecasts, which are an input to the system, or to override order quantities, which are the system output. Which one works better? We test this question in the context of a behavioral experiment.

4 Expanding Knowledge Graphs with Humans in the Loop

Emaad Manzoor, NY

Curated knowledge graphs encode domain expertise and improve the performance of machine learning systems in several domains. As new concepts emerge in a domain, knowledge graphs must be expanded to preserve machine learning performance. Manually expanding knowledge graphs, however, is infeasible at scale. In this work, we propose a method for knowledge graph expansion with humans-in-the-loop. We show that our method is both accurate and provably "human-friendly", and validate human-friendliness with a controlled experiment. We further evaluate our method on a knowledge graph from Pinterest and show that it outperforms competing methods on both accuracy and human-friendliness. Upon deployment in production at Pinterest, our method reduced the time needed for knowledge graph expansion by ~400% and contributed to a subsequent increase in ad revenue of 20%.

5 Blame in Delegated Inventory Decision Making

Mirko Kremer[1], Doug Thomas[2], [1]Frankfurt School of Finance and Management gGmbh, Frankfurt Am Main, Germany; [2]University of Virginia, Charlottesville, VA, Contact: thomasd@darden.virginia.edu

Employees making inventory decisions are typically evaluated and compensated by managers rather than being owners of the firm. Additionally, employees often have access to more detailed information pertaining to their decision task as compared to the manager evaluating them. When such information asymmetry exists, managers can only imperfectly assess the quality of an employee's decision. In a controlled laboratory setting, we study how managers evaluate and compensate employees who are making an inventory order decision in the presence of demand uncertainty. We find evidence to support the notion that managers reward or punish the employee based on the outcome, even when the manager has sufficient information to evaluate the quality of the decision. Our findings have implications for managers mis-identifying good (and poor) performers in the workplace.

Monday, October 16, 2:15 PM - 3:30 PM

MD18

CC-North 127B

Fairness in Platforms and Recommendations

Community Committee Choice Session

Session Chair: Jackie W. Baek, UC Berkeley, Berkeley, CA

1 Online Platforms and the Fair Exposure Problem Under Homophily

Jakob Schoeffer[1], Alexander Ritchie[2], Keziah Naggita[3], Faidra Monachou[4], Jessie Finocchiaro[5], Marc Juarez[6], [1]Karlsruhe Institute of Technology, Karlsruhe, Germany; [2]University of Michigan, Ann Arbor, MI, [3]TTIC, Chicago, IL, [4]Harvard University, Cambridge, MA, [5]Harvard University, Cambridge, MA, [6]University of Edinburgh, Edinburgh, United Kingdom. Contact: jef556@g.harvard.edu

In the wake of increasing political extremism, online platforms have been criticized for contributing to polarization. We study the *fair exposure problem*: given limited intervention power of the platform, how does one balance the spread of content among two groups of users. We develop a stylized framework that models intra- and inter-group content propagation, and we formulate the platform's decision as an optimization problem that aims at maximizing user engagement under fairness constraints that require each group see a mixture of their preferred and non-preferred content, encouraging information diversity. Fairness constraints only partially mitigate homogeneity in optimal policies: there exist optimal fairness-aware solutions which target one group with different types of content and the other group with only one type of content.

2 Game-Theoretic Perspective of Trust in Recommendation

Sarah Cen[1], Andrew Ilyas[2], Aleksander Madry[3], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]MIT EECS, Cambridge, MA, [3]Massachusetts Institute of Technology, Cambridge, MA, Contact: shcen@mit.edu

Recommendation platforms—such as Netflix and Facebook—use various strategies in order to engage and retain users. These measures are meant to improve performance, but they can also erode their users' trust. In this work, we study the role of trust in recommendation. We show that, because recommendation platforms rely on users for data, trust is key to a platform's success. Our main contribution is a game-theoretic view of recommender systems and a corresponding formalization of trust. Precisely, if a user trusts their platform, then their optimal long-term strategy is to act greedily—and thus report their preferences truthfully—at all times. To illustrate the implications of this definition, we explore two simple examples of trust. We show that distrust can hurt the platform and that trust can be beneficial for both the user and platform.

3 Design and Engineering of Residential Crowdsourcing Systems

Nikhil Garg, Cornell Tech, New York, NY, Contact: ng343@cornell.edu

Modern city governance relies heavily on crowdsourcing (or "coproduction") to identify problems such as downed trees and power-lines. A major concern in these systems is that residents do not report problems at the same rates, leading to an inefficient and inequitable allocation of government resources. However, measuring such under-reporting is a difficult statistical task, as, almost by definition, we do not observe incidents that are not reported. Thus, distinguishing between low reporting rates and low ground-truth incident rates is challenging. First, joint with Zhi Liu, we develop a method to identify (heterogeneous) reporting rates, without using external (proxy) ground truth data. Second, I'll overview our work in redesigning inspection decisions to improve system efficiency and equity.

4 When Collaborative Filtering Is Not Collaborative: Unfairness Of PCA For Recommendations

David Liu[1], Jackie W. Baek[2], [1]Northeastern University, Boston, MA, [2]NYU Stern School of Business, Berkeley, CA, Contact: liu.davi@northeastern.edu

We study the fairness of dimensionality reduction methods for recommendations. We focus on the established method of principal component analysis (PCA). We identify two underlying mechanisms of PCA that induce unfairness at the item level. The first negatively impacts less popular items, due to the fact that less popular items rely on trailing latent components to recover their values. The second negatively impacts highly popular items, since the leading PCA components specialize in individual popular items instead of capturing similarities between items. We then develop a polynomial-time algorithm, Item-Preference PCA that addresses these unfairness issues. Our evaluations on real-world datasets show that Item-Preference PCA not only improves overall recommendation quality but also improves on both popular and less popular items.

Monday, October 16, 2:15 PM - 3:30 PM

MD19

CC-North 127C

OR in Healthcare: Bridging the Gap between Research and Implementation

Panel Session

1 OR in Healthcare: Bridging the Gap between Research and Implementation

Holly Mika Wiberg, Carnegie Mellon University, New York, NY

This panel will focus on translating healthcare research in OR into practice. Panelists will discuss both the unique challenges and opportunities posed by implementing research in healthcare settings.

Session Chair: Holly Mika Wiberg, Carnegie Mellon University, New York, NY

2 Panelist

Carri Chan, Columbia Business School, New York, NY

3 Panelist

Amy Cohn, University of Michigan, Ann Arbor, MI

4 Panelist

Pengyi Shi, Purdue University, West Lafayette, IN

5 Panelist

Maria Esther Mayorga, North Carolina State University, Raleigh, NC

Monday, October 16, 2:15 PM - 3:30 PM

MD20

CC-North 128A

HAS Junior Faculty Lighting Session

Flash Session

Session Chair: Emily L. Tucker, Clemson University, Clemson, SC

Session Chair: Yonatan Mintz, University of Wisconsin Madison, Madison, WI

Monday, October 16, 2:15 PM - 3:30 PM

MD21

CC-North 128B

Increasing Efficiency in Healthcare Delivery

Community Committee Choice Session

Session Chair: Feryal Erhun, University of Cambridge, Cambridge, United Kingdom

Session Chair: Zidong Liu, Cambridge Judge Business School, Cambridge, United Kingdom

Session Chair: Harshita Kajaria-Montag, University of Cambridge, Cambridge, United Kingdom

Session Chair: Houyuan Jiang, University of Cambridge,

Cambridge, United Kingdom

1 NHS Advice & Guidance: A Game Theoretical Consideration

Zidong Liu, Feryal Erhun, Houyuan Jiang, University of Cambridge, Cambridge, United Kingdom. Contact: zl424@jbs.cam.ac.uk

In the UK, general practitioners (GPs) are the primary point of contact for medical treatment, and specialist care usually require a GP referral. In recent years, the growing demand of secondary care resources has placed increased pressure on gatekeeping functions. To address this, the Advice & Guidance (A&G) service has been introduced as an optional and additional telemedicine gatekeeper, while the regulation and payment of this service remain unclear. Our study evaluates the system's performance under different contractual and regulatory arrangements and proposes a contract design to maximize the A&G's potential in reducing inefficiencies.

2 Incentivized Referral System with Co-Payment and Green Channels

Houyuan Jiang[1], Pengfei Guo[2], Qingxia Kong[3], Weifen Zhuang[4], [1]University of Cambridge, Cambridge, United Kingdom; [2]City University of Hong Kong, Hong Kong, Hong Kong; [3]Erasmus University, Rotterdam, Netherlands; [4]Xiamen University, Xiamen, China. Contact: h.jiang@jbs.cam.ac.uk

The Chinese government launched a major healthcare reform in 2009 to establish a tiered healthcare delivery system that can integrate and coordinate primary care and hospital care and deliver services effectively and efficiently. Incentive mechanisms are needed to leverage patients' preferences and re-direct patient flow from overcrowded large and urban hospitals to small community and rural clinics. We study two practical incentive mechanisms based on a co-payment approach and a specialist resource allocation approach. Our results show that a combination of both mechanisms can coordinate the system while the co-payment mechanism can only coordinate the system in some cases which are characterized by patients' medical conditions and their diagnosis abilities.

3 Patient Choice and Quality Competition Under Imperfect Quality Information

Zhan Pang[1], Linggang Qi[2], [1]Purdue University, West Lafayette, IN, [2]Soochow University, Suzhou, China. Contact: zpang@purdue.edu

Quality information imperfection is one of the most prominent characteristics of hospital markets. Employing the notion of rational expectations and the random utility theory, we characterize the choice behavior of quality- and delay-sensitive patients under imperfect quality information and hospital quality competition. We analyze the effects of imperfect quality information on both rational expectations equilibria and Nash equilibria. In particular, we show that more accurate quality information may not always lead to better quality under competition. We further discuss the policy implications of imperfect quality information and analyze how policy makers should coordinate the reimbursement and quality information strategies.

4 Estimating Heterogeneous Treatment Effects of Continuous Treatments with an Application to Diarrheal Infections

Zijun Gao, University of Cambridge, Cambridge, United Kingdom. Contact: gaozijun1995318@gmail.com

Diarrhea is a significant cause of child mortality and its occurrence is influenced by climatic factors. In this study, we examine the heterogeneous causal effect of precipitation shocks on diarrhea. In particular, we develop a method to estimate the effect curve of the continuous treatment precipitation shocks. Our method can incorporate effect modifiers, relies on mild model assumption, and leverages powerful machine learning algorithms. We apply the method to a survey data of low and middle-income countries combined with gridded climate data and find that precipitation shocks increase the susceptibility to diarrhea. We also identify specific social vulnerabilities, such as disposal practices and child feeding practices, that exacerbate the adverse effects of the precipitation shocks, which could be used to devise public health interventions.

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CC-North 129A

Operations Research and Machine Learning for Maternal Health

Community Committee Choice Session

Session Chair: Lauren N. Steimle, Georgia Tech ISyE, Atlanta, GA

Session Chair: Meghan Meredith, Georgia Institute of Technology, Atlanta, GA

1 American Indians Travel Great Distances for Obstetrical Care: Examining Rural and Racial Disparities

Andreas Thorsen[1], Maggie Thorsen[2], Sean Harris[1], Janelle Palacios[3], Ronald McGarvey[4], [1]Montana State University, Bozeman, MT, [2]Montana State University, Bozeman, MT, [3]Kaiser-Oakland Medical Center, Oakland, CA, [4]IESEG, Paris, ., France. Contact: andreas.thorsen@montana.edu

Rural, American Indian/Alaska Native (AI/AN) people, a population at elevated risk for complex pregnancies, have limited access to risk-appropriate obstetric care. Obstetrical bypassing, seeking care at a non-local obstetric unit, is an important feature of perinatal regionalization that can alleviate some challenges faced by this rural population, at the cost of increased travel to give birth. Using data from Montana, we developed models to identify predictors of bypassing and predictors of factors associated with the distance people drove beyond their local obstetric unit to give birth. While bypassing may connect rural birthing people to more risk-appropriate care, rural and racial inequities in access persist, with rural, reservation-dwelling AI/AN birthing people experiencing greater likelihood of bypassing and traveling further when bypassing.

2 Scalable Decision-Focused Learning in Restless Multi-Armed Bandits with Application to Maternal and Child Health

Sanket Shah, Harvard University, Cambridge, MA, Contact: sanketshah@g.harvard.edu

We present the first algorithm for decision-focused learning in restless multi-armed bandit (RMAB) problems that scales to real-world problem sizes. Prior works often learn the model by maximizing the predictive accuracy instead of the final RMAB solution quality, causing a mismatch between training and evaluation objectives. In this paper, we propose a novel approach for decision-focused learning in RMAB that directly maximizes the downstream solution quality. We present three key contributions: (i) we establish differentiability of the Whittle index policy to support decision-focused learning; (ii) we significantly improve the scalability of decision-focused learning approaches in sequential problems, specifically RMAB problems; (iii) we apply our algorithm to a previously collected dataset of maternal and child health to demonstrate its performance.

3 Using Simulation Modeling to Improve Decision Making for Maternal Health

Karen T. Hicklin[1], Toni Reeves[2], [1]University of Florida, Gainesville, FL, [2]University of Florida, Gainesville, FL, Contact: khicklin@ufl.edu

Each year nearly 800 women die from pregnancy- or delivery-related complications in the United States. Non-Hispanic Black women are 2 times more likely to experience high-risk obstetric conditions and mortality compared to non-Hispanic white women, despite having similar rates of underlying health conditions. Discrete event simulation is used to model patient trajectories for prenatal care taking into account conditions that would make a pregnancy high-risk, such as advanced maternal age, eclampsia, diabetes, and/or high body mass index. Through this model we are able to identify opportunities for intervention that can reduce severe maternal morbidity and mortality and increase health equity.

4 An Adaptive Multilevel Neural Network for Early Detection of Preeclampsia

Rachel Bennett[1], Talayeh Razzaghi[2], [1]University of Oklahoma, Oklahoma City, OK, [2]University of Oklahoma, School of Industrial and Systems Eng, Norman, OK, Contact: rachel.l.bennett-1@ou.edu

The massive increase of healthcare data from electronic health records has been extremely beneficial to maternal complications diagnosis, allowing machine learning models such as neural networks to be applied to the tasks of disease early detection and treatment. With the increase in dataset size, however, comes a corresponding increase in computational complexity. Additionally, these datasets often suffer from class imbalance, leading to bias in the resulting models. To address these challenges, we develop an adaptive multilevel graph-based neural network and demonstrate its superiority over conventional neural networks.

5 Multi-Criteria Optimization to Balance Quality and Access for Risk-Appropriate Maternity Care

Meghan Meredith[1], Lauren N. Steimle[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Tech ISyE, Atlanta, GA, Contact: mmeredith8@gatech.edu

Among the factors contributing to the maternal mortality crisis in the United States is a lack of access to risk-appropriate obstetric care services. We present a multi-objective optimization model that seeks to design a hierarchical regionalization strategy to expand access considering travel distance, risk-appropriate care, and lower quality associated with low-volume obstetric hospitals. We present a case study that uses data on births and hospitals in Iowa to inform regionalized care and discuss the implications for healthcare policy.

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CC-North 129B

Efficiency and Fairness in Operations Management

Community Committee Choice Session

Session Chair: Yichuan Ding, McGill University, Montreal, QC, Canada

Session Chair: Daniel Granot, University of British Columbia, Vancouver, BC, Canada

1 Achieving High Individual Service Levels Without Safety Stock? Optimal Rationing Policy of Pooled Resources

Jiashuo Jiang[1], Shixin Wang[2], Jiawei Zhang[3], [1]Hong Kong University of Science and Technology, New York, NY, [2]The Chinese University of Hong Kong, Hong Kong, China; [3]New York University, New York, NY, Contact: jzhang@stern.nyu.edu

We present a general framework to study the problem of allocating pooled resources when customers require individual and possibly different service levels. Our modeling framework generalizes and unifies many existing models in the literature and includes second-stage allocation costs. We propose a simple randomized rationing policy for any fixed feasible capacity level. Our main result is the optimality of this policy for very general service level constraints. The result follows from a semi-infinite linear programming formulation of the problem and its dual. As a corollary, we also prove the optimality of index policies for a large class of problems when the set of feasible fulfilled demands is a polymatroid.

2 Fairness in Accessibility of Public Service Facilities

Sheng Liu[1], Nooshin Salari[2], [1]University of Toronto, Toronto, ON, Canada; [2]University of Alberta, Edmonton, AB, Canada. Contact: snooshin@ualberta.ca

Our paper studies a fair stochastic facility location problem with congestion under the max-min principle. We analyze the price of fairness in a two-location problem and develop a tractable optimization framework for the general multi-location setting. Evaluating the fair solution against the utilitarian solution on Buffalo's demographic data reveals that implementing a fair solution can substantially improve fairness measures (up to 81%) with relatively limited impact on the overall service quality.

3 Tight Bounds for the Price of Fairness

Yifeng Cao[1], Daniel Granot[1], Yichuan Ding[2], [1]University of British Columbia, Vancouver, BC, Canada; [2]McGill University, Montreal, QC, Canada. Contact: yifeng.cao@sauder.ubc.ca

A central decision maker (CDM), who seeks an efficient allocation of scarce resources among a finite number, n, of players, often has to incorporate fairness criteria to avoid unfair outcomes. Indeed, the price of fairness (POF), a term coined in Bertsimas et al. (2011), refers to the efficiency loss due to the incorporation of fairness criteria into the allocation method. Quantifying the POF would help the CDM strike an appropriate balance between efficiency and fairness. In this paper we improve upon existing results in the literature, by providing tight bounds for the POF for the proportional fairness criterion for any n, when the maximum achievable utilities of the players are equal or are not equal, and we provide as well a tight bound for the max-min (Kalai - Smordinsky) fairness criterion, when the maximum achievable utilities of the players are not equal.

4 On Fairness and Efficiency in Nonprofit Operations: Dynamic Resource Allocations

Tong Wang, Yuanzheng Ma, Huan Zheng, Shanghai Jiao Tong University, Shanghai, China

We study a sequential resource allocation problem balancing fairness and efficiency for nonprofit operations. (Un)fairness is measured by the expected maximum demand shortfall among all communities, and (in)efficiency is measured by the expected remaining resources after allocation. We characterize the optimal allocation policy as a two-threshold policy in which the optimal allocation quantities are spoon-shaped in terms of the current maximum demand shortfall. We further show that the thresholds and optimal allocation quantity for each community are nondecreasing in resource levels, realized demand from the current community, and weight of the efficiency objective. Based on these results, we propose a simple heuristic policy and numerically show that it performs well and generates fair allocations in a stochastic majorization order. The numerical results show that adding a small weight to the fairness objective significantly improves the system's fairness at a small efficiency cost. Moreover, the optimal initial capacity level is increasing (decreasing) in demand variance if the efficiency weight is small (large). Our theoretical analysis can be extended to the fill rate--based fairness metric

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Emerging Topics in Supply Chain Empirical Research

Community Committee Choice Session

Session Chair: Wenting Li, 1</sup

Session Chair: Zenan Zhou, 1</sup

1 The Impact of the Rivalry Behaviors Among the Vertical Partners on Their E-Commerce Performance

Woohyun Cho, Hao Su, University of New Orleans, New Orleans, LA, Contact: hsu3@uno.edu

We examine the impact of the relationship between the individual merchants' make or buy decisions and corresponding reactions of the online marketplace operator (i.e., Amazon.com) on the sales performance. Our study contributes to literature that significantly neglects the role of rivalry behaviors among the vertical partners on related outcomes.

2 Liquidity Shock and Behavior of Supply Chain Network

Mingyang Zhang, Wenting Li, Arizona State University, Tempe, AZ, Contact: mzhan235@asu.edu

We investigate the effects of the adoption of Basel III on the distribution of trade credit within the supply chain. The Basel III introduces a stricter risk framework, resulting in reduced financing provided by banks to firms. By considering the heterogeneous impact across firms in different supply-chain hierarchies and varying exposure to regulatory shock, we observe different effects on trade credit throughout the supply-chain network. Moreover, our hypothesis suggests that Basel III may indirectly undermine the financial stability of mid-stream firms.

3 The Impact of Shop and Scan Technology on Retail Store Visits: Assessing the Role of the Digital Divide

Brett Wang[1], Martin E. Dresner[1], Xiaodan Pan[2], Oliver Yao[3], Hyosoo Kevin Park[4], [1]University of Maryland, College Park, MD, [2]Concordia University, Montreal, QC, Canada; [3]Lehigh University, Bethlehem, PA, [4]University of Dayton, Dayton, OH, Contact: brett@umd.edu

Through a quasi-experiment, we examine the impact of an in-store product selection and purchase technology application on retail operations. Results reveal that the application leads to a reduction in shopper dwell time and an increase in new customers and total customer visits. Moreover, differential impacts of the technology are found, dependent on demographic characteristics of the retail market.

4 The Effect of the Chips Act on Stock Market Reaction: An Event Study Analysis

Zenan Zhou[1], Dale S. Rogers[1], Wenting Li[1], Molly Hughes[2], [1]Arizona State University, Tempe, AZ, [2]The Ohio State University, Columbus, OH, Contact: zzhou119@asu.edu

The United States Chips and Science Act (CHIPS Act) is designed to promote innovation, increase domestic production capabilities, and address supply chain vulnerabilities in the semiconductor industry. This empirical research employs an event study approach to investigate the impact of the CHIPS Act on the stock market reaction for semiconductor-related companies traded in China and the United States. To ensure validity and robustness, multiple statistical tests and various return models are employed. The study highlights the significance of the CHIPS Act, offers potential theoretical advancements by challenging conventional assumptions, and provides practical implications for investors, supply chain practitioners, and policymakers.

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Healthcare Analytics and Operations

Community Committee Choice Session

Session Chair: Guihua Wang, The University of Texas at Dallas, RICHARDSON, TX

Session Chair: Minmin Zhang, The University of Texas at Dallas, Richardson, TX

1 Calibrate to Operate: Turning Patient Predictions into System-Wide Forecasts

Song-Hee Kim[1], William Overman[2], Jean Pauphilet[3], [1]Seoul National University, Gwanak-gu, Korea, Republic of; [2]Stanford, Stanford, CA, [3]London Business School, London, United Kingdom. Contact: wpo@stanford.edu

We investigate the usefulness of individual-level models for improving predictions on system-wide quantities in the healthcare industry. Using the prediction of occupancy in the emergency department as an example, we aim to predict short-term occupancy using patient-level predictions on length of stay. We identify and address various challenges in this process, including the construction of a credible benchmark, the choice of a suitable modeling technique, and the aggregation of patient-level predictions to obtain estimates on future occupancy. In particular, we observe, empirically and analytically, the emergence of a bias when naively summing patient-level predictions. We propose a simple calibration step to correct this bias and demonstrate the robustness of aggregating patient-level predictions to non-stationary processes.

2 Mitigating Nurse Shortage Via Inter-hospital Nurse Transfers: A Data-driven Multi-stage Distributionally Robust Optimization Approach

Wei Liu, Tianchun Li, Mengshi Lu, Pengyi Shi, Purdue University, West Lafayette, IN, Contact: mengshilu@purdue.edu

Motivated by the nurse shortage of our partner, IU Health, during the COVID-19 pandemic, we consider a nurse transfer plan by moving nurses from hospitals with surpluses to those with shortages. One key feature in our nurse transfer problem is that the nurses need to stay in the transferred hospital for a few days, known as secondment, before returning to their home location to avoid extended and possibly hazardous commutes. However, the introduction of the secondment further amplifies the pre-existing challenge incurred by the demand shift from the historical sample path, caused by the quick spread of COVID-19 and statewide distribution of hospitals. To overcome this challenge, we consider possible perturbations from historical data in advance by using a multi-stage distributionally robust optimization approach.

3 The Spillover Effect of Suspending Non-Essential Surgery: Evidence from Kidney Transplantation

Guihua Wang[1], Minmin Zhang[1], Tinglong Dai[2], [1]The University of Texas at Dallas, Richardson, TX, [2]Johns Hopkins University, Baltimore, MD

In this paper, we estimate the potential spillover effect of suspending non-essential surgery on patient access to essential health services, using deceased-donor kidney transplantation as the clinical setting. Through analyzing a dataset of all U.S. kidney transplantation procedures, we observe a steep reduction in the volume of deceased-donor kidney transplantation across nearly all states amid the initial months of the pandemic. However, states that suspended non-essential surgery experienced far steeper reductions than those without. Using a difference-in-differences approach, we estimate a state-level suspension of non-essential surgery led to a 23.6% reduction in the transplant volume. Our study reveals the spillover effect of state-level health policies on patient access to essential services such as deceased-donor kidney transplantation.

4 Examining the Impact of e-Consults on Access to Specialty Care: A Path Towards Improving Health Equity

Mengdi Tan, Apurva Jain, University of Washington, Seattle, WA, Contact: mengdit@uw.edu

This study investigates a eConsult system with a modified referral process, enabling primary care physicians (PCP) to deliver specialty care with support from specialists (SP) through remote consultations. The PCP has the option to independently treat the patient, refer them to a specialist, or seek guidance from a specialist. While consultations are assumed to offer cost-effective and timely benefits compared to referrals, the potential for treatment success may be lower. The analysis focuses on examining the impact on physicians' decisions, system performance, and the patients' experiences from diverse health and socio-economic backgrounds. The aim is to explore how eConsults can contribute to reducing health disparities among underserved patients by enhancing their access to specialty care.

5 The Effect of Must-Access Prescription Drug Monitoring Programs on Patient Volume and Outcomes

Beyza Celik[1], Guihua Wang[2], Behrooz Pourghannad[3], [1]University of Texas at Dallas, Dallas, TX, [2]The University of Texas at Dallas, RICHARDSON, TX, [3]Lundquist College of Business, University of Oregon, Eugene, OR, Contact: bxc190000@utdallas.edu

This study examines the effect of must-access Prescription Drug Monitoring Programs (PDMPs) on patient volume and outcomes. We first use the difference-in-differences approach to analyze the average effect of PDMPs. We then use an empirical machine learning approach to analyze the treatment effect heterogeneity across healthcare providers. Our analysis sheds light on the effects of must-access PDMPs, informing policymakers and stakeholders about their implications in addressing the opioid crisis and optimizing patient care.

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Risk Management for Commodity and Energy Operations

Community Committee Choice Session

Session Chair: Sridhar Sridhar, 1</sup

Session Chair: Qi Wu, 1</sup

1 A Safe Reinforcement Learning Framework for Energy Real Options

Selvaprabu Nadarajah, University of Illinois at Chicago, Chicago, IL, Contact: selvan@uic.edu

Energy investments and operations require adapting decisions to future uncertainties (e.g., prices, climate, and supply intermittency). These decision flexibilities can be modeled as real options and optimized using reinforcement learning (RL). We propose a safe RL framework that manages the performance risks that arise when deploying RL policies.

2 Business Operations Redesign and Working-Condition Improvement in Agribusiness
Dongsheng Li[1], Saurabh Bansal[2], Karthik V. Natarajan[3], Phillip Coles[4], [1]Penn State University, State College, PA, [2]Penn State University, University Park, PA, [3]Carlson School of Management, University of Minnesota, Minneapolis, MN, [4]Lehigh University, Bethlehem, PA, Contact: dul596@psu.edu
We investigate how business operations can be redesigned to improve both a firm's performance and workers' working conditions in agribusiness. We provide a multi-dimensional decision support system based on the optimal strategies of our model. We further calibrate our model using industry data.

3 Agricultural Supply Chains in Emerging Markets: Competition and Cooperation Under Correlated Yields
Maqbool Dada, Johns Hopkins University, Baltimore, MD
We model the development of effective agricultural supply chains (agri-chains) in emerging economies for better utilization of land and intermediate processing resources for harvested export-oriented goods. We study decisions made by farmers, intermediate processors, and government officials in agri-chains. The structure and management of supply chains and government minimum guaranteed prices to farmers affect the performance of these chains and are in the domain of our study. We develop models of agricultural supply chains in which yields are correlated across regions, and, farmers sell to competing capacitated-processors.

4 Analysis on the Effect Environmental Cost on Financial Riskand Operational Decisions
Qi Wu, Peter Ritchken, Case Western Reserve University, Cleveland, OH, Contact: qxw132@case.edu
We aim to address the environmental challenge caused by abandoned mines. Mining firms incur significant financial risk due to the fluctuation in commodity price. When a mining firm faces financial difficulty, it may decide to abandon the mining land. According to Bureau of Land Management, there are over 50,000 abandoned mining sites in U.S., the majority of which need to be remediated. We consider and compare three payment schemes that government/environmental agency can adapt to make sure that mining firms commit to fulfill its environmental obligations. We study the effect of the three different environmental schemes on firms' production decision and financial risk. We provide insights and recommendations to policy makers in designing proper mechanism to address this environmental problem.

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CC-North 131C

Information and Strategic Behavior in Queueing Systems

Community Committee Choice Session

Session Chair: Philipp Afèche, University of Toronto The Rotman School of Management, Toronto, ON, Canada

1 Advertising by Recruiting Influencers
Maya Jalloul[1], Vasiliki Kostami[2], [1]HEC Paris, Paris, France; [2]HEC Paris, Jouy-En-Josas, France
The growth of social media platforms allowed customers to rely on influencers and past consumers' experiences for their purchase decision. We address some of the firm's challenges of influencer marketing by considering different types of influencers and partnership schemes with them and address the effect of social learning in a two-period model. In the first period, the firm launches a new service experience of unknown quality and an influencer marketing campaign that relies on two types of influencers: sponsored advertising and public relations. We suggest the strategic partnerships a firm should establish with social media influencers to promote a new product depending on their credibility and popularity, on the market composition and the characteristics of the social media platform. We further instruct on capitalizing on social learning and optimal market choices.

2 Strategic use of Information in Healthcare
Jeunghyun Kim[1], Laurens G. Debo[2], Robert Shumsky[2], [1]Korea University Business School, Seoul, Korea, Republic of; [2]Dartmouth College, Hanover, NH, Contact: jeunghyunkim@korea.ac.kr
Maintaining costly effort to keep up with good health practices may be challenging at times. We explore how a care provider can strategically provide information to persuade a care receiver to sustain their effort over time, which is of benefit to both of them.

3 Behavior-Aware Queueing: When Strategic Customers Meet Strategic Servers
Yueyang Zhong[1], Raga Gopalakrishnan[2], Amy R. Ward[1], [1]The University of Chicago Booth School of Business,

Chicago, IL, [2]Smith School of Business at Queen's University, Kingston, ON, Canada

Traditional queueing theory assumes that customers do not balk and servers work at constant speeds. However, customers and servers in *service systems* are people, and the incentives created by managerial design decisions influence their behavior. First, we study strategic servers whose choice of work speed depends on (i) how many servers to staff and how much to pay them, and (ii) whether and when to turn away customers. We develop a queueing game model in which the work speeds emerge as solutions to a noncooperative game and asymptotically study the existence, uniqueness, and monotonicity properties of underloaded, critically loaded, and overloaded equilibria. Then, we extend our model to also include strategic customers' joining decisions, which endogenously induce a finite buffer. We conclude by discussing some managerial consequences of ignoring strategic behavior.

4 On The Design Of A Shared Waiting Room

Yanting Li[1], Ricky Roet-Green[2], [1]University of Rochester, Simon business school, Rochester, NY, [2]Simon Business School, University of Rochester, Rochester, NY, Contact: yanting.li@simon.rochester.edu

Many service facilities, such as food courts and clinics, provide multiple different services under one roof. These services often have a single waiting area for all customers. Unlike conventional line-up queueing, where customers can observe the queue in front of each server, customers in a shared waiting room cannot distinguish which server current customers are waiting for. In other words, customers do not have exact information about their actual queue length. However, in contrast to an unobservable queue setting, customers observe the number of customers in the system, and can use this information to infer their expected queue length. Based on such an estimation, customers decide whether to join the queue. We ask how the availability of designated queue-length information affects system performance in terms of throughput and social welfare.

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CC-North 132A

Emerging Issues in Sustainable Supply Chains

Community Committee Choice Session

Session Chair: Andre Du Pin Calmon, Scheller College of Business, Georgia Institute of Technology, Atlanta, GA

Session Chair: Sytske Wijnsma, UC Berkeley, Berkeley, CA

1 Manufacturer's Intervention into Secondary Market: Implications for Firm's Pricing, Refurbishing Quality, Profit and Consumer Welfare

Hailong Cui[1], Greys Sosic[2], [1]University of Minnesota, Minneapolis, MN, [2]University of Southern California, Los Angeles, CA, Contact: hailongc@umn.edu

We utilize an analytical model to study the manufacturer's trade-in programs. We focus on the firm's two operational levers, decisions on pricing andquality of refurbishing, and show that for most products it is optimal for the manufacturer to partially intervene into the secondary market.

2 Index-Based Yield Protection for Smallholder Farmers

Kehan Lu, Jing-Sheng Jeannette Song, Can Zhang, Duke University, Durham, NC, Contact: c.zhang@duke.edu

Government subsidies are common in the agricultural sector to protect farmers from unexpected losses. Two major categories of agricultural subsidies are price protection policies that subsidize farmers when the market price is low and yield protection policies that subsidize farmers when the crop yield is low. While both price and yield protection policies are widely implemented in developed countries, yield protection is typically difficult to implement in emerging economies due to the high cost of yield assessment for small farm sizes. To overcome this challenge, an innovative index-based approach for yield protection has emerged in recent years, under which farmers receive a subsidy payment when a pre-determined index (e.g., rainfall level) predicts that the yield level is low. This paper explores the design and value of such an index-based yield protection policy.

3 Reducing Lead and CO2 Emissions from a Deadly Circular Economy

Erica Plambeck[1], Qiong Wang[2], Amrita Kundu[3], [1]Stanford University, Stanford, CA, [2]University of Illinois at Urbana-Champaign, Urbana, IL, [3]McDonough School of Business, Georgetown University, Washington DC, WA, Contact: elp@stanford.edu

I will describe the deadly circular economy of lead acid batteries for electric vehicles in Bangladesh, and opportunities to reduce its lead and CO2 emissions through profitable business and operating model innovation.

4 Influence of Irrelevant Alternatives on Choices with Environmental Attributes

Mirel Yavuz[1], Charles J. Corbett[1], Guia Bianchi[2], Tayler Bergstrom[1], Aimee Drolet[1], Timothy F. Malloy[1], Deepak

Rajagopal[1], Rakesh Kumar Sarin[1], Francesco Testa[3], [1]University of California-Los Angeles, Los Angeles, CA, [2]European Commission, Sevilla, Spain; [3]Sant'Anna School of Advanced Studies, Pisa, Italy. Contact: charles.corbett@anderson.ucla.edu

Although several tools exist to collect environmental information, there is minimal guidance on making decisions based on such information. Decision-makers are subject to a wide range of context effects in other domains. We replicate an earlier study on choices involving non-environmental attributes and conduct an equivalent set of experiments involving trade-offs between environmental attributes. We show that context effects are frequently significant and substantial in the non-environmental as well as environmental settings; the choice frequency of an alternative can change by 30 percentage points after adding an irrelevant alternative. Our results highlight the importance of incorporating behavioral science into the broader environmental literature that involves trade-offs between environmental attributes.

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CC-North 132B

Sustainable Operations Issues

Community Committee Choice Session

Session Chair: Helen Zhou, Singapore Management University, Singapore, Singapore

Session Chair: Natalie Ximin Huang, University of Minnesota, Minneapolis, MN

1 Effects of Ride-Hailing Platforms on Dual Distribution Channels

Gokce Esenduran, Jianing Li, Purdue University, West Lafayette, IN, Contact: li3193@purdue.edu

Automobile manufacturers in the U.S. typically distribute cars through dealers in the sales market and through rental agencies in the rental market. The emergence of ride-hailing platforms like Uber and Lyft has had a significant impact on both markets. When a platform exists, some customers may rely on using the platform's services instead of buying/renting a car, while others who buy a new or used car may provide rides on the platform. In this paper, constructing a detailed consumer utility model, we identify how the dealer and rental agency decisions, and thus the total ownership change after the ride-hailing platform's entrance. We also study extensions by allowing heterogeneity in the time car owners offer rides through the platform and by allowing the rental agency to sell used cars in the secondary market.

2 Storing Carbon in Supply Chains

Donghyun (Daniel) Choi[1], Andre Du Pin Calmon[2], Beril L. Toktay[1], [1]Georgia Institute of Technology, Atlanta, GA, [2]Scheller College of Business, Georgia Institute of Technology, Atlanta, GA, Contact: donghyun.choi@scheller.gatech.edu

A nascent carbon mitigation practice involves the production of carbon-negative products using bio-based materials or carbon-capturing technologies. Motivated by a carpet manufacturing company that uses bio-based materials, we model the firm's sourcing and manufacturing decisions under different carbon accounting mechanisms and investigates how operating under these mechanisms can shape the firm's decisions.

3 Selling Agricultural Products via Livestream: Implications for Poverty Alleviation in Rural Economies

Xi Lin[1], Luyi Gui[1], Yixin Lu[2], [1]The Paul Merage School of Business, UC Irvine, Irvine, CA, [2]George Washington University, Washington, Contact: xlin32@uci.edu

Livestreaming has been increasingly used by farmers from remote rural areas to sell their agricultural products to consumers. In this paper, we study whether and under what circumstances selling through livestreaming can improve farmers' income compared to traditional approaches such as selling to wholesalers.

4 When To Regulate? The Case With Extended Producer Responsibility

Guiyun Feng[1], Natalie Ximin Huang[2], Bin LI[3], Yangfang (Helen) Zhou[4], [1]Singapore Management University, Singapore, Singapore; [2]University of Minnesota, Minneapolis, MN, [3]Wuhan University, Wuhan, China; [4]Singapore Management University, Singapore, Singapore. Contact: helenzhou@smu.edu.sg

We study the optimal timing decision of extended producer responsibility (EPR) regulation, which is an important lever, especially for emerging industries (e.g., electric vehicles). In those cases, delaying the regulation may allow the industries to advance further along the learning curve. Our study provides useful insight into the optimal design of EPR regulation.

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CC-North 132C

Service and Product Innovations in Healthcare and Pharma

Community Committee Choice Session

Session Chair: Panos Markou, Darden School of Business

1 Does Transparency Hinder Technological Novelty? Evidence from Large Pharmaceutical Firms

Hanu Tyagi, Rachna Shah, University of Minnesota, Minneapolis, MN

Does transparency into a firm's new product development initiatives hinder technological novelty? In this paper, we examine the relationship in the context of the pharmaceutical industry. Using fine-grained data from approximately 10,000 clinical trials conducted between 2000 and 2014, we find that transparency pushes firms to increase the use of existing technologies that are less novel and less risky.

2 Preference Signaling in the Market for Medical Residents

Sasa Zorc, University of Virginia, Darden School of Business, Charlottesville, VA

The market for medical residents uses the celebrated Gale-Shapley algorithm for centralized matching, which guarantees stable and efficient matching. Despite this, inefficiency has crept into the market at the interview stage (so, prior to the application of the algorithm) as market congestion causes applicants to be interviewed only at a small fraction of institutions to which they apply. In an attempt to alleviate this problem, two medical specialties (urology and otolaryngology) introduced preference signals in 2022, which are centralized tokens that are given in limited quantities to candidates. Candidates can send these tokens to hiring institutions prior to interviews to signal interviews. In a retrospective cohort study, we empirically investigate the consequences of this intervention.

3 Behavioral Aspects in the Design of Procurement Auctions: The Capacity to Bid

Ivan Lugovoi[1], Jurgen Mihm[2], [1]Kühne Logistics University, Hamburg, Germany; [2]Insead, Fontainebleau, France. Contact: ivan.lugovoi@the-klu.org

Practical experience and academic research have shown that the design of a tender may have a substantial impact on its outcome. A recent focus on behavioral biases has complemented our understanding of rational aspects in auction design. But while extant work has focused mainly on individual behavioral biases, we focus on organizational biases afflicting entire organizations. Particularly, we are interested in understanding how a buyer should consider the bidders "capacity to bid". We conduct an empirical investigation of large-scale tenders of pharmaceutical products performed by German health insurance companie in order to study which tenderdesigns influence the number of participants. We thus hope to give tender designers practical advice based on rigorous analysis.

4 The Effect of Vote Timing Rules on New Product Evaluation Decisions: Advisory Committees at the Fda

Panos Markou[1], Tian Chan[2], [1]UVA Darden School of Business, Charlottesville, VA, [2]Emory University, Atlanta, GA

How should an expert committee vote to reach a collective recommendation on a complex issue? We examine how sequential versus simultaneous voting schemes shape the discussion, voting patterns, and ultimately the decision quality of the committee's recommendation. Combining multiple data sets based on FDA Advisory Committees' evaluations of new drugs and medical devices, we leverage a 2007 change from sequential to simultaneous voting to establish three key insights. We show that, relative to a sequential voting protocol, adoption of simultaneous voting by FDA Advisory Committees led to (1) a broader search for information in discussions, (2) a reduction in unanimous votes, and (3) an increase in the quality of recommendations made. We discuss academic and managerial implications.

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MD31

CC-North 221A

The Role of Operations Research in Disaster Risk Reduction, Building Disaster Resilience and Effective Crisis Response

Panel Session

Session Chair: Fatma Salman, Koc University, Istanbul, Turkey

1 The Role of Operations Research in Disaster Risk Reduction, Building Disaster Resilience and Effective Crisis Response

Fatma Salman, Koc University, Istanbul, Turkey

Operations Research methods have been applied to problems arising in disaster management and humanitarian operations, especially with increasing interest by researchers over the past two decades. Moreover, the algorithms, tools, and insights developed by these studies have been instrumental in disaster and crisis management in practice and have found value among relief agencies and crisis managers. The role of OR in building disaster resilience and optimizing response operations will be discussed by panelists who are experts on disaster and crisis management and humanitarian operations management with anecdotes and findings from recent major disasters experienced worldwide, including the devastating earthquakes in Turkey, the wildfire in Hawaii, the global COVID-19 pandemic, and the Ukrainian war together with the resulting refugee crises and global supply chain disruptions.

2 Panelist

Pinar Keskinocak, ISyE Georgia Tech, Atlanta, GA

3 Panelist

Bahar Yetis Kara, Ihsan Dogramaci Bilkent University, Ankara, Turkey

4 Panelist

Anna B. Nagurney, University of Massachusetts Amherst, Amherst, MA

5 Panelist

Christopher W. Zobel, Virginia Tech, Blacksburg, VA

Monday, October 16, 2:15 PM - 3:30 PM

MD32

CC-North 221B

Data-driven Operation of Emerging Mobility Systems

Community Committee Choice Session

Session Chair: Devansh Jalota, Stanford University, Stanford, CA
Session Chair: Karthik Gopalakrishnan, Stanford University, Cambridge, MA

1 Optimal Design of Best Response Dynamics in Multi-Agent Resource Assignment

Rohit Konda[1], Rahul Chandan[2], David Grimsman[3], Jason R. Marden[4], [1]University of California, Santa Barbara, Santa Barbara, CA, [2]Amazon.com, North Reading, MA, [3]Brigham Young University, Provo, UT, [4]University of California, Santa Barbara, Santa Barbara, CA

Game theory has emerged as a promising paradigm for the design of coordination algorithms in multi-agent systems. However, the emphasis of existing game-theoretic approaches is on the study of asymptotic (i.e., equilibrium) behaviour, whereas transient behaviour is often less explored. In this work, we adapt common game-theoretic techniques to study transient efficiency guarantees in the context of multi-agent resource assignment problems. Specifically, our main focus is on designing agent utility functions that induce optimal short-term, system-level behaviour under best response learning dynamics. Interestingly, we show that the performance guarantees under the induced transient learning dynamics are relatively close to the best achievable asymptotic performance guarantees.

2 Using Digital Infrastructure to Manage the Curbside in Real-Time

Shushman Choudhury, Lacuna Technologies, Palo Alto, CA, Contact: shushman.choudhury@lacuna.ai

As urban areas contend with increasing congestion, surging delivery demand, and diverse transportation modes, real-time optimization of limited curb space is crucial. This talk will explore how digital infrastructure, built upon sensors and algorithms, can enhance curb utilization via priority access, reservations, and other tactics. By analyzing two published case studies, we will explore the computational complexities inherent in designing algorithms for public right-of-way operations. Furthermore, the talk will highlight the advantages of managing the curb adaptively, including reduced traffic congestion and emissions, as well as increased safety and revenue opportunities.

3 Connected and Automated Vehicles in Mixed Traffic: Learning Human Driver Behavior for Effective On-Ramp Merging

Aditya Dave, University of Delaware, Newark, DE, Contact: adidave@udel.edu

Connected and automated vehicles (CAVs) are expected to improve safety and energy-efficiency of transportation systems. Since CAVs will penetrate the market gradually, it is critical to develop controls for CAVs in mixed-traffic scenarios involving human-driven vehicles (HDVs). This problem is challenging due to a dearth of well-understood models for CAV-HDV interactions. In this talk, we consider highway on-ramp merging scenarios requiring a CAV to merge with an HDV in a safe and energy-efficient manner. We present an approach to learn an approximate information state model for this goal. Then, we use it to generate trajectory predictions for the HDV and to control the CAV efficiently. We show in numerical simulations that our approach effectively predicts future trajectories of an HDV and generates safe control policies for a CAV during merging with the HDV.

4 Data-Driven Distributionally Robust Vehicle Routing for Heterogeneous Heavy-Duty Trucks
Ruiting Wang, University of California Berkeley, Berkeley, CA, Contact: rtwang@berkeley.edu
In this work, we study the routing of electric trucks through an application of distributionally robust optimization (DRO) for route planning and dispatch. This approach aims to minimize the cost of operation for the fleet, and considers the variability in energy consumption due to uncertain road conditions, traffic, weather, and driving behavior. Furthermore, we augment the distributionally robust energy-minimizing vehicle routing problem by learning the energy efficiency distribution over a horizon. We show that convergence to the true distribution is achieved while learning from samples taken from vehicles in operation on the network. Numerical experiments are conducted to validate this method and to compare it with the deterministic model.

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MD33

CC-North 221C
Optimization for Sequential Decision-Making
Community Committee Choice Session
Session Chair: Sebastian Perez, [1</sup]
Session Chair: Alfredo Torrico, Cornell University, Ithaca, NY

1 Online Allocation with Priorities and Quotas
Matthew Eichhorn[1], Siddhartha Banerjee[1], David Kempe[2], [1]Cornell University, Ithaca, NY, [2]University of Southern California, Los Angeles, CA, Contact: meichhorn@cornell.edu
In online applications such as the rationing of medical care, the decision of who is treated is justified by various ethical, financial, and legal criteria. We build upon recent work on priority respecting allocations, adapting the model to an online setting. We highlight the fundamental trade-off between an allocation mechanism’s efficiency, its assurance that goods are allocated to the greatest extent, and its adherence to pre-defined notions of priority. In particular, in a setting with T online arrivals, we show that while insisting on zero priority violations leads to an $\Omega(T)$ loss in efficiency, one can design policies ensuring that the sum of the efficiency loss and priority violations is ⍰(1) under mild regularity conditions.

2 Response-Adaptive Clinical Trials with Many Treatments
David Brown, Cleo Yan, Duke University, Durham, NC, Contact: jingyi.yan@duke.edu
Clinical trials are traditionally designed to be non-adaptive. Although this design guarantees a well-performing treatment to be identified by the end of the trial with low bias, the process can be costly in terms of both time and resources. Response-adaptive design of clinical trials, on the other hand, enables the decision maker to alter the number of patients assigned to a treatment given its previous performances. Using an approach based on Lagrangian relaxations, we develop feasible policies and performance bounds. In a simplified two-period model, we bound the performance loss of the feasible Lagrangian policy and show that these policies are asymptotically optimal in a regime in which patients and treatments grow at the same rate.

3 Online ***K***-Median with Consistent Clusters
Benjamin Moseley[1], Heather Newman[1], Kirk Pruhs[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]University of Pittsburgh, Pittsburgh, PA, Contact: hanewman@andrew.cmu.edu
We consider the online k-median clustering problem in which n points arrive online and must be irrevocably assigned to a cluster on arrival. As there are lower bound instances that show that an online algorithm cannot achieve a competitive ratio that is a function of n and k, we consider a beyond worst-case analysis model in which the algorithm is provided a priori with a predicted budget B that upper bounds the optimal objective value. We give an algorithm that achieves a competitive ratio that is exponential in the the number k of clusters, and show that the competitive ratio of every algorithm must be linear in k. To the best of our knowledge this is the first investigation in the literature that considers cluster consistency using competitive analysis.

4 A Simple Algorithm for Online Decision Making
Rui Chen[1], Oktay Gunluk[2], Andrea Lodi[1], Guanyi Wang[3], [1]Cornell Tech, New York, NY, [2]Cornell University, Ithaca, NY, [3]National University of Singapore, Singapore, Singapore. Contact: rc678@cornell.edu
Motivated by recent progress on online linear programming (OLP), we study the online decision making problem (ODMP) as a natural generalization of OLP. ODMP significantly broadens the modeling framework of OLP by allowing more general feasible regions (for local and long-term constraints) potentially involving both discreteness and nonlinearity in

each local decision making problem. We propose a Fenchel dual-based algorithm for ODMP that achieves sublinear long-term constraint violation and competitive difference in reward with respect to the optimal offline decisions. Experiments are conducted on an online knapsack problem with two different long-term fairness constraints.

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MD34

CC-North 222A

Recent Advances in Nonsmooth Optimization

Community Committee Choice Session

Session Chair: Shaoning Han, University of Southern California, Los Angeles, CA

1 On the Tractable Resolution of Chance-Constrained Optimization Problems

Uday V. Shanbhag, Pennsylvania State University, University Park, PA, Contact: udaybag@psu.edu

We begin by considering the probability maximization where under suitable distributional assumptions, by leveraging properties of Minkowski functionals, the probability of interest can be expressed as the expectation of a Clarke-regular function with respect to an appropriately defined Gaussian density (or its variant). In fact, we may show that a suitably defined equivalent compositional representation is shown to be convex. We then derive rate and complexity guarantees for a regularized variance-reduced framework for computing approximate global maximizers of the original problem. We then extend our framework to a chance-constrained regime where distributional assumptions are weakened. Complexity guarantees for resolving this inclusion are provided for an inexact variance-reduced proximal-point scheme.

2 An Optimization Algorithm for Nonsmooth Problems with Weakly Concave Objective

Jingyi Wang, 1</sup

We present an optimization algorithm for a group of nonsmooth optimization problems that arise in solutions to parametric optimization problems and applications such as security-constrained AC optimal power flow problems. More specifically, the line search sequential quadratic programming method can be applied to constrained optimization problems with weakly concave objective. We present global convergence analysis and numerical examples in the form of two-stage optimization problems. Further, the algorithms can be extended to stochastic optimization where the exact function values and subgradients are unavailable. The algorithm is scalable and has been implemented and tested on supercomputers at national labs. The capabilities of the algorithm are demonstrated by solving a realistic optimal power flow problem as used in current power grid industry practice.

3 Adaptive Importance Sampling for Bayesian Hierarchical Models via Logarithmic Integral Optimization

Ziyu He[1], Junyi Liu[2], Jong-Shi Pang[3], [1]University of Southern California, Los Angeles, CA, [2]Tsinghua University, Beijing, China; [3]University of Southern California, Los Angeles, CA, Contact: ziyuhe@usc.edu

We explore Maximum a Posteriori inference of Bayesian Hierarchical Models (BHMs) with intractable normalizers, which are increasingly prevalent in contemporary applications and pose computational challenges when combined with nonconvexity and nondifferentiability. To address these, we propose the Adaptive Importance Sampling-based Surrogation method, which efficiently handles nonconvexity and nondifferentiability while improving the sampling approximation of the intractable normalizer through variance reduction. Our analysis ensures its almost sure subsequential convergence to a surrogation stationary point, a necessary candidate for a local minimizer. Extensive numerical experiments demonstrate the efficiency and stability of our algorithm in enabling advanced BHMs with intractable normalizers arising from enhanced modeling capability.

4 Variational Theory and Algorithms for a Class of Asymptotically Approachable Nonconvex Problems

Hanyang Li, Ying Cui, UC Berkeley, Berkeley, CA, Contact: hanyang_li@berkeley.edu

We investigate a class of composite nonconvex functions, where the outer function is the sum of univariate convex functions and the inner function is the limit of diﬀerence-of-convex functions. A notable feature of this class is that the inner function can be merely lower semicontinuous instead of continuous. It covers challenging applications, including bi-parameterized two-stage stochastic programs, value-at-risk for continuous distributions. We propose an asymptotic decomposition of the composite functions that epiconverges to the original function, leading to necessary optimality conditions for the minimization problems. We also design an algorithm provably convergent to the introduced optimality conditions. These results expand on the study of amenable functions by Poliquin and Rockafellar in 1992 and the prox-linear algorithm for their minimization.

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MD35

CC-North 222B

First-Order Methods for Machine Learning

Community Committee Choice Session

Session Chair: Trang Tran, Cornell University, Ithaca, NY

Session Chair: Lam M. Nguyen, IBM Research, Thomas J. Watson Research Center, Yorktown Heights, NY

1 On the Convergence to a Global Solution of Shuffling-Type Gradient Algorithms

Lam M. Nguyen[1], Trang Tran[2], [1]IBM Research, Thomas J. Watson Research Center, Yorktown Heights, NY, [2]Cornell University, Ithaca, NY, Contact: lamnguyen.mltd@ibm.com

Stochastic gradient descent (SGD) algorithm is the method of choice in many machine learning tasks thanks to its scalability and efficiency in dealing with large-scale problems. In this paper, we focus on the shuffling version of SGD which matches the mainstream practical heuristics. We show the convergence to a global solution of shuffling SGD for a class of non-convex functions under over-parameterized settings. Our analysis employs more relaxed non-convex assumptions than previous literature. Nevertheless, we maintain the desired computational complexity as shuffling SGD has achieved in the general convex setting.

2 Stochastic Optimization Methods with Momentum

Trang Tran[1], Lam M. Nguyen[2], Katya Scheinberg[1], [1]Cornell University, Ithaca, NY, [2]IBM Research, Thomas J. Watson Research Center, Yorktown Heights, NY, Contact: htt27@cornell.edu

The empirical risk minimization problem (ERM) arises in most machine learning tasks, including logistic regression and some neural networks. Stochastic Gradient Descent (SGD) has been widely used to solve this problem thanks to its scalability and efficiency in dealing with large-scale tasks. Many variants of SGD involve momentum techniques which incorporate the past gradient information to the descent direction. Since the momentum methods offer encouraging practical performance, it is desirable to study their theoretical aspects and apply that knowledge to algorithm design. In this talk, we provide an overview of some of the stochastic momentum methods for the ERM problem and highlight some practical algorithms and/or settings where the momentum methods may have theoretical/heuristic advantages compared to plain SGD.

3 How to Escape Sharp Minima

Kwangjun Ahn, Massachusetts Institute of Technology, Cambridge, MA

Modern machine learning applications have seen a remarkable success of optimization algorithms that are designed to find flat minima. Motivated by this paradigm, this work formulates the algorithmic question of how to find flat minima. As an initial effort, we adopt the trace of hessian of the cost function as the measure of flatness and formally define the notion of approximate flat minima. We then design algorithms that find approximate flat minima efficiently. For general cost functions, we present a gradient-based algorithm that finds an approximate flat local minimum efficiently by using gradients computed from randomly perturbed iterates to estimate a direction that leads to flatter minima. For the setting where the cost function is an empirical risk over training data, we present a faster algorithm that is inspired by sharpness-aware minimization.

4 A Variance-Reduced and Stabilized Proximal Stochastic Gradient Method with Support Identification Guarantees for Structured Optimization

Yutong Dai[1], Guanyi Wang[2], Frank E. Curtis[3], Daniel Robinson[4], [1]Lehigh University, Bethlehem, PA, [2]National University of Singapore, Singapore, Singapore; [3]lehigh university, Bethlehem, PA, [4]Lehigh University, Bethlehem, PA, Contact: yud319@lehigh.edu

We propose, *S-PStorm,* a proximal stochastic gradient method with variance reduction and stabilization for structured sparse optimization. We prove an upper bound on the number of iterations required by *S-PStorm* before its iterates correctly identify with high probability an optimal support. Most algorithms with such a support identification property use variance reduction techniques that require either periodically evaluating an exact gradient or storing a set of stochastic gradients, while *S-PStorm* does not require either of these. Moreover, our support-identification result shows that, with high probability, an optimal support will be identified correctly in all iterations with the index above a threshold, while the few existing results prove that the optimal support is identified with high probability at each iteration with a sufficiently large index.

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MD36

CC-North 222C

Recent Progress in Optimization Software III

Community Committee Choice Session

Session Chair: Hans Mittelmann, Arizona State University, Tempe, AZ

1 The Supporting Hyperplane Optimization Toolkit - Recent Advances

Andreas Lundell, Åbo Akademi University, Vaasa, Finland. Contact: andreas.lundell@abo.fi

The Supporting Hyperplane Optimization Toolkit (SHOT) is an open-source solver for mixed-integer nonlinear programming (MINLP) problems that combines a polyhedral outer approximation algorithm (Extended Supporting Hyperplane, ESH) with primal heuristics. SHOT has already been shown to work well for convex MINLP problems and can solve this problem class to global optimality. For most nonconvex problems, however, SHOT will only act as a heuristic method, without any guarantee to find the global optimal solution. In this presentation, some recent advances in solving nonconvex problems are described. Also, some recent benchmarks comparing SHOT to other MINLP solvers are provided.

2 Recent Progress in the Global Optimization of NLPs and MINLPs with BARON

Nick Sahinidis[1,2], [1]Georgia Institute of Technology, Atlanta, GA, [2]The Optimization Firm, Atlanta, GA

We review recent developments toward the global optimization of nonlinear and mixed-integer nonlinear programming problems with BARON. We discuss relaxation construction, preprocessing, branching, and tree management techniques. In addition to widely accepted benchmarks, we present results for a large test set. In all cases, we discuss historical progress and emphasize recent developments.

3 Highs: An Improved Interior Point Solver for the World

Julian Hall, University of Edinburgh, Edinburgh, United Kingdom. Contact: jajhall@ed.ac.uk

HiGHS is open-source optimization software for linear programming (LP), mixed-integer programming (MIP) and quadratic programming (QP). Independent benchmark results demonstrate HiGHS to be the world's best open-source linear optimization software, in particular when solving LPs by interior point. However, the interior point solver can still be totally uncompetitive with commercial solvers. This has been noticed particularly in the context of energy systems, and led to major funding for the development of a new interior point solver. This talk will discuss our work in the area, as well as providing an update on more general advances in HiGHS.

4 Latest Progress in Optimization Software

Hans Mittelmann, Arizona State University, Tempe, AZ

We will report on selected of our optimization software benchmarks

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MD37

CC-North 223

Algorithms for Robust Optimization

Community Committee Choice Session

Session Chair: Kartikey Sharma, Zuse Institute Berlin, Berlin, Germany

1 Frank Wolfe for Robust Combinatorial Optimization

Kartikey Sharma, Zuse Institute Berlin, Berlin, Germany

Robust Combinatorial Optimization (RCO) problems play a crucial role in many optimization applications. So far most research on RCO problems has focused on linear objective functions. In this project, we present a novel approach to solving nonlinear RCO problems with convex costs using the composite Frank-Wolfe (FW) algorithm. Our algorithm involves iteratively solving a linear RCO to compute the descent direction and then leveraging the convergence properties of the FW algorithm to solve the overall problem. The linear RCO is efficiently computed by solving a collection of nominal combinatorial optimization problems with modified objectives. We evaluate the performance of our algorithm through numerical experiments.

2 Decomposition Method for Two-Stage Distributionally Robust Optimization over 1-Wasserstein Balls

Geunyeong Byeon[1], Kibaek Kim[2], [1]Arizona State University, Tempe, AZ, [2]Argonne National Laboratory, Lemont, IL, Contact: geunyeong.byeon@asu.edu

We present optimality conditions for two-stage distributionally robust conic linear programming under constraint uncertainty over type-1 Wasserstein balls. Based on the optimality conditions, we propose binary representations of uncertain parameters that are supported on a hyperrectangle and develop a decomposition algorithm that achieves ⍰-optimality in a finite number of iterations. The proposed approach is validated through computational studies on electric power distribution systems.

3 First-Order Conditions for Optimization in the Wasserstein Space

Nicolas Lanzetti, Saverio Bolognani, Florian Dörfler, ETH Zürich, Zürich, Switzerland. Contact: lnicolas@ethz.ch

We consider the optimization of real-valued functionals over the probability space. This problem prompts us to tailor differential calculus to the space of probability measures. Specifically, we first explain the concept of "gradient with respect to a probability measure" (so-called Wasserstein gradient), which we then leverage to derive first-order optimality conditions. Remarkably, simple rationales such as "set the derivative to zero" and "the gradients of the objective function and the constraint align at optimality" carry over to the probability space. The generality of our methodology allows us to naturally deal with functionals, such as mean-variance, Kullback-Leibler divergence, and Wasserstein distance, which are traditionally difficult to study in a unified framework. We conclude with an application in distributionally robust optimization.

4 On the Convex Formulations of Robust Markov Decision Processes

Julien Grand-Clement[1], Marek Petrik[2], [1]HEC Paris, Paris, France; [2]University of New Hampshire, Durham, NH, Contact: mpetrik@cs.unh.edu

Robust Markov decision processes (MDPs) are used for applications of dynamic optimization in uncertain environments and have been studied extensively. Many of the main properties and algorithms of MDPs, such as value iteration and policy iteration, extend directly to RMDPs. Surprisingly, there is no known analog of the MDP convex optimization formulation for solving RMDPs. This work describes the first convex optimization formulation of RMDPs under the classical sa-rectangularity and s-rectangularity assumptions. We derive a convex formulation with a linear number of variables and constraints but large coefficients in the constraints by using entropic regularization and exponential change of variables. Our work opens a new research direction for RMDPs and can serve as a first step toward obtaining a tractable convex formulation of RMDPs.

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MD38

CC-North 224A

Statistics and Robust Optimization

Community Committee Choice Session

Session Chair: Bart Paul Gerard Van Parys, Massachusetts Institute of Technology, Cambridge, MA

Session Chair: Amine Bennouna, MIT, Cambridge, MA

1 Optimal Holistic Robustness in Stochastic Optimization

Amine Bennouna, Bart Paul Gerard Van Parys, Massachusetts Institute of Technology, Cambridge, MA, Contact: amineben@mit.edu

We study the design of data-driven decision-making and machine learning methods that enjoy a guaranteed out-of-sample performance. We consider the setting where data points can be corrupted by noise or completely misspecified. Existing robust methods often overlook generalization issues and only protect against corruption, failing to provide guaranteed out-of-sample performance. We design a novel approach that offers a holistic solution that not only protects against corruption but also ensures strong generalization. This is achieved through a distributionally robust formulation with a novel combination of Kullback-Leibler and Levy-Prokhorov ambiguity. We prove our novel DRO approach optimal for learning under corruption and demonstrate its effectiveness in training neural networks, resulting in novel robust networks with state-of-the-art performance.

2 Smoothed ***F***-Divergence Distributionally Robust Optimization: Information-Theoretic Efficiency and Complexity Independence

Zhenyuan Liu[1], Bart Paul Gerard Van Parys[2], Henry Lam[1], [1]Columbia University, New York, NY, [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: vanparys@mit.edu

In measuring model discrepancy against empirical data in DRO, divergence metrics are known impose the restriction of absolute continuity through as an indirect results of its definition involving likelihood ratios. On the other hand, distances such as Wasserstein operate via support point perturbations and do not impose continuity restrictions. However, neither satisfy the information-theoretic efficiency enjoyed by the KL-divergence; a special divergence metric. We study new computationally tractable distances by smoothing divergences with transport distances via a variational-representation-type optimization problem. We show that DRO based on such a distances may achieve the same large deviations asymptotic efficiency enjoyed by KL-divergence for general, possibly continuous, ground-truth distributions.

3 Generalization Power of Distributionally Robust Optimization: From Worst-Case Analysis to Minimal Hypothesis Class Dependence

Yibo Zeng, Henry Lam, Columbia University, New York,

NY, Contact: yz3587@columbia.edu

Established approaches to obtain generalization bounds in data-driven optimization mostly build on empirical risk minimization (ERM), which depend crucially on the hypothesis class complexity. We present an alternate route to obtain bounds for distributionally robust optimization (DRO). In contrast to the class complexity in ERM, our DRO bounds depend on the ambiguity set geometry and its compatibility with the true loss function. Notably, for distance-based DRO, our analysis implies generalization bounds whose dependence on the hypothesis class appears the minimal possible: The bound depends solely on the true loss function, independent of any other candidates in the hypothesis class. We discuss how our bounds reveal the strengths and weaknesses of DRO, and also how they amplify the benefits of DRO under distribution shift that ties to robustness.

4 Conditional Robust Optimization: A Framework for Decision Making Under Uncertainty

Abhilash Chenreddy, Erick Delage, HEC Montréal, Montreal, QC, Canada. Contact: abhilash.chenreddy@hec.ca

Conditional Robust Optimization (CRO) is a decision-making framework that blends the flexibility of robust optimization (RO) with the ability to incorporate additional information regarding the structure of uncertainty. This approach solves the RO problem, where the uncertainty set accounts for the most recent side information provided by a set of covariates. In this presentation, we will introduce two data-driven approaches to CRO: a sequential predict-then-optimize method and an integrated end-to-end method. We will demonstrate the application of both approaches and examine how each approach can incorporate additional information about the distribution of uncertainty into the optimization model. Finally, we will compare CRO with other contextual and non-contextual decision-making frameworks to emphasize their advantages and limiations.

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MD39

CC-North 224B

TSL Student Paper Prize

Award Session

Session Chair: Chiwei Yan, University of Washington, Seattle, WA

1 Fleet Sizing and Service Region Partitioning for Same-Day Delivery Systems

Dipayan Banerjee, Georgia Institute of Technology, Atlanta, GA

2 Probabilistic Bounds on the k-Traveling Salesman Problem and the Traveling Repairman Problem

Moïse Blanchard, MIT, Cambridge, MA

3 Optimizing the Path Towards Plastic-Free Ocean

Baizhi Song, London Business School, London, United Kingdom

4 Electric Vehicle Fleet and Charging Infrastructure Planning

Sushil Varma, Georgia Institute of Technology, Atlanta, GA

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MD40

CC-North 225A

Machine Learning/Reinforcement Learning in Vehicle Routing

Community Committee Choice Session

Session Chair: Xinwei Chen, Bucknell University, Lewisburg, PA

1 A Neural Separation Algorithm for the Rounded Capacity Inequalities

Hyeonah Kim[1], Jinkyoo Park[2], Changhyun Kwon[3], [1]KAIST, Daejeon, Korea, Republic of; [2]Korea Advanced Institute of Science and Technology, Daejeon, Korea, Republic of; [3]University of South Florida, Tampa, FL

The cutting plane method is a key technique for successful branch-and-cut and branch-price-and-cut algorithms that find the exact optimal solutions for various vehicle routing problems (VRPs). Among various cuts, the rounded capacity inequalities (RCIs) are the most fundamental. We design a learning-based separation heuristic algorithm with graph coarsening that learns the solutions of the exact separation problem with a graph neural network (GNN). We embed our separation algorithm within the cutting plane method to find a lower bound for the capacitated VRP (CVRP) with up to 1,000 customers. We compare the performance of our approach with CVRPSEP, a popular separation software package for various cuts used in solving VRPs.

2 Maximizing the Service Level over Time in Same-Day Delivery with Demand Evolution

Xinwei Chen[1], Marlin Wolf Ulmer[2], Barrett Thomas[3], Tong Wang[3], [1]Bucknell University, Lewisburg, PA, [2]Otto-von-Guericke Universität Magdeburg, Magdeburg, Germany; [3]University of Iowa, Iowa City, IA, Contact: xc003@bucknell.edu

The market for same-day delivery (SDD) is fast-growing, and the increasing demand brings challenges in delivering the service. Existing research focuses on improving service levels over a short period such as a day. However, the number of customer requests may evolve in the long run depending on the historical service level. For example, more customers are expected to be attracted if service levels increase in a neighborhood, and vice versa. In this talk, we consider the evolution of demand for SDD and develop a deep reinforcement learning approach to maximize the service level over time. We also compare different training strategies and discuss how our policies can help companies avoid significant customer churn and stay competitive in all neighborhoods.

3 Dynamic Time Slot Management with Uncertain Basket Sizes

Liana Van der Hagen[1], Niels Agatz[2], Remy Spliet[3], [1]Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands; [2]Erasmus University Rotterdam, Rotterdam, Netherlands; [3]Erasmus Universiteit-Rotterdam, Rotterdam, Netherlands

In grocery home delivery, retailers usually let customers select a delivery time slot for receiving their groceries. The delivery capacity - the number of vehicles and drivers - is often fixed and inflexible in the short term. To effectively use their delivery capacity, e-grocers may dynamically close time slots for certain new customers given the already accepted customer orders. One complicating factor is that many online grocers allow customers to change their order basket at any time before the cut-off. Consequently, the e-grocer is uncertain about how much vehicle capacity should be reserved for each of the customers during the booking process. We study the challenges that arise with this order basket uncertainty, propose strategies to deal with it and assess if Machine Learning (ML) approaches are more reliable in these real-world settings.

4 Crowdsourced Delivery with Rental Electric Vehicles

Justin Goodson[1], Shu Zhang[2], Zhiwei Zhang[2], [1]Saint Louis University, Saint Louis, MO, [2]Chongqing University, Chongqing, China. Contact: goodson@slu.edu

We study a problem where crowdsourced drivers rent electric vehicles to deliver orders for an online retailer. Drivers' arrival times and work durations are uncertain. Vehicles' state of charge at the time of rental are also uncertain. We develop a cost function approximation to dynamically manage capacity. The approach seeks to balance the cost of hiring too many drivers against the cost of not having enough drivers.

Monday, October 16, 2:15 PM - 3:30 PM

MD41

CC-North 225B

Applications of Optimization

Contributed Session

Session Chair: Rachael May Alfant, Rice University, Houston, TX

1 Adaptive Linear Algebra

Theodoros Koukouvinos, MIT, Cambridge, MA

In this paper, we address two fundamental problems in linear algebra, linear systems and eigenvalues-eigenvectors (eigen-pairs), under adaptive optimization, by allowing the optimal solutions to be functions $f(\cdot)$ of uncertain parameters. Assuming $f(\cdot)$ is a linear function, we formulate both adaptive linear systems and adaptive eigen-pairs. We derive upper bounds for the optimal value and solve the problems to optimality using cutting planes. In the numerical experiments, we demonstrate the benefit of the adaptive linear systems and adaptive eigen-pairs over the nominal and robust ones in multi-period linear systems and multi-period eigen-pair problems. Moreover, we illustrate that the adaptive linear systems and adaptive eigen-pairs are more accurate than the nominal and robust ones on perturbations of ill-conditioned matrices.

2 Boole's Probability Bounding Problem and Linear Programming Aggregations

Joonhee Lee[1], Endre Boros[2], [1]Pace University, New York, NY, [2]Rutgers University, Piscataway, NJ

George Boole proposed the union bounding problem, a class of probabilistic satisfiability/optimization problems. In its most frequently studied case, we are given the probabilities of n events and the probabilities of their pairwise intersections and want to know how small/large can the probability of their union be. Hailperin (1965) provided a linear programming model for this problem which involves an exponential number of variables. We study methods that aggregate subsets of variables in Hailperin's model in various ways. We present one aggregation model with a polynomial number of variables that is equivalent to Hailperin's model.

3 Research Trends for Inventory Optimization with Product Substitution: From Model-Based to Data-Driven Approaches
Thais de Castro Moraes[1], Xue-Ming Yuan[1], Ek Peng Chew[2], [1]Agency for Science, Technology and Research (A*STAR), Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore. Contact: e0508687@u.nus.edu
Product substitution impacts different levels of the supply chain and contributes to the decisions in assortment planning, inventory optimization, and pricing. The increasing variety of products, level of consumer diversity and amount of historical data available has been instigating the development of new data-driven frameworks that account for different demand patterns and improve decisions flexibility due to substitution. We present a thorough review on the studies about product substitution with a focus on its effects on inventory optimization, evolving from the classical model-based approaches that rely on distributional assumptions, to fully data-driven decision-making methods. The studies are categorized based on the methodology to model and solve the inventory problem with the aim to identify knowledge gaps and suggest research directions.

4 A Stochastic Nonlinear Programming Approach to Pricing in the Cloud
Rachael M. Alfant, Sebastian Perez Salazar, Andrew J. Schaefer, Rice University, Houston, TX, Contact: rma10@rice.edu
There are three usage-payment plans that cloud computing providers often offer: reserved (long-term), on-demand (short-term), and spot (one-time). The spot market offers significantly discounted services by taking advantage of unused resources, which motivates the question of how to appropriately price spot market resources. This talk presents stochastic nonlinear programming formulations that optimize prices for the spot market under uncertain demand and available resources. We consider both static and dynamic pricing policies, and compare both in terms of revenue and interpretability. These formulations seek to maximize revenue for the cloud provider, and may also inform optimal pricing mechanisms for the on-demand and reserved markets.

Monday, October 16, 2:15 PM - 3:30 PM

MD42

CC-North 226A
RAS Problem Solving Award Session
Award Session
Session Chair: Marcella Samà, Roma Tre University, Rome, Italy
Session Chair: Homero Larrain, Pontificia Universidad Catolica de Chile, Santiago, Chile

Monday, October 16, 2:15 PM - 3:30 PM

MD43

CC-North 226B
Advanced Air Mobility
Community Committee Choice Session
Session Chair: Gokhan Inalhan, 1</sup
Session Chair: Michael Hardt, 1</sup

1 Congestion Management Protocols For Advanced Air Mobility
Christopher Chin, Massachusetts Institute of Technology, Cambridge, MA
The demand for advanced air mobility (AAM) operations is expected to be at a much larger scale than conventional aviation. Centralized optimization approaches to air traffic flow management assume that a central entity has complete knowledge of proposed flight trajectories in full. This assumption may not hold for AAM applications, where demand is expected to be more dynamic, and operators may be sensitive to sharing information. Therefore, we consider traffic management protocols that preserve operator privacy, while providing enough structure to mitigate efficiency loss. We demonstrate that our traffic management protocols can help balance efficiency and fairness.

2 A Comparative Study of Routing Options and Network Topologies for AAM Traffic Networks
Arinc Tutku Altun, Cranfield University, Bedford, United Kingdom
Future Advanced Air Mobility (AAM) is a concept that envisions to transform the current air transportation system into a more agile, flexible, and accessible system. Yet, the considered transformation and integrated system is not easy to achieve since it involves providing high level of safety as well as efficiency. For that purpose, we explored various metrics related to safety, efficiency, resiliency, social and environmental impact and analyzed different routing options

through the defined metrics over three vertiport networks. With these analysis, we aim to provide assistance for the integration process of the AAM.

3 An Airlift Scheduling Solution Based on Combination of Integer Programming and AI-Based Techniques
Michael Hardt, Boeing Research & Technology, Madrid, Spain. Contact: michael.w.hardt@boeing.com
We present a solution for an airlift scheduling pickup and delivery problem which contains probabilistic events in the route availability. A hierarchical approach is taken for which a high-level integer programming formulation provides a multi-agent solution in the planning horizon window and for the cargo to be delivered, while a lower level AI-based tree search solution performs a more detailed planning taking into consideration the uncertain elements in the distribution graph structure.

Monday, October 16, 2:15 PM - 3:30 PM

MD44

CC-North 226C
Meet the Editors of International Transactions in Operational Research (ITOR)”
Panel Session
Session Chair: Celso C. Ribeiro, Universidade Federal Fluminense, Rio de Janeiro, Brazil

1 Meet the Editors of International Transactions in Operational Research (ITOR)
Celso C. Ribeiro, Universidade Federal Fluminense, Rio de Janeiro, Brazil
The General Editor of the International Transactions In Operational Research (ITOR) will present some statistics, good publication practices, and information about the submission, refereeing, and publication workflow of the journal. The Associate Editors will discuss relevant results, recent trends, and research opportunities in their areas. They will be glad to welcome questions from the audience, readers, authors, and students. ITOR is the flagship journal of the International Federation of Operational Research Societies, published by Wiley.

2 **Panelist**
Anna B. Nagurney, University of Massachusetts Amherst, Amherst, MA

3 **Panelist**
Eli Olinick, Southern Methodist University, Dallas, TX

4 **Panelist**
James J. Cochran, The University of Alabama, Tuscaloosa, AL

5 **Panelist**
Kathryn E. Stecke, University of Texas at Dallas, Richardson, TX

6 **Panelist**
Kenneth Sorensen, University of Antwerp, Antwerp, Belgium

Monday, October 16, 2:15 PM - 3:30 PM

MD45

CC-North 227A
Recent Trends in Causality and Experimentation on Digital Platforms
Community Committee Choice Session
Session Chair: Ruoxuan Xiong, Emory University, DECATUR, GA
Session Chair: Jinglong Zhao, Boston University, Boston, MA

1 Design-based Estimation Theory for Complex Experiments
Haoge Chang, Microsoft Research, Cambridge, MA
This paper considers the estimation of treatment effects in randomized experiments with complex experimental designs, including cases with interference between units. We develop a design-based estimation theory for arbitrary experimental designs. Our theory facilitates the analysis of many design-estimator pairs that researchers commonly employ in practice and provide procedures to consistently estimate asymptotic variance bounds. We propose new classes of estimators with favorable asymptotic properties from a design-based point of view. In addition, we propose a scalar measure of experimental complexity which can be linked to the design-based variance of the estimators. We demonstrate the performance of our estimators using simulated datasets based on an actual network experiment studying the effect of social networks on insurance adoptions.

2 High-Dimensional Regression Adjustment in Completely Randomized Experiments

Dennis Shen, University of California-Berkeley, Berkeley, CA
Randomized experiments are a powerful tool for estimating causal effects. While the simple difference in means provides an unbiased estimator of the average treatment effect, it is often possible to improve the estimation by accounting for the impact of additional covariates on the outcome. Several regression adjustment methods have been proposed, but many of them have limitations in high-dimensional settings where the number of covariates is comparable to or even larger than the sample size. In this work, we propose and analyze regression adjustment via ordinary least squares interpolation in high-dimensional settings. We show that our method produces consistent estimates of the average treatment effect. Additionally, we conduct numerical experiments to support our theoretical findings and demonstrate the practical benefits of our approach.

3 Design and Analysis of Temporal Experiments in Ride-Hailing Platforms

Ruoxuan Xiong[1], Alex Chin[2], Sean Taylor[3], [1]Emory University, DECATUR, GA, [2]Lyft, New York, NY, [3]Motif Analytics, San Francisco, CA, Contact: ruoxuan.xiong@emory.edu
We study the design and analysis of temporal experiments. The motivating setting is a ride-hailing platform testing changes to marketplace algorithms, such as pricing, and estimating effects from observed outcomes at the city level. We propose an autoregressive specification for the outcomes, from which treatment effects can be efficiently estimated. Based on this specification, we propose a meta-analysis approach that leverages massive historical data to plan for a new experiment optimally.

Monday, October 16, 2:15 PM - 3:30 PM

MD46

CC-North 227B

Policing and the Opioid Crisis

Community Committee Choice Session

Session Chair: Veronica White, University of Wisconsin Madison, Madison, WI

1 Opioid Treatment Policies Using Discrete Event Simulation

Veronica White, Laura Albert, University of Wisconsin-Madison, Madison, WI, Contact: vmwhite@wisc.edu
The US opioid crisis has strained hospitals, treatment facilities, and law enforcement agencies due to inadequate resources and procedures to manage the crisis. Our study presents a discrete event simulation model that evaluates diverting individuals who use opioids to opioid use disorder treatment through three treatment policies: arrest diversion, overdose diversion, and re-entry case management. Using publicly available 2011 to 2019 data from Dane County, WI we estimate various opioid-related outcomes through 2032. Our analysis suggests that treatment policies alone may not reverse the opioid crisis in a community. However, high implementation of multiple treatment policies can reduce opioid-related crimes, hospital encounters, opioid use, and societal costs, suggesting communities need high levels of investment for effective treatment interventions.

2 Agent-Based Model of the Opioid Overdose Epidemic in a Rural Setting

Chelsea Spence[1], Mary Beth Kurz[2], Thomas Sharkey[2], Bryan Miller[1], [1]Clemson University, Seneca, SC, [2]Clemson University, Clemson, SC, Contact: cspenc2@g.clemson.edu
In 2021, 80,411 people died due to opioid overdoses in the United States. We report on progress in developing an agent-based model to simulate opioid use spread and overdose deaths in a rural community. The model is intended to support the evaluation of the effects of both harm reduction and drug control policies and changes in the opioids available. The model fills research gaps by including multiple types of opioids, including fentanyl, and can represent a heterogeneous population across rural regions.

3 Spatiotemporal Correlation of Drug Crime Data with Emergency Department Admissions - A Model for Geographically Estimating Underreported Crimes

Matthew Hudnall, University of Alabama, Tuscaloosa, AL
The ability of law enforcement to impact drug-related crime is directly related to the quality of information that the enforcement agencies have available to them. Research indicates that there is a high spatial correlation between criminal offenses and point-of-origin incidents in emergency medical service data. Given these considerations, we analyzed the potential in the utility of emergency room data and its ability to 1) identify the relative proportion of drug crimes unreported to the Alabama Law Enforcement Agency and 2) inform law enforcement and community partners as to levels of estimated unreported crimes to promote better community trust and engagement with law enforcement.

Monday, October 16, 2:15

PM - 3:30 PM

MD47

CC-North 227C

Bayesian Methods in OR

Community Committee Choice Session

Session Chair: Tevfik Aktekin, University of New Hampshire, Durham, NH

1 A Semi-Parametric Bayesian Model for Queueing Arrival Processes: An Application to Call Centers

Kaan Kuzu[1], Refik Soyer[2], Murat Tarimcilar[3], [1]University of Wisconsin-Milwaukee, Milwaukee, WI, [2]George Washington University, Washington, [3]The George Washington University, Washington, Contact: kuzu@uwm.edu

Nonhomogeneous Poisson process models are commonly used to forecast arrivals and require specification of intensity (arrival rate) functions that are typically defined in parametric form. Predictive accuracy of parametric models is highly sensitive to the choice of intensity function. We use a Bayesian framework by proposing a nonparametric form for the intensity function and introduce a robust semi-parametric model. The model is suitable for analyzing both time of arrival and interval censored count data and can capture both monotonic and non-monotonic intensity. We present three model extensions and implement them on two call center data sets. Our proposed model has robust performance for out-of-sample predictions, which can assist managers in determining appropriate staffing levels and effective workforce scheduling, resulting in more efficient operations.

2 Adversarial Outlier Detection: A Bayesian Decision Theoretic Approach

Tahir Ekin, Texas State University, San Marcos, TX

Outlier detection methods typically assume clean and legitimate data streams. However, adversaries may attempt to influence data which in turn may impact outlier designations. This paper presents a Bayesian decision theoretic approach for outlier detection in adversarial environments. Proposed adversarial risk analysis based framework allows incomplete information and adversarial perturbations on the data inputs. We solve the adversary's poisoning decision problem where he manipulates batch data inputted into outlier detection methods. We discuss potential defender strategies to improve the security of existing frameworks.

3 Information Concepts in Reliability Modeling

Refik Soyer, George Washington University, Washington, DC, Contact: soyer@gwu.edu

In this talk we present use of information theoretic methods in reliability analysis and discuss how models and inferences are developed and decisions are made in this framework. We present a range of Bayesian information measures for reliability analysis and discuss their use in failure model selection, prior specification, prediction, assessment of reliability importance and optimal design of life tests.

4 Zero-Inflated Poisson State Space Models: Application to Consumer Goods Demand

Tevfik Aktekin, University of New Hampshire, Durham, NH, Contact: tevfik.aktekin@unh.edu

In this study, we extend the literature on Poisson time series state space models when the count data has an excess number of zeros. In doing so, we implement an updating scheme that is analytically tractable under certain conditions. We term the model "Zero-inflated Poisson-Gamma State Space (ZIP-PGSS)". We introduce efficient sequential Markov chain Monte Carlo methods for model learning, updating, monitoring, and predicting. For illustration, the study uses weekly consumer goods demand data for sixty nine distinct household items for several households across several years. Several consumer good categories typically exhibit abundance of zero counts that cannot be analyzed/predicted using traditional supervised learning methods. The performance of the model are compared against these traditional predictive analytics tools as benchmarks.

Monday, October 16, 2:15 PM - 3:30 PM

MD48

CC-North 228A

JQT Invited Session

Panel Session

1 Moderator

L. Allison Jones-Farmer, Miami University, Oxford, OH

Session Chair: L. Allison Jones-Farmer, Miami University, Oxford, OH

2 Panelist

Chen Zhang, Tsinghua University

3 Panelist

Joseph Navelski, 1</sup

4 **Panelist**

Ryan Lekivetz, JMP Statistical Discovery LLC, Cary, NC

Monday, October 16, 2:15 PM - 3:30 PM

MD49

CC-North 228B

Knowledge Discovery in Artificial Intelligence Applications

Community Committee Choice Session

Session Chair: Yuhao Zhong, Texas A&M University, COLLEGE STATION, TX

1 Controllable Generation for Cimate Modelling

Moulik Choraria, University of Illinois Urbana-Champaign, IL

Recent years have seen increased interest in modeling future climate trends, from the point of view of accurately predicting and mitigating downstream impacts. However, high-resolution climate data for future climates needs to be simulated, which for multiple possible climate scenarios, becomes prohibitively expensive via traditional methods. Generative models leveraging the expressivity of neural networks have achieved immense success in modeling complex distributions. Herein, we demonstrate realistic simulation of climate scenarios via the GAN (Generative Adversarial Network) framework. We condition the model by quantifying the degree of "extremeness" of the observed sample, which allows the user to controllably sample from different parts of the distribution. Quantitative and qualitive evaluation demonstrate the efficacy of the proposed methods.

2 No-Show Prediction in Clinical Appointments Using Graph Neural Networks Based on Non-Euclidean Patient Data

Dyutimoy Nirupam Das, Paul Griffin, Soundar Kumara, The Pennsylvania State University, University Park, PA, Contact: dnd5258@psu.edu

Patient no-shows or cancellations have a negative impact on both provider efficiency and patient health outcomes. Previous approaches for estimating no-shows have trained machine learning models using Euclidian data consisting of features derived from socioeconomic factors and appointment details. However, we propose a novel approach that leverages non-Euclidean data derived from a network representation of the patient's journey through the healthcare system. The suggested network is effective in capturing patient preferences and physician referrals. A graph neural networks-based model is used to identify behavioral patterns from retrospective data and predict no-show behavior. Further, we study the network to infer congestion and vulnerable nodes in the physician referral network.

3 Eblime: Enhanced Bayesian Local Interpretable Model-Agnostic Explanations

Yuhao Zhong[1], Anirban Bhattacharya[2], Satish Bukkapatnam[3], [1]Texas A&M University, COLLEGE STATION, TX, [2]Texas A&M University, COLLEGE STATION, TX, [3]Texas A&M University, College Station, TX, Contact: hirobin_zhong@tamu.edu

We propose EBLIME to explain black-box machine learning models and obtain the distribution of feature importance using Bayesian ridge regression models. We provide mathematical expressions of the Bayesian framework and theoretical outcomes including the significance of ridge parameter. Case studies were conducted on benchmark datasets and a real-world industrial application of locating internal defects in manufactured products. Compared to the state-of-the-art methods, EBLIME yields more intuitive and accurate results, with better uncertainty quantification in terms of deriving the posterior distribution, credible intervals, and rankings of the feature importance.

4 Efficient Optimization of Cellular Automata Corrosion Simulation Parameters Using Neural Networks and Global Search Algorithms

Maha Yazbeck, Balavignesh Vemparala Narayana Murthy, Theodore T. Allen, Soheil Soghrati, Ohio State University, Columbus, OH, Contact: yazbeck.4@buckeyemail.osu.edu

This work presents an optimal design of experiment for data collection from a cellular automata corrosion simulation, to enable a neural network to learn the mapping between input parameters and image metrics. Global search minimization algorithms used the neural network predictions to provide optimized parameters to fit simulated corrosion patterns to real images. The approach enables efficient and accurate parameter optimization for agent-based simulations.

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MD50

CC-North 229A

ENRE Award Session

Award Session

Session Chair: Benjamin D. Leibowicz, The University of Texas at Austin, Austin, TX

1 ENRE Student Best Paper Award: Condition-based Maintenance For Wind Farms using a Distributionally Robust Chance Constrained Program

Heraldo Rozas, Georgia Institute of Technology, Atlanta, GA

2 ENRE Best Publication - Energy: Failure Probability Constrained AC Optimal Power Flow

Anirudh Subramanyam, The Pennsylvania State University, University Park, PA, Contact: asubram2@alumni.cmu.edu

3 ENRE Early Career Best Paper Award: Dynamic Valuation of Battery Lifetime

Bolun Xu, Columbia University, New York, NY

4 ENRE Best Publication - Natural Resources: Optimization Strategies for Resource-Constrained Project Scheduling Problems in Underground Mining

Alessandro Hill, California Polytechnic State University, San Luis Obispo, CA

5 ENRE Best Publication - Environment and Sustainability: Smart Charging of Electric Vehicles: An Innovative Business Model for Utility Firms

Safak Yucel, Georgetown University, Washington, DC

Monday, October 16, 2:15 PM - 3:30 PM

MD51

CC-North 229B

Incorporating Equity in Energy System Decision Makings

Community Committee Choice Session

Session Chair: Feng Qiu, Argonne National Laboratory, Lemont, IL

1 Energy Justice Implication of Large-Scale Electric Vehicle Adoption: A New England Case Study

Jie Xu[1], Richard Kornitsky[2], Ke Ma[2], Saba Siddiki[3], Victor Wang[4], Feng Qiu[5], [1]George Mason University, Fairfax, VA, [2]ISO-NE, Holyoke, MA, [3]Syracuse University, Syracuse, NY, [4]George C. Marshall High School, Falls Church, VA, [5]Argonne National Laboratory, Lemont, IL, Contact: jxu13@gmu.edu

Large-scale adoptions of electric vehicles (EVs) is hailed as an effective measure for reducing greenhouse gas emissions and fighting climate change. However, increasing charging loads coinciding with greater uptake of EVs will place additional pressure on the current and future electric grid. To better understand the implications of transportation electrification on the electric grid, here we conducted an in-depth study of large-scale EV grid integration using the ISO New England (ISO-NE) network as a case study. Using the regional system planning (RSP) model of ISO-NE, we investigated the changes in wholesale electricity price in 13 RSP areas in a baseline scenario that represents the current system projected into 2040, and a deep decarbonization scenario set forth in the technical report of Massachusetts 2050 decarbonization roadmap study.

2 Equitable Deployment of Weatherization and Distributed Generation Interventions

Miguel Heleno[1], Alexandre Moreira[2], [1]Lawrence Berkeley National Laboratory, Berkeley, CA, [2]Lawrence Berkeley National Laboratory, Oakland, CA

This talk presents an optimization model for equitable deployment of distributed energy resources and energy efficiency policy interventions. This model can be used to support policy decisions around just energy infrastructure investment by state and local authorities. The model adds sociodemographics to traditional energy planning models and formulates energy insecurity explicitly as an objective.

3 Approximating Time Domain in Equitable Deployment of Energy Storage

Alexandre Moreira, Miguel Heleno, Paul Lesur, Lawrence Berkeley National Laboratory, Oakland, CA

4 A Literature Review of Energy Justice

Weihang Ren[1], Feng Qiu[2], Yongpei Guan[1], [1]University of Florida, Gainesville, FL, [2]Argonne National Laboratory, Lemont, IL

Here, we present the modern definitions of energy equity and frameworks of energy justice.We review the tools adopted to measure equity in the energy context and reveal various forms ofHere, we present the modern definitions of energy equity and frameworks of energy justice. We review the tools adopted to measure equity in the energy context and reveal various forms of inequity throughout energy systems around the world. We analyze publications that examined current practices and proposed improving methods toward a more equitable energy market for society from policy, planning, and operation perspectives. inequity throughout energy systems around the world. We analyze publications that examinedcurrent practices and proposed improving methods towards a more equitable energy market forthe society from policy, planning, and operation perspectives.

Monday, October 16, 2:15 PM - 3:30 PM

MD52

CC-North 230

Power Systems Planning and Optimization

Community Committee Choice Session

Session Chair: Anil Kaya, Karlsruhe Institute of Technology, Karlsruhe, Germany

1 Data-Driven Multistage Distributionally Robust Optimization for Economic Dispatch Problem

Zhiming Zhong, Neng Fan, University of Arizona, Tucson, AZ, Contact: zhongz@arizona.edu

This paper investigates data-driven multistage distributionally robust optimization (MDRO) for economic dispatch. A data-driven dynamic ambiguity set based on spatial-temporal autoregressive technique is introduced to model the uncertain netload. The conditional distributions of regression coefficients and Gaussian noise are derived explicitly, their joint confidence regions are incorporated into the ambiguity set. The proposed MDRO model enables the ambiguity set to be updated dynamically as the planning horizon rolls forward. Adaptive dispatch decisions are made to guarantee secure operation despite imperfect knowledge of future realizations. The case study demonstrates that the proposed MDRO approach effectively captures the spatial-temporal correlation, enabling less conservative decisions without compromising system reliability.

2 Dynamic Pricing in an Energy Community Providing Capacity Limitation Services

Bennevis Crowley, Technical University of Denmark, Lyngby, Denmark

A mathematical framework using bi-level optimization is proposed in which dynamic energy prices are used to coordinate prosumers in an energy community that subscribes to a limit on its maximum power import from the external grid in exchange for tariff reductions from the distribution system operator. In the upper-level problem, an energy community manager minimizes the total operational cost of the community while setting energy prices. In the lower-level problem, each community member optimizes their energy usage to minimize their daily cost based on the set prices. The proposed bi-level model is reformulated into a mixed integer quadratic problem and applied to a 15-node radial distribution grid case study in which different degrees of freedom are applied to the pricing constraints and the performance compared to other coordination methods.

3 Generation and Storage Capacity Expansion Problem Considering Cost Recovery of New Units

Miguel Carrion[1], Rafael Zárate-Miñano[2], [1]Universidad de Castilla - La Mancha, Toledo, Spain; [2]Universidad de Castilla - La Mancha, Almadén, Spain. Contact: miguel.carrion@uclm.es

The design of future power systems is one of the most challenging problems that power system planners are currently facing to supply the demand at minimum cost, considering the minimum percentage of demand supplied by low-emission energies. However, the increasing capacity of renewable units with almost zero operation costs significantly reduces pool prices at certain hours. Thus, the economic income of new generation units may be much smaller than expected if the installation rate of new renewable units is maintained or increased. In this study, we propose a bi-level programming approach to formulate the generation and storage capacity expansion problem, in which the cost recovery of new units is enforced. Different financial support mechanisms for the new units are considered, and a realistic case study is conducted and analyzed.

4 A Polyhedral Study on Unit Commitment with a Single Type of Binary Variables

Bin Tian, Kai Pan, Chung-Lun Li, The Hong Kong Polytechnic University, Kowloon, Hong Kong. Contact: bin12.tian@connect.polyu.hk

Previous studies for the Unit Commitment (UC) problem have primarily focused on formulations using two or three groups of binary variables, as it is believed to be challenging to derive strong valid inequalities using a single group of binary variables, and the improvement of compactness is often accompanied by a compromise in tightness. This paper presents a compact UC formulation using a single group of binary variables, which reduces the size of the search tree. To enhance the tightness of the formulation, two-period UC polytope and multi-period strong valid inequalities are developed. Conditions under which these strong valid inequalities are facet-defining for the multi-period UC polytope are provided. The effectiveness of the proposed compact formulation and strong valid inequalities is demonstrated through numerical experiments.

5 Integrated Stochastic Model with Electricity Market Simulation for Long-Term Generation Expansion Planning

Anil Kaya[1], Steffen Rebennack[2], Aboubakr Achraf El Ghazi[3], Ulrich Frey[3], [1]Karlsruhe Institute of Technology, Karlsruhe, Germany; [2]Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany; [3]German Aerospace Center, Stuttgart, Germany. Contact: anil.kaya@kit.edu

Our study introduces a long-term stochastic power generation expansion model under uncertainty. Our aim is to minimize the total cost (investment and operational) during the planning horizon. The model is a two-stage stochastic mixed-integer linear program solved using Benders decomposition. The master problem determines investment and retirement decisions deterministically, while the sub-problem optimizes operational decisions through stochastic dual dynamic programming. Our model is coupled with an agent-based electricity market simulation (AMIRIS) to evaluate portfolio decisions and their market impact. Using Benders decomposition, optimality cuts incorporate AMIRIS feedback. With two optimality cuts, our multi-objective master problem is solved via a weighted sum approach. German power system case study shows our approach’s efficiency.

Monday, October 16, 2:15 PM - 3:30 PM

MD53

CC-North 231A

Planning for Reliable and Secure Electricity Markets

Community Committee Choice Session

Session Chair: Golbon Zakeri, University of Massachusetts - Amherst, Amherst, MA

Session Chair: Arash Khojaste, University of Massachusetts - Amherst, Amherst, MA

1 Reliability in Electricity Markets

Arash Khojaste[1], Golbon Zakeri[2], Geoffrey Pritchard[3], [1]University of Massachusetts Amherst, Amherst, MA, [2]University of Massachusetts - Amherst, Amherst, MA, [3]University of Auckland, Auckland, New Zealand. Contact: AKHOJASTE@UMASS.EDU

There are various sources of uncertainty when it comes to renewable energy. These variations range from seasonal to diurnal. Therefore, some fleets of generation-firming sources are needed to ensure grid reliability. This study focuses on addressing uncertainties in wind power generation by employing Markov decision processes. We construct Markov decision processes that accommodate periodic variations in residual demand (i.e., demand after wind power generation). These processes serve as a framework for decision-making in renewable energy systems. We use a technique for constructing such processes that allows for periodic variations both in the values taken by the process and in the serial dependence structure. Additionally, we develop an investment model aimed at determining the optimal quantity and sources of backup power for renewable energy.

2 The Value of Coordination in Interdependent Urban Energy Systems with Operational Flexibility Under Uncertainty

Sebastian Maier[1], Afzal Siddiqui[2], [1]University College London (UCL), London, United Kingdom; [2]Stockholm University, Kista, Sweden. Contact: s.maier@ucl.ac.uk

Coordinated decision making policies between operators of district heating networks (DHNs) can play a key role in the effective decarbonisation of interdependent urban energy systems under uncertainty; however, the value of coordination has been little studied. We consider two independently operated DHNs - one consists of a combined heat and power plant and a thermal storage; the other one has also a heat pump - that interact through markets (gas & electricity) and a DHN. We model the operators’ decision problems as multi-stage stochastic mixed-integer linear programs, where the interactions represent box-constraints, and investigate the value of coordination using ideas from adjustable robust optimization and generalized Nash equilibria in repeated games. We conclude with a numerical example illustrating the benefit of the proposed approach using real data.

3 Guiding Investment Decisions for Electricity Markets Under Risk and Uncertainty

Golbon Zakeri[1], Arash Khojaste[2], Geoffrey Pritchard[3], [1]University of Massachusetts - Amherst, Amherst, MA, [2]UMass Amherst, Amherst, MA, [3]University of Auckland, Auckland, New Zealand. Contact: gzakeri@umass.edu

We will present an investment model under uncertainty and risk to enable smooth integration of renewable sources of generation within electricity markets. We model renewable generation from offshore wind using quantile Fourier regression and (time inhomogeneous) Markov chains. We use Markov decision processes (MDPs) to model risk adjusted, (near) optimal operations of a grid given a mix of generation. This process is embedded within an investment model to ensure resilience of the grid.

Monday, October 16, 2:15

PM - 3:30 PM

MD54

CC-North 231B

Computational and Methodological Advances for Optimization Problems Under Uncertainty

Community Committee Choice Session

Session Chair: Matheus Ota, University of Waterloo, Waterloo, ON, Canada

Session Chair: Andre Augusto Cire, University of Toronto Scarborough, Rotman School of Management, Toronto, ON, Canada

1 Computational Study of Cutting Plane Algorithms for Multi-Stage Stochastic Programming Models

Akul Bansal, Simge Kucukyavuz, Northwestern University, Evanston, IL

We report a computational study of cutting plane algorithms for multi-stage stochastic programming models on multiple classes of real-world problems and consider the following cuts: (i) Benders cuts, (ii) integer L-shaped cuts, (iii) strengthened Benders cuts, and (iv) Lagrangian cuts. We enhance the performance of these cuts by using a mixture of these cuts. Specifically, we alternate between the relaxed and exact computation of subproblems, utilizing a Benders cut from the relaxation and either of (ii)-(iv) from the exact computation. Our preliminary results show that this approach leads to improvement in the solve times.

2 Accelerating Benders Decomposition for Solving a Sequence of Sample Average Approximation Problems

Kothari Harshit, James R. Luedtke, University of Wisconsin-Madison, Madison, WI

Sample average approximation (SAA) is a technique to get good approximate solutions to stochastic programs (SP). When applying SAA, it is often useful to solve multiple SAA problems to obtain a confidence interval on the true optimal value of the SP and also get a better solution. We study techniques to accelerate the solution of this sequence of SAA problems, when solving them via Benders decomposition. We exploit similarities in the problem structure, as the problems just differ in the realizations of the random samples. Our extensive computational experiments of large scale problems provide empirical evidence of the improved efficiency of our algorithm. In addition, we also present theoretical results that provide insight into the algorithm's performance.

3 A Two-Stage Chance-Constrained Stochastic Program for Disaster Housing Assistance Logistics Planning

Sheng-Yin Chen, Yongjia Song, Clemson University, Clemson, SC, Contact: shengyc@clemson.edu

We propose and study two-stage chance-constrained stochastic programming models to achieve the balance between logistics operational cost and its resiliency towards extreme disastrous situations. This consideration is reflected in utilizing two operational modalities, one for the ordinary modality and the other for the emergency modality, and the emergency modality is only allowed to be activated for a limited number of scenarios among all that may arise, according to the underlying uncertainty associated with a linear regression model for characterizing the disaster housing demand based on a selected number of independent variables from historical data. Preliminary numerical results based on a case study on Hurricane Ian have shown the effectiveness of the proposed approach and provided managerial insights in disaster housing logistics planning.

4 Recent Advances in Pyros: The Pyomo Solver for Two-Stage Nonconvex Robust Optimization

Jason Sherman[1], Natalie Isenberg[1], John Siirola[2], Chrysanthos E. Gounaris[1], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Sandia National Laboratories, Albuquerque, NM

In this work, we present recent algorithmic and implementation advances of the two-stage robust optimization (RO) solver PyROS, and a benchmarking study which demonstrates the utility of PyROS for two-stage RO problems. Our advances include extensions of the scope of PyROS to models with uncertain variable bounds, improvements to the initializations of the subproblems used by the underlying cutting set algorithm, and extensions of the uncertainty set interfaces. The benchmarking study is performed on a library of over 8,500 instances, with variations in the nonlinearities, degree-of-freedom partitioning, uncertainty sets, and polynomial decision rule approximations. Overall, our results highlight the effectiveness of PyROS for obtaining robust solutions to optimization problems with uncertain equality constraints.

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MD55

CC-North 231C

Innovative Platform Operations

Community Committee Choice Session

Session Chair: Ming Hu, University of Toronto, Minneapolis, MN

Session Chair: Zhoupeng (Jack) Zhang, Rotman School of Management, University of Toronto, Toronto, ON, Canada

1 Riding Through Rallies: Will You Tip More?

Ming Hu[1], Zhoupeng (Jack) Zhang[2], Wanjiang Deng[3], [1]University of Toronto, Minneapolis, MN, [2]Rotman School of Management, University of Toronto, Toronto, ON, Canada; [3]National University of Singapore, Singapore, Singapore. Contact: wanjiang.deng@u.nus.edu

Do customers treat gig workers in a more prosocial manner during social movements? In this research, we study the impacts of 2020 Chicago George Floyd protests on passengers' tipping in the ridehailing marketplace. While we find significant increases in tips after protests, such positive impacts do not last long or improve drivers' incomes very much. Moreover, the protests have no impacts on tips in the taxi market, yet the tipping standard for taxi is also much higher than that for ridehailing. Potential mechanisms in the ridehailing marketplace are a weakened social norm of tipping on platforms like Uber and passengers' empathy during protests. Interestingly, the empathy effect may have not only benefited Black drivers but also spilled over to non-Black drivers.

2 What is the Impact of Labor Productivity on the Optimal Staffing Level?

Terry Taylor, University of California at Berkeley, CA

An analysis of canonical operations models reveals that the answer exhibits a surprising, simple structure.

3 Minimum Wage Regulation in Ride-Hailing Platforms: Unintended Consequences in Spatially-Dispersed Markets

Harish Guda[1], Ashish Kabra[2], [1]Arizona State University, Tempe, AZ, [2]University of Maryland-College Park, College Park, MD, Contact: hguda@asu.edu

Ride-hailing platforms experienced tremendous growth in the recent past. As these platforms matured, a large population of drivers have reported dissatisfaction with their earnings. Motivated by their low wages, several large cities have proposed regulations to improve the effective driver pay, the most popular of which is a utilization-adjusted minimum wage. We analyze the implications of such a minimum wage in a spatially-dispersed market. Our model captures two key features. First, most large cities comprise a dense core zone, surrounded by peripheral zone. Second, the demand patterns between these zones exhibit large imbalances. We find that the effect of such a minimum wage leads to a disproportionate effect on the cross-zone demand, in comparison to the within-core-zone demand.

4 Market Thickness and Delivery Efficiency in Food Delivery Platforms

Wenchang Zhang[1], Ruomeng Cui[2], Zhanzhi Zheng[3], [1]Indiana University, Bloomington, IN, [2]Emory University, Decatur, GA, [3]University of North Carolina at Chapel Hill, Chapel Hill, NC, Contact: wenczhan@iu.edu

In food delivery platforms, market thickness entails the restaurant density within a geographic area (i.e., a regional market) on the platform. We study the implications of the market thickness and restaurant performances in food delivery platforms. First, we find that higher market thickness leads to shorter order wait times (i.e., faster deliveries), suggesting an improvement in delivery efficiency. Second, increasing market thickness is estimated to boost restaurants' sales and revenues but reduce consumers' spending per order on the platform. Third, exploiting market thickness' heterogeneous effects, we tease out the cause of the delivery efficiency improvement and attribute it to drivers' delivery pooling.

Monday, October 16, 2:15 PM - 3:30 PM

MD56

CC-North 232A

Statistical Learning

Community Committee Choice Session

Session Chair: Ilias Zadik, MIT, Cambridge, MA

1 Algorithmic Barriers from Intricate Geometry in Random Computational Problems

Eren C. Kizildag, Columbia University, New York, NY, Contact: eck2170@columbia.edu

Many computational problems that involve randomness exhibit a statistical-to-computational gap (SCG): the best known polynomial-time algorithm performs strictly worse than the corresponding existential guarantee. In this talk, we focus on the SCG of the symmetric binary perceptron (SBP), a random constraint satisfaction problem as well as a toy model of a single-layer neural network. We establish that the solution space of the SBP exhibits intricate geometrical features, known as the multi Overlap Gap Property (m-OGP). By leveraging the m-OGP, we obtain nearly sharp hardness guarantees against the class of stable and online algorithms, which capture the best known polynomial-time algorithms for the SBP. Our results mark the first instance of intricate geometry yielding nearly tight algorithmic hardness guarantees against classes beyond stable algorithms.

2 Universality of Approximate Message Passing Algorithms and Tensor Networks

Zhou Fan[1], Tianhao Wang[2], [1]Yale, [2]Yale, New Haven, CT

We develop several new results on AMP universality. For AMP algorithms tailored to independent Gaussian entries, we show that their state evolutions hold over broadly defined generalized Wigner and white noise ensembles, including matrices with heavy-tailed entries and heterogeneous entrywise variances that may arise in data applications. For AMP algorithms tailored to rotational invariance in law, we show that their state evolutions hold over matrix ensembles whose eigenvector bases satisfy only sign and permutation invariances, including sensing matrices composed of subsampled Hadamard or Fourier transforms and diagonal operators. We establish these results via a simplified moment-method proof, reducing AMP universality to the study of products of random matrices and diagonal tensors along a tensor network.

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MD57

CC-North 232B

Emerging Technologies in Transportation Systems II

Community Committee Choice Session

Session Chair: Daniel Vignon, New York University, Brooklyn, NY

1 A Metaheuristic Approach for the Capacitated Truck Multi-Drone Pollution Routing Problem with Simultaneous Delivery and Pickup

Arash Alizadeh, Sharan Srinivas, James Noble, University of Missouri, Columbia, MO

This research deals with a new variant of the capacitated pollution routing involving a truck and drone fleet for last-mile parcel delivery and pickup. An adaptive large neighborhood search (ALNS) algorithm with novel destroy and repair operators that employ problem-specific characteristics to explore the search space is proposed. The results from our extensive computational experiments on small and large instances demonstrate the effectiveness of the proposed ALNS algorithm. Furthermore, the proposed variant achieves up to a 40% reduction in logistics costs compared to traditional truck-only logistics system. Finally, several managerial implications are provided based on the sensitivity analysis of key problem parameters.

2 Real-Time Signal and Trajectory Optimization Within Mixed-Autonomy Environments with White Phase

ali Hajbabaie[1], Ramin Niroumand[1], Leila Hajibabai[2], [1]North Carolina State University, Raleigh, NC, [2]North Carolina State University, Raleigh, NC

This study uses connected automated vehicles (CAVs) as mobile controllers during a portion of the cycle called the “white” phase. During the white phase, CAVs form platoons of connected human-driven vehicles (CHVs) and navigate them through the intersection through conflicting movements simultaneously. An efficient shooting heuristic is developed to optimize the trajectories of CAVs while the trajectories of CHVs are estimated using a customized car-following model with a given set of signal timing plans in the lower level. The upper level enumerates all the feasible signal timing plans and selects the one with the best objective function to be implemented. In addition, a platooning logic is presented to operate platoons of vehicles containing one or more vehicle groups at a time during white phases to improve the quality of the solutions.

3 Cost-Effective Approaches for the Joint Electric Bus Charger Installation and Fleet Management

Yen-Chu Wu[1], Xiaotong Guo[1], Jinhua Zhao[2], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: yenchuwu@mit.edu

Many transit agencies across the US are working towards a zero-emission electric bus fleet in order to reduce petroleum use and carbon emissions. To identify the most cost-effective approach for charger installation while best using the purchased electric buses, this study proposes a Mixed Integer Programming (MIP) model based on a generalized multi-commodity network flow problem. The goal is to minimize total expenditure on electric bus procurement and in-garage charger installation while maintaining the current trip schedule and achieving a target percentage of electrified mileage. The results recommend optimal electric bus fleet size, installations of different levels of chargers, as well as efficient in-garage charging schedules.

4 Safety and Liability Under Infrastructure-Assisted Automated Driving

Daniel Vignon[1], Yafeng Yin[2], [1]New York University, New York, NY, [2]University of Michigan, Ann Arbor, MI, Contact: daniel.vignon@nyu.edu

We investigate safety and liability under infrastructure-assisted automated driving. In our model, automakers and infrastructure support service providers (ISSPs) make technology choices which impact both road safety and their exposure to accident risk. We show that, regardless of market structure, automakers and ISSPs fully bear the cost of accidents related to their technology. However, under the Nash game, this feature does not ensure social efficiency. An appropriate liability rule can alleviate that issue. Moreover, despite a shift of liability from customers to producers, the former do not necessarily experience lower ownership costs. The insurance provided by automakers and producers impacts retail prices, potentially nullifying welfare gains from increased safety.

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MD58

CC-North 232C

Cliques and Their Relaxations

Community Committee Choice Session

Session Chair: Jack Zhang, 1</sup

1 The K-Core Interdiction Problem

Arlei Silva[1], Samuel Kroger[2], Illya V. Hicks[2], [1]Rice University, Houston, TX, [2]Rice University, Houston, TX, Contact: al110@rice.edu

Paramount to understanding and designing networks is identifying cohesive structures. The k-core - the maximal subgraph such that every vertex has a degree at least k - is one of the prominent ways to identify these structures. In this paper, we study the k-core Interdiction (KCI)} problem in which we try to reduce the size of the k-core by removing some budget b of edges or vertices from the graph. The KCI problem identifies the most crucial connections in a network to preserve the underlying k-core structure. We present the first exact method of solving the vertex and edge-based k-core interdiction problem by constructing an IP formulation. We compare the computational performance of the IP formulation to existing heuristic methods. Finally, we explore two applications epidemic propagation and the robustness of power grids. All code is made available on GitHub.

2 Interdicting Dense Clusters in Networks

Haonan Zhong[1], Foad Mahdavi Pajouh[2], Sergiy Butenko[3], Oleg A. Prokopyev[4], [1]Kunming University of Science and Technology, Kunming, China; [2]Stevens Institute of Technology, Hoboken, NJ, [3]Texas A&M University, College Station, TX, [4]University of Pittsburgh, Pittsburgh, PA, Contact: fmahdav1@stevens.edu

Given a graph with weights on its vertices and blocking costs on its vertices and edges, we aim to find a minimum-cost subset of vertices and edges to block such that the weight of any dense cluster in the interdicted graph is at most equal to some predefined threshold. Dense clusters are modeled using the concept of a quasi-clique. This problem has important applications in settings where we are trying to bound functional “tightly knit” groups of components in adversarial social and communication networks. We address the computational complexity of this problem and develop several exact algorithms for its solution. The computational performance of our exact algorithms is studied on a test bed of randomly-generated and real-life networks.

3 MIP Formulations for Partitioning a Graph into Low-Diameter Clusters

Lucas Silveira[1], Jack Zhang[2], Hamidreza Validi[3], Logan Smith[4], Austin Buchanan[5], Illya V. Hicks[4], [1]Military Institute of Engineering, Rio de Janeiro, Brazil; [2]Massachusetts Institute of Technology, Cambridge, MA, [3]Texas Tech University, Lubbock, TX, [4]Rice University, Houston, TX, [5]Oklahoma State University, Stillwater, OK

In this paper, we study the problem of partitioning the vertices of a graph into s-clubs (the s-clustering problem) from the lens of Operations Research. An s-club is a subset of vertices for which the diameter of its included subgraph is at most s. We propose mixed integer programming (MIP) formulations with length-bounded constraints and compare them with the existing ones theoretically and computationally. We propose approximation algorithms for the s-club partitioning problem. Further, we develop fixing procedures to improve the performance of our MIP formulations. We test our MIP formulations on a large set of benchmark instances. Our computational experiments show the superiority of our approach when s is 2 or 3. Our code and data are available on GitHub.

4 Exact Solution Methods For A Class Of Fractional Mixed-integer Programs

Yehor Blokhin, Texas A&M University, College Station, TX, Contact: blokhin23@tamu.edu

We present a class of fractional knapsack mixed-integer problems with applications in service systems design and facility location problems with congestion. We explore two linearization approaches. The first one is based on Charnes and Cooper transformation. The second method utilizes a piecewise linearization.

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CC-West 101A

Breaking the Chain: Leveraging Operations Research to Control and Mitigate Infectious Outbreaks

Community Committee Choice Session

Session Chair: Hrayer Aprahamian, Texas A&M University, College Station, TX
Session Chair: Su Li, Texas A&M University, College Station, TX

1 An Optimization-Based Framework to Minimize the Spread of Diseases in Social Networks with Heterogeneous Nodes

Su Li, Hrayer Aprahamian, Texas A&M University, College Station, TX, Contact: dclisu@tamu.edu

We present an optimization framework that identifies social separation policies to control the spread of diseases in networks. The framework considers subject-specific risk, social structure, and the economic consequences of restrictions. We first analyze a simplified variation consisting of a single period and a specific social structure to establish key properties and construct a tailored globally-convergent scheme. We extend this scheme to heuristically solve the general model with multiple periods and any social structure. It is evaluated using COVID-19 data and shows significant reductions in disease spread compared to existing algorithms. The optimized policies continue to perform well in realistic settings, emphasizing the importance of considering subject-specific information in policy design and providing tailored data-driven insights.

2 Robust Screening Policies in a Pandemic

Marwan S. Shams Eddin[1,2], Hadi El-Amine[1], Hrayer Aprahamian[3], [1]George Mason University, Fairfax, VA, [2]American Airlines, Euless, TX, [3]Texas A&M University, College Station, TX

Emerging pandemics cause severe strains on the healthcare systems. In this paper, we introduce a testing intervention to control the disease progression. We address several aspects of the problem including, testing inaccuracies, adherence to testing, and dependency between the disease prevalence and testing strategies. We consider uncertainty in the disease dynamics and model via stochastic and robust approaches. We develop Markov-decision process formulations and apply DP algorithms to obtain exact screening policies. We exploit the structure of the problem which enables us to drastically improve the computational time. We consider a simulation-based case study in which we generate different instances of pandemics in a average and antagonistic environments. Our results show that early testing has the potential in drastically reducing total healthcare costs.

3 Vaccine Prioritization in a Social Network Against a Pandemic Outbreak

Yang Zhang[1], Dong Liang[2], Ming Hu[3], [1]University of Kent, Canterbury, United Kingdom; [2]Tsinghua University, Beijing, China; [3]University of Toronto, Minneapolis, MN, Contact: yangzhang.buz@gmail.com

We investigate the vaccination over a social network to curb a pandemic (e.g. COVID-19). Under limited vaccine supply, the planner has to prioritize different social groups in the order of receiving the vaccine. The conventional wisdom suggests a vulnerability-first allocation: the vaccination should begin with those who suffer most from the infection and then reach out to those suffering less. However, given the contagious nature of the disease, the planner may also consider the role of different social groups in transmitting the virus (characterized by their centrality in the social network). We show that the optimal vaccination policy combines *vulnerability* and *transmissivity*, and follows the *Bonacich priority* which linearly depends on a variant of Bonacich centrality of the social network. We calibrate our model using NYC data.

4 Covid-19: Agent-Based Simulation-Optimization to Vaccine Center Location Vaccine Allocation Problem

Xuecheng Yin[1], Esra Buyuktahtakin Toy[2], Sabah Bushaj[3], Yue Yuan[4], [1]Yale University, New Haven, CT, [2]Virginia Tech, Blacksburgh, VA, [3]State University of New York at Plattsburgh, Plattsburgh, NY, [4]Altfest Personal Wealth Managemen, New York, NY, Contact: sunnysunnyyuan@qq.com

This paper presents an agent-based simulation-optimization modeling and algorithmic framework to determine the optimal vaccine center location and vaccine allocation strategies under budget constraints during an epidemic outbreak. Both simulation and optimization models incorporate population health dynamics, while their integrated utilization focuses on the COVID19 vaccine allocation challenges. We calibrate, validate, and test our simulation-optimization vaccine allocation model using the COVID-19 data and vaccine distribution case study in New Jersey. The integrated epidemiological MIP and agent based approach balances the proportion of vaccines distributed to a county with that county's population in proportion to all counties under different budgets.

5 Quantifying and Realizing the Benefits of Targeting for Pandemic Response

Sergio Camelo[1], Dragos Florin Ciocan[2], Dan Andrei Iancu[1], Xavier Warnes[1], Spyros Zoumpoulis[2], [1]Stanford University, Stanford, CA, [2]INSEAD, Fontainebleau, France

To respond to pandemics such as COVID-19, policy makers have relied on interventions that target specific population groups or activities. Rigorously quantifying the benefits of targeting is critical for effective and equitable pandemic control. We propose a flexible framework that leverages publicly available data and a novel optimization algorithm to compute optimized interventions that can target two dimensions of heterogeneity: age groups and the specific activities that individuals normally engage in. We showcase a complete implementation focused on the Ile-de-France region of France and use this case study to quantify the benefits of dual targeting and to propose practically implementable policies.

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MD60

CC-West 101B

DEIC/MIF Panel: Broad and DEI-Specific Funding Opportunities at NSF

Panel Session

1 Moderator

Diana Gineth Ramirez-Rios, University at Buffalo, Buffalo, NY

This panel aims at bringing together NSF program managers and faculty getting funds from NSF to discuss broad funding opportunities at NSF and specific initiatives promoted across Diversity, Equity, and Inclusion. According to NSF's latest report in "Diversity and STEM," the representation of minority groups in STEM employment and Science and Engineering education in the U.S. is still quite low. The panel will discuss their experience with DEI efforts within the different NSF programs, the specific DEI funding opportunities, and the ways to become more active in DEI within the different research fields.

Session Chair: Clara Novoa, Texas State University, San Marcos, TX

Session Chair: Sofía Pérez-Guzmán, Georgia Institute of Technology, Atlanta, GA

2 Panelist

Thiago Serra, Bucknell University, Lewisburg, PA

3 Panelist

Siqian Shen, U of Michigan/NSF, Ann Arbor/Alexandria, MI

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MD61

CC-West 101C

Advancing Equity and Inclusion Through Social Impact

Community Committee Choice Session

Session Chair: Shikha Safaya, Scheller College of Business Georgia Institute of Technology, Atlanta, GA

1 Food Bank Responsiveness During Disasters

Faith Idoko[1], Chrysafis Vogiatzis[2], Lauren Berrings Davis[3], [1]North Carolina Agricultural and Technical State University, Greensboro, NC, [2]University of Illinois at Urbana-Champaign, Urbana-Champaign, IL, [3]North Carolina A&T State University, Greensboro, NC, Contact: faithidoko13@gmail.com

The unpredictable nature of disasters often leads to disruptions in food supply which affects the role of food banks. The increase in food insecure people due to a disaster causes a surge in demand to food banks. Prepositioning relief items to mitigate the effect of disasters has proven to be viable. In this work, we incorporate this concept in building a resilient network system for a non-profit organization. The state of the network, such as road and facility availability post disaster is crucial in managing the flow within the network. Pop-up delivery options such as mobile pantries or self-accessible food lockers are also considered to strengthen the relief response. A mixed integer linear programming model is used to propose a robust network for food banks while accounting for the distribution of food items.

2 A Good Teacher is Worth $420000. What Would It Cost Us, Though?

Hemanshu Das[1], Edward H. Kaplan[1], Edieal J. Pinker[2], [1]Yale University, New Haven, CT, [2]Yale School of Management, New Haven, CT, Contact: hemanshu.das@yale.edu

The study aims to examine the cost-benefit analysis of improving teacher mix in K-12 education through teacher evaluation policies. Through a flow model, we determined the relationship between teacher retention (due to evaluation policies) and changes in the required school budget. We connect our model to the existing literature in education policy to estimate the societal gains in terms

of incremental student lifetime incomes. Using parameters from two exemplars of teacher evaluation programs in DC and Chicago. Our findings suggest that while the cost of improving the teacher mix may be substantial, the long-term benefits in terms of increased student earnings justify the investment. The study highlights the importance of considering both the financial and educational impacts of policies aimed at improving teacher quality.

3 Does Leader Disability Status Influence the Operational Performance of Teams with Workers with Disabilities? an Empirical Study in the Apparel Industry

Dustin Cole[1], Sriram Narayanan[2], Shawnee Vickery[2], [1]Auburn University, Auburn, AL, [2]Michigan State University, East Lansing, MI

This research examines the impact of leader disability status on the operational performance of teams that have workers with disabilities. We hypothesize a beneficial moderating effect of leader-worker disability status similarity on team performance. Hypotheses are tested using Prais-Winsten regression applied to micro-data gathered over multiple years from an apparel manufacturing facility. The results show that the presence of a line leader with a disability has a beneficial impact on workgroup performance, measured in labor hours and operator caused defects to produce a garment, when there is an increasing number of workers with a disability. The quantitative analysis is complemented with semi-structured interviews of 50 individuals across three large organizations that employ individuals with disabilities to explore possible mechanisms.

4 Forming a Humanitarian Coalition when Time is Short

Iman Parsa[1], Mahyar Eftekhar[2], Scott Webster[2], Luk N. Van Wassenhove[3], [1]INSEAD, Fontainebleau, France; [2]Arizona State University, Tempe, AZ, [3]INSEAD, Fontainebleau Cedex, France. Contact: iman.parsa@insead.edu

Creating a higher social impact in humanitarian operations requires coordination among actors, as emphasized in the UN sustainable development goals. Yet, a lack of well-coordinated response remains a problem. We develop a sylized non-cooperative game theoretical model to analyze horizontal coordination among humanitarian organizations in the immediate response to a large-scale sudden onset disaster. Our analysis highlights the important role of time pressure and the structural barriers to higher levels of coordination.

5 Graph Partitioning & Assignment to Heterogeneous Resources: Applications in Disaster Debris Collection

Buse Eylul Oruc[1], Pinar Keskinocak[2], Mohit Singh[1], [1]Georgia Institute of Technology, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA, Contact: buseeyluloruc@gmail.com

Disaster debris collection operations require municipalities to partition the affected area into zones and assign them to multiple contractors of varying capacities. Collecting debris from the affected area as quickly as possible is desirable, while contractors' capacities affect the collection time (i.e., resource-dependent processing time). Additionally, the assigned zones must be contiguous for contractors to operate effectively. We formulate this problem as integer and mixed-integer programs, introduce approximation algorithms with provable bounds for some cases, and provide several heuristics. We present the results of an extensive computational study, including a case study focusing on a realistic hurricane scenario for Florida.

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CC-West 102A

PSOR Best Paper Award Finalists

Award Session

Session Chair: Yanhan (Savannah) Tang, Carnegie Mellon University, Pittsburgh, PA

Session Chair: Alan Scheller-Wolf, Tepper School of Business, Pittsburgh, PA

1 Dynamic Budget Allocation for Public Health Procurement: A Multi-Product Inventory Model with Partial Backlogging

Iva Rashkova[1], Jérémie Gallien[2], [1]Washington University in St Louis, St Louis, MO, [2]London Business School, London, United Kingdom

Motivated by Global Fund grant recipients, we study the periodic inventory procurement of multiple health products subject to a common uncertain fund disbursement schedule. The objective is to minimize expected health costs in the presence of random demand, procurement lead times and inventory dynamics driven by alternative distribution channels. We derive near-optimal heuristics for the dynamic allocation of funds and characterize their theoretical and computational performance. We illustrate how to estimate the model parameters and evaluate the benefit of modifying grants' funding patterns.

2 Leapfrogging for Last-Mile Delivery in Health Care: Drone Delivery for Blood Products in Rwanda

Harriet Jeon[1], Claudio Lucarelli[1], Jean Baptiste Mazarati[2], Donatien Ngabo[3], Hummy Song[1], [1]The Wharton School, University of Pennsylvania, Philadelphia, PA, [2]University of Global Health Equity, Kigali, Rwanda; [3]Ministry of Health, Kigali, Rwanda

The access to and quality of health care, especially in hard-to-reach areas, are challenges for many countries. Traditional solutions improve geographic connectivity through incremental and costly infrastructure investments. Radical technological innovations may allow leapfrogging to directly improve access to quality medical care. Using data from Rwandan public hospitals, we examine whether adopting drone delivery technology improves operational and health outcomes. We find that adopting drone delivery leads to a substantial reduction in on-hand inventory, wastage, and inpatient mortality for patients with post-partum hemorrhage (PPH). Additional analyses suggest that the drone delivery system exhibits a leapfrogging effect.

3 Food Subsidies at the Base-of-the-Pyramid: Take-Up, Substitution Effects and Nutrition

Alp Sungu, Ali Aouad, Kamalini Ramdas, London Business School, London, United Kingdom. Contact: asungu@london.edu

We investigate the impact of consumer food subsidy programs on poor consumers' nutrient purchases and data-driven pathways to improve the efficacy of such programs. We conduct an experiment in an urban settlement in Mumbai, India. First, we open a subsidy store to mimic governments' food subsidy programs. Second, we equip local grocery stores with point of sale scanner devices and start a loyalty card program to track individuals' shopping baskets. By randomly assigning households to a subsidy program, we examine how government-like subsidies affect food shopping behaviour. Next, we exogenously vary the subsidized food. Based on estimates of the take-up rates, we uncover a tradeoff between the nutrient richness of different staples and their attractiveness to customers.

4 Planning Bike Lanes with Data: Ridership, Congestion, and Path Selection

Sheng Liu[1], Auyon Siddiq[2], Jingwei Zhang[3], [1]University of Toronto, Toronto, ON, Canada; [2]University of California-Los Angrles, Los Angeles, CA, [3]UCLA, Los Angeles, CA, Contact: jingwei.zhang.phd@anderson.ucla.edu

We study the bike lane planning problem considering its conflicting effects in reducing and increasing traffic congestion. In an extensive case study in Chicago, we estimate adding 25 miles of prescribed bike lanes can lift cycling mode share from 3.6% to 6.1%, with at most an 9.4% increase in driving times.

5 Treatment Planning of Victims with Heterogeneous Time-Sensitivities in Mass Casualty Incidents

Yunting Shi[1], Nan Liu[2], Guohua Wan[1], [1]Shanghai Jiao Tong University, Shanghai, China; [2]Boston College, Chestnut Hill, MA, Contact: sherryshi@sjtu.edu.cn

Mass casualty incidents (MCIs) lead to a sudden jump in patient demand, making it inevitable to ration medical resources. Informed by a unique timestamps dataset collected during a large-scale earthquake, we develop data-driven approaches to aid treatment planning for MCIs . A distinguishing feature of our modeling framework is to simultaneously consider victim health deterioration and wait-dependent service times in making decisions. We identify conditions under which victims with a less critical initial condition have higher or lower priority than their counterparts in an optimal schedule—the priority order depends on victim deterioration trajectories and the resource (i.e., treatment time) availability.

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CC-West 102B

Service Science Best Cluster Paper Award Competition (I)

Award Session

1 The Impact of AI Technology on the Productivity of Gig Economy Workers

Serguei Netessine, The Wharton School, Philadelphia, PA

2 Sequential Selection of Candidates: An Experimental Investigation

Morvarid Rahmani, Georgia Institute of Technology, Atlanta, GA

3 Social Learning with Polarized Preferences on Content Platforms

Dongwook Shin, HKUST Business School, Clear Water Bay, Hong Kong

4 Operational Risk Management: Optimal Inspection Policy

Youngsoo Kim, University of Alabama, Tuscaloosa, AL

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CC-West 102C

Social Media Analytics in E-commerce and Digital Platforms

Community Committee Choice Session

Session Chair: Keumseok Kang, KAIST

Session Chair: JaeHong Park, Kyunghee University, Seoul, Korea, Republic of

1 Should be a First Mover, Fast Follower, or Just Stay?: Re-Categorization of Digital Products on Online Platforms

Mingi Song, Gunwoong Lee, Korea University, Seoul, Korea, Republic of. Contact: smgnc3@korea.ac.kr

Product categorization has been considered to reduce search costs for buyers and enhance the discoverability of a product for sellers. Thus, many e-commerce platforms often alter product categories to improve the matching between buyers and sellers. This study examines how digital goods suppliers can leverage platform-driven product re-categorizations to succeed in mobile app software markets. In November 2015, a leading mobile app store market introduced a new category that allowed app developers to move to this new category. Using a quasi-experiment design, we find that migrated apps exhibited improved sales compared to non-movers, and early-movers showed higher performances than those who followed. Our key findings provide important implications for the product search literature and offer practical insights for online platform participants and designers.

2 Customer Choice in Group-Buying: Empirical Study with Discrete Choice

YongJun Kwon, JaeHong Park, Kyung Hee University, Seoul, Korea, Republic of. Contact: yjun209@khu.ac.kr

The group-buying is known as a business activity that a group of customers purchase the same products or services at a discounted price at platforms. To get discounts, customers have to meet the predefined number of customers with a limited time. In particular, social e-commerce platforms have now adopted another form of group-buying strategy: group-buying with just two people to facilitate the group-buying deals. Since the deal can only be completed when the second participant joins (here, we call her co-purchaser), the participation of co-purchasers is essential to complete a deal on group-buying platforms. Therefore, the success of the deal is determined by the customers' choice to be a co-purchaser. To understand the customers' choice patterns, we use a discrete choice model to analyze the factors influencing consumers' decisions to become co-purchasers.

3 Population Level Analysis of Urban Social Media Data

Ann-Kathrin Meyer, Tobias Brandt, University of Münster, Münster, Germany. Contact: ann-kathrin.meyer@ercis.uni-muenster.de

Large-scale urban social media data can provide substantial insights into the real-time development of cities around the globe, illuminating phenomena such as gentrification, urban decay, and resilience to major adverse events. We explore methodological challenges associated with the analysis of this type of data, leveraging a data set of 150 million tweets from various major cities before, during, and after the Covid-19 pandemic. We identify four critical challenges potentially biasing analyses if not sufficiently considered: event-induced population shift, bots, between-city variation in baselines, and issues surrounding the collection and persistence of social media data. We provide effect estimates and suggest solution approaches.

4 Self-disclosure in Online Social Networks: An Empirical Study of Location-based Check-ins and Health-conscious Impression Management

Mahyar Sharif Vaghefi[1], Derek L. Nazareth[2], Sridhar P. Nerur[3], Kay-Yut Chen[4], [1]University of Texas at Arlington, Arlington, TX, [2]University of Wisconsin, Milwaukee, WI, [3]University of Texas-Arlington, Arlington, TX, [4]University of Texas at Arlington, Mansfield, TX, Contact: mahyar.sharifvaghefi@uta.edu

This study investigates self-disclosure dynamics and impression management in location-based online social networks. Using theories of social and hyperpersonal information processing, we develop a model to understand how peer influence, geographical proximity, and exposure to brand content affect self-disclosure. Using Twitter and Foursquare location-based data, we find that friends' health-related disclosures and their proximity significantly impact self-disclosure. Individuals tend to avoid unhealthy

impressions if they are surrounded by health-conscious peers. The influence of promotional content from health-related brands and social media pages is also explored. Our research expands our knowledge of online impression management, providing key insights with practical and theoretical applications.

5 The Impact of Network Neutrality Violation on the Streaming Platform Ecosystem: Evidence from Twitch TV

Dongwon Shin, Gunwoong Lee, Korea University, Seoul, Korea, Republic of. Contact: petter1286@korea.ac.kr

The widespread use of media streaming services has resulted in a surge in network traffic, triggering debates on network usage fees between internet service providers (ISPs) and content providers (CPs). As a response to network usage fees imposed by ISPs, CPs can opt to provide discriminatory service quality to mitigate costs. In 2022, a leading Korean ISP charged discriminatory fees to Twitch TV, due to its excessive network traffic. In response, Twitch implemented a service quality reduction policy for Korean viewers. Our study exploits this event and examines the impact of the policy on the streaming platform ecosystem. Our results indicate that the implementation of the policy led to a remarkable decline in the number of viewers. This study contributes to the literature on network neutrality violation by offering empirical evidence.

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CC-West 103A

Technology and Future of Work: A Panel Discussion

Panel Session

Session Chair: Morvarid Rahmani, Georgia Institute of Technology, Atlanta, GA

1 Technology and Future of Work: A Panel Discussion

Morvarid Rahmani, Georgia Institute of Technology, Atlanta, GA

We cordially invite you to join this thought-provoking panel where we collectively embrace the future of work and explore the transformative role of technology in workplace. Our esteemed panelists will discuss how automation, AI, and remote collaboration are reshaping industries, redefining skillsets, and creating new opportunities.

2 Panelist

Maryam Alavi, Georgia Tech

3 Panelist

Patrick Hall, George Washington University

4 Panelist

Mohan Gopalakrishnan, Arizona State University, Tempe, AZ

5 **Panelist**

Tinglong Dai, Johns Hopkins University, Baltimore, MD

Monday, October 16, 2:15 PM - 3:30 PM

MD66

CC-West 103B

Introduction to Manufacturing Systems Integration Program at NSF

Panel Session

Session Chair: Janis Terpenny, Penn State University, University Park, PA

1 New NSF Program Focused on Digitalization, Integration and Smart/Intelligent Manufacturing

Janis Terpenny, National Science Foundation, Alexandria, VA

This session provides participants with the opportunity to learn about the newest core program in the NSF CMMI Division: Manufacturing Systems Integration (MSI). The MSI program focuses on fundamental research addressing the opportunities and challenges digital technologies present for the next industrial revolution, with particular emphasis on the digital integration of design and manufacturing within the larger life cycle ecosystem. MSI proposals might address underlying principles and advances such as: :

- Digital representation, protocols, and/or processes for integration and collaboration in manufacturing systems (machines and/or humans)
- Intelligent self-organizing production systems

- Ease of use, interoperability and seamless integration of technologies, machines, and humans
- Service-oriented architectures and systems
- Data sets that are compatible and usable across platforms
- Reliable and secure communications within and across the manufacturing value chain
- Integration of distributed manufacturing systems across time and space, including incorporating both legacy and leading-edge equipment and technologies
- Methods for assessing the impact and value of externalities throughout the life cycle within the digital environment

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MD68

CC-West 104B

Applications of Data Mining I

Community Committee Choice Session

Session Chair: ZEWEI Lin, University of Cincinnati, Cincinnati, OH

1 Feature Engineering Versus Green AI: Applications of Machine Learning Models to Support Analysis and Decisions on This Trade-Off

Marcos Machado[1], Amin Asadi[1], Renato W. de Souza[2], [1]University of Twente, Enschede, Netherlands; [2]IFCE, Boa Viagem, Brazil. Contact: m.r.machado@utwente.nl

This paper contrasts the processing time and accuracy of individual and hybrid Machine Learning (ML) models obtained when predicting customer loyalty in financial settings. We use frameworks that account for feature engineering and green AI philosophy aspects separately within the individual and hybrid proposed approaches. Our findings indicate that using a lower number of features results in a slightly smaller accuracy than models incorporating features. Besides, we explicitly illustrate the tradeoff between the higher accuracy and computational time of the hybrid ML models against the lower accuracy and computational time of the individual models when assessing customers' loyalty levels. Thus, our results provide managers with information regarding the model to be deployed based on their firms' specifications.

2 Deep Learning-Based Sentiment Analysis in Online Retail Stores

Roohollah Jahanmahin[1], Sara Masoud[2], [1]wayne state university, DETROIT, MI, [2]Wayne State University, Detroit, MI, Contact: hi3334@wayne.edu

This research focuses on the importance of sentiment analysis in online retail stores. Machine learning approaches have been used for sentiment analysis, but with the advancement of deep learning approaches, significant improvements have been made in text classification and sentiment analysis. The study evaluates and compares five machine learning classification models and three deep neural networks models such as a convolutional neural network, and bi-directional long short-term memory neural network with Bert-based embedding layers and Fasttext. The results show that deep learning models outperform other machine learning models in classifying sentiments in three classes of positive, neutral, and negative.

3 A Data-Driven Optimization Framework for Automating Product Design

Jongmin Han, Seokho Kang, Sungkyunkwan University, Suwon, Korea, Republic of. Contact: hjm9702@gmail.com

Manual product design can be time-consuming and labor-intensive, often requiring repetitive trial-and-error experiments. We present a data-driven optimization framework for automating the design of the target product. The framework formulates an optimization problem where the decision variables are product design parameters, the constraints are the control ranges of the parameters, and the objective function is the product performance determined by the parameters. The objective function is approximated by a neural network trained using data collected from previous experiments. The optimal design parameters are then derived by solving the optimization problem. The proposed framework can significantly reduce the time and cost required for the product development process. A case study is presented to demonstrate the effectiveness of the proposed framework.

4 Product Misrepresentation in Dietary Supplements - Sentiment Analysis of Customer Reviews

Stanislav Mamonov, Liam Horton, Ben Besthof, Montclair State University, Montclair, NJ, Contact: stanislav.mamonov@montclair.edu

Dietary supplements are defined as products that supplement diet and provide nutrients that may be lacking or insufficient in a person's regular diet. Dietary supplements are considered food products and they are exempt from FDA review. Regulatory intervention can occur post-market introduction. To assess the substance of dietary supplement consumer complaints, we collect a dataset of the bestselling dietary supplements on a leading e-commerce platform and we develop sentiment analysis models for each product. We leverage sentiment analysis models to identify linguistic cues associated with negative sentiment. Analysis of linguistic cues reveals that product misrepresentation and adverse health conditions account for the vast majority of negative reviews. We discuss the implication of our results for market participants, including regulators.

5 Unfolding Tweedie Regression Model for Insurance Premium Pricing: A Diagnostic Tool Leading to Actionable Insights

ZEWEI LIN[1], Dungang Liu[1], Daniel Bauer[2], [1]University of Cincinnati, Cincinnati, OH, [2]University of Wisconsin-Madison, Madison, WI, Contact: linzw@mail.uc.edu

The viability of an insurance company depends on its ability to accurately estimate the cost of the financial protection. Tweedie compound Poisson regression model is used to capture the loss in insurance. However, the model diagnostic results have not been widely discussed in the literature. Traditional goodness-of-fit measurement focuses on prediction performance. They do not reveal why the working model is good/bad and how to make adjustments to improve the model. To this end, we propose a new diagnostic framework for Tweedie models. Through analysis of real data sets, we demonstrate that our diagnostic tools can generate insights on 1. What components of the Tweedie model may be misspecified; and 2. How to refine the model or segment data to achieve a better fit. It can help lower the data literacy requirement and increase the model transparency for policy maker.

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CC-West 105A

Structural Learning for Heterogeneous Data

Community Committee Choice Session

Session Chair: Chen Zhang, Tsinghua University, Japan
Session Chair: Hao Yan, Arizona State University, Tempe, AZ
Session Chair: Ziyue Li, University of Cologne, Kowloon, Hong Kong

1 Multimodal Regression and Mode Recognition via an Integrated Deep Neural Network

Di Wang, Shanghai Jiao Tong University

Existing deep learning approaches in manufacturing are often used to directly predict the variables of interest (VoI) such as the system status from a set of sensor measurements by supervised learning. However, in various complex manufacturing systems, components are operated under multiple modes that are not well known beforehand. This study develops a novel deep learning method for multimodal regression and mode recognition to predict the VoI under multiple modes and recognize the specific mode of a component from its sensor measurements. Specifically, we establish a deep neural network (DNN)-based regression- and classification-integrated framework. We innovatively develop an Expectation-Maximum (EM)-based backpropagation algorithm for model training, where the modes of components are set as latent variables.

2 Bayesian Multi-Objective Optimization for Stochastic Simulations

Mei Han, Jiangchen Li, Nanjing University of Aeronautics and Astronautics, Nanjing, China. Contact: meihan2@nuaa.edu.cn

Multi-objective stochastic simulation optimization is important in designing engineering systems. To identify optimal solutions via simulations, Bayesian optimization has been popular in machine learning. However, existing studies are limited and can give undesired performances. In this work, we propose a novel framework for Bayesian optimization of multiple stochastic responses. Stochastic kriging metamodels are constructed considering heterogeneous noise. Quantiles of metamodels are employed to define the Pareto dominance. Acquisition functions are then proposed by integrating the hypervolume-based and probability-of-improvement-based acquisition functions with typical acquisition functions from stochastic optimization. This not only enhances the convergence and diversity of non-dominated solutions but also handles heterogeneous noise.

3 Multi-Size Industrial Anomaly Segmentation Using Incomplete Image
Hao Xu[1], Juan Du[1,2], Andi Wang[3], [1]The Hong Kong University of Science and Technology (Guangzhou), Guangzhou, China; [2]The Hong Kong University of Science and Technology, HongKong, China; [3]Arizona State University, Mesa, AZ
Unsupervised anomaly detection is essential for product inspection and root cause analysis in industrial manufacturing processes. However, due to the randomness ofthe industrial manufacturing environment and products with complex representations. Existing approaches are easily affected by unpredictable or multi-size anomalies. To tackle this problem, we propose anomaly segmentation method by only inputting normal information of the original image. We use the structure of the vision transformer to reconstruct a normal prior image only using the normal patches of the image. Then the anomaly segmentation result is obtained by comparing the normal prior image with the original image. We demonstrate the superiority of our approach through relevant simulation experiments and case studies. relevant parameters affecting the model performance are also discussed.

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CC-West 105B
Machine Learning and Deep Learning for e-Business Research
Community Committee Choice Session
Session Chair: Bin Zhang, Texas A&M University, College Station, TX

1 Content Creator Versus Brand Advertiser? the Effect of Inserting Advertisements in Videos on Influencers
Tengteng Ma[1], Yingda Lu[2], Yuheng Hu[2], Xi Chen[3], Yuxin Chen[4], [1]University of Illinois at Chicago, Chicago, IL, [2]University of Illinois-Chicago, Chicago, IL, [3]Zhejiang University, Zhejiang, China; [4]New York University - Shanghai, Shanghai, China
Influencer advertising is important in online marketing due to the rise of social influencers and their impact., but it's unclear how inserted ads affect the influencers themselves. We studied how inserted ads in videos impact an influencer's reputation using live comment sentiment and video feedback. Our result suggests that inserting advertisements have a negative impact on both instantaneous and longer-term viewer engagement; advertisements with influencers' face showing moderate the negative effect of advertisements on viewers' instantaneous response, while the different impact between advertisements with/out influencers showing their faces is not significant in the longer term. Our study provides insights into how influencer endorsement can be effectively moderated to maintain viewer engagement and protect an influencer's reputation.

2 A Machine Learning-Based Framework Towards Assessment of Labelers' Biases
Wanxue Dong[1], Maria De-Arteaga[2], Maytal Saar-Tsechansky[3], [1]The Chinese University of Hong Kong, Hong Kong, Hong Kong; [2]University of Texas at Austin, Austin, TX, [3]University of Texas at Austin, Austin, TX, Contact: wanxue.dong@utexas.edu
Across key domains, human expert assessments and crowd annotations are essential for labeling data to train machine learning models, and constitute a pathway through which biases are learned by algorithms. In this research, we propose a machine learning-based framework to produce a relative assessment of the extent of bias contained in labels produced by different sources, when gold standard labels are costly or difficult to acquire and thus available for only a small set of instances. We provide theoretical guarantees and show empirically that our method outperforms the commonly used alternative to assess biases reflected in human assessments. The proposed approach lays the groundwork towards increased transparency in labelers' biases and offers an important building block towards mitigating algorithmic bias stemming from biased labels.

3 Responding to Supply Chain Uncertainty: Evidence from a Cutting-Edge NLP Technique-Based Measure
J. Frank Li[1], Wenting Li[2], Xuan Wei[3], Wenjian Xu[4], [1]Stanford University, Palo Alto, CA, [2]Lund University, Lund, Sweden; [3]University of Arizona, Tucson, AZ, [4]Shanghai Jiaotong University, Shanghai, China. Contact: jfli@stanford.edu
Managing supply chain uncertainty is essential for firms' production and operations strategies. Recently, the concern about supply chain has intensified due to massive disruptions caused by global pandemics, trade war, political unrest, and natural disasters, etc. Relying on cutting-edge NLP techniques (prompt-based zero-shot learning), we develop a new index to quantify supply chain uncertainty from corporate 10-K/Q filings. Our measure tracks intuitive variations over time and correlates with

other well-known uncertainty measures. Using firm-level data, we find that supply chain uncertainty is associated with higher human capital skill demand related to supply chain management, which facilitates a smoother navigation through uncertainty shocks.

4 Beyond Star Ratings: A Deep Learning Investigation of Online Doctor Reviews and Service Quality

Bin Zhang[1], Yongcheng Zhan[2], Jiang Wu[3], Haijing Hao[4], [1]Texas A&M University, College Station, TX, [2]California Polytechnic State University, San Luis Obispo, CA, [3]Wuhan University, Wuhan, China; [4]Bentley University, Waltham, MA, Contact: binzhang@tamu.edu

This study introduces a deep learning method for text mining online doctor reviews to extract sentiment scores, which are used to estimate a healthcare service quality model investigating the impact of online doctor reviews on consultation demand. Using data from China's largest online health platforms, our model demonstrates significant effects of sentiment scores on online consultation demand. The developed algorithm outperforms four common text mining methods and can be applied to various online platforms. Our results identify factors influencing healthcare service quality and consultation demand, guiding healthcare professionals to improve their services.

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CC-West 105C

Digital Platforms and Social Network

Community Committee Choice Session

Session Chair: Yinan Yu, University of Memphis, Collierville, TN

1 Machine Learning Measures of Social Proximity for Business Partnership Management

Ruiyun Xu, Miami University, Oxford, OH

We develop a new and generalized measure of social proximity, which denotes the closeness between two organizations or individuals in terms of social relations or sociodemographic attributes, using graph embedding approach. We assess the proposed measure across three distinct settings in the venture capital context. Our empirical findings reveal that this machine learning-based measure not only correlates with existing measures, but also offers two novel features: (1) delivering a more granular and precise evaluation of social proximity through simultaneous consideration of diverse connectivity patterns between actors, and (2) demonstrating flexibility in quantifying social proximity within a single relation or across multiple relations. This measure also exhibits superior predictive power on the investment decisions made by venture capitalists.

2 CEO Political Orientation And Software Innovation

Inmung Choi, Texas Tech University, Lubbock, TX, Contact: Inmyung.Choi@ttu.edu

This study conceptualizes CEO political orientation and examines how CEOs' values and beliefs reflected on CEO political orientation are associated with their firms' software innovation, drawing upon upper echelon theory. Specifically, we suggest that liberal CEOs are more likely to support software innovation because they are more open to newness and changes compared to conservative CEOs. Then, by considering CEO political orientation and top management team (TMT) political orientation together, we find that liberal CEOs' tendency to spur software innovation is more pronounced when they work with liberal top managers than conservative top managers. Our findings underscore the need to consider CEO political orientation as a critical characteristic of CEOs in IS research for examining its influence on IT-related strategic decision makings.

3 Leveraging Memory Cues on a Healthcare Crowdsourcing Platform for Engaging Crowds and Experts: An NLP Approach

Yiwen Gao[1], Sezgin Ayabakan[2], Sunil Wattal[2], [1]Colorado State University, Fort Collins, CO, [2]Temple University, Philadelphia, PA

Online healthcare crowdsourcing platform involves two types of participants: experts with medical field-related training and crowds with similar disease experiences. However, there is a lack of understanding about how different types of participants, i.e., crowds and experts, contribute and the factors leading to their engagement on healthcare crowdsourcing platforms. In this research, we examine (1) the differential impact of the participation levels of experts and crowds on case solutions and (2) the contextual communication factors, i.e., structural and emotional memory cues, leading to their participation in crowdsourcing platforms. By analyzing data from CrowdMed, this study seeks to shed light on the roles of experts and crowds in online healthcare crowdsourcing platforms and explain the differences between them using the episodic memory perspective.

4 The Role of AI Assistants in Livestream Selling: Evidence from a Randomized Field Experiment

Lingli Wang[1], Yumei He[2], Ni Huang[3], De Liu[4], Xunhua Guo[5], Yan Sun[6], Guoqing Chen[5], [1]Beijing University of Posts and Telecommunications, Beijing, China; [2]Tulane University, New Orleans, LA, [3]University of Miami, Gilbert, AZ, [4]University of Minnesota, Minneapolis, MN, [5]Tsinghua University, Beijing, China; [6]Alibaba Damo Academy, Hangzhou, China. Contact: yhe17@tulane.edu

Live-stream selling transforms online shopping, allowing streamers to present products while interacting with consumers. In collaboration with Alibaba, our study addresses how livestream selling platforms mitigate the tension between streamers' constrained service capacity and individual service demands with algorithm-based assistants (termed "AI assistants"). By analyzing data from 132,199 consumers, we find that the introduction of the AI assistant increases sales by 2.61% and reduces product returns by 62.86%. The AI assistant extends awareness and consideration stages, improves probability of placing an order in the evaluation stage, and reduces the likelihood of product return. Further, interacting with the AI assistant reduces consumers' expressions of affection and positive emotions, which we claim as mechanism.

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CC-West 106A

FinTech

Community Committee Choice Session

Session Chair: Murat Tunç, Tilburg University, Netherlands

1 Financial Inclusion and Comparative Efficiency Across Lenders in Credit Scoring: The Role of AI

Yidi Liu[1], Xin Li[2], Zhiqiang (Eric) Zheng[3], [1]The Chinese University of Hong Kong, Shenzhen (CUHK-Shenzhen), Shenzhen, China; [2]City University of Hong Kong, Kowloon Tong, Hong Kong; [3]University of Texas at Dallas, Richardson, TX, Contact: Yidi.Liu.PhD@gmail.com

Artificial Intelligence (AI) has proven to have remarkable credit-scoring capabilities in assessing borrowers' creditworthiness, enabling efficient credit underwriting and precise credit score identification. However, in practice, conservative lending practices and inadequate use of AI in consumer lending often result in the financial exclusion of disadvantaged groups, such as females, low-income households, rural populations, and youth. This research aims to examine the effects of AI-powered credit scoring on financial inclusion, particularly among underprivileged populations, while also considering the efficiency of credit risk control across multiple lenders. By providing cross-lender evidence, this study sheds light on the potential of AI to promote greater financial inclusiveness while maintaining efficiency in lending practices.

2 Proof-Of-Merit: Harnessing the Computing Power Used by Blockchain Consensus Mechanisms for Complex Transaction Generation

Haozhao Zhang[1], Zhe Zhang[2], Zhiqiang (Eric) Zheng[3], Varghese S. Jacob[4], [1]The Chinese University of Hong Kong, Shenzhen, Shenzhen, China; [2]University of Texas Dallas, Irvine, CA, [3]University of Texas at Dallas, Richardson, TX, [4]University of Texas-Dallas, Richardson, TX

We propose a new blockchain consensus mechanism that integrates transaction generation with transaction recording, wherein the transaction to be recorded needs to be first generated by solving a complex problem. We call it the Proof-of-Merit (PoM) mechanism - this approach decentralizes the transaction-generation process and selects proposed solutions to the problem based on their merit. We illustrate the PoM mechanism in the context of ridesharing, where a group of solvers provide solutions to the problem of matching riders with drivers. Moreover, we define two objectives - efficiency and equity - to evaluate PoM. We introduce a parameter called the Decentralized Control Parameter (DCP) that governs the intrinsic tradeoffs between efficiency and equity. We demonstrate PoM's as well as DCP performance and nuanced properties using agent-based simulation.

3 How Free Market Entry Affects Creation and Engagement: Evidence from Non-Fungible Tokens

Ioannis Filippos Kanellopoulos[1], Dominik Gutt[1], Murat Tunc[2], Ting Li[1], [1]Erasmus University Rotterdam, Rotterdam, Netherlands; [2]Tilburg University, Tilburg, Netherlands. Contact: kanellopoulos@rsm.nl

Market entry costs present a threat for online marketplaces that wish to attract new users. In this work, we use data from an NFT marketplace to investigate how a new policy to deal with these costs affects the generated content and the engagement with that content. Studying creation, we find that the policy gives rise to a creation-effort trade-off, as creators introduce more work in the market but exert less effort when creating it. Studying engagement, we find that it decreases, while most affected are the creators whose engagement before the new policy was close to the median range. We also find that this decrease is driven by

effort and attention, while a larger follower count does not shield creators from this decrease. Moreover, we find no evidence that the reduced costs are passed to the first-time buyers. Finally, we discuss our contributions to the literature and management.

4 Market Punishment of Strategic Generosity: An Empirical Examination of NFT Charity Auctions

Chen Liang[1], Murat M. Tunc[2], Gordon Burtch[3], [1]University of Connecticut, Storrs, CT, [2]Tilburg University, Tilburg, Netherlands; [3]Boston University, Boston, MA, Contact: m.m.tunc@tilburguniversity.edu

NFT charity auctions, which involve the sale of artistic works as non-fungible tokens with proceeds donated to a philanthropic cause, have been an important development in crypto donations. Due to the potential for rapid increases in the value of charity NFTs, donors may be perceived as motivated by financial incentives. We explore how social image may translate into quantifiable economic penalties for donors in the context of a large NFT charity auction. We examine the consequences of charity NFT purchase and subsequent relisting, finding that donors who engage in such behavior experience a systematic penalty in terms of the prices in the later sale of other NFTs in their portfolio. Moreover, we demonstrate that these effects accrue to donors who re-listed their charity NFTs for sale shortly after purchase, and to those who are more socially embedded in the NFT community.

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CC-West 106B

Machine Learning and Stochstic Control

Community Committee Choice Session

Session Chair: Xianhua Peng, Peking University, Shenzhen, China

1 Reinforcement Learning for Continuous-Time Optimal Execution: Actor-Critic Algorithm and Error Analysis

Boyu Wang, Xuefeng Gao, Lingfei Li, Chinese University of Hong Kong, Hong Kong SAR, China

We propose an actor-critic RL algorithm for the optimal execution problem. We consider the Almgren-Chriss model in continuous time and formulate a relaxed control problem for execution under an entropy regularized mean-quadratic variation objective. We obtain in closed form the optimal value function and the optimal feedback policy, which is Gaussian. We then use these results to parametrize our value function and control policy. In addition to policy evaluation and policy gradient update, we introduce a recalibration step which turns out to be critical for convergence. We develop a finite-time error analysis of our algorithm and show that it converges linearly. We test our algorithm in three different types of market simulators. Empirical results demonstrate the advantages of our algorithm over the classical control method and a deep learning based RL algorithm.

2 Dynamic Portfolio Selection and Asset Pricing Under Neo-Additive Probability Weighting

Xuedong He[1], Yu Sun[2], [1]The Chinese University of Hong Kong, Shatin, MN, Hong Kong; [2]The Hong Kong Polytechnic University, Kowloon, Hong Kong. Contact: yu-hkpolyu.sun@polyu.edu.hk

We study a dynamic portfolio selection problem in which an agent trades a stock and a risk-free asset with the objective of maximizing the rank-dependent utility of her wealth at the end of the investment horizon. Due to time inconsistency, we consider three types of agents, pre-committed, sophisticated, and naive agents, who differ from each other in whether they are aware of the time inconsistency and whether they have self-control. Assuming a neo-additive probability weighting function, we solve the strategies of these agents. We find that the pre-committed agent takes a loss-exit strategy, leading to a positively skewed wealth in the end. We also study equilibrium asset pricing and find that with pre-committed agents, the stock return exhibits a reversal effect, and the initial stock price is lower than in the case when the market consists of sophisticated agents only.

3 Reinforcement Learning for Financial Index Tracking

Xianhua Peng[1], Chenyin Gong[2], Xuedong He[3], [1]Peking University, Shenzhen, China; [2]Hong Kong University of Science and Technology, Hong Kong, China; [3]The Chinese University of Hong Kong, Shatin, MN, Hong Kong

We propose a novel reinforcement learning based approach for financial index tracking under both return-based tracking error and value-based tracking error. The approach better captures the joint market dynamics of a large number of stocks through learning from a much longer time period of data than existing approaches. We also propose to solve the portfolio rebalancing equation using a Banach fixed point iteration, which allows to accurately take into account the transaction cost specified as nonlinear functions of transaction volume that is used in practice. To effectively train the reinforcement learning agent, we develop a training strategy that addresses data limitation issues. Empirical results demonstrate that the proposed approach outperforms existing methods in terms of tracking accuracy and generates relatively low transaction costs.

4 Deep Learning the SABR Model Implied Volatility

Jaehyuk Choi[1], Jeonggyu Huh[2], [1]Peking University, Shenzhen, China; [2]Chonnam National University, Gwangju, Korea, Republic of. Contact: jaehyuk@phbs.pku.edu.cn

The stochastic-alpha-beta-rho (SABR) model is a standard volatility smile model for pricing European options. The asymptotic implied volatility approximation is quick to use but prone to errors and arbitrage. Pricing based on the Monte-Carlo simulation is accurate but slow to use. We fill this gap by training a neural network to learn the SABR implied volatility obtained from simulations. The efficiency and accuracy of the neural network approach are significantly enhanced by several innovations: (i) the reduction of parameter dimensions, (ii) the adoption of the asymptotic behavior of the implied volatility to the objective function, and (iii) a novel simulation scheme under the CEV model.

5 Probabilistic Forecasting of Multivariate Irregularly Sampled Sequences

Yijun LI, Cheuk Hang LEUNG, Qi Wu, City University of Hong Kong, Kowloon Tong, Hong Kong. Contact: yijunli5-c@my.cityu.edu.hk

Multivariate sequential data becomes asynchronous whenever components are not aligned. If temporal irregularity is endogenous rather than a result of insufficient observation, it shall play a defining role in characterizing the dependence dynamics. Recurrent architectures, e.g. RNN, GRU, LSTM, become insufficient as they share hidden states among components and often rely on biased imputation to handle multivariate asynchrony. We present an end-to-end solution that overcomes these limitations by letting the observation times dictate when, how, and which hidden state to update, and representing the data distribution via the normalization flow. We carefully explore the likelihood structure to ensure that the complete exploitation of the heterogeneous and asynchronous characteristics of the data is not compromised while capturing the dependence structure.

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CC-West 106C

Applied Market Design

Community Committee Choice Session

Session Chair: Daniela Saban, Stanford University, Palo Alto, CA

Session Chair: Gabriel Weintraub, Stanford Graduate School of Business, Stanford, CA

1 Redesigning VolunteerMatch's Search Algorithm: Toward More Equitable Access to Volunteers

Vahideh Manshadi[1], Scott Rodilitz[2], Daniela Saban[3], Akshaya Suresh[1], [1]Yale University, New Haven, CT, [2]UCLA Anderson School of Management, Los Angeles, CA, [3]Stanford University, Palo Alto, CA, Contact: vahideh.manshadi@yale.edu

In collaboration with VolunteerMatch—the world's largest online platform for connecting volunteers with nonprofits—we designed and implemented a novel recommendation algorithm called SmartSort to improve equity in access to volunteers. Based on promising experimental results in three large metro areas, each showing a statistically significant 8-9% increase in our metric for equity, VolunteerMatch has deployed SmartSort nationwide. We expect it to provide an additional 30,000 volunteer sign-ups annually to opportunities with limited access to volunteers.

2 Competing Platforms and Transport Equilibrium

Nicola Rosaia, 1</sup

This paper studies platform competition in the app-based transportation industry. I present a model of competing platforms in transport equilibrium, characterize analytically the profit-maximizing allocations and prices, and estimate it using high-frequency data on the operations of the two main platforms in New York City. The model identifies two key sources of inefficiency: platform market power and missed network economies due to platform competition. These factors contribute to an inefficient use of drivers, resulting in higher traffic per ride than the social optimum. I find that a substantial share of the traffic externalities that ride-sharing services create can be traced back to these inefficiencies, and explore the implications for merger analysis and for the optimal design of congestion pricing policies.

3 Designing Incentive Mechanisms to Reduce Public Spending: A Field Experiment in Government Procurement

Marcelo Olivares, Universidad de Chile / Instituto Sistemas Complejos de Ingenieria, Santiago, Chile

This paper explores incentive mechanisms to align public officials' goals and reduce inefficiencies in public spending. Large-scale field experiments in Chile, in collaboration with Chilecompra and the Ministry of Finance, assessed interventions improving incentive alignment in public procurement. Monthly reports on purchasing performance were provided to managers and officers, reducing overspending and increasing efficiency. After five months, significant reductions in overspending were observed among officers whose performance was known by top-level executives, amounting to 33% of the control group mean. This represents potential savings of 20 million dollars per year. The study highlights the efficacy of information-based monitoring interventions and the role of incentive alignment in driving procurement behavior change.

4 Redesigning Framework Agreement Auctions in Chile Reduces Government Spending

Daniela Saban, Stanford University, Palo Alto, CA

Framework agreements (FAs) mechanisms by which a central procurement agency selects an assortment of products, typically through auctions, and then affiliated organizations can purchase from the selected assortment as needs arise. In Chile's central procurement agency (ChileCompra), FAs accounted for 23% of the procurement expenditures during 2018-19. We collaborated with ChileCompra to redesign FAs to enhance competition. These changes were implemented through an experimental design in the new Food FA to measure its impact, showing that inducing more intense competition in the auction stage reduced transaction prices by 8%.

Monday, October 16, 2:15 PM - 3:30 PM

MD75

Session.Location:CC-West 208A

Operational Planning of Emerging Vehicle Technologies

Contributed Session

Session Chair: Yining Liu, University of Illinois at Urbana-Champaign, Urbana, IL

1 How Sustainable are Shared e-Scooters? Insights from a Real-World Application and Managerial Implications

Ja'far Mohammad Mandouri[1], Murat Kucukvar[2], Nuri Onat[1], [1]Qatar University, Doha, Qatar; [2]Daniels College of Business, Denver, CO

E-scooters are emerging technologies as a shared economy application in cities. In this research, we investigate environmental, economic, and social impacts of shared e-scooters and provide key managerial and policy insights for sustainable applications of e-scooter mobility solutions in cities. We develop a novel a novel life cycle sustainability assessment model and a set of utilization scenarios derived from a real-world application in city of Doha, Qatar. We quantified life-cycle sustainability impacts encompassing from regional and global value chains of each life cycle phase of e-scooters. The results highlight that the utilization of e-scooters has a paramount importance for successful application of shared e-scooters.

2 A Simulation-Based Approach for Rebalancing Micro-Mobility Systems with Incentives

Mehr Sadat Salami[1], Leila Hajibabai[2], [1]North Carolina State University, Raleigh, NC, [2]North Carolina State University, Raleigh, NC, Contact: msalami@ncsu.edu

This study presents a simulation-based technique for rebalancing an e-scooter-sharing system by incentivizing customers. The offers are made when destinations are chosen that balance the number of scooters in all zones at any time, maximizing profits for the company, or when scooters are dropped off at destinations that are in the vicinity of charging areas, minimizing the collection efforts. The effects of varying parameters, including incentive offer, discomfort coefficient, demand, and optimization time, on profits are analyzed and the best configuration is presented.

3 Inventory Management at Points-Of-Sale of Recreational Off-Road Vehicles

Mathieu Sylvestre, IVADO Labs, Montreal, QC, Canada

Inventory management of recreational off-road vehicles is challenging due to many factors, including low retail volumes at points of sale and strong seasonality in demand. In this presentation we discuss how we leverage numerous data sources to generate recommended inventory position targets for different products at all points of sale in a large manufacturer's network in North America.

4 Planning Charging Stations and Incentive Mechanisms for Shared Dockless e-Scooter Services

Yining Liu[1], Yanfeng Ouyang[2], [1]University of Illinois at Urbana-Champaign, Urbana, IL, [2]University of Illinois at Urbana-Champaign, Urbana, IL, Contact: yiningl5@illinois.edu

This talk focuses on planning charging stations for shared e-scooter services, where customers are rewarded with incentives for returning e-scooters at nearby charging stations. A queuing network model is developed to describe customer assignment, customer usage, e-scooter battery consumption, and recharging operations. Closed-form formulas for expected agency cost and passenger travel time are derived. A meta-heuristic method is integrated with a nonlinear programming model to optimize the number of deployed e-scooters, the density and capacity of charging stations, the priority for assigning e-scooters at different battery levels, the rebalancing headway, and the incentive mechanism.

Monday, October 16, 2:15 PM - 3:30 PM

MD76

Session.Location:CC-West 208B

Financial Portfolio Selection and Risk Analysis

Contributed Session

Session Chair: Alex Bernstein, University of California, Santa Barbara, CA

1 The Dodd-Frank Act and Hedge Fund Operational Risk

William N. Goetzmann[1], Bing Liang[2], Jue Wang[2], [1]Yale University, New Haven, CT, [2]University of Massachusetts Amherst, Amherst, MA, Contact: juewang@umass.edu

In this paper, we examine the impact of the post-Dodd-Frank change in 2011 on hedge fund disclosure. Our LASSO-selected indicators for operational risk are effective in identifying potential negative outcomes for hedge funds in the future. We also construct a more comprehensive uni-dimensional ADV-based Ω-score to predict future appraisal ratio, style-adjusted return, leverage, and adverse liquidation events in the 11-year panel sample. Our analysis indicates that the amended Form ADV Filing improves the ability to forecast future adverse operational events compared to the pre-Dodd-Frank era. Additionally, our ADV-based Ω-score has a negative association with future fund flows, suggesting that investors take into account the operational risk exposure of hedge funds when making investment decisions.

2 How Bad is Myopia for a Mean-Variance Investor?

Jinye Du, Moris Simon Strub, Zhongfei Li, Southern University of Science and Technology, Shenzhen, China. Contact: 12131291@mail.sustech.edu.cn

The mean-variance framework is widely used in portfolio selection but often overlooks the investment horizon. Current investment practices rely on myopic mean-variance approaches that neglect long-term considerations. Existing algorithms solve single-period mean-variance problems and extend the solution over time. This paper contributes to the existing research by incorporating a time dimension. We compare the out-of-sample performance of the dynamic mean-variance strategy with myopic strategies and three 1/N-type strategies. The results demonstrate that the dynamic mean-variance strategy outperforms the myopic approach in out-of-sample scenarios. Additionally, we highlight the benefits of optimization in a dynamic context compared to naive diversification.

3 Valuation Premium Effectof Targets' Operations Capability in M&As

Mehdi Nezami[1], Sara Rezaee Vessal[2], Ali Shantia[3], [1]Bradly University, Chicago, IL, [2]ESSEC Business School, Cergy-Pontoise, France; [3]Toulouse Business School, Toulouse, France. Contact: a.shantia@tbs-education.fr

Valuation of target firms in mergers and acquisitions (M&As) has far-reaching implications for shareholder wealth. This study investigates the effect of a target's operations capability on the valuation premiums, above its market value, that it receives from the acquiring firm. We find that target firms' operations capability has a positive and economically significant effect on their M&A valuation premiums. However, this effect becomes weaker with increasing market overlap between the target and acquiring firms. These findings offer corporate executives a comprehensive perspective on the role of operations capability in enhancing shareholder wealth---beyond its effect on stock market value---in the context of a major strategic decision: corporate M&As.

4 Robustness of the Higher Moment Risk Measure

Fabio Gómez[1], Spiridon Penev[2], Qihe Tang[1], [1]University of New South Wales, Sydney, Australia; [2]University of New South Wales, Sydney, Australia. Contact: qihe.tang@unsw.edu.au

The higher moment (HM) risk measure generalizes expected shortfall by incorporating an additional parameter interpreted as risk aversion. This work examines various robustness issues related to the HM risk measure. We prove that the HM risk measure is robust against optimization in a sense recently proposed by Embrechts, Schied, and Wang (2022, Operations Research). Based on the HM risk measure, we consider the distributionally robust optimization problem for linear portfolios and revisit the topics of risk parity and capital allocation under ambiguity, where ambiguity is quantified using the Wasserstein distance.

5 Analytical Solutions to the Constrained Markowitz Problem via Fixed Point Theory

Alex Bernstein[1], Alexander Shkolnik[2], [1]University of California, Santa Barbara, Santa Barbara, CA, [2]University of California, Santa Barbara, Santa Barbara, CA, Contact: abernstein@ucsb.edu

Harry Markowitz transformed finance by framing portfolio construction as a mean-variance tradeoff. Building on a special case solved (or rather, guessed) previously, we develop an analytical formula for the solution to the Markowitz problem with no short sales. Our results make use of fixed point theory to characterize the solution in a way that reveals its geometric properties.

Monday, October 16, 2:15 PM - 3:30 PM

MD77

Session.Location:CC-West Lecture Hall

On Recommendation Systems

Contributed Session

Session Chair: Dirk Daniel Sierag, Stitch Fix, San Francisco, CA

1 Budget Bot: A Hotel Recommendation Tool Powered by Generative AI and Mixed-Integer Programming

Han Dong, Elliot Wilens, Zhenzhen Zhu, Yunhong Liao, Michele Meyers, Marriott International, Bethesda, MD

Selecting hotel accommodations is a key component of planning a memorable road trip, and identifying options that match each traveler's preferences can be time-consuming. This presentation will cover a hotel recommendation tool that integrates generative AI and mixed-integer programming (MIP) to optimize hotel selections for multi-day and multi-hotel trips. The generative AI component captures the trip information and hotel preferences as inputs to the MIP model. The optimization model identifies the best combination of hotels that meet the traveler's requirements. This integration of generative AI and MIP creates an efficient and effective decision-making process for travelers.

2 AI: Automated Itinerary (For Road Trips)

Kyle Murphy, Anirudha Kulkarni, Zelin Jiang, David Todd, Marriott, Bethesda, MD, Contact: kyle.murphy@marriott.com

When planning a road trip, travelers typically plan routes, book hotels, and find local attractions using different online platforms. This presentation will discuss a tool that integrates Google Maps, Chat GPT, and hotel property location data to do all three things in one place. The tool starts with a list of user-specified required stops and uses a heuristic to generate a list of recommended additional stops. Then it leverages ChatGPT prompts to generate relevant, fun, and safe recommendations for a unique user-experience at each additional stop. Once a travel itinerary is planned, location data is used to recommend hotels along the way.

3 The Effect of Friend Recommendation Algorithms on Information Cocoon Formation: Evidence from a Field Experiment

Lin Wang, Communication University of China, Beijing, China. Contact: carolinewang@cuc.edu.cn

Along with the proliferation of social media, polarization has become a critical issue; widely implemented algorithms have changed the way users access information on platforms, facilitating the formation of information cocoons. However, recent research has focused on the existence and impact of information cocoons on social media platforms while ignoring the mechanisms that may drive their formation. Specifically, whether the widely adopted friend recommendation algorithms intensify or alleviate the information cocoon issue is unclear. Furthermore, the heterogeneous effects of friend recommendations on information cocoon formation remain unrevealed. Collaborating with one of the most popular short-video social networking apps, we implemented a large-scale randomized field experiment with further causal forest analysis to address the above questions.

4 Client Time Series Model: A Multi-Target Recommender System Based on Temporally Masked Encoders

Dirk Daniel Sierag, Stitch Fix, San Francisco, CA

Stitch Fix is an online personal styling and shopping service on multiple platforms. For example, a client can request a stylist to curate a personalized 'Fix', an assortment of 5 items; or they can make direct purchases in their own personalized shop in our 'Freestyle' experience. In order to provide the client with the most personalized experience across all platforms, we developed the Client Time Series Model (CTSM): a scalable and efficient recommender system based on Temporally-Masked Encoders (TME) that learns one client embedding across all platforms, yet is able to provide distinctive recommendations depending on the platform. An A/B test showed that our model outperformed the baseline model by 5.8% in terms of expected revenue.

Monday, October 16, 2:15 PM - 3:30 PM

MD78

Session.Location:CC-West 211A

spORts IV

Community Committee Choice Session

Session Chair: Ben Grannan, Queens University of Charlotte, Fort Mill, SC

1 Unsupervised Data Mining to Identify Golfer Performance by Course Profile on the PGA Tour

Ben Grannan, Queens University of Charlotte, Fort Mill, SC

This study develops an analytical approach to understand how different profiles of golfers perform on specific types of golf courses. A golfer's profile could be identified as a long-hitter, strong iron player or elite putter, or a combination of those strengths. A golf course can defend itself with length, necessity of shot-making and precision, or complexity of the putting areas. Anecdotally, "any type of player can win at the RBC Harbor Towne" but "great putting is a requirement at Augusta National." In a similar manner, the longest drivers on the PGA Tour do not win each week, but there may be some destinations on tour where the bombers aggregate towards the top of the leaderboard more than expected. Through data analysis this study seeks to understand who plays well where on tour and which tournaments are unlikely to yield success to specific groups of golfers.

2 Which Algorithm to Select in Sports Timetabling?

David Van Bulck, Dries Goossens, Ghent University, Gent, Belgium

In a round-robin sports timetable, each team competes against every other team a predetermined number of times. Over the years, a variety of sports timetabling algorithms have been proposed, including integer programming, meta-heuristics, and satisfiability solvers. The International Timetabling Competition on Sports (ITC2021) suggests that the performance of sports timetabling algorithms heavily depends on the specific constraints involved. This presentation demonstrates the use of machine learning techniques to predict the most suitable algorithm for a given sports competition. It also explores what properties are most important in making these predictions, and illustrates how the predictions can contribute to improve existing solvers.

3 Scheduling Women's Soccer in Belgium

Dries Goossens[1], Frits C. Spieksma[2], [1]Ghent University, Gent, Belgium; [2]Eindhoven University of Technology, EINDHOVEN, Netherlands. Contact: dries.goossens@ugent.be

The scheduling of women soccer leagues has hardly received attention in the literature. Perhaps due to lower interest by the general public (and hooligans), it has not been perceived as very challenging or important. However, the success of the women's national team prompted a TV channel to live broadcast a weekly match from the highest division of the Belgian women's soccer league. This triggered a number of scheduling constraints which require a more sophisticated approach. For instance, the TV channel wanted to broadcast a home game for each team at least once in the season. Moreover, as most teams lacked a suitable venue, live broadcasting was only possible when better infrastructure (typically from the men's teams) was available. We discuss the development of a tailor-made scheduling algorithm and its use in practice for the 2022-23 season.

4 Round-Robin Scheduling with Regard to Rest Differences: A Novel Branch-And-Price Method and Heuristic Approach

Tonguc Yavuz[1], Tankut Atan[2], Burak Cavdaroglu[3], [1]İstanbul Bilgi University, İstanbul, Turkey; [2]Bahçeşehir University, İstanbul, Turkey; [3]Teesside University, Middlesbrough, United Kingdom. Contact: tonguc.yavuz@bilgi.edu.tr

Fairness in rest durations is critical in round-robin sports scheduling. Our study introduces a novel branch-and-price (B&P) method to minimize rest differences, offering significant improvements in computation time and objective function value over conventional methods. Additionally, a new heuristic for basic solution identification consistently outperforms traditional integer programming solutions. These advancements present a promising path towards improved fairness in round-robin scheduling, with potential applications extending beyond sports. Future research will explore the wider applicability of these innovative methods.

Monday, October 16, 2:15 PM - 3:30 PM

MD79

Session.Location:CC-West 211B

Learning and Optimization

Contributed Session

Session Chair: Xiaotong Sun, University of Arkansas, Springdale, AR

1 Decision-Focused Surrogate Modeling for Mixed-Integer Optimization

Shivi Dixit, Rishabh Gupta, Qi Zhang, University of Minnesota, Twin Cities, Minneapolis, MN, Contact: dixit064@umn.edu

Many real-world operational decision-making problems are modeled as mixed-integer programs (MIPs) and involve solving multiple similar instances over time, which vary based on problem-specific input parameters. Due to their computational complexity, solving these MIPs in real time is often challenging. In this work, we propose a data-driven decision-focused surrogate modeling approach that constructs fast surrogate optimization models, e.g. in the form of convex quadratic programs, which generate solutions that closely approximate those obtained from the original MIPs.

2 Nested Learn to Branch-And-Price for Large-Scale Network Optimization Problems

Babak Aslani, Shima Mohebbi, George Mason University, Fairfax, VA, Contact: baslani@gmu.edu

While the Branch-and-Price algorithm is an effective solution approach for combinatorial optimization problems, high computational time and memory usage are still the main challenges for real-life problems. To address this gap, we propose a nested learning-based framework to use the information during the optimization process and accelerate the Branch-and-Price procedure. In specific, we use a learning component to select the most promising columns for the column selection step and embed a learning procedure to predict the upper bound for solving the pricing problem stage. We apply the proposed framework to a set of benchmark problems and a city-scale network flow problem for a case study in Tampa, FL. We compare the performance of the proposed framework with state-of-the-art methods to validate the applicability of the approach.

3 Experimental Design and Two Stage Stochastic Programming Analysis for Cyber Resilience

Tu Feng[1], Theodore T. Allen[2], Antonio Conejo[1], [1]The Ohio State University, Columbus, OH, [2]Ohio State University, Columbus, OH, Contact: feng.1039@osu.edu

Resilience relates to the ability to prepare for and recover from disruptions which implies that concepts from two stage stochastic programming are relevant. Yet, in many cases experimentation and empirical modeling are needed to enable optimal resilience. We offer perhaps the first results that relate optimal experimentation to optimal resilience.

4 Adaptive Boosting with Sensitivity to Interaction Among Regressors

Xiaotong Sun, Justin Chimka, University of Arkansas, Fayetteville, AR, Contact: xs018@uark.edu

We will motivate the need for and introduce a new ensemble learning algorithm used for classification or regression where there is significant interaction among regressors. During rounds of training, we delete regressors that are insignificant and participate in no significant interaction or determine natural clusters of observations with respect to significant interaction among regressors.

Monday, October 16, 2:15 PM - 3:30 PM

MD80

Session.Location:CC-West 212A

Sequential Decision Problems and Applications

Contributed Session

Session Chair: Pavankumar Murali, IBM Research, Yorktown Heights, NY

1 Decomposition Strategies in Markov Decision Processes: Implications for Accuracy and Efficiency in Stochastic Logistics Networks

Ali Tolooie, Mercer University, Macon, GA, Contact: tolooie_a@mercer.edu

This study investigates the impact of varying decomposition strategies on Markov Decision Processes (MDPs) within stochastic logistics networks. We focus on constructing a theoretical framework that could guide the decomposition of MDPs considering stochastic rates inherent in the problem, while considering the tradeoff between the accuracy and efficiency of the decomposition. Moreover, we explore the characterization of optimal policies within these decomposed subsystems and discuss the extension of these policies to the original, higher-dimensional problem. Our goal is to enhance understanding and application of decomposition-based algorithms in complex logistics networks.

2 A Family of s-Rectangular Robust MDPs: Relative Conservativeness, Asymptotic Analyses, and Finite-Sample Properties

Siva Ramani, Archis Ghate, University of Washington, Seattle, WA

We study a family of distance-based s-rectangular robust MDPs (s-RMDPs), where in each state, the ambiguity set equals a sublevel set of the norm of a vector of distances from reference pmfs. This construction allows us to perform a rigorous analysis of the relative conservativeness behavior of (s,a)-RMDPs versus s-RMDPs from our family. We also study data-driven versions of our s-RMDPs. We prove that the optimal values of the RMDP converge to the true optimal, asymptotically with sample sizes. The robust optimal value also provides a probabilistic lower bound on the out-of-sample value of a robust optimal policy. This finite-sample result indicates that (s,a)-RMDPs are the least conservative among all s-RMDPs within our family.

3 Integrating Stochastic Approximation Algorithm into Markov Decision Process for Hotel Dynamic Pricing Optimization

Aysajan Eziz, Ivey Business School, Western University, London, ON, Canada. Contact: aeziz@ivey.ca

This research article presents a novel approach for dynamic pricing in the hotel industry by integrating a stochastic approximation algorithm (SAA) into a Markov decision process (MDP) formulation. The model optimizes booking prices for multi-day stays, taking into account room availability and demand fluctuations. The SAA helps find optimal pricing strategies, yielding higher revenues and minimizing losses during high-demand periods, as validated by computational experiments. While primarily focused on the hotel industry, the findings can be applied to other sectors with capacity constraints and variable demand, like transportation and e-commerce, providing valuable insights for dynamic pricing and revenue management.

4 Mining Sequential Decision-Making Behavior Based on Latent States

Chen Wang, Yuanyuan Lei, Tsinghua University, Beijing, China. Contact: chenwang@tsinghua.edu.cn

We propose an influence diagram model representing sequential decision-making behavior with underlying latent states. The model utilizes a generalized reward function to capture stationary decision rules, whether normative or descriptive. We then transform the influence diagram into a hidden Markov chain with neural networks for estimation. Case studies on the click data of online shopping from 100K customers and the pilot landing operations of about 5000 flights show surprisingly good predictability and explainable latent states.

5 Sequential Decision Making (SDM) with Long Term Reward Estimates

Pavankumar Murali[1], Dharmashankar Subramanian[2], Nianjun Zhou[3], [1]IBM Research, Yorktown Heights, NY, [2]IBM TJ Watson Research Center, Rye Brook, NY, [3]IBM, Chappaqua, NY

We study optimal control problems, wherein actions to be taken at a time step are dependent on a dynamical system's behavior such as realized demand or process behavior in a plant. Traditional SDM methods may not account for long-term effects of decisions or changing conditions. In our framework, we extend our objective function with two parts - the first part is the rewards within the time horizon for optimal policy, and we also include a modifier to the objective. The modifier term is the expected remaining reward after the recommended policies. Therefore, we can capture the holistic reward of the scenario, allowing us to ensure that the recommended policies benefit not only the period of the recommendation but also that the system is brought into a good system state for better future rewards. We benchmark the performance of our model on a use-case from a processing plant.

Monday, October 16, 2:15 PM - 3:30 PM

MD81

Session.Location:CC-West 212B

Exploring Entrepreneurship: Ownership, Innovation, and Training

Contributed Session

Session Chair: Huan He, Tianjin University, Tianjin, China

1 Innovation on Firm Performance and Moderating Role of State Ownership and Corporate Governance: Empirical Evidence China

Rushatey Feroz, Xi'an Jiaotong University, Xi'an, China. Contact: rushateyferoze@gmail.com

Although various aspects of innovation and firm performance have been studied, previous research has overlooked the overall impact of innovation on firm performance. Therefore, this study aims to determine the significance of innovation on the performance of Chinese firms. This study uses data from Chinese firms listed on the Shenzhen and Shanghai stock exchanges from 2007 to 2018. The result signifies that innovation has a positive impact on firm performance. State ownership and corporate governance both positively moderate this effect. The study also found that when corporate governance is high and state-owned support is low, the relationship between innovation and firm performance is stronger. Conversely, when corporate governance is low and state-owned support is high, the relationship between innovation and firm performance is weaker.

2 How Does Competition Affect AI Investment in Firms? Evidence From a Quasi-Natural Experiment in the United States

Taekyun Kim[1], Gangmin Park[2], Sukwoong Choi[3], [1]KAIST College of Business, Daejeon, Korea, Republic of; [2]Software Policy & Research Institute, Seoul, Korea, Republic of; [3]University at Albany, SUNY, Albany, NY

While previous research has predominantly focused on micro-level factors such as organizational structure and technological readiness, we propose that a macro-level competition policy (the US-China trade war) can also significantly influence AI investment. We suggest that tariffs on Chinese goods lessen production competition for US companies, boosting their likelihood to invest in AI and spur innovation. We empirically reveal a significant increase in AI investment among firms protected by the trade war, which in turn contributes to AI-relevant innovation. We further examine the mechanisms driving this investment, including slack resources, value chain complexity, and prior technological knowledge. We underscore the unforeseen positive repercussions of protectionism on US firms' AI endeavors and subsequent innovation.

3 How Employee Training Drives Firm Production Repurposing in Covid-19 Pandemic

Huan He, Yuxiao Ye, Baofeng Huo, Tianjin University, Tianjin, China. Contact: hohuan@tju.edu.cn

In the COVID-19 pandemic, we found some firms successfully repurpose production (i.e., adjusting firm production/services partially/fully) to adapt to the pandemic, which motivates us to study what factors drives firm production repurposing in COVID-19 pandemic. Drawing upon the ability, motivation and opportunity (AMO) framework, we study how to leverage human capital (by employee training) to enhance firm adaptation (i.e., production repurposing) in the pandemic. The results indicate that employee training prior to the pandemic develops human capital and firm capability to initiate production repurposing during the pandemic. Government wage subsidy and less labor shortage will enhance firm motivation and opportunity respectively in production repurposing, thus amplifying the positive impact of employee training prior to the pandemic.

Monday, October 16, 2:15 PM - 3:30 PM

MD82

Session.Location:CC-West 212C

Prediction and Data Mining in Healthcare

Contributed Session

Session Chair: Ajit Appari[1,2], [1]Boston University, Boston, MA, [2]Northeastern University, Boston, MA

1 Mitigating Underreported Error in Food Frequency Questionnaire Data Using a Supervised Machine Learning Method and Error Adjustment Algorithm

Anjolaoluwa A. Popoola[1], Jennifer K. Frediani[2], Terryl J. Hartman[2], Kamran Paynabar[3], [1]Georgia Institute of Technology, Atlanta, GA, [2]Emory University, Atlanta, GA, [3]ISyE Georgia Tech, Atlanta, GA, Contact: apopoola3@gatech.edu

Food frequency questionnaires (FFQ) are one of the most useful tools for understanding diet-disease relationships. However, they are susceptible to bias and misclassification. In this paper, a machine learning method is proposed to adjust for measurement error found in misreported data by using a random forest classifier and an algorithm that adjusts the measurement error. We show this method by addressing underreporting in selected FFQ responses. We have high model accuracies ranging from 78% to 92% in participant collected data and 88% in simulated data. This shows that our proposed method of using a RF classifier and error adjustment algorithm is efficient to correct most of the underreported entries in the FFQ dataset and could be used independent of diet-disease models. This could help nutrition experts to use dietary data estimated by FFQs with less measurement error.

2 Developing an Ensemble Model to Predict Safe Ambulatory Surgery

Clark Howell[1], Hamed Zaribafzadeh[1], Ursula Rogers[1], John Rollman[1], Dan Buckland[2], Peter Allen[1], Bruce Rogers[1], [1]Duke University, Durham, NC, [2]Duke University, Durham, NC, Contact: clark.howell@duke.edu

Health systems are seeking to perform more ambulatory surgeries to improve quality and patient satisfaction while decreasing cost and inpatient bed utilization. However, there is no reliable and generalizable model that predicts which patients and which surgeries are appropriate for ambulatory venues. Our aim is to create an ensemble model of distinct machine learning models that predict accepted metrics for safe ambulatory surgery. Ambulatory cases should be less than 5 hours (AUC 0.94), a patient must stay less than 23 hours (AUC 0.96), and the patient must be discharged home rather than to a facility (AUC 0.89). The ensemble of these models robustly predicts these three criteria (AUC 0.96) and ambulatory patient class (AUC 0.96).

3 A Modified Feature Selection Method to Build Interpretable and Trustable Machine Learning Model for Diabetic Retinopathy Disease Prediction

Enrico Laoh, Tieming Liu, Oklahoma State University, Stillwater, OK, Contact: elaoh@okstate.edu

The use of AI to help physicians make medical predictions is extensively explored nowadays. However, medical domain knowledge not provided in the data set plays a pivotal role in prescribing medical decisions. Current research direction predominantly focuses on extracting insights from data which is limited compared to well-established medical domain knowledge. Addressing this gap, our study aims to develop an approach to gather medical domain knowledge from well-published medical corpus available in the PubMed library and use it to select ML model variables for predicting diabetic retinopathy patient's condition. Moreover, this method also can preserve the model's interpretability which facilitates the limitation of user capability. This approach will help to make a robust and trustable AI-driven decision to support physicians in making better predictions.

4 Classification of Cognitive Groups in Aging Using dMRI

Mohammad Fili[1], Parvin Mohammadiarvajeh[1], Guiping Hu[1], Auriel A. Willette[1,2], [1]Iowa State University, Ames, IA, [2]University of Iowa, Iowa City, IA

"Positive-Agers" are middle-aged individuals who defy age-related cognitive decline and display superior cognitive abilities. This study develops a two-step approach to identify and differentiate "Positive-Agers" from "Cognitive-Decliners." First, a cognitive scoring procedure based on multiple cognitive tests was employed. Second, diffusion Magnetic Resonance Imaging (dMRI) and demographic data were used to distinguish between the two groups. This research contributes to the understanding of cognitive differentiation by exploring its relationship with dMRI attributes and cognitive tests.

5 Composite Risk Prediction of All-Types Hospital-Acquired Conditions Using Machine Learning for Pediatric Patients

Ajit Appari[1,2], [1]Boston University, Boston, MA, [2]Northeastern University, Boston, MA, Contact: aappari.work@gmail.com

Hospital-acquired conditions (HACs) are mostly preventable risk to the safety of hospitalized children, especially with multiple chronic conditions (MCC), that can result in elevated mortality & morbidity, longer hospitalization, and higher cost of care. Unlike past research focusing on specific HACs, my study develops composite risk prediction model for all types HACs among chronically ill children. I used administrative data on 710,320 pediatric hospitalizations (age: 1days-17years; includes 515,470 neonates & 33,375 infants) during 2015Q4-2016Q4 at all hospitals in Texas. I developed Poisson regression (with random effects) model for predicting HACs count with predictors including MCC patterns {estimated using Bernoulli Mixture model clustering}, patient factors, hospital factors, and physician factors controlling for admission type and time factors.

Monday, October 16, 2:15 PM - 3:30 PM

MD83

Session.Location:CC-West 213A

Data Mining: Drawing Insights from Data

Contributed Session

Session Chair: Jingwei Dai, Carnegie Mellon University, Pittsburgh, PA

1 Personality Classification with Reddit Data Using Natural Language Processing

Sungmin Lim, Juheon Kwak, Dongil Kim, Ewha Womans University, Seoul, Korea, Republic of. Contact: 8962468@ewhain.net

Recently, Myers-Brix Type Indicators (MBTIs) are the key keywords that identify and infer personal characteristics of community users. In addition, the MBTIs have been increasingly used in business fields for a personalized management of employees. In this paper, we propose an MBTI classification method with natural language processing (NLP) models. The MBTI_reddit, consisting of real-world reddit data of various users, was used for train. The experiment showed that the proposed method outperformed the conventional machine learning methods for real-world dataset.

2 The Consequences of the Economic Crisis on the Number of Deaths Resulting from Accidents

Mayssam Tarighi Shaayesteh, University of North Texas, Denton, TX, Contact: mayssamshaayesteh@gmail.com

This paper delves into a comprehensive examination of the impact of the annual inflation rate on traffic fatalities. By analyzing a rich dataset encompassing the years 1975 to 2020 in the United States, the study explores the intricate relationship between the total number of traffic-related deaths and the average annual inflation rate over this period. The aim is to uncover patterns and trends that could shed light on the potential forecasting of yearly fatalities.

3 The Sound of Silence: Effect of Disclosing User Location on Users' Social Engagement

Jingwei Dai[1], Emaad Manzoor[2], Michael D. Smith[1], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Cornell University, Madison, WI, Contact: jingwei.dai6@gmail.com

This research explores how disclosing user location will affect platform users' social engagement and content quality and credibility. We leverage a natural experiment that took place on Zhihu, China's largest knowledge-sharing platform. We use difference-in-difference methods to identify the policy shock's impact, and the regression results indicate that disclosing user location led to a significant decrease in user activeness in terms of posting answers. However, when location information was relevant to the answer content and displayed, it resulted in an increase in answer upvote counts and commenting activity. We also conducted NLP analysis to analyze the answer texts via text mining.

Monday, October 16, 2:15 PM - 3:30 PM

MD84

Session.Location:CC-West 213B

Insights Into Food Supply Chain and Food Insecurity

Contributed Session

Session Chair: Rashik Intisar Siddiquee, North Carolina State University, Raleigh, NC

1 A Coordinated Network Allocation Model for Food Bank Operations

Naurin Zoha[1], Julie Simmons Ivy[2], Negash Medhin[3], [1]North Carolina State University, Raleigh, NC, [2]University of Michigan, Ann Arbor, MI, [3]North Carolina State University, Raleigh, NC, Contact: nzoha@ncsu.edu

Food banks and their partner agencies operate to mitigate food insecurity. However, during the onset of COVID-19, a lot of these agencies shutdown causing a huge disruption in the network. This paper proposes a coordinated network infrastructure that permits trans-shipments between the agencies to absorb this disruption. Here, some agencies work as super-agencies to store food. In case of any agency closure, other agencies within a predetermined radius become helping agencies to receive food from the super-agencies and serve the food insecure population who were supposed to be served by the closed agency. The study has two main objectives: i) Develop a deterministic linear programming model minimizing unmet demand, inventory cost and shipping cost of the food bank, ii) Develop structural properties and policy insights to aid in food banks' decision making.

2 Weighting Approach for Evaluating Organizations within the Food Rescue Landscape

Abdullah Al Nadim[1], Rashik Siddiquee[1], Naurin Zoha[1], Naimur Rahman Chowdhury[1], Ricky Owusu[2], Mo Ogunmola[3], Julie Simmons Ivy[4], Lauren Berrings Davis[2], Shona D. Morgan[2], [1]North Carolina State University, Raleigh, NC, [2]North Carolina A&T State University, Greensboro, NC, [3]North Carolina A&T State University, Greensboro, NC, [4]University of Michigan, Ann Arbor, MI, Contact: anadim@ncsu.edu

In the US, 13.5 million households were food insecure at some point during 2021 and a plethora of non-profit organizations play a crucial role in hunger relief through their programs. This study analyzes over 50 companies within the food rescue landscape and categorizes them based on their potential for partnership with hunger relief organizations. We developed a framework for effective partner selection considering categories such as Fund Development, Logistics, Relationship Building, Adaptability etc. Through a systematic method of attribution weighting, our technique generates results that provide decision-making insights, assisting hunger relief organizations in selecting partners and maximizing their impact on reducing food insecurity.

3 A New Produce Ordering Policy

Mark Velednitsky, Afresh, Bothell, WA

In this work, we propose a new policy for managing the inventory of perishable items in grocery stores. Existing models capture either highly perishable items (ex. newsvendor) or relatively shelf-stable items (ex. EOQ). Our new model consumes a distributional forecast as well as item shelf life estimates. Relative to our incumbent policy, the new policy is show in real-world experiments to reduce food waste by approximately 10% without increasing stock-out rates, driving a 2% increase in profitability. We offer insights into the factors driving this improvement, such as a better characterization of uncertainty, a sales-aligned safety stock, and better shelf life estimates.

4 Food Rescue Landscape Analysis Framework to Characterize For-Profit and Nonprofit Organizations

Rashik Intisar Siddiquee[1], Naimur Rahman Chowdhury[1], Abdullah Al Nadim[1], Naurin Zoha[1], Ricky Owusu[2], Motunrayo Ogunmola[2], Julie Simmons Ivy[3], Lauren Berrings Davis[2], Shona D. Morgan[4], [1]North Carolina State University, Raleigh, NC, [2]North Carolina A&T State University, Greensboro, NC, [3]University of Michigan, Ann Arbor, MI, [4]North Carolina A&T State University, Greensboro, NC, Contact: rsiddiq2@ncsu.edu

The broader area of food rescue and food waste reduction has seen the entry of many companies with varied operating and profit models. This study develops a framework for evaluating these companies' performance regarding attributes, including technology management, logistics, relationship building, and fundraising. These attributes are compared relative to perceived strengths and opportunities of existing nonprofit hunger relief infrastructure. A SWOT analysis is performed to compare service operations of the for-profit and nonprofit organizations. Potential partnership opportunities among these companies are explored.

5 Discretion in Automated Supermarket Replenishment: Censorship Bias and Self-Inflicted Stockouts

Bengu Ozdemir, Antti Tenhiala, IE Business School, Madrid, Spain. Contact: bengu.ozdemir@student.ie.edu

Retail store managers can use their discretion to adjust order proposals of automatic store replenishment (ASR) systems to incorporate their private knowledge. Apart from occasionally improving ordering decisions with human insights that is not available to the ASR system, store managers are suspect to biases. We examine the prevalence and performance implications of censorship bias, which explains a paradox where retailers order less than ASR proposals after a stockout. Accounting for the endogeneity of ordering decisions, we show that censorship bias is equally prevalent and detrimental as the well-known anchoring bias of ordering behavior. By out-of-sample analysis, we show that ASR systems can be improved to block deviations susceptible to censorship bias.

Monday, October 16, 2:15 PM - 3:30 PM

MD88

CC-North Exhibit Hall

QSR Best Student Poster Competition

Poster Session

Session Chair: Minhee Kim, University of Florida, Gainesville, FL

Session Chair: Wenmeng Tian, Mississippi State University, Mississippi State, MS

1 Poster

Grace Babalola; Binghamton University, SUNY, USA

2 Poster

Davide Cacciarelli; Technical University of Denmark, Denmark

3 Poster

Mengfei Chen; Rutgers University, USA

4 Poster

Duong Do; Arizona State University, USA

5 Poster

Zheng Dong; Georgia Institute of Technology, USA

6 Poster

Chaoran Dou; Virginia Tech, USA

7 Poster

Hankang Lee; The Pennsylvania State University, USA

8 Poster

Haoqian Li; University of Wisconsin-Madison, USA

9 Poster

Ridwan Olabiyi; Arizona State University, USA

10 Pivotal Uncertainties To Resolve - Optimal Information Gathering In Supply Chain Design

Austin Saragih; Massachusetts Institute of Technology, USA

This paper addresses a critical supply chain management problem of designing networks amid uncertainties. It proposes a non-monotone non-submodular minimization approach, utilizing the value of information analysis, to optimize the trade-off between cost reduction achieved by resolving uncertainties through information gathering and the expenses incurred in the process. Results demonstrate the significant value of the proposed information-gathering strategy, with managerial implications for enhancing overall objectives in similar stochastic programming problems.

11 Poster

Abhin Shah; MIT, USA

12 Poster

Naichen Shi; University of Michigan, USA

13 Poster

Laixi Shi; California Institute of Technology (Caltech), USA

14 Poster

Jie Wang; Georgia Institute of Technology, USA

15 Poster

Zekai Wang; The University of Tennessee. Knoxville, USA

16 Poster

Song Wei; Georgia Institute of Technology, USA

17 Poster

Yiling Xie[1], Xiaoming Huo[2]; [1]Georgia Tech, USA, [2]ISyE Georgia Tech, USA

We propose an adjusted Wasserstein distributionally robust estimator---based on a nonlinear transformation of the Wasserstein distributionally robust estimator in statistical learning.This transformation will improve the statistical performance of WDRO because the adjusted

WDRO estimator is asymptotically unbiased and has an asymptotically smaller mean squared error.The adjusted WDRO will not sacrifice the out-of-sample performance guarantee of WDRO. Sufficient conditions for the existence of the adjusted WDRO estimator are presented. Numerical experiments demonstrate the favorable practical performance of the adjusted estimator over the classic one.

18 Poster
Yujing Yang; The University of Texas at Arlington, USA

19 Poster
Emmanuel Yangue; Oklahoma State University, USA

20 Poster
Zehao Ye; University of Texas at Arlington, USA

21 Poster
Christian Zamiela; Mississippi State Univeristy CAVS, USA

22 Poster
Xin Zan; University of Florida, USA

23 Tensor-based Feedback Control For Local Structured High-dimensional Streaming Data Under Limited Control Capability
Zihan Zhang, Kamran Paynabar, Jianjun Shi; ISyE Georgia Tech, USA
This study introduces a tensor-based feedback control model for structured high-dimensional (LSHD) streaming data, addressing limitations of conventional control models. Unlike traditional models that often overlook local correlation structures, our approach leverages kernel distributions to capture local response auto-correlations and incorporates the practical knowledge of control actions. We propose a dynamic control strategy that determines optimal control locations to boost efficiency under resource constraints. The model effectiveness is confirmed through simulations and case studies.

24 Poster
Siqi Zhang; The Pennsylvania State University, USA

26 Poster
Ziyang Zhang; Oklahoma State University, USA

26 Poster
Meng Zhao; University OF Florida, USA

27 Poster
Yue Zhao; Rensselaer Polytechnic Institute, USA

28 Poster
Ziqian Zheng; University of Wisconsin-Madison, USA

29 Poster
Siqiong Zhou; Arizona State University, USA

Monday, October 16, 4:00 PM - 5:15 PM

ME03

CC-North 120D
Springer/Frontline
Technology Tutorial

1 Unleash the Future: AI-Powered Insights and Services for Researchers and Authors
Janina Krieger, Springer, New York, NY, Contact: janina.krieger@springer.com
AI Unveiled: Discover the magic behind AI technology and how it’s transforming the landscape of research and writing. Gain insights into the latest advancements that are reshaping the way we approach academic exploration.
AI as your Research Partner: Imagine having an AI collaborator that helps you navigate the sea of information effortlessly. Learn how AI can assist researchers in sifting through vast datasets, identifying trends, and generating valuable hypotheses, propelling your research to new heights.
Global Collaboration: Uncover the potential of AI in bridging geographical gaps and fostering cross-border collaboration. Explore our AI-powered translation tool that enable seamless communication and idea exchange among researchers and authors from around the world.
Future Forward: Get a sneak peek into the future of AI and its evolving role in research and writing. Gain a visionary perspective on how AI might redefine creativity, innovation, and knowledge dissemination in the years to come.

2 Automated Risk Analysis of Machine Learning Models: A Novel Approach
Daniel H. Fylstra, Frontline Systems Inc., Incline Village, NV, Contact: daniel@solver.com
See a new approach to risk analysis of machine learning models in action in this tutorial session. We’ll explain why the traditional machine learning approach - training a model on a data set, validating it on another data set, and testing it (or comparing it to other models) on a third data set isn’t “risk analysis” - and isn’t sufficient to assess or quantify the risk that the model will perform differently than expected when

deployed for production use, with disappointing or even costly business consequences. We'll discuss the complexity and time required to apply conventional risk analysis during machine learning model development. And we'll demonstrate a new, patent-pending approach that automates and integrates simulation-based risk analysis into the machine learning development process. As a side benefit, we'll show a new, fully automated approach to synthetic data generation, with many potential uses, and a novel use of such synthetic data in risk analysis. As time permits, we'll demonstrate use of these methods in our cloud platform RASON®, in Excel with Analytic Solver®, and in your choice of programming languages with Solver SDK®.

Monday, October 16, 4:00 PM - 5:15 PM

ME04

CC-North 121A

New Pricing Models for Online Economies

Community Committee Choice Session

Session Chair: Michael L. Hamilton, University of Pittsburgh, Pittsburgh, PA

Session Chair: Sekar Shreyas, University of Toronto, Toronto, ON, Canada

1 Pricing Strategies for Online Dating Platforms

Titing Cui, Michael L. Hamilton, University of Pittsburgh, Pittsburgh, PA

Dating apps have become the most common way for romantic partners to meet. These dating apps generate revenue through subscription-based pricing, which is a common monetization strategy for mobile apps. However, in the context of online dating, different subscription-period lengths can lead to very different outcomes for the platform and its users. In this study, we analyze the profit and welfare trade-offs associated with different length subscription pricing strategies for online dating platforms. Using a novel model, we find that short subscription periods are robust, guaranteeing 26.9\% of the optimal profit. However, when operating costs are low, a switch to long period pricing can both increase profits and improve user welfare.

2 List Now or Later? an Equilibrium Analysis of Asset-Sharing Platforms

Neha Sharma, Kellogg School of Management, Evanston, IL

Many sharing platforms facilitate on-demand service to their guests and allow guests to reserve assets ahead of service. On such platforms, ``hosts" inform the platform beforehand about their asset's availability by creating a ``listing", and by doing so, the hosts commit to the assets' availability in the future. In practice, many platforms use dynamic pricing, and the hosts earn a share of the revenue generated. Using data from a large car-sharing platform, we find empirical evidence to support our assumption that hosts' are strategic about their listings. Our analysis highlights the limitations of revenue-share contracts on asset-sharing platforms. Finally, we find revenue share based on the time of listing is optimal.

3 Incentives For Exploration At Market Equilibrium

Vijay Kamble, University of Illinois Chicago, Chicago, IL

Online marketplaces face an exploration problem: qualities of new supply units are unknown and must be discovered through customer feedback so that higher quality supply gets prioritized for matching. However, customers are unwilling to participate in exploratory matches. This paper sheds light on the role of congestion and the resulting market equilibrium prices in creating incentives for such exploratory behavior among myopic customers. The intuition is that since customers prefer established higher-quality supply units, these units demand higher equilibrium prices due to congestion compared to newer units, effectively incentivizing customers to explore. This paper presents a comprehensive analysis of the extent to which this intuition holds and exogenous incentives for exploration are necessary for such markets.

4 Help and Haggle: Social Commerce Through Randomized, All-Or-Nothing Discounts

Luyi Yang[1], Chen Jin[2], Zhen Shao[3], [1]University of California, Berkeley, Berkeley, CA, [2]National University of Singapore, Singapore, Singapore; [3]University of Science & Technology of China, Hefei, China. Contact: disjinc@nus.edu.sg

This paper studies a novel social commerce practice known as "help-and-haggle," whereby an online consumer can ask friends to help her "haggle" over the price of a product. Each time a friend agrees to help, the price is cut by a random amount, and if the consumer cuts the product price down to zero within a time limit, she will get the product for free; otherwise, the product reverts to the original price. Help-and-haggle enables the firm to promote its product and boost its social reach as consumers effectively refer their friends to the firm. We model the consumer's dynamic referral behavior in help-and-haggle and provide prescriptive guidance on how the firm should randomize price cuts.

Monday, October 16, 4:00

PM - 5:15 PM

ME05

CC-North 121B
RMP for Cultural Markets
Community Committee Choice Session
Session Chair: Abhishek Deshmane, IESE Business School, Barcelona

1 Multi-Player Game Design: Boost Engagement in Contests Through Intervention
Yifu Li[1], Lifei Sheng[2], Xuying Zhao[3], [1]University of Science and Technology of China, Hefei, China; [2]University of Houston Clear Lake, Houston, TX, [3]Texas A&M University, College Station, TX, Contact: sheng@uhcl.edu
In multi-player video games, it is important for game designers to boost players' engagement in contests. Some "handicapping policies" that intend to create an evenly-matched competition based on players' performance can improve players' engagement. We derive the players' equilibrium efforts and analyze the optimal intervention schemes. Our analysis reveals that a bang-bang solution can be optimal when players are strategic.

2 Ups and Downs in Audience Experience Management
Hongqiao Chen[1], Ming Hu[2], Jingchen Liu[3], Yaniv Ravid[4], [1]Nanjing University, Nan Jing Shi, China; [2]University of Toronto, Minneapolis, MN, [3]Nanjing University, Nanjing, China; [4]University of Toronto, Toronto, ON, Canada
Within the framework of prospect theory, we consider a service provider who wishes to maximize an audience's experienced utility under three different settings. First, we study how to release a piece of good news vs. bad news, where the provider may incrementally reveal the news over a preemptive period. Second, we consider how to organize an event such as a concert with performances of known valuations, where the provider needs to arrange the sequence of all performances. Lastly, we investigate the problem of simultaneous vs. sequential release of a series such as songs or TV episodes, where the provider does not know a priori the audience's exact valuation of each item. Across all of the settings, we show that the audience's sensitivity to losses relative to a reference point is a critical factor that governs how to design and manage the audience's evolving experience dynamics.

3 Beyond Cookies: Evidence About Team Environment and Engagement Retention from Girl Scouts Cookie Program
Tom Tan[1], Bradley R. Staats[2], [1]Southern Methodist University, Dallas, TX, [2]University of North Carolina at Chapel Hill, Chapel Hill, NC, Contact: ttan@cox.smu.edu
We collaborate with the Girl Scouts of USA to examine team-based factors of Girl Scouts' engagement retention in their Cookie Program. We find that a small troop size and more evenly distributed sales performance within the troop are positively associated with the propensity to stay. In addition, a troop having a high adult-to-girl ratio and a significant scout level (i.e., an age measure) heterogeneity are conducive to scout retention. However, we find that racial diversity has no significant effect on turnover. Finally, conducting troop-based booth sales is related to scouts' deciding to stay. Our study carries implications for developing more innovative and cost-effective approaches to keeping participants engaged in the volunteering and fundraising activities in an NPO setting.

4 Offering Memories to Sell Goods? Pricing and Welfare Implications of Experiential Retail
Nevin Mutlu[1], Hadi El-Amine[2], Ozge Sahin[3], [1]Eindhoven University of Technology, Eindhoven, Netherlands; [2]George Mason University, Fairfax, VA, [3]Johns Hopkins University, Baltimore, MD
In an environment where consumers' rising valuation of Instagrammable memories drives their spending from products to experiences, retailers offer experiences to attract consumers back to their stores. In this work, we study under which settings consumers can benefit from these experiences and raise retailers' profits via a novel consumer choice model. Being the first to study this new retail format, our results highlight that there is no one-size-fits-all strategy. We show that experiences affect main product sales in non-obvious ways, especially in competitive markets. In a (post)-pandemic world where retailers try to attract consumers back to stores, we offer insights that can guide retailers in the process.

5 Intertemporal Spillovers in Consumer Experiences: Empirical Evidence and Service Design Implications
Abhishek Deshmane[1], Victor Martinez de Albeniz[1], Guillaume Roels[2], [1]IESE Business School, Barcelona, Spain; [2]INSEAD, Fontainebleau, France. Contact: guillaume.roels@insead.edu
This study examines intertemporal spillover effects in experiential consumption, where the evaluation of future activities can be influenced positively (assimilation) or negatively (contrast) by previous ones. We develop a model that disentangles these spillovers from underlying experience

quality and test it with retrospective data in four contexts. Results show that both types of spillovers are salient, especially when activities are similar and experienced closely in time. Positive spillovers have implications for experience design, suggesting scheduling the best activity in the middle and saving it as a "wild card" under uncertainty. New insights for service experience design based on counterfactual analyses are provided.

Monday, October 16, 4:00 PM - 5:15 PM

ME06

CC-North 121C

Network Revenue Management and Supply Chain Interface

Community Committee Choice Session

Session Chair: Levi DeValve, University of Chicago, Chicago, IL

1 Efficient Algorithms for Minimizing Compositions of Convex Functions and Random Functions and Its Applications in Network Revenue Management

Xin Chen[1], Niao He[2], Yifan Hu[3], Zikun Ye[4], [1]Georgia Institute of Technology, Atlanta, GA, [2]University of Illinois Urbana-Champaign, Urbana, IL, [3]EPFL, Lausanne, Switzerland; [4]University of Illinois Urbana Champaign, Urbana, IL

We study a class of nonconvex stochastic optimization, where the objective function is a composition of a convex function and a random function. Leveraging an (implicit) convex reformulation via a variable transformation, we develop stochastic gradient-based algorithms and establish their sample and gradient complexities for achieving a global optimal solution. Interestingly, our proposed Mirror Stochastic Gradient method operates in the original decision space using gradient estimators of the original objective and achieves sample and gradient complexities matching the lower bounds for solving stochastic convex optimization problems. Our methodology applies to the air-cargo network revenue management problem using booking limit control and provides superior performance over the state-of-the-art bid-price-based control policies.

2 The Golden Geese Problem

Weizhong Zhang[1], R. Ravi[1], Alan Scheller-Wolf[2], Karan Singh[1], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Tepper School of Business, Pittsburgh, PA, Contact: weizhong@andrew.cmu.edu

In the task of sequential short-form content recommendations such as YouTube shorts, the engine must carefully balance the need to prioritize items that provide high revenue, which may lead to termination (such as ads) and the need to serve lower revenue but a potentially more engaging content (such as short videos). We formalize this via an episodic reward aggregation model, a strict generalization of previously studied cascading bandit models.

With known parameters, we give an efficient, optimal dynamic program to sequence the items. Without such prior info, we propose an efficient UCB-style algorithm and furnish both instance-dependent and worst-case regret guarantees, which are tight in terms of their dependence on the horizon and the size of the item set. We demonstrate our proposal's efficacy in synthetic experiments and two real-world data sets.

3 Combining a Smart Pricing Policy with a Simple Replenishment Policy: Managing Uncertainties in the Presence of Stochastic Purchase Returns

Alys Liang[1], Stefanus Jasin[2], Joline Uichanco[3], [1]Michigan Ross, Ann Arbor, MI, [2]University of Michigan, Ann Arbor, MI, [3]University of Michigan, Ross School of Business, Ann Arbor, MI, Contact: jiaxinl@umich.edu

Regarded as the 'ticking time bomb' in the industry, returns have cost US retailers hundreds of billions of dollars. Undesirable as returns are, they cannot be entirely eliminated and lenient return policies are essential to maintain customer loyalty. Motivated by the reality, we ask: How can a retailer offering lenient return policy improves business efficiency? We model a single store/warehouse setting with lost sales, positive lead time, periodic review, and Binomial (Poisson) demand. Within a grace period, a purchase might be returned at a full refund and restocked after inspection. We develop an easy-to-implement heuristic policy that combines a 'smart' adaptive pricing policy with a very simple replenishment policy, under which the uncertainties in both demands and returns are effectively turned, leading to significant improvements in business performance.

4 Dynamic Control in On-Demand Inventory Sharing Networks

Hansheng Jiang, University of Toronto, Toronto, ON, Canada

We address the operational challenge inherent in one-way on-demand sharing services comprising a fixed number of units dispersed across multiple network locations. In such a system, customers can rent units without prior reservations and return them to any location within the network. The service provider must periodically reposition units to equilibrate supply and demand, minimizing costs related to repositioning labor and lost sales. Beyond direct repositioning measures, supplementary control mechanisms like pricing and wage adjustments may also alleviate supply-demand imbalances. This presentation delves into an adaptive inventory control problem aimed at devising a comprehensive solution that incorporates both pricing and repositioning tactics in managing one-way on-demand sharing networks.

Monday, October 16, 4:00 PM - 5:15 PM

ME07

CC-North 122A

Policy Evaluation and Long-term Treatment Effects

Community Committee Choice Session

Session Chair: Daniel Russo, Columbia University, New York, NY

Session Chair: David Cheikhi, Columbia University, New York, NY

1 On the Statistical Benefits of Temporal Difference Learning

David Cheikhi, Daniel Russo, Columbia University, New York, NY

Given a dataset on actions and long-term rewards, a direct estimation approach fits value functions that minimize prediction error on the training data. Temporal difference learning (TD) instead fit value functions by minimizing inconsistency between estimates made at successive time-steps. For finite state Markov chains, we provide a crisp asymptotic theory of the statistical advantages of TD. First, we show that an intuitive inverse trajectory pooling coefficient completely characterizes the reduction in mean-squared error of value estimates. Depending on problem structure, the gain could be enormous or nonexistent. Next, we prove that there can be dramatic improvements in estimates of the difference in value-to-go for two states: TD's errors are bounded in terms of a novel measure - the trajectory crossing time - which can be much smaller than the time horizon.

2 The Many Faces of TD: Approximation, Estimation, and Acceleration

Ashwin Pananjady, Georgia Tech, Atlanta, GA, Contact: apm7@gatech.edu

Temporal difference (TD) learning is the de facto algorithm for policy evaluation, and a linear parametrization is often used to approximately compute the original value function. In infinite horizon, discounted Markov reward processes, it is designed to estimate a certain projected fixed point and converges to this point while satisfying certain deterministic (optimization) and stochastic (statistical) error bounds. We ask whether (a) the fixed point of TD best approximates the original value function, (b) the statistical error of the algorithm is locally optimal, and (c) the optimization rate of the algorithm can be improved. This talk will present answers to these questions, introducing variants of TD that attain improved (and/or optimal) approximation, estimation, and acceleration.

3 Correcting for Interference in Experiments: A Case Study at Douyin

Andrew T. Zheng, Massachusetts Institute of Technology, Boston, MA

Interference is a ubiquitous problem in experiments on two-sided content marketplaces, such as Douyin. In many cases, creators are the natural unit of experimentation, but creators interfere with each other through competition for viewers' time and attention. Estimators ignoring interference incur bias on the order of the treatment effect; but unbiased estimators are impractically high variance. We introduce a novel estimator, based on ``Differences-in-Qs'' (DQ) techniques, which is sample efficient and achieves bias second-order in the treatment effect. In doing so, we develop a generalized theory of Taylor expansions for policy evaluation, extending to all major MDP formulations. Finally we implement our estimator on Douyin's experimentation platform, and in the process develop DQ into a truly ``plug-and-play'' estimator for interference in the real-world.

4 Estimating the Long-Term Effects of Novel Treatments

Keith Battocchi[1], Eleanor Dillon[1], Maggie Hei[2], Greg Lewis[3], Miruna Oprescu[4], Vasilis Syrgkanis[5], [1]Microsoft, Cambridge, MA, [2]ByteDance, Bejing, China; [3]Amazon, Cambridge, MA, [4]Cornell University, New York, NY, [5]Stanford University, Stanford, CA

Policy makers often need to estimate the long-term effects of novel treatments, while only having historical data of older treatment options. We propose a surrogate-based approach using a long-term dataset where only past treatments were administered and a short-term dataset where novel treatments have been administered. Our approach generalizes previous surrogate-style methods, allowing for continuous treatments and serially-correlated treatment policies while maintaining consistency and root-n asymptotically normal estimates under a Markovian assumption on the data and the observational policy. Using a semi-synthetic dataset on customer incentives from a major corporation, we evaluate the performance of our method and discuss solutions to practical challenges when deploying our methodology.

Monday, October 16, 4:00 PM - 5:15 PM

ME08

CC-North 122B

Advances in Revenue Management

Community Committee Choice Session

Session Chair: Tarek Abdallah, Northwestern University, Kellogg School of Management, Chicago, IL

Session Chair: Ashwin Venkataraman, University of Texas at Dallas, Richardson, TX

1 An Ensemble Learning Approach for Estimating the Mixture of the MNL Choice Models

Mohammad Amin Farzaneh[1], Tarek Abdallah[2], Ashwin Venkataraman[1], [1]University of Texas at Dallas, Richardson, TX, [2]Northwestern University, Kellogg School of Management, Chicago, IL, Contact: mxf180000@utdallas.edu

Estimating mixture models, such as the mixture of multinomial logit (MNL) models, is often challenging due to slow convergence and sensitivity to initialization when using the Expectation-Maximization (EM) algorithm. We investigate ensemble learning approaches as alternative estimation methods for the mixture of MNL models. Through empirical experiments, we compare the performance of ensemble learning techniques such as bagging and boosting with the EM algorithm. Our findings demonstrate that ensemble learning approaches offer improved estimation accuracy.

2 Joint Estimation of Arrival Rate and Customer Preference Parameters Under the Nested Logit Model

Xinchang Wang, Weikun Xu, Washington State University, Pullman, WA, Contact: weikun.xu@wsu.edu

This work aims to jointly estimate the arrival rate of customers to a market and the nested logit model that forecasts the probability of customers choosing a specific product from a set of alternatives. The goal is to determine the arrival rate, customer preference parameters, and nest dissimilarity parameters that maximize the likelihood of the observed transactional data. The problem is challenging since the likelihood function may be non-concave. We provide sufficient and necessary conditions under which the model parameters are identifiable. We develop a sequential minorization-maximization algorithm to solve the problem, by which the problem boils down to solving a series of convex optimization models. The algorithm is highly scalable, making it well-suited to problems with large-scale data. The algorithm is tested using real flight ticket booking data.

3 A Unified Analysis for Assortment Planning with Marginal Distributions

Zeyu Sun[1], Xiaobo Li[1], Selin Ahipasaoglu[2], [1]National University of Singapore, Singapore, Singapore; [2]SUTD, Singapore, Singapore

We study assortment planning under the marginal distribution model (MDM), a semiparametric choice model that only requires information about the marginal noise. We demonstrate that some multi-purchase choice models such as the multiple-discrete-choice (MDC) model and the threshold utility model (TUM) also fall into the framework of MDM. For assortment problems within the MDM framework, we identify a general condition under which a strictly profit-nested assortment is optimal. While the problem is NP-hard, we show that the best strictly profit-nested assortment is a 1/2-approximate solution for all MDMs. Additionally, we present a simple example of an MDM for which the 1/2-approximate bound is tight. Additionally, we present an arbitrary-close approximation algorithm for MDM, and an improved version for a class of choice models that includes MDC as a special case.

4 Heavy Tailedness and the Single Item Dynamic Pricing Problem

Tarek Abdallah, Northwestern University, Kellogg School of Management, Chicago, IL

We consider the single item dynamic pricing problem in an asymptotic regime where the selling horizon tends to infinity. Our main results provide the asymptotics of the optimal expected revenue, selling price and purchasing probability in the extreme value regime for valuations that have a heavy tail. We show that the optimal policy is of a generalized run out rate form that is different from those obtained from the fluid regime. Through extensive numerical simulations we demonstrate that when expected demand is high relative to inventory levels our proposed extreme value regime pricing policies are capable of outperforming other commonly used policies designed for the traditional fluid regime.

Monday, October 16, 4:00 PM - 5:15 PM

ME09

CC-North 122C

Markov Lecture

Award Session

Session Chair: R. Srikant, University of Illinois, Urbana, IL

1 **Markov Lecture**

Assaf Zeevi, Columbia University, New York, NY

2 Discussant

N. Bora Keskin, Duke University, Durham, NC

Monday, October 16, 4:00 PM - 5:15 PM

ME10

CC-North 123

Simulation-based Stochastic Optimization

Community Committee Choice Session

Session Chair: Wei Xie, Northeastern University, Boston, MA

Session Chair: Ilya O. Ryzhov, University of Maryland, College Park, MD

1 Nested Elimination: A Simple Algorithm for Best-Item Identification from Choice-Based Feedback

Junwen Yang[1], Yifan Feng[2], [1]National University of Singapore, Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore

We study a ranking and selection problem from choice-based feedback. In this problem, a company sequentially presents display sets to customers and collects their choices, aiming to identify the most preferred item with minimal samples and high confidence. We introduce Nested Elimination (NE), a novel elimination-based algorithm inspired by the nested structure implied by the information-theoretic lower bound. Boasting a simple structure and ease of implementation, NE offers robust theoretical guarantees concerning sample complexity. Numerical experiments using synthetic and real data support our theoretical results.

2 Adaptive Experimentation at Scale: A Computational Framework

Hongseok Namkoong, Ethan Che, Columbia University, New York, NY, Contact: namkoong@gsb.columbia.edu

Bandit algorithms can provide substantial statistical power but are difficult to implement and maintain in practical problem instances involving large batches, delayed feedback, and a small number of opportunities to reallocate sampling effort. We design near-optimal, easy-to-deploy adaptive experimentation algorithms that can flexibly deal with any batch size. Our main observation is that normal approximations universal in statistics can guide the design of scalable adaptive experimentation methods. Our method significantly improves statistical power over standard adaptive policies (e.g., Thompson sampling). Overall, we expand the scope of adaptive experimentation to settings that are difficult for standard adaptive policies, including problems with a small number of reallocation epochs, low signal-to-noise ratio, and unknown reward distributions.

3 Semidiscrete Optimal Transport with Unknown Costs

Yinchu Zhu[1], Ilya O. Ryzhov[2], [1]Brandeis University, Waltham, MA, [2]University of Maryland, College Park, MD, Contact: iryzhov@rhsmith.umd.edu

In semidiscrete optimal transport, we design a joint distribution for two random variables (one continuous, one discrete) with fixed marginals, in a way that minimizes an expected cost function. We formulate a novel variant of this problem in which the cost function is unknown, but can be learned through stochastic simulation. This problem presents a novel combination of contextual ranking and selection and stochastic approximation. We propose a computationally efficient solution procedure, again combining elements of both methodologies, that achieves near-optimal convergence rates and performs well in numerical experiments.

4 Reinforcement Learning Based Process Control with Digital Twin Model Calibration

Hua Zheng[1], Wei Xie[1], Ilya O. Ryzhov[2], [1]Northeastern University, Boston, MA, [2]University of Maryland, College Park, MD, Contact: zheng.hua1@northeastern.edu

To support biopharmaceutical manufacturing automation, we present a novel reinforcement learning framework that integrates digital twin calibration and optimal control of the physical system. The objective is to maximize the expected accumulated reward while enhancing the fidelity of the digital twin model. Through local polynomial regression, we incorporate crucial information from the physical system into the action-value function, enabling a sample-efficient calibration of the digital twin model. The effectiveness and resilience of the proposed framework are shown with both empirical analysis and theoretical study.

Monday, October 16, 4:00

PM - 5:15 PM

ME11

CC-North 124A

Simulation & AI

Community Committee Choice Session

Session Chair: Wei Xie, Northeastern University, Boston, MA

Session Chair: Mingbin Feng, University of Waterloo, Waterloo, ON, Canada

1 Deep Reinforcement Learning for Large Scale Inventory Management

Xiaotian Liu, Yijie Peng, Peking University, Beijing, China. Contact: xiaotianliu01@gmail.com

This work introduces a simulation-driven machine learning framework exploiting both Deep Learning (DL) and Reinforcement Learning (RL) for large-scale inventory management. On data generated by simulation of the decision processes, a DL model is first trained by imitating the well-performing policy, after which an RL procedure is applied to fine-tune the DL model for further improvement. We formulate a multi-echelon multi-product problem with a practical warehouse network structure and shared storage resource as a representative of hard inventory problems without existing well-performing policies. RL model is trained based on feedback from the simulation of the decision processes. Our numerical results on real data from JD.com show that our method significantly outperforms a combination of several heuristics adapted to this problem.

2 Integrating Single Observation Adaptive Search with Probabilistic Branch and Bound for Noisy Black-Box Optimization

Pariyakorn Maneekul, Zelda B. Zabinsky, University of Washington, Seattle, WA, Contact: parim@uw.edu

We address noisy black-box optimization using single observations, as opposed to multiple replications, within Probabilistic Branch and Bound (PBnB). The single observation method estimates stochastic objective function values from neighboring solutions. This study integrates single observation adaptive search with PBnB and enhances the statistical estimation with a local quadratic regression. Additionally, a regularization technique is applied to the quadratic regression to accommodate problems in high dimensions. Numerical experiments on benchmark problems are presented to compare the performance of PBnB with multiple replications, single observations, and enhanced single observation method with statistical models.

3 Pricing Catastrophe Bonds --- A Probabilistic Machine Learning Approach

Hong Li[1], Xiaowei Chen[2], Yufan Lu[2], Rui Zhou[3], [1]University of Guelph, Guelph, ON, Canada; [2]Nankai University, Tianjin, China; [3]University of Melbourne, Melbourne, Australia. Contact: lihong@uoguelph.ca

This paper proposes a probabilistic machine learning method to price catastrophe bonds in the primary market. The proposed method combines machine-learning-based predictive models with conformal predictions, generating generate distribution-free probabilistic predictions of bond spreads. Using primary market bond data, the proposed method is found to be more robust and yields more accurate predictions of the bond spreads than traditional methods such as linear regression. Furthermore, the proposed method generates more informative prediction intervals than learning regression and identify important nonlinear relationships between different risk factors and bond spreads, suggesting that linear regression could mis-estimate the bond spreads. Overall, this paper demonstrates that machine learning methods could improve pricing of catastrophe bonds.

4 Mortality And Longevity Capital Risk Management: A Simulation Approach Using Surrogate Models

Shuai Yang[1], Kenneth Q. Zhou[2], [1]Aon PathWise Solutions Group, Toronto, ON, Canada; [2]Arizona State University, Tempe, AZ, Contact: kenneth.zhou@asu.edu

In the insurance industry, life insurers are required by regulators to meet capital requirements to avoid insolvency caused by, for example, sudden mortality changes due to the COVID-19 pandemic. To prevent any large movements in this required capital, insurance companies are incentivized to establish hedging strategies to mitigate their underlying risk exposures. However, the development and implementation of a risk mitigation solution for reducing solvency capital requirements are often challenged by computational burdens due to the large number of simulation. In this paper, we investigate a surrogate-based approach for solving this simulation problem. Our finding provides a numerical justification to the market-making of the mortality-linked securities in the context of mortality and longevity capital risk management.

5 Truncated Likelihood Ratio Method

Guangxin Jiang[1], Liang YIjuan[2], [1]Harbin Institute of Technology, Harbin, China; [2]Southwest University, Chongqing, China

In many decision-making problems, historical data obtained from repeated experiments is often available. However, when applying the likelihood ratio method to reuse this data, the distribution of new data may significantly differ from the distributions of the historical data, leading to a high variance for the likelihood ratio and a poorly performing estimator. In this talk, we introduce a truncated likelihood ratio method to control the variance of the likelihood ratio. We establish the optimal relationship between the truncated threshold and the sample size using Renyi divergence and Bernstein inequality in two settings: bounded performance function and unbounded performance function with existing higher-order moments. Our numerical examples demonstrate the effectiveness of the truncated likelihood ratio method.

Monday, October 16, 4:00 PM - 5:15 PM

ME12

CC-North 124B

Simulation Applications in Operations Planning

Community Committee Choice Session

Session Chair: Canan Corlu, Boston University, Boston, MA

1 Optimizing Resource Allocation in Service Systems via Simulation: A Bayesian Formulation

Weiwei Chen[1], Gao Siyang[2], Wenjie CHEN[3], Jianzhong Du[4], [1]Rutgers University, Piscataway, NJ, [2]City University of Hong Kong, Kowloon, NA, Hong Kong; [3]City University of Hong Kong, Hong Kong SAR, Hong Kong; [4]City University of Hong Kong, Hong Kong, Hong Kong. Contact: wchen@business.rutgers.edu

This paper studies a class of resource allocation problems, where the performance measures are probabilistic and evaluated via simulation. An optimal computing budget allocation (OCBA) formulation is proposed to select the optimal solution subject to random noises in simulation. The OCBA formulation minimizes the expected opportunity cost that penalizes based on the quality of the selected solution. Further, the formulation takes a Bayesian approach to consider the prior knowledge and potential performance correlations on candidate solutions. Then, the asymptotic optimality conditions of the formulation are derived, and an iterative algorithm is developed. Numerical experiments and a case study in a hospital emergency department demonstrate the effectiveness of the proposed algorithm for solving the resource allocation problem via simulation.

2 Pandemic Management: Minimizing Vaccine Waste and Group Wait Time with Line Jumpers

Chun-Miin (Jimmy) Chen, Bucknell University, Lewisburg, PA, Contact: cmc052@bucknell.edu

During the initial rollout of COVID-19 vaccines, individuals from the non-priority groups, or line jumpers, managed to get vaccinated before their turn by taking advantage of any leftover vaccine doses. Some argue that all vaccine doses should be strictly reserved for requesters from the priority groups, while others argue that vaccinating jumpers with leftover doses could reduce leftover doses that may expire. We define a heuristic policy that specifies a limit on the number of jumpers allowed. Moreover, we formulate an objective function of the average total wait time of requesters and vaccines to evaluate the optimal parameter values for the policy. Using the sample average approximation method, we suggest policy proposals by which the sites can minimize the objective function value.

3 Repair Kit Simheuristic Inventory Modeling

John Maleyeff, Ruthairut Wootisam, Boston University, Boston, MA, Contact: maleyeff@bu.edu

A simheuristic model creates repair kit inventory policies for intermittent demand repairs, where every part must be available for the repair to take place. The approach starts by applying a deterministic optimization model to calculate initial values for reorder points and order-to-to levels (s,S) for each part. This model is applied independently to each part within the repair kit. A simulation of the entire repair kit estimates the total annual cost associated with the (s,S) policy. The simheuristic algorithm uses a stochastic method to calculate slopes for the total cost equation based on unit changes (up or down) to each part's reorder points and order-up-to level. A modified branch-and-bound algorithm creates near optimal solutions in the presence of uncertainty.

4 Queueing Inspired Feature Engineering to Improve and Simplify Patient Flow Simulation Metamodels

Mark W. Isken, Osman T. Aydas, Yazan F. Roumani, Oakland University, Rochester, MI, Contact: aydas@oakland.edu

This study merges the application of discrete-event simulation with alternative metamodeling techniques for modeling patient flow in healthcare. We consider two cases: A tandem queueing system of obstetric hospital units and a transient analysis of an outpatient clinic. We use several metamodels including various types of linear models, random forests and neural networks. We evaluate the performance improvement of metamodel estimations when empowered with supplementary queueing theory knowledge. We consider three knowledge levels: no queueing inspired features, simple queueing features and sophisticated queueing approximations. Our results show that queueing related inputs improve the accuracy for the metamodels, independent of the model type. Moreover, the queueing related inputs improve model explainability and can lead to more parsimonious models.

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ME13

CC-North 125A

DAS Awards Session

Award Session

Session Chair: Yael Grushka-Cockayne, Darden School of Business, Charlottesville VA, VA

1 DAS Ramsey Award 2023

Emanuele Borgonovo, Bocconi University, Milano, Italy

This session will introduce the 2023 Ramsey Awardee of the Decision Analysis Society. The Frank P. Ramsey medal is awarded for distinguished contributions in decision analysis. Distinguished contributions can be internal, such as theoretical or procedural advances in decision analysis, or external, such as developing or spreading decision analysis in new fields.

2 Decision Analysis Practice Award 2023

K. Nadia Papamichail, The University of Manchester, Manchester, United Kingdom

We will introduce the 2023 Decision Analysis Practice Award Finalists and Winners. The Decision Analysis Practice Award is sponsored jointly by the Decision Analysis Society and the Society of Decision Professionals. It is given annually to an outstanding decision analysis application that has made a significant difference in a critical decision.

3 Award Presenter

Aurelien Baillon, Erasmus University Rotterdam, Rotterdam, Netherlands

4 Best Paper Award

Sasa Zorc, University of Virginia, Darden School of Business, Charlottesville, VA

The Award is given annually to the best decision analysis paper by a student author, as judged by an award selection committee. For this award, decision analysis is defined as a prescriptive approach to provide insight for decision making based on axioms that are logically consistent with the axioms of von Neumann and Morgenstern and of Savage. Key constructs of decision analysis are the utility to quantify one's risk preferences and the probability to quantify the state of one's knowledge. The intent of the award is to recognize the best publication in decision analysis, by a student. This includes, but is not limited to, theoretical and methodological contributions to decision analysis, descriptions of applications, and experimental studies.

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ME14

CC-North 125B

Emerging Topics in Socially Responsible Operations

Community Committee Choice Session

Session Chair: Can Zhang, Duke University, Durham, NC

1 Improving Group Testing in a Pandemic

Tong Wang, Kamalini Ramdas, S. Alex Yang, London Business School, London, United Kingdom

During a pandemic, we rely on accurate tests to identify positive cases and reduce infection, yet large-scale tests can be costly to run and subject to capacity constraints. Group testing can efficiently test populations and significantly save testing capacities. In a group test, samples are first pooled and tested. If the result is negative, every individual in the group is healthy. Otherwise, individual tests are conducted to detect the infected individuals. The appropriate group size depends on the underlying risk level of individuals. In this study, we examine different approaches that health policymakers or health administrators can use to improve group formation for the pooling stage of the testing procedure, particularly in the presence of heterogeneous and unobservable risk levels among individuals.

2 A Framework for Designing Policy for Incentivizing Sustainable Crop Cultivation

Sanchita Das, Masha Shunko, University of Washington, Seattle, WA

We propose a data driven framework to study the gap between the optimal crop production preferences of the government and smallholder farmers in the context of India. We characterize the gap analytically and design incentives for coordinating the two optima. Parallelly, we build a forecasting pipeline for yield of crops and use causal models/trees to determine pathways to bridge the gap. This study is generalizable and can provide a useful framework to design policy towards facilitating a financially viable shift to sustainable crop production at scale.

3 Ethics in the AI Supply Chain: A Study on Experiences and Fairness in Crowdwork
Martin Gonzalez Cabello, Auyon Siddiq, Charles J. Corbett, University of California, Los Angeles, Los Angeles, CA, Contact: martin.gonzalez.cabello.phd@anderson.ucla.edu
This paper explores the role of human labor in the Artificial Intelligence (AI) industry, with a specific focus on crowdwork and data labelling. We conducted a survey on the personal experiences of crowdworkers, examining the correlation between these experiences and how they perceive fairness of the platforms. Our research uncovers a wide spectrum of crowdwork experiences and analyzes various factors to ascertain their impact on workers' fairness perception. We also explore how these experiences and fairness perceptions vary across different platforms. The paper concludes with prescriptions for improving crowdworker welfare and suggestions for future research, emphasizing the potential influence on AI development and the crowdwork industry.

4 Sustainable Sourcing of Agricultural Products: Fixed vs. Flexible Premiums
Vishal Agrawal[1], Can Zhang[2], [1]Georgetown University, Washington, DC, [2]Duke University, Durham, NC, Contact: va64@georgetown.edu
Sustainability certification programs, such as Fairtrade, have gained increasing popularity for the sourcing of agricultural products. In order to help smallholder farmers achieve a living income and to promote sustainable agricultural practices, an important lever these certification programs use is a premium that manufacturing firms pay to certified farmers. This paper analyzes and compares the effectiveness of two different premium strategies that have been considered by different certifiers in practice: fixed premium, under which farmers receive a fixed premium level that is independent of the market price, and flexible premium, under which farmers receive a higher premium level when the market price is lower.

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ME15

CC-North 126A

2023 MAS Annual Awards

Award Session

Session Chair: Brian J. Lunday, Air Force Institute of Technology, Beavercreek, OH

1 MAS President's Introductory Remarks
Shaun Doheney, Amazon Web Services (AWS), Stafford, VA
This session is made possible by the efforts of MAS Past-president Dr. Brian Lunday, who orchestrated the MAS Annual Awards for 2023, as well as the chairs of the respective committees: Dr. David Myers for the Bonder Scholarship; Dr. William Caballero for the Koopman Prize; and Dr. Greg Parnell for the J. Steinhardt Prize.

2 Seth Bonder Scholarship for Applied Operations Research in Military and Security Applications (Sponsored by the Bonder Estate) - Presentation by Recipient on Emerging Research Thread
David Myers, Air Force Research Laboratory, Nashville, TN

3 Koopman Prize (Sponsored by MAS Members)
William Caballero, United States Air Force Academy, United States Air Force Academy, CO
Koopman Prize (sponsored by MAS members) - Presentation by Recipients on Award-winning Publication

4 Jacinto Steinhardt Prize (Sponsored by CNA Corporation) - Presentation by Recipient on Career Insights and Observations
Gregory S. Parnell, University of Arkansas, Fayetteville, AR

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ME16

CC-North 126B

OR and Analytics in Healthcare: From Predicitons to Decisions

Flash Session

Session Chair: Afrooz Moatari-Kazerouni, Widener University, Chester, PA

1 ML-CTG: Machine Learning for Cardiotocography-Based Fetal Health Classification
Maryam Ahmadi[1], Minoo Ahmadi[2], [1]Clark University, WORCESTER, MA, [2]University of Southern California, Los Angeles, CA
In pursuit of the UN Sustainable Development Goals to reduce child and maternal mortality, this study leverages Cardiotocography (CTG) for fetal health assessment, aiming to develop accurate classification models with a focus on

prioritizing recall as the key metric. We evaluate several methods, including Decision Trees, K-Nearest Neighbors, Gaussian Naive Bayes, Logistic Regression, Random Forest, and Voting Classifier. The Pruned Decision Tree performs the best, achieving 96% accuracy with recall scores of 100% (Pathological), 96% (Normal), and 94% (Suspect). Our findings emphasize the significance of the Abnormal Short-Term Variability (ASTV) indicator in fetal health. This study contributes to global efforts to reduce mortality, providing valuable guidance for healthcare practitioners.

2 Digital Phenotyping-Based Depression Detection in the Context of Comorbidity

Zhijun Yan[1], Fei Peng[1], Dongsong Zhang[2], [1]Beijing Institute of Technology, Beijing, China; [2]The University of North Carolina at Charlotte, Charlotte, NC

Depression and is a growing health and societal concern that has become increasingly prevalent and burdensome, especially for the patients with other comorbidities. Digital phenotyping (DP) has emerged as a such promising tool that is widely used to detect depression. However, existing DP-based detection of depression doesn't consider the uncertainty caused by similar symptoms between depression and its comorbidities. In this study, we propose a deep learning model that can fuse and analyze different sensor data based on the evidence theory to address the uncertainty in depression detection. We evaluate the proposed model against state-of-the-art models on the sensor data. Our work contributes to the remote monitoring and self-management of mental health.

3 Analysis of U.S. Medical Device Recalls

Shuyu Lai, Westwood High School, Austin, TX

We investigate the medical device registration and recall data accessed from FDA. We find that medical device recalls in the U.S. increased significantly during 2001-2004, 2007-2010 and 2012-2017, and decreased from 2018 and during the pandemic. Class II recalls (that may cause temporary or medically reversible adverse health consequences, or the probability of serious adverse health consequences is remote) were the most among the three classes of recalls, but there is no significant correlation between the classes of recalls and the classes of devices. We also find that the proportion of foreign manufacturers among all that request US device approvals has significantly increased, while there is no significant correlation between this trend and the recalls.

4 Data-Driven Modeling to Project Omicron Scenarios in the U.S. While Tracking Population-Level Immunity

Kaiming N. Bi, UT austin, Austin, TX, Contact: kaiming.bi@austin.utexas.edu

As new COVID-19 variants emerge, rapid risk assessments are vital for estimating the epidemiological impact, designing mitigation strategies, and communicating with the public. Here, we introduce a COVID-19 transmission model that tracks the changing levels of population-wide immunity resulting from infections and vaccines. The model accurately predicted the timing and magnitude of the waves following the emergence of the BA.1, BA.4 and BA.5 variants. As of October, 2022, we estimate that population immunity against the BA.4/BA.5 variants totalled 36.52% with 22.57%, 5.35%, and 8.6% attributable to infections by prior variants, primary series vaccination, and booster vaccination, respectively.

5 When are Predictions Useful? A New Method for Evaluating Interval-Form Epidemic Forecasts

Maximilian Marshall, Felix Parker, Lauren Gardner, Johns Hopkins University, Baltimore, MD, Contact: mmarsh29@jh.edu

We introduce the Weighted Contextual Interval Score (WCIS), a new method for evaluating interval-form forecasts. Developed in response to the challenges of predicting turbulent COVID-19 outcomes, the score provides a pragmatic characterization of the utility of pandemic predictions. Currently used evaluation techniques generally fall into two groups: those that generate an individually interpretable metric, and those that generate a comparable and aggregable metric. The WCIS harmonizes these attributes, resulting in a normalized score that is nevertheless intuitively representative of the in-situ quality of individual forecasts. We also discuss why contextual interpretation of epidemic forecasts is necessary in a broader sense, and why this is important to consider as the community refines and develops prediction methods for future challenges.

6 An Examination of Disruptive Healthcare Technologies for Emergency Departments

Afrooz Moatari-Kazerouni, Shea'lyn Hubbs, Amin Keramati, Widener University, Chester, PA, Contact: amoatarikazerouni@widener.edu

This research presents a comprehensive review of disruptive technologies, including Blockchain, IoT, and RFID, for emergency department at hospitals. With the increasing demand for efficient and effective healthcare services, the adoption of technologies has become a critical consideration for healthcare institutions. This study focuses on exploring the role of these emerging healthcare technologies, to transform emergency department operations, through the Business Process Reengineering (BPR) approach. Findings indicate that these technologies have the potential to enhance the quality of care, reduce costs, and improve patient outcomes. The results highlight the need for further research and collaboration between healthcare providers and technology developers to fully realize the benefits of disruptive technologies in emergency departments.

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ME17

CC-North 127A

2023 BOM Best Working Paper Award

Award Session

Session Chair: Rafael Escamilla, Tilburg University, Tilburg, Netherlands

1 Measuring Strategic Behavior by Gig Economy Workers: Multihoming and Repositioning

Gad Allon, Daniel Chen, Ken Moon, University of Pennsylvania, Philadelphia, PA

Gig economy workers make strategic decisions about where and when to work. These decisions are central to gig economy operations and are important policy targets both to firms that operate ridehail and delivery platforms and to regulators that oversee labor markets. We collaborate with a driver analytics company to empirically measure two types of strategic behavior: multihoming, an online change between platforms, and repositioning, a physical change between locations. Using a comprehensive dataset that tracks worker activity across platforms, we estimate a structural model to analyze how workers optimize their earnings and respond to earnings-based incentives to switch platforms or locations. We show that workers are highly heterogeneous in their preferences and find multihoming especially costly, both in absolute terms and relative to the cost of repositioning. Through counterfactual simulations, we show that firms and regulators can substantially improve system efficiency by enabling workers to freely multihome: workers' hourly earnings increase by 2.0% and service levels increase by 53.1%. In contrast, the existing equilibrium is similar to a system without multihoming, in which hourly earnings increase by 1.3% but service capacity decreases by 4.1%. Additionally, we show that policies to limit traffic congestion by increasing travel costs should include incentives to ensure that workers remain able to efficiently reposition. An increase to repositioning costs by $1 per mile increases hourly earnings by 2.3% but substantially decreases service capacity by 29.6%.

2 Improving Human-Algorithm Collaboration: Causes and Mitigation of Over- and Under-Adherence

Jordan D. Tong[1], Kris Ferreira[2], Maya Balakrishnan[2], [1]University of Wisconsin Madison, Madison, WI, [2]Harvard University, Boston, MA

Even if algorithms make better predictions than humans on average, humans may sometimes have "private" information which an algorithm does not have access to that can improve performance. How can we help humans effectively use and adjust recommendations made by algorithms in such situations? When deciding whether and how to override an algorithm's recommendations, we hypothesize that people are biased towards following a naïve advice weighting (NAW) heuristic: they take a weighted average between their own prediction and the algorithm's, with a constant weight across prediction instances, regardless of whether they have valuable private information. This leads to humans over-adhering to the algorithm's predictions when their private information is valuable and under-adhering when it is not. In a lab experiment where participants are tasked with making demand predictions for 20 products while having access to an algorithm's recommendations, we confirm this bias towards NAW and find that it leads to a 20-61% increase in prediction error. In a follow-up experiment, we find that feature transparency - even when the underlying algorithm is a black box - helps users more effectively discriminate when and how to deviate from algorithms, resulting in a 25% reduction in prediction error.

3 Competition in Optimal Stopping: Behavioral Insights

Ignacio Rios, Pramit Ghosh, The University of Texas at Dallas, Richardson, TX

: Problem definition: We study settings in which a clearinghouse organizes a market where agents sequentially search among different options under competition. We focus on the effect of two market design choices that are motivated in the context of kidney transplants: (i) transparency, i.e., whether agents know their priority relative to the other agents searching; and (ii) the mechanism to collect decisions, i.e., whether all agents make their decisions simultaneously or sequentially.Methodologies/results: We introduce a model of sequential search under competition, whereby agents are exogenously prioritized and must decide when to stop their search to maximize the chosen option's value. For each configuration, we characterize the optimal policy, which defines a sequence of thresholds that determine when each agent should accept an option depending on the information available. We find that, although the mechanism does not affect the optimal policy, providing information about agents' priorities reduces the overall welfare and fairness. We design and conduct a lab experiment that replicates our theoretical model to test these predictions. We find that agents significantly deviate from their corresponding optimal policies. Moreover, we find that the mechanism has a significant effect on their decisions, due primarily to two drivers: (i) saliency of competition and (ii) frustration. Finally, we find that the benefits of opaqueness do not translate to practice, mainly because agents do not incorporate relevant information about the amount of competition.Managerial implications: Our results show that the mechanism to collect agents' decisions matters, as it may affect the saliency of competition and induce frustration. Moreover, our results show that welfare and fairness could increase if agents have only partial information about their ranking, but these benefits do not translate to practice due to information friction.Thus, clearinghouses should accompany these changes with information policies and guidance to alleviate these effects.

4 Customers' Multihoming Behavior in Ride-hailing: Empirical Evidence Using a Structural Model

Maxime Cohen[1], Dmitry Mitrofanov[2], Sandeep Chitla[3], Srikanth Jagabathula[3], [1]McGill University, Kirkland, QC, Canada; [2]Boston College, Newton, MA, [3]New York University, New York, NY

Are customers loyal to a ride-hailing platform or they see this service as a commodity and multihome (i.e., check several platforms before booking a ride)? Using a large panel dataset on ride-hailing transactions, we investigate to what extent customers multihome. Our dataset offers a unique opportunity to study this question as we observe the repeated choices of riders for both Uber and Lyft. Our dataset comprises more than 1.4 million rides completed by 160 thousand riders in NYC in 2018. We develop a comprehensive structural model that incorporates both operational (price and waiting time) and behavioral factors (e.g.,platform stickiness) to explain riders' choices. Our model also accounts for the dynamic interactions between customers and platforms by assuming that riders update their beliefs on price and waiting time in a Bayesian fashion. Finally, the riders' propensity to multihome is modeled by incorporating the consideration set formation of customers into our framework. We find that riders' choices are not fully explained by operational factors, hence indicating that customers view the platforms as differentiated service providers. While 65% of riders took rides with a single platform, our model shows that even the remaining 35%, who used both Uber and Lyft at least once, considered both platforms 43% of the time. It is crucial for ride-hailing platforms to capture this single (or multi)-homing behavior while designing promotions. Specifically, personalized promotions may be ineffective if the platform is not part of the customer's consideration set. Our results show that targeting customers earlier in their lifecycle can enhance the platform's market share by 77.56% more than their current promotional strategy. We also find that targeting customers with low search friction results in a 24.78% higher increase in market share than targeting customers with high search friction

Monday, October 16, 4:00 PM - 5:15 PM

ME18

CC-North 127B

Fairness in Operations Research

Community Committee Choice Session

Session Chair: Swati Gupta, ISyE Georgia Tech, Atlanta, GA

1 Fair Fares for Vehicle Sharing Systems

Adam Elmachtoub[1], Hyemi Kim[2], [1]Columbia University, New York, NY, [2]Columbia University, New York, NY, Contact: hk3181@columbia.edu

Vehicle sharing systems show inequalities in fares and accessibility correlated to demographic factors of riders' neighborhoods. This paper proposes a framework for embedding fairness considerations in vehicle sharing systems from the consumer perspective. We consider two notions of fairness that measure how similar the prices are and how similar the access is at each location, where access is a product of vehicle availability and ride affordability. Under a stylized model, we analyze the impact of these fairness criteria on consumer surplus and social welfare. We find that achieving both price and access fairness simultaneously is impossible in practice. With price fairness, we characterize four regimes corresponding to different effects on social welfare and consumer surplus. Surprisingly, we show that imposing access fairness always makes all parties worse off.

2 Scalable Constant-Factor Approximation Algorithms for Socially Fair K-Clustering

Mehrdad Ghadiri[1], Mohit Singh[2], Santosh Vempala[1], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, ATLANTA, GA

Given a set of points and a metric, the socially fair k-clustering asks for a set of k-centers that minimizes the maximum average clustering cost across demographic

groups. We discuss constant factor approximation algorithms for this problem. Given m demographic groups, using an iterative rounding approach, we show how to obtain a constant factor approximate solution in polynomial time with at most k+m centers. We also present two different algorithms for converting such a solution to a solution with exactly k centers in polynomial time for fixed m. To speed up our algorithm, we propose using a combination of coresets and the k-means++ algorithm. We compare the performance of our algorithms with existing approximation algorithms on benchmark datasets, and find that our algorithms outperform existing methods in practice.

3 Optimizing Equitable Infrastructure Investment Decisions Under High Wildfire Risk Scenarios

Swati Gupta[1], Alyssa Kody[2], Daniel K. Molzahn[3], Ryan Piansky[3], Madeleine Pollack[1], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Argonne National Laboratory, Lemont, IL, [3]Georgia Institute of Technology, Atlanta, GA, Contact: pollack9@mit.edu

In this work, we model emergency power shutoffs to mitigate wildfire risk on a synthetic transmission network in Texas. To eliminate both wildfire risk and power loss, one can "underground" a transmission line at a high cost per mile. While considering multiple objectives, we explore how a fixed budget for line undergrounding is distributed across the network and which populations benefit most from the investment. Due to the intersection of network characteristics from the power grid, the spatiotemporal-varying distribution of wildfire risk, and demographic patterns; many vulnerable communities are more likely to experience power loss, according to our model. This necessitates the incorporation of "equity" objectives into the optimization model, and we study their impact on the structural properties of load shedding across the network.

4 Fairness and Memory in Online Learning

Jad Salem, U.S. Naval Academy, Annapolis, MD

In recent years, the design of online algorithms subject to fairness constraints has seen increased interest. For example, algorithms satisfying variants of individual fairness have been proposed for several online learning problems. When constraining online decisions, a key decision point is the memory of the constraint: how far back in time should one look when constraining the current decision? Should an offline fairness constraint be imposed across all time, or in a sliding window of length 50, or of length 100? In this talk, I explore the impact of the choice of memory on performance and fairness.

Monday, October 16, 4:00 PM - 5:15 PM

ME19

CC-North 127C

Transforming Healthcare Using Artificial Intelligence

Panel Session

1 Moderator

Mehmet U.S. Ayvaci, The University of Texas at Dallas, Richardson, TX

Session Chair: Mehmet U.S. Ayvaci, The University of Texas at Dallas, Richardson, TX

2 Panelist

Idris Adjerid, Virginia Tech, Blacksburg, VA

3 Panelist

Tinglong Dai, Johns Hopkins University, Baltimore, MD

4 Panelist

Margret V. Bjarnadottir, University of Maryland, College Park, MD

5 Panelist

Ritu Agarwal, Johns Hopkins Carey Business School, Baltimore, MD

Monday, October 16, 4:00 PM - 5:15 PM

ME20

CC-North 128A

Sanjay and Panna Mehrotra Award

Award Session

Session Chair: Andrew J. Schaefer, Rice University, Houston, TX

Monday, October 16, 4:00 PM - 5:15 PM

ME21

CC-North 128B

Causal Reinforcement Learning and Human In The Loop

Community Committee Choice Session

Session Chair: Gabriel Zayas-Caban, University of Wisconsin Madison, Madison, WI

Session Chair: Valerie Odeh-Couvertier, University of Wisconsin-Madison, Madison, WI

1 Quasi-Experimental Designs for Learning Health Systems

Valerie Odeh Couvertier, Gabriel Zayas-Caban, Brian Patterson, Amy Cochran, Kenneth Nieser, University of Wisconsin-Madison, Madison, WI, Contact: odehcouverti@wisc.edu

Learning systems use data to improve operations, with risk prediction algorithms playing a key role in deriving knowledge from data. While these algorithms identify individuals or processes that may benefit from interventions, measuring their impact remains a challenge. We develop a causal inference framework, with specific application to learning health systems, for estimating the average causal effect of intervening according to these continually assessed and updating risk prediction algorithms.

2 Can Humans be out of the Loop?

Junzhe Zhang, Columbia University, New York, NY, Contact: junzhez@cs.columbia.edu

Recent advances in Reinforcement Learning have allowed automated agents to achieve a high level of performance across a wide range of tasks, which, when supplemented with human feedback has led to faster and more robust decision-making. This paper studies an interactive reinforcement learning setting where the agent and the human have different sensory capabilities, disagreeing, therefore, on how they perceive the world (observed states) while sharing the same reward and transition functions. We show that agents are bound to learn sub-optimal policies if they do not take into account human advice, perhaps surprisingly, even when human's decisions are less accurate than their own. We propose the counterfactual agent who proactively considers the intended actions of the human operator, and proves that this strategy dominates standard approaches regarding performance.

3 Confounding-Robust Policy Improvement with Human-AI Teams

Ruijiang Gao[1], Mingzhang Yin[2], [1]University of Texas at Austin, Austin, TX, [2]University of Florida, Gainesville, FL, Contact: ruijiang@utexas.edu

Human-AI collaboration has the potential to transform various domains by leveraging the complementary strengths of human experts and Artificial Intelligence (AI) systems. However, unobserved confounding can undermine the effectiveness of this collaboration. In this paper, we propose a novel solution to address unobserved confounding in human-AI collaboration by employing the Marginal Sensitivity Model. We present a deferral collaboration framework for incorporating the marginal sensitivity model into policy learning from observational data, enabling the system to control for the influence of unobserved confounding factors. By adjusting for potential biases, our proposed solution enhances the robustness and reliability of collaborative outcomes.

4 A Reinforcement Learning Framework for Dynamic Mediation Analysis

Zhenke Wu, University of Michigan, Ann Arbor, MI, Contact: zhenkewu@umich.edu

Mediation analysis explores causal effects via mediator variables between treatments and outcomes, gaining attention in diverse scientific domains. Existing studies often focus on single-time-point-treatment scenarios. However, in applications like mobile health, sequential treatments and dynamic mediation effects are key. We propose a reinforcement learning (RL) framework to assess dynamic mediation effects in settings with infinite horizons. By decomposing the average treatment effect into immediate and delayed direct and mediation effects, we develop robust estimators to infer these causal effects. Extensive numerical studies, theoretical results, and mobile health dataset analysis demonstrate the superior performance of our method.

5 Community/Committee'S Choice Submission

Rahul Ladhania, University of Michigan, Ann Arbor, MI, Contact: ladhania@umich.edu

Monday, October 16, 4:00 PM - 5:15 PM

ME22

CC-North 129A

Capacity Management and Decision Making for Hospital Operations

Community Committee Choice Session

Session Chair: Hyojung Kang, University of Illinois at Urbana-Champaign, Champaign, IL

Session Chair: Gabriel Zayas-Caban, University of Wisconsin Madison, Madison, WI

1 Analyzing Temporal Visit Patterns of Frequent Emergency Department Users

Hyojung Kang[1], Lloyd Fernandes[2], [1]University of Illinois at Urbana-Champaign, Champaign, IL, [2]University of Illinois at Urbana-Champaign, CHAMPAIGN, IL, Contact: hyokang@illinois.edu

Frequent users of the emergency department (ED) contribute significantly to the overall number of ED visits. This study aims to analyze temporal visit patterns using similarity measures developed for semantic trees and identify clusters of frequent ED users. We will use electronic health records from multiple EDs that have different facility and patient characteristics to develop and validate the models.

2 Unveiling Bias in Sequential Decision Making: A Causal Inference Approach for Stochastic Service Systems

Juan David[1], Amy Cochran[2], Gabriel Zayas-Caban[3], [1]University of Wisconsin-Madison, Madison, WI, [2]University of Wisconsin-Madison, Madison, WI, [3]University of Wisconsin Madison, Madison, WI, Contact: davidgomez@wisc.edu

Decision-makers are often confronted with making a random number of decisions sequentially over time. How sequential decisions are made may depend on the decision-maker's perception of prior and analogous decisions and their outcomes. This phenomenon, known as sequential bias, violates a core assumption in causal inference that the decision for one person does not interfere with the potential outcomes of another. By connecting sequential bias in service systems to dynamic treatment regimes, and extending these latter settings to allow for a randomized number of decisions, we are to define and identify average causal effects for quantifying sequential bias. Subsequently, we propose estimators, and derive properties thereof. In a case study, we demonstrate that a provider's decision to route a patient in the Emergency Department impacts the care of future patients.

3 A Clinically Applicable Approach for Early Prediction of Septic Shock in ICU

Gyumin Kim[1], Juhyun Song[2], Hyo Kyung Lee[1], [1]Korea University, Seoul, Korea, Republic of; [2]Korea University Anam Hospital, Seoul, Korea, Republic of. Contact: jkp0123@korea.ac.kr

Numerous studies have presented early prediction systems for acute deterioration in ICUs, with a primary focus on achieving good predictive performance. Here, we propose a clinically applicable early prediction system and demonstrate its application for predicting septic shock in ICUs. The system is developed using the MIMIC-IV dataset and designed to be clinically applicable through the integration of three modules: prediction module generating timely adequate warnings, risk progression subtyping module, and risk subtype early detection module. Via our systematic approach, the system achieved considerable predictive performance for septic shock with clinical applicability, and enabled identifying risk progression subtypes that could potentially benefit from early detection.

Monday, October 16, 4:00 PM - 5:15 PM

ME23

CC-North 129B

Empirical Research in Marketplace Operations

Community Committee Choice Session

Session Chair: Rakesh Allu, Cornell University, Ithaca, NY

Session Chair: Vishal Gaur, Cornell University, Ithaca, NY

1 Understanding Matching Quality on Freelance Platforms Through Conversational Analytics

Jiannan Xu, Ashish Kabra, Kunpeng Zhang, University of Maryland, College Park, MD, Contact: jiannan@umd.edu

The past decade witnessed the rapid growth of online labor marketplaces. However, the key challenge for marketplace intermediaries remains to foster high-quality matches to ensure that outsourced tasks are completed successfully by freelancers. Understanding what leads to effective conversations can aid the design of better labor marketplaces. In this paper, we leverage machine learning techniques to explore the different linguistic aspects of conversational interactions in high-quality matches and low-quality matches. Specifically, we examine the temporal differences in sentiments expressed and topics discussed by recruiters and freelancers. Our results offer insights into the factors that influence successful matching and shed light on the underlying mechanisms of effective communication.

2 Signaling Competition in Two-Sided Markets

Fanyin Zheng[1], Omar Besbes[1], Yuri Fonseca[1], Ilan Lobel[2], [1]Columbia University, New York, NY, [2]New York University Stern, New York, NY

A central question for two-sided matching platforms is how to manage congestion and improve market outcomes. We study the impact of a detail-free lever: the disclosure of information to agents on current competition levels. Disclosing competition reduces the perceived value of popular units, but, at the same time, it can help agents on

the other side better elect across options. How large are such effects, and how do they affect overall market outcomes? We answer these questions empirically.

3 Service Indicators and Social Dynamics in Online Reviews Using Text

Anugna Reddy Gondi[1], Li Chen[2], Shawn Mankad[3], [1]Cornell University, Ithaca, NY, [2]Cornell University, Ithaca, NY, [3]North Carolina State University, Raleigh, NC, Contact: ag2446@cornell.edu

Existing research has shown that online customer reviews reflect not only customers' experience with the product/service but also the influence of other customers' ratings. In this work, we focus on service-oriented reviews (mainly restaurants) where operational factors such as wait time and service are frequently mentioned in the review content. We employ a word embedding approach to quantify such content and measure the impact of social dynamics in the reviews using both review ratings and textual content. By modeling the arrival of reviews via hazard processes with business-specific baseline rates, we separate the effects of social influence of past reviews from the underlying review behavior. Our results indicate that the influence of past review ratings and content on subsequent reviews is significant and can vary based on restaurant characteristics.

Monday, October 16, 4:00 PM - 5:15 PM

ME24

CC-North 130

Customer Strategy and Learning in Queues

Community Committee Choice Session

Session Chair: Ran Snitkovsky, Tel Aviv University, Tel Aviv, Israel

1 Can Machines Solve General Queueing Problems

Opher Baron[1], Dmitry Krass[2], Arik Senderovich[1], Eliran sherzer[1], [1]University of Toronto, Toronto, ON, Canada; [2]Rotman School of Management, University of Toronto, Toronto, ON, Canada. Contact: opher.baron@rotman.utoronto.ca

We use a neural net to provide a fast and accurate predictor of the stationary system-length distribution of a GI/GI/1 queue - a fundamental queueing model with closed form solution.

We overcome three main challenges: (1) generating a library of training instances that covers a wide range of arbitrary inter-arrival and service time distributions, (2) labeling the training instances, and (3) providing continuous arrival and service distributions as inputs to the neural net. To overcome (1), we develop an algorithm to sample phase-type inter-arrival and service time distributions with complex transitions structure, (2) we use QBD to lable our training set, and (3) we find that using the first 5 moments of both distributions is sufficient. We show that our neural model is better than other methods in both accuracy and runtimes.

2 Naor's Unobservable Model with Partial Arrival Rate Information

John Hasenbein[1], Grani Adiwena Hanasusanto[2], Johan S. van Leeuwaarden[3], Wouter van Eekelen[3], [1]University of Texas-Austin, Austin, TX, [2]University of Illinois Urbana-Champaign, Urbana-Champaign, IL, [3]Tilburg University, Tilburg, Netherlands

We consider an M/M/s queueing model in which the arrival rate is a random variable whose distribution is an ambiguity set defined by its mean, variance, and support. We use results on distributionally robust optimization to study the decisions of a revenue maximizer, in the presence of strategic customers operating in the so-called unobservable framework.

3 Dynamic vs Static Pricing of Priority in a Queue with Uncertain Arrival Rate

Binyamin Oz, Gregory Skir, Elisheva Zur, Hebrew University of Jerusalem, Jerusalem, Israel. Contact: b.oz@huji.ac.il

We study an unobservable single-server queue with uncertain arrival rates, where customers arrive according to a Poisson process with a random arrival rate, and decide whether to pay for priority. We characterize the equilibrium customer behavior under different pricing and information-disclosure policies. The model is analyzed under two different assumptions regarding the customers' degree of rationality. The first assumes that customers are fully rational and take into account the fact that the ASTA (arrivals see time averages) property does not hold, and base their behavior on the RASTA (rate-biased ASTA) phenomenon. The second assumes that customers are naive and base their decision on the PASTA phenomenon, despite the non-Poisson arrival process.

4 Learning Algorithms for Service Systems with Strategic Customers

Ran Snitkovsky, Tel Aviv University, Tel Aviv, Israel

This talk will discusses a family of iterative algorithms for computing, or learning, Nash equilibria and optimal regulation in queueing games. Our purpose is to suggest robust, easy-to-implement stochastic approximation algorithms that learn customer equilibrium behavior and related quantities based on adaptive simulation of the underlying queueing game.

Monday, October 16, 4:00 PM - 5:15 PM

ME25

CC-North 131A

Stochastic Models in Healthcare

Community Committee Choice Session

Session Chair: Huiyin Ouyang, the University of Hong Kong, Hong Kong, Hong Kong

1 Resource Allocation in Urban Search and Rescue Operations During a Flooding Emergency

Huiyin Ouyang[1], Zheqi Zhang[2], Sukriye Nilay Nilay Argon[3], Serhan Ziya[3], [1]The University of Hong Kong, Hong Kong, Hong Kong; [2]Walmart global tech, Silicon Valley, CA, [3]University of North Carolina, Chapel Hill, NC, Contact: oyhy@hku.hk

This study aims to develop effective strategies for allocating limited resources to different areas during urban search and rescue operations in natural disasters. We model the resource allocation problem as a clearing system with limited rescue resources and formulate it as a Markov decision process. Our analysis reveals that the optimal policy for the stylized model has a threshold structure. We propose a dynamic heuristic policy for the multi-class resource allocation problem based on this structure, which performs close to optimal in numerical simulations. In a simulation study based on air-rescue operations during Hurricane Harvey, our policy outperforms other commonly applied scheduling policies. Our study provides valuable insights and practical solutions for improving the efficiency of urban search and rescue operations during natural disasters.

2 Rl or Url: Managing Outpatient (Tele)visits with Strategic Behavior

Nan Liu[1], Shan Wang[2], Noa Zychlinski[3], [1]Boston College, Chestnut Hill, MA, [2]Sun Yat-sen Univerisity, Guangzhou, China; [3]Technion - Israel Institute of Technology, Haifa, Israel. Contact: wangsh337@mail.sysu.edu.cn

Many outpatient care providers offer virtual service that patients can access via televisits. Televisits allow patients to wait to be seen in the location of their choice, protected from exposure to ill patients and without going through the trouble of physical travel. We develop a stylized queueing-game model, which incorporates patient strategic choice between virtual (or URL) and in-person (real-life, or RL) services, to study how best to manage a practice that simultaneously offers both. We find that the size of the system, measured by the total available service capacity relative to total patient demand, plays a determining role here. We also find that overall patient access to care may be hurt with the use of in-person incentives, unless the payment gap between the two channels is significantly large.

3 Emergency Department Modeling with Time-Varying Physician Productivity

Zhankun Sun[1], Huiyin Ouyang[2], [1]City University of Hong Kong, Kowloon, Hong Kong; [2]The University of Hong Kong, Hong Kong, China. Contact: zhanksun@cityu.edu.hk

Motivated by an intriguing observation on the time-varying physician productivity, we study a continuous-time optimal control problem to understand the transient behavior of individual physicians within their shifts in emergency departments (EDs). By applying Pontryagin's maximum principle, we characterize the optimal policy and provide insights into physician capacity, productivity, and throughput. We leverage the insights to model the complex ED system as a time-varying multi-server queue with shift-hour-dependent service rates. Validation using data from two Canadian EDs shows that our model can accurately capture the time-of-day-dependent patient waiting times.

Monday, October 16, 4:00 PM - 5:15 PM

ME26

CC-North 131B

Renewable Energy and Storage Investment

Community Committee Choice Session

Session Chair: Zuguang Gao, The University of Chicago, Chicago, IL

Session Chair: Nur Sunar, [1]</sup

1 Pay It Forward: On Renewable Energy Investments Under Fixed-Price and Fixed-Volume Forward Contracts

Alexandar Angelus[1], Alain Bensoussan[2], [1]Texas A&M University, College Station, TX, [2]University of Texas-Dallas, Richardson, TX, Contact: aangelus@mays.tamu.edu

We consider a firm's investment in renewable energy under correlated, stochastically evolving price and demand for renewable energy when the firm commits to a fixed-price or fixed-volume forward contract. Using infinite-horizon, continuous-time model, we establish both the threshold structure of the firm's optimal timing of the investment and its optimal capacity of investment. We derive explicit expressions for the optimal thresholds, capacity levels, and associated optimal profit functions. We explore the sensitivity of optimal decisions on the underlying model parameters and derive managerial insights.

2 Renewable, Flexible, and Storage Capacities: Friends or Foes?

Xiaoshan Peng[1], Owen Wu[1], Gil Souza[2], [1]Indiana University, Bloomington, IN, [2]University of Tennessee Knoxville, Knoxville, TN, Contact: xp1@iu.edu

In this paper, we optimize the joint operations of these three types of resources and identify the structure of the optimal operating policy--in particular, the optimal storage control policy. Furthermore, we optimize the investment mix of these resources and examine the investment relations among them (i.e., investment substitutes or complements). We explain the investment relations using the operational insights obtained from the storage control policy. We find that whether storage complements or substitutes other resources depends on how storage reduces operating cost and whether the potential cost reduction is constrained by charging or discharging. Through extensive numerical analysis using data from a Florida utility, government agencies, and industry reports, we demonstrate how storage operations drive the investment relations among these resources.

3 Design of Power Purchase Agreements with Renewable Energy Producers

Zuguang Gao[1], Nur Sunar[2], John R. Birge[3], [1]The University of Chicago, Chicago, IL, [2]UNC Kenan-Flagler Business School, Chapel Hill, NC, [3]University of Chicago, Chicago, IL

We study a firm that aims to sign a power purchase agreement (PPA) with a renewable energy producer. Using a stochastic control framework, we identify the optimal renewable PPA for the firm. Our analysis generates various valuable insights for both managers and policy makers.

Monday, October 16, 4:00 PM - 5:15 PM

ME27

CC-North 131C

Social Impact of Platforms

Community Committee Choice Session

Session Chair: Basak Kalkanci, Georgia Institute of Technology, Atlanta, GA

Session Chair: Li Ding, 1</sup

1 The Impact of Social Nudges on User-Generated Content for Social Network Platforms

Zhiyu Zeng[1], Hengchen Dai[2], Dennis Zhang[3], Heng Zhang[4], Renyu Zhang[5], Zhiwei Xu[6], Zuo-Jun Max Shen[7], [1]Washington University in St. Louis, St. Louis, MO, [2]UCLA Anderson School of Management, Los Angeles, CA, [3]Washington University in St Louis, ST LOUIS, MO, [4]Arizona State University, Phoenix, AZ, [5]The Chinese University of Hong Kong, Hong Kong, China; [6]Tsinghua University, Beijing, China; [7]University of California Berkeley, Berkeley, CA

To tackle the underprovision of user-generated content, we develop an intervention that leverages peer recognition. Via two field experiments (N=1,671,766) conducted on a video-sharing social network platform, we reveal that receiving peer recognition not only immediately boosts users' video production by 13.21% but also increases users' likelihood of giving recognition to others by 15.57%. Such effects last several days and are bigger when the recognition sender and recipients have a stronger tie. Our social network model, combined with the experimental data, shows that estimating and optimizing the overall impact of peer recognition on production over the entire platform requires accounting for its diffusion and over-time effects.

2 Reducing Traffic Incidents in Meal Delivery:Penalize the Platform or Its Independent Drivers?

Wenchang Zhang[1], Chris S. Tang[2], Liu Ming[3], Yue Cheng[4], [1]Indiana University, Bloomington, IN, [2]University of California-Los Angeles, Los Angeles, CA, [3]The Chinese University of Hong Kong, Shenzhen, Shenzhen, China; [4]Peking University HSBC Business School, Shenzhen, China. Contact: mingliu@cuhk.edu.cn

As the on-demand meal delivery industry expands into a multi-trillion-dollar global market, traffic violations and accidents related to meal deliveries are surging at an alarming rate. By analyzing a three-stage Stackelberg game, we establish the following results. (1) Imposing higher penalties on meal delivery drivers for traffic incidents will have unintended consequences: It will prompt platforms to increase delivery payments, leading drivers to travel faster and ultimately causing more accidents and reduced profits for the platform. (2) Applying stricter penalties to the platform for traffic incidents will encourage it to lower delivery payments, which will, in turn, motivate drivers to travel at safer speeds. (3) The socially optimal policy penalizes only the platform for traffic violations and accidents, not the drivers.

3 From Red Tape to Regtech: How Do Online Platforms Facilitate International Trade?

Jingyuan Cui[1], Zhihan (Helen) Wang[2], Andrew Wu[2], [1]University of Michigan, Ann Arbor, MI, [2]Ross School of Business, University of Michigan, Ann Arbor, MI

Although the impact of digital services on individual and micro entity decision-making has been well documented, empirical evidence on the effect of digital platforms on the macroeconomy is still rare. Leveraging shipment-level custom data from 2013 to 2017, we quantify the impact of a regulatory technology (RegTech) platform that facilitates value-added tax (VAT) rebates on regional exports in China. Our causal identification relies on the roll-out of the platform and a staggered treatment design. Our empirical results show that the availability of the RegTech platform directly increases regional aggregate export value, the number of shipments, as well as the value per shipment. Further, we utilize the variations in VAT rebate rates for different products to show that RegTech facilitates international trade by reducing the waiting time for VAT rebates.

4 Using Meta-Learning to Improve Military Aviator Performance

Xufei Liu, University of Pennsylvania, Philadelphia, PA, Contact: xufei@wharton.upenn.edu

For military aviators, functioning within a high-stress, no-fail work environment is a necessity. They have to make split-second decisions in the air, all while piloting 44,000 lbs of machinery and experiencing up to 9G's of acceleration. These unique circumstances increase an aviator's risk of hypoxia, and they must quickly learn how to manage their physiological reactions to these intense stressors. We train a CNN model on sensor data that records environmental and physiological factors of aviators-in-training, determining segments of their flight path where they are at risk or under-performing. Eventually, we will determine optimal moments during a flight for intervention to improve the aviator's learning curve and performance.

5 Breaking the Invisible Cage: Investigating the Gender Wage Gap in Gender-Blind Online Platforms

Li Ding, Basak Kalkanci, Georgia Institute of Technology, Atlanta, GA, Contact: basak.kalkanci@scheller.gatech.edu

We investigate differences in self-evaluation biases between genders as potential contributors to the gender wage gap in online platforms, and explore strategies to mitigate the gap. Leveraging a gender-blind online labor platform, we conduct a field experiment, wherein workers are presented with the opportunity to work on math grading tasks over two phases. We consider two interventions: (1) task recommendation, wherein workers are nudged to work on hard and high-paying (HH) tasks early on, and (2) giving workers performance feedback on the first task before they select the second task. We find that in the absence of a nudge, women are more likely to select easier and lower-paying tasks than men, and performance feedback alone reinforces this behavior. However, combining performance feedback with a nudge to take on HH tasks early on reduces the subsequent gender wage gap.

Monday, October 16, 4:00 PM - 5:15 PM

ME28

CC-North 132A

Strategic Collaboration and Coopetition in the Supply Chain

Community Committee Choice Session

Session Chair: Guangwen (Crystal) Kong, Temple University, Philadelphia, PA

Session Chair: Abhishek Roy, Temple University Fox School of Business, Philadelphia, PA

1 Resale-As-A-Service: The Impact of Second-Hand Platforms on Fashion Goods Retailer

Yuan Guo[1], Fernando Bernstein[2], Robert Swinney[2], [1]George Washington University, Washington, D.C., DC, [2]Duke University, Durham, NC, Contact: yuan.guo@gwu.edu

We examine how a retailer selling fashion apparel should account for a second-hand market amid changing fashion trends and diverging customer tastes. We propose a customer decision model that incorporates both customer purchase decisions (i.e., purchasing a new product, a used product, or no product) as well as their selling decisions (i.e., selling a used product) over time. Customers have heterogeneous tastes for product design and each product released by the retailer has random popularity in the market. We discuss how uncertainty in customer taste over time can affect the retailer's production decisions when the second-hand market is absent. Next, we explore how the presence of a second-hand platform affects the retailer's production decisions. Finally, we examine the potential benefit for the retailer from cooperating with a platform under Resale-as-a-Service.

2 The Role of Product Quality in Marketplaces

Leela Aarthy Nageswaran[1], Aditya Jain[2], Haresh B. Gurnani[3], [1]University of Washington, Seattle, WA, [2]Baruch

College, Zicklin School of Business, New York, NY, [3]Wake Forest University, Winston Salem, NC

Traditional retailers have started to offer marketplaces, wherein suppliers sell directly to customers. We study which mode of contracting -- marketplace, wholesale, or a hybrid -- will prevail when the supplier's product quality is uncertain. We show that the retailer may induce an equilibrium wherein a low-quality product is offered via marketplace and a high-quality product is offered via wholesale.

3 Collaborative New Product Development: Co-Creating with a Shared Supplier in the Presence of a Competitor

Abhishek Roy, Temple University Fox School of Business, Philadelphia, PA, Contact: abhishek.roy@temple.edu

Firms are increasingly involving their suppliers in co-creating new products and services through collaborative alliances. In many industries, such suppliers are shared by competing manufacturers, who may benefit from forming alliances and co-creating new products jointly with their shared suppliers. Using a game theoretic model, we analyze the strategic interactions in such a collaborative alliance and examine the strategic trade-offs that arise when competing buyers decide to co-create a common component with the supplier, instead of relying on the supplier to independently develop the component. We demonstrate that competing buyers may sometimes benefit from collaborating jointly with the shared supplier in co-creating common components, instead of shirking away from the collaboration or letting the supplier be the sole developer of the component.

Monday, October 16, 4:00 PM - 5:15 PM

ME29

CC-North 132B

Novel Business Models and Their Environmental and Social Footprint

Community Committee Choice Session

Session Chair: Philippe Blaettchen, Bayes Business School (formerly Cass), City, University of London, London, United Kingdom

1 Wastewater Recycling Capacity Investment in Urban Water Systems

Onur Boyabatli[1], Buket Avci[1], Qian Luo[2], [1]Singapore Management University, Singapore, Singapore; [2]Xi'an Jiaotong Liverpool University, Suzhou, China. Contact: oboyabatli@smu.edu.sg

Wastewater plays a pivotal role in water sustainability by closing the urban water cycle and serving as another water source. This paper investigates a wastewater recycling capacity optimization problem considering rainfall and recycling cost uncertainties in the integrated urban water management system. We formulate the water utility's decisions as a two-stage stochastic problem and characterize the optimal water allocation schemes and the optimal recycling capacity. We also conduct sensitivity analysis to investigate the impacts of rainfall and recycling cost variabilities on the optimal expected cost and recycling capacity. In this paper, we also conduct a case study using publicly available data to calibrate the model and conduct extensive numerical analysis to complement the analytical results.

2 Competitive Adoption of Mass Customization and Environmental Sustainability in Fashion

Aydin Alptekinoglu[1], Adem Orsdemir[2], [1]Pennsylvania State University, University Park, PA, [2]University of California Riverside, Riverside, CA, Contact: orsdemir@ucr.edu

We explore adoption of mass customization (MC) in a competitive environment as a solution to overproduction endemic in the fashion industry. Building on a demand model sensitive to product variety, price and a lead time for mass-customized products, we analyze a duopoly competition game that includes production technology selection between MP and MC. We uncover when MC adoption by one firm leads to higher profits for both firms and lower total environmental impact. We find low-to-medium marginal cost of production is more conducive for MC adoption to lead to greener outcomes. We ask two policy questions: (1) How does promoting MC in the sense of making the wait for mass-customized products more tolerable for consumers change the relationship between MC adoption and environmental impact? (2) What does charging a disposal fee for overproduction do for the same relationship?

3 The Impact of Variety on the Economic and Environmental Performance of a Fashion Rental Business Model

Vishal Agrawal[1], Ekaterina Astashkina[2], Anna Saez de Tejada Cuenca[3], [1]Georgetown University, Washington, [2]Ross School of Business, University of Michigan, Ann Arbor, MI, [3]IESE Business School, Barcelona, Spain. Contact: astash@umich.edu

Using the proprietary dataset from a US-based fashion rental company, we first analyze the impact of product variety on customer rental behavior and the company's operational performance. We find that higher variety leads to customers keeping their rented items for a shorter time, renting new items sooner, and overall renting more items. This, in turn, increases items' utilization: they get rented more times and spend less time idle. However, if variety is too high -- this relationship gets reversed. We then use these findings to illustrate how the tradeoffs related to company's economic and environmental performance metrics associated with increase in variety are resolved.

4 Business Model Choice for Heavy Equipment Manufacturers

Philippe Blaettchen[1], Niyazi Taneri[2], Sameer Hasija[3], [1]Bayes Business School (formerly Cass), London, United Kingdom; [2]Cambridge Judge Business School, Cambridge, United Kingdom; [3]Insead, Singapore, Singapore. Contact: philippe.blaettchen@city.ac.uk

Technological advances enable new business models for heavy equipment manufacturers allowing customers to access equipment without ownership. This study seeks to understand different emerging business models' profitability and environmental performance in light of salient economic and operational factors. We identify the optimal choice between a traditional ownership-based business model and access-based models using servicization or sharing. After-sales services, crucial for heavy equipment manufacturers, strongly affect this choice. We further provide a novel framework to analyze a business model's environmental impact and show that all models can create win-win situations for the manufacturer and the environment.

Monday, October 16, 4:00 PM - 5:15 PM

ME30

CC-North 132C

Operations and Technologies in E-commerce and Online Platforms

Community Committee Choice Session

Session Chair: Ruomeng Cui, Emory University, Decatur, GA

Session Chair: Wenchang Zhang, Indiana University, Bloomington, IN

1 The Economics of Digital Dark Patterns

Andrey Fradkin[1], Tesary Lin[1], Chiara Farronato[2], [1]Boston University, Cambridge, MA, [2]Harvard Business School, Brookline, MA, Contact: tesary@bu.edu

Companies often obfuscate cookie preference policies and consent forms in order to nudge users to share their data more than they would otherwise do. These practices, known as "dark patterns," are pervasive despite their effects being poorly understood. With the use of Webmunk, a browser extension developed for research studies of this type, we explore the effects of dark patterns on consumers' privacy choices and the effects that such choices have on the type and quantity of ads they receive. We are particularly interested in exploring how the effects of dark patterns differ across large and small companies, and the ensuing firms' competitive advantage in consumer data.

2 No Call, No Show: Impact of No Show and Its Remedies on Service Platforms

Nil Karacaoglu[1], Simin Li[2], Martin Lariviere[3], [1]The Ohio State University, Columbus, OH, [2]Tulane University, New Orleans, LA, [3]Northwestern University, Evanston, IL, Contact: simin.li@tulane.edu

Absenteeism can severely impact service platforms where each customer is assigned a designated service provider. With the rising popularity of service platforms, it is not uncommon for customers to bear the brunt of no-shows. In this study, we aim to empirically quantify the impact of no-shows on customer retention and lifetime value. We also investigate the effectiveness of two potential remedies platforms can offer to mitigate the adverse effects of no-shows. Finally, we construct and calibrate a model to determine the optimal no-show mitigation strategies for service platforms based on their specific characteristics. By doing so, we aim to provide service platforms with actionable insights that can help them reduce the impact of no-shows on customer retention.

3 A Moment for Reflection: De-biasing Server Evaluations

Hallie Cho, Vanderbilt University, Nashville, TN

Customers provide server feedback in an evaluation form where quantitative feedback is often solicited before qualitative feedback. Managers often use quantitative feedback as a standardized data source to judge the performance of servers, however research has shown that bias (e.g., demographic) exists in quantitative feedback. We examine the impact of changing the order of feedback (quantitative vs. qualitative) on bias.

Monday, October 16, 4:00 PM - 5:15 PM

ME32

CC-North 221B

Efficiency of Transportation and Transportation-Enabled Services

Community Committee Choice Session

Session Chair: Hai Wang, Singapore Management University, Singapore, Singapore

1 Temporal Equilibrium for Electrified Ride-Sourcing Markets Considering Charging Capacity and Driving Fatigue

Yuhao Liu[1], Zhibin Chen[1], Chi Xie[2], Kai Liu[3], [1]New York University Shanghai, Shanghai, China; [2]Tongji University, Shanghai, China; [3]Dalian University of Technology, Dalian, China. Contact: zc23@nyu.edu

Given their demand for charging, ride-sourcing electric vehicle (EV) drivers may have distinct work schedules from gasoline vehicle (GV) drivers, yielding significant impacts on the market supply when their penetration becomes high. We propose an equilibrium modeling framework based on a time-expanded network to describe the work schedules of EV and GV drivers with the consideration of their driving fatigue and EVs' charging opportunities subject to the limited charging infrastructure. To solve the equilibrium model, we develop a gap function-based method coupled with the column generation scheme in which a non-additive shortest path problem appears as a subroutine. Numerical examples reveal that the temporal equilibrium of the electrified ride-sourcing market is moderated by the charging capacity, EV penetration as well as the competition among drivers.

2 A Robust Data-driven Linear Programming Approach for Minimizing Energy Consumption in Railway Networks

Shuvomoy Das Gupta[1], J. Kevin Tobin[2], [1]MIT, Cambridge, MA, [2]Thales Canada, Toronto, ON, Canada. Contact: kevin.tobin@urbanandmainlines.com

We present a robust, data-driven linear programming model for minimizing total effective energy consumption in railway networks. In contrast with existing works that are either NP-hard or requires multi-stage optimization, our model involves a single linear programming problem. Our approach simultaneously minimizes total energy consumed by all the trains while maximizing the transfer of regenerative energy from braking trains to accelerating trains. The interplay between energy consumption and its reuse is modeled in an empirically validated data-driven manner. Furthermore, our model robustly safeguards against uncertainties that are inherent in railway networks. When applied to a real-world metro network, the timetables computed by our model outperformed existing timetables, achieving a significant reduction in effective energy consumption.

3 Learning in the Airspace for Combinatorial Network Routing

Xiyitao Zhu[1], Jing Gao[2], Lavanya Marla[3], Ankur Mani[4], [1]University of Illinois Urbana-Champaign, Champaign, IL, [2]university of minnesota, Sunnyvale, CA, [3]University of Illinois at Urbana-Champaign, Urbana, IL, [4]University of Minnesota - Twin Cities, Minneapolis, MN, Contact: xiyitao2@illinois.edu

In the US National Aviation System (NAS), aircraft rely on weather information for routing decisions. We propose that using en-route aircraft as sensors to collect updated weather information at the right place and right time maintains high-quality weather information that benefits the NAS. Motivated by the spatial and temporal correlations in weather, we propose a novel modeling framework for routing decisions on (airspace) networks with non-stationary Gaussian bandits, temporal information diffusion, and in particular, with combinatorial path structures. Our framework is also applicable to intra-city aircraft and unmanned aircraft such as UAVs and drones.

4 Assessing and Explaining the Efficiency of Urban Transportation Networks

Hao Hao[1], Hai Wang[2], Peter Zhang[1], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Singapore Management University, Singapore, Singapore

Urban transportation networks are critical systems for individual mobility and the economy. Traditional and emerging transportation-enabled services require assessing the routing efficiency in transportation networks for decision-making. This paper studies the efficiency of the fundamental class of routing problems - the efficiency of TSPs. Leveraging modern transportation data and the well-known BHH theorem, we propose a scalable method for assessing transportation networks' TSP efficiency under different demand distributions. We also implement interpretable models to find that the distribution of the network nodes, and the network topology are among the most significant features in explaining TSP efficiency. Finally, we conduct case studies on the TSP efficiency of urban service-level sub-networks, and the evolution of subway networks' TSP efficiency.

Monday, October 16, 4:00 PM - 5:15 PM

ME33

CC-North 221C

Game Theory and Discrete Optimization

Community Committee Choice Session

Session Chair: Gabriele Dragotto, Princeton University, Princeton, NJ

1 Capacity Planning in Stable Matching: An Application to School Choice

Federico Bobbio[1,2], Margarida Carvalho[3], Andrea Lodi[4], Ignacio Rios[5], Alfredo Torrico[6], [1]University of Montreal, Montreal, QC, Canada; [2]CIRRELT, Montreal, QC, Canada; [3]University of Montreal & CIRRELT, Montreal, QC, Canada; [4]Cornell Tech, New York, NY, [5]The University of Texas at Dallas, Richardson, TX, [6]Cornell University, Ithaca, NY, Contact: federico.bobbio@umontreal.ca

A successful application of Matching Theory is the admission of students to schools (SC). We introduce the problem of jointly allocating extra spots to schools and finding the best matching for the students. We analyze theoretically the problem, and we propose a novel MILP formulation. We show that its stability constraints can be separated in linear time, leading to an effective cutting-plane method. Our cutting-plane method outperforms MIP solving the generalizations of existing formulations. Moreover, we propose two heuristics that are effective for large instances. Finally, we use the Chilean SC data to demonstrate the impact of capacity planning. Our results show that our methodology can prioritize the assignment of previously unassigned students or improve those matched. These insights empower the decision-maker in tuning the matching to provide a fair solution.

2 Learning Rationality Parameters in Potential Games

Stefan Clarke, Princeton University, NJ

We propose a stochastic first-order algorithm to learn the rationality parameters of simultaneous and non-cooperative potential games, i.e., the parameters of the agents' optimization problems. Our technique combines an active-set step that enforces that the agents play at a Nash equilibrium, and an implicit-differentiation step to update the estimates of the rationality parameters. We detail the convergence properties of our algorithm and perform numerical experiments on Cournot and congestion games, showing that our algorithm effectively finds high-quality solutions (in terms of out-of-sample loss) and scales to large datasets.

3 A Geometric Algorithm for Stable Matching Problems

Chengyue He, Columbia Universiy, New York, NY, Contact: ch3480@columbia.edu

Gale-Shapley algorithm and its variants have been widely used to find stable matchings in many different settings. In this talk, we focus on a different, more general approach to find stable matchings due to Scarf. Scarf's algorithm is a pivoting procedure to find a special vertex---a dominating vertex---in matching polytopes, and such vertex can encode stable matchings. We studied the behavior of Scarf's algorithm when employed to find stable matchings on different classes of graphs/hypergraphs. While finding a dominating vertex is generally PPAD-hard, we prove that Scarf's algorithm runs in polynomial time on several classes of matching polytopes. Our results provide in particular a new polynomial time algorithm for stable matching problems. Meanwhile, we give evidence that some famous algorithms like Gale-Shapley are indeed implementations of Scarf's algorithm.

4 Information and Tractability in Many-To-Many Stable Matching

Aapeli Vuorinen, Columbia University, New York, NY

The stable marriage problem generalizes to instances where one or both sides can be matched to more than one partner, by replacing strict preference lists over candidates with choice functions over subsets of candidates. Such choice functions need only satisfy the conditions of substitutability and consistency for a stable match to exist and be found by Roth's generalization of the Deferred-Acceptance algorithm. However, the set of such choice functions is doubly exponential in size and the information required to describe them is too large, making them intractable for all but the smallest applications.
To overcome this computational roadblock, in this talk we present some results on a special class of choice functions, known as Kuhn choice functions. They are defined through the solution of a (classical) maximum weight matching problem in an auxiliary bipartite graph.

5 Who Plays First?

Gabriele Dragotto[1], Bartolomeo Stellato[2], [1]Princeton University, Princeton, NJ, [2]Princeton University, Princeton, NJ, Contact: gdragotto@princeton.edu

We consider the problem of determining which player should play first in a sequential game. In other words, given a series of selfish and interacting players, we are interested in determining the order of play that maximizes a function of the players' decisions. We formulate this problem as a mixed-integer optimization problem, and we propose an efficient algorithm to solve the problem by dynamically generating valid inequalities (i.e., cutting planes). We contextualize our framework in trajectory planning for autonomous vehicles and drones, portfolio optimization, and Cournot games.

Monday, October 16, 4:00 PM - 5:15 PM

ME34

CC-North 222A

Recent Advances in Optimization: Theory and Applications

Flash Session

Session Chair: Jeremy Curuksu, Amazon, New York, NY

1 Dynamics of Inverse Vertex Images in the Schwarz-Christoffel Integral: Kufarev's Differential Equations and Initial Conditions

Soninbayar Jambaa, National University of Mongolia, Ulaanbaatar, Mongolia. Contact: soninbayar@seas.num.edu.mn

The practical use of the well-known Schwarz-Christoffel integral formula is complicated by the determination of the inverse images of the vertices of a polygon that correspond to given side lengths. This work presents a method for determining these inverse images for rectilinear polygons, as well as a procedure for transforming the system of Kufarev ordinary differential equations that describe the movement of these inverse images into a form suitable for numerical analysis. The resulting dynamic system is then solved numerically, and the algorithm's effectiveness is demonstrated by its ability to preserve distances between the vertices during the cut. The article references the original method presented by Jambaa et al. in the Tomsk State University Journal of Mathematics and Mechanics, Vol. 5, No. 43 (2016).

2 What-If: A Method to Measure the Markov Property in Data Driven Reinforcement Learning

Jeremy Curuksu[1], Charles Prosper[2], [1]Amazon, New York, NY, [2]Amazon Web Services, Brisbane, Australia

Offline reinforcement learning can learn a policy from historical data collected from a Markov Decision Process. But when using historical data for offline learning, the reinforcement learning problem setup may not be Markov and the historical data may not have sufficient variability in states and actions to learn an optimal policy. We propose a method designed to determine if some available historical data was generated by a Markov Decision Process, and to measure the order of this Markov Decision Process. We use this method to show that learning from data simulated with a GPT model can improve the Markov property and overall quality of offline learning, with up to 25% increase in accumulated rewards in typical optimal control problems.

3 Discrepancy-based Distributional Robustness With Discrete Loss

Belleh Fontem, University of Massachusetts Lowell, Lowell, MA

The classical paradigm in distributionally robust decision-making presupposes connectedness of either the decision space, state space, or both. Driven by reliability considerations in supply chain planning, we use discrepancy-based ambiguity sets to explore distributionally robust models with piecewise affine, bounded discrete loss functions that are defined on decision, and state spaces which are discrete. For this class of problems, we propose an exact decomposition algorithm that in each iteration, solves a mixed integer linear program and a nonlinear convex program. We show that the algorithm's complexity scales linearly with the allowable maximum expected loss on account of all distributions in the ambiguity set. To demonstrate the algorithm's effectiveness, we run it on a large-scale unreliable sourcing problem with advance demand information.

4 A Study on the Gap-Time Relationship in Solving Scheduling Problem

Shaheen Pouya[1], Oguz Toragay[2], [1]Auburn University, Auburn, AL, [2]Lawrence Technological University, Southfield, MI, Contact: shaheen@auburn.edu

This article presents a study on the job shop problem, a combinatorial optimization problem that models scheduling and resource allocation in industrial settings. The article aims to investigate the relationship between the optimality gap and required computational resources, considering various optimality gap levels that are applicable in real-life situations. The study uses a Monte Carlo simulation to analyze the behavior of solvers in solving different sizes of random-generated scheduling problems. The findings of the study offer insights into the worthiness of reaching an optimal solution versus implementing a near-optimal solution and starting the work. The codes used in the study are accessible on the author's GitHub account.

5 Optimizing Bi-Objective Routing for Perishable Products with Customer Heterogeneity in Green Label Incentive on Time Slot Choice

Xinyue LIANG, Nengmin WANG, Xi'an Jiaotong University, Xi'an City, China. Contact: 95xinyue@gmail.com

The rapid growth of the perishable produce e-commerce market has led to a surge in their road freight. Prompt delivery is crucial for such products to minimize degradation over time and reduce missed deliveries. Therefore, offering customizable time slots might be necessary to ensure delivery efficiency. Growing customer awareness of sustainability sparked us to explore the use of green labels as an intrinsic motivator to steer customers to eco-friendly delivery options.

Accordingly, we develop a novel bi-objective VRP model with categorized-labeled time slots, aiming at optimizing both cost and customer satisfaction. Flexible vehicle departure times are allowed. Computational studies conducted by two meta-heuristics prove the efficiency of the solution methods. Finally, we draw managerial insights from the obtained Pareto frontier and sensitivity analysis.

6 Knowledge Graph Hashing Through Rotation

Yeshuai He[1], Jianqiang Cheng[2], Yong Ge[2], [1]University of Arizona, Tucson, AZ, [2]University of Arizona, Tucson, AZ

Knowledge graph hashing is to infer binary vector representations of the graph. Compared with knowledge graph embedding that learns continuous vector representations, knowledge graph hashing could significantly reduce storage and computational time due to its binary nature. In this paper, we propose a novel discrete optimization framework for knowledge graph hashing. We treat the links between entities and relations in the graph as rotations to learn binary codes. An alternating optimization algorithm is then proposed to produce high-quality binary codes. Moreover, to control the margin hyperparameters in the Relu function, we use a dynamic range approach to adjust the tolerable margins in each iteration. Evaluation results demonstrate the superiority of the proposed algorithm against the direct binary representations of several state-of-the-art baselines.

Monday, October 16, 4:00 PM - 5:15 PM

ME35

CC-North 222B

Reinforcement Learning

Community Committee Choice Session

Session Chair: sajad Khodadadian, Georgia Institute of Technology, Atlanta, GA

1 Stochastic First-Order Policy Optimization for Robust Markov Decision Process

Yan Li[1], Guanghui Lan[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, Contact: yli939@gatech.edu

We consider the problem of solving robust Markov decision process (MDP), which involves a set of discounted, finite state, finite action space MDPs with uncertain transition kernels. The goal of planning is to find a robust policy that optimizes the worst-case values against the transition uncertainties, and thus encompasses the standard MDP planning as a special case. For (s,a)-rectangular uncertainty sets, we develop a policy-based first-order method, namely the robust policy mirror descent (RPMD), and establish linear convergence when the transition is known. We further develop a stochastic variant of the robust policy mirror descent method, named SRPMD, when the first-order information is only available through online interactions with the nominal environment, which attains an $O(1/\epsilon^2)$ sample complexity for finding an ϵ-optimal policy.

2 Revisiting the Linear-Programming Framework for Offline Reinforcement Learning with General Function Approximation

Asuman Ozdaglar[1], Sarath Pattathil[1], Jiawei Zhang[1], Kaiqing Zhang[2], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]University of Maryland, College Park, College Park, MD, Contact: jwzhang@mit.edu

Offline RL optimizes policies using a pre-existing dataset, without more environment interaction. Current research emphasizes sample-efficient offline RL algorithms to tackle large state-action spaces. The LP reformulation of Markov decision processes is significant, allowing sample-efficient offline RL with function approximation under partial data coverage and realizability assumptions. We reexamine this LP framework, offering a new version that enhances past results, softens assumptions, and reaches optimal statistical rates regarding sample size. This is attained by introducing suitable constraints and selecting function classes and initial state distributions. Our work may enhance the understanding of LP formulations and the associated primal-dual minimax optimization in offline RL.

3 Provably Efficient Model-Free Algorithms for Non-Stationary CMDPs

Honghao Wei[1], Arnob Ghosh[2], Ness Shroff[3], Lei Ying[4], Xingyu Zhou[5], [1]University of Michigan, Ann Arbor, MI, [2]Ohio State University, Columbus, OH, [3]The Ohio State University, Columbus, OH, [4]The University of Michigan, Ann Arbor, Ann Arbor, MI, [5]Wayne State University, Rochester Hills, MI, Contact: honghaow@umich.edu

We study model-free reinforcement learning (RL) algorithms in episodic non-stationary CMDPs, in which an agent aims to maximize the expected cumulative reward subject to a cumulative constraint on the expected utility (cost). In the non-stationary environment, reward, utility functions, and transition kernels can vary arbitrarily over time. We propose the first model-free, simulator-free RL algorithms with sublinear regret and zero constraint violation for non-stationary CMDPs in both tabular and linear function approximation settings with provable performance guarantees. Additionally, We present a general framework for addressing the well-known challenges associated with analyzing non-stationary CMDPs, without requiring prior knowledge of the variation budget.

4 Performance Bounds for Policy-Based Average Reward Reinforcement Learning Algorithms

Yashaswini Murthy[1], Mehrdad Moharrami[2], R. Srikant[1], [1]University of Illinois, Urbana, IL, [2]University of Iowa, Iowa City, IA, Contact: moharami@uiowa.edu

Many policy-based RL algorithms can be viewed as instances of approximate policy iteration (PI). In applications where average reward serves as the performance metric, discounted reward formulations with a high discount factor are commonly used. However, the corresponding theoretical performance bounds for the discounted reward scale with the square of the horizon. Consequently, the resulting performance bounds for average reward problems tend to go to infinity. Therefore, an open problem has been to obtain meaningful performance bounds for approximate PI and RL algorithms in the average-reward setting. In this paper, we address this open problem by deriving the first non-trivial finite-time error bounds for average-reward MDPs, which approach zero as the errors in policy evaluation and policy improvement tend to zero.

Monday, October 16, 4:00 PM - 5:15 PM

ME36

CC-North 222C

Recent Progress in Optimization Software IV

Community Committee Choice Session

Session Chair: Hans Mittelmann, Arizona State University, Tempe, AZ

1 Recent Developments of PDLP

Haihao Lu, University of Chicago, Chicago, IL

In this talk, we will talk about the recent computational and theoretical development of PDLP, a first-order method based LP solver.

2 Pushing the Limits of Computation: Solving Previously Unsolvable Instances

Yuji Shinano, Zuse Institute Berlin, Berlin, Germany

We have developed the Ubiquity Generator framework (UG), which is a software framework to parallelize state-of-the-art solvers on large-scale computing environments, for more than 10 years. The parallel solvers instantiated by the UG successfully solved more than 20 previously unsolved instances from MIPLIB(benchmark instances for Mixed Integer Programing), 5 instances from SteinLib (benchmark instances for Steiner Tree Problems), and 3 instances from QAPLIB (benchmark instances for Quadratic Assignment Problems).
In this talk, we present the latest status of UG and parallel solvers instantiated by the UG, including QUBO(Quadratic unconstrained binary optimization) solver QuBowl.

3 Mixed-Integer Presolve Progress in COPT

Nils-Christian Kempke, COPT GmbH, Berlin, Germany

Presolving is an essential component of modern MIP solvers. It cleans up the model, identifies structures in the problem, and tightens the formulation before the branch-and-cut search starts.
In this talk, we present new presolving techniques implemented in the Cardinal Optimizer (COPT). We discuss the underlying structures that are exploited and show how a careful mathematical analysis of those structures resulted in new presolving reductions. We also present computational experiments showing the impact of the new techniques.

Monday, October 16, 4:00 PM - 5:15 PM

ME37

CC-North 223

Distributionally Robustness under Dynamic Environment

Community Committee Choice Session

Session Chair: Yifan Hu, 1</sup

1 The Curious Price of Distributional Robustness in Reinforcement Learning with a Generative Model

Laixi Shi[1], Gen Li[2], Yuting Wei[3], Yuxin Chen[3], Matthieu Geist[4], Yuejie Chi[5], [1]Carnegie Mellon University, Pittsburgh, PA, [2]The China University of Hong Kong, Hong Kong, China; [3]University of Pennsylvania, Philadelphia, PA, [4]Google Research, Brain Team, Paris, France; [5]Carnegie Mellon University, Pittsburgh, PA, Contact: laixishi@cmu.edu

This work investigates model robustness in reinforcement learning (RL) to address the ubiquitous sim-to-real gap in modern practice, by considering distributionally robust Markov decision processes (RMDPs). Despite recent efforts, the sample complexity of RMDPs is much less understood --- large gaps between existing upper and lower bounds, and it is unclear if distributional robustness bears any statistical consequences when benchmarked against standard RL.
We derive the sample complexity of RMDPs---using either

total variation or χ^2 divergence uncertainty set, and develop minimax lower bounds to benchmark its tightness. Our results deliver surprising messages that learning RMDPs is not necessarily easier or more difficult than standard MDPs --- depends heavily on the size and shape of the uncertainty set.

2 Distributionally Robust Policy Gradient for Offline Contextual Bandits

Anqi Liu, JHU, Baltimore, MD, Contact: aliu@cs.jhu.edu

Learning an optimal policy from offline data is notoriously challenging. We study the policy optimization problem in offline contextual bandits using policy gradient methods. We employ a distributionally robust policy gradient method, DROPO, to account for the distributional shift between the static logging policy and the learning policy in policy gradient. Our approach conservatively estimates the conditional reward distributional and updates the policy accordingly. We conduct experiments on real-world datasets under various scenarios of logging policies to compare our proposed algorithm with baseline methods in offline contextual bandits. We also propose a variant of our algorithm, DROPO-exp, to further improve the performance when a limited amount of online interaction is allowed.

3 Multistage Distributionally Robust Optimization Under Stochastic Disruptions

Haoxiang Yang, The Chinese University of Hong Kong, Shenzhen, Shenzhen, China

A stochastic disruption is a type of infrequent event in which the timing and the magnitude are random. We introduce the concept of stochastic disruptions, and a stochastic optimization framework is proposed for such problems. In this talk, we discuss two possibilities where we do not know the exact probabilistic distribution of the uncertainty under the stochastic disruption setting, one for the uncertainty magnitude and the other for the timing. We formulate a multi-stage distributionally robust optimization model while considering potential stochastic disruptions. To solve such complex models, we propose stochastic programming models for each case and solve them using cutting-plane methods. We present the computational results of our approach applied to an optimal power flow problem with N-1 contingencies.

Monday, October 16, 4:00 PM - 5:15 PM

ME38

CC-North 224A

Stochastic Optimization and Reinforcement Learning for Infrastructures

Community Committee Choice Session

Session Chair: Siqian Shen, University of Michigan, Ann Arbor, MI

1 Static and Dynamic Infrastructure System Monitoring Under Uncertain Time-Dependent Failures

Juan Estrada[1], Bo Zhou[1], Ruiwei Jiang[2], Siqian Shen[2], [1]University of Michigan at Ann Arbor, Ann Arbor, MI, [2]University of Michigan, Ann Arbor, MI, Contact: juanest@umich.edu

Modern society relies on infrastructure systems such as power grids, where aged components become unreliable, possibly triggering cascading failures, and thus should be monitored closely. We consider the problem of dispatching multiple maintenance fleets (e.g. drones) to examine different parts of a system, whose failures are probabilistic and depend on the fleet's arrival time. The goal is to balance the fleet's routing and operational cost with the uncertain cost of system failure and maintenance. We compare a static dispatch schedule by solving a stochastic integer nonlinear program and a dynamic dispatching policy based on updated failure probabilities. We demonstrate the numerical performance of the two approaches by testing the problem on IEEE 33-bus system.

2 Route Recommendation Optimization Under Unknown and Uncertain Travelers' Trust

Xinyu Fei[1], Bo Zhou[2], Ruiwei Jiang[1], Xi Jessie Yang[1], Siqian Shen[1], [1]University of Michigan, Ann Arbor, MI, [2]University of Michigan at Ann Arbor, Ann Arbor, MI, Contact: xinyuf@umich.edu

Route recommendation is a fundamental problem in transportation and arises in various applications, including autonomous navigation, shared mobility, and evacuation planning. Taking disaster response as an example, we consider evacuation route recommendation under ambiguous uncertain evacuees' trust, and the goal is to tradeoff between estimated travel time and crowdsourcing travel information gained from evacuees, to achieve better overall effectiveness of the recommended routes. We formulate a static stochastic mixed-integer program and a dynamic model with reinforcement learning, to update traffic, human trust, and route recommendations over time. We compare both models via numerical studies of diverse evacuation scenarios.

3 Trust-Aided Distributionally Robust Resource Allocation with Multi-Source Reference Information

Yanru Guo, Bo Zhou, Ruiwei Jiang, Xi Jessie Yang, Siqian Shen, University of Michigan, Ann Arbor, MI

Reference information plays an essential role in decision-making yet may vary across different information sources (e.g., mobile and fixed sensors in infrastructure systems). We consider resource allocation in stochastic dynamic systems, where we conduct multisource information fusion based on human trust, and design an ambiguity set of the probabilistic trust to attain robust solutions. We design a human-robot interaction process to simulate trust variation and adopt trial-and-error method to update trust. We demonstrate the performance of our approaches in applications of wildfire prevention and dynamic control.

4 Risk-Averse Reinforcement Learning for Real-Time Economic Dispatch

Bo Zhou[1], Ruiwei Jiang[2], Siqian Shen[2], Xian Yu[3], [1]University of Michigan at Ann Arbor, Ann Arbor, MI, [2]University of Michigan, Ann Arbor, MI, [3]The Ohio State University, Columbus, OH, Contact: siqian@umich.edu

We study risk-averse reinforcement learning (RL) that controls dynamic risk of a sequence of rewards in infinite-horizon Markov Decision Processes (MDPs), where we adapt the Expected Conditional Risk Measures (ECRMs) and prove time consistency. Using a combination of expectation and conditional value-at-risk (CVaR), we reformulate the risk-averse MDP as a risk-neutral counterpart with augmented action space and manipulation on the immediate rewards. We further prove that the Bellman operator is a contraction mapping, which guarantees the convergence of any value-based RL algorithms. Accordingly, we develop a risk-averse deep Q-learning framework to reduce variance and enhance solution robustness, and demonstrate our methods for real-time economic dispatch on IEEE bus systems under uncertain power disruptions.

Monday, October 16, 4:00 PM - 5:15 PM

ME39

CC-North 224B

TSL Best Dissertation Award

Award Session

Session Chair: Jennifer A. Pazour, Rensselaer Polytechnic Institute, Troy, NY

1 **TSL Best Dissertation Award**

Jennifer A. Pazour, Rensselaer Polytechnic Institute, Troy, NY

- Presentations to come
- TSL Best Dissertation Award
- TSL Best Dissertation Award Winner
- TSL Best Dissertation Honorable Mention

Monday, October 16, 4:00 PM - 5:15 PM

ME40

CC-North 225A

Challenges from Parking in Last-Mile Delivery

Community Committee Choice Session

Session Chair: Sara Reed, University of Kansas, Lawrence, KS

1 Delivery Drivers' Parking Preferences in Last Mile Urban Operations

Johanna Amaya[1], Trilce Encarnacion[2], Maira Delgado-Lindeman[3], [1]Pennsylvania State University, University Park, PA, [2]University of Missouri- St. Louis, Saint Louis, MO, [3]University of Cantabria, Santander, Spain. Contact: amayaj@psu.edu

In this paper, we examine drivers' perspectives regarding parking in urban areas in the northeastern United States. Stated preferences data were collected and analyzed using a mixed logit and a hybrid discrete choice models. The results show that searching time, walking time to the delivery destination, and cost of parking impact parking selection. Additionally, Safe Behavior, a moderating latent variable, influences parking choices and impacts drivers differently. We also observed that the first choice for drivers is to park in an available spot, followed by double parking. Even though drivers try to avoid parking in restricted areas, their first priority is making on time deliveries. The paper provides recommendations to policymakers and logistics service providers (carriers) to improve last-mile operations and reduce the cost of deliveries in urban areas.

2 On-Street Parking for Freight, Services, and E-Commerce Traffic in Us Cities

Diana Gineth Ramirez-Rios[1], Lokesh Kumar Kalahasthi[2], Jose Holguin-Veras[3], [1]University at Buffalo, Buffalo, NY, [2]Indian Institute of Technology Delhi, India, India; [3]Rensselaer Polytechnic Institute, Troy, NY, Contact: dgramire@buffalo.edu

We develop a simulation model incorporating freight and service vehicle demand estimates, probability distributions of parking durations, and industry sectors to estimate the on-street parking demand needs for urban commercial traffic in the US. Our paper shows results at the city block level and ZIP code level. We tested four demand management initiatives to reduce the peak-hour needs. The off-hours strategy, which indicates 30 % of freight pick-ups and deliveries and 51 % of service visits shifting to the off-hours, is the most effective one, with the potential to reduce daytime parking needs by 30 %. Results also show the need to dedicate curb space for FSA vehicle parking to satisfy time-of-day requirements.

3 Inclusive Curbside Parking Allocation for Cargo Bicycles

Rishi Verma, University of Washington, Seattle, WA

The use of cargo bicycles for last-mile delivery has been gaining traction in recent years due to their low environmental impact and impacts on traffic congestion compared to vehicles. However, using cargo bicycles for delivery means a different set of constraints and challenges than traditional vehicle delivery, for example, a different road network, parking availability, and delivery radius. In this study we will use a queueing model to analyze the curbside parking capacity of a street network for mixed fleet compositions of delivery vehicles and cargo bicycles. The same set of delivery requests may be undertaken by either cargo bicycle or delivery vehicle, thereby using different load sizes and speeds and affecting arrival rates for curbside parking spaces. The optimal parking allocation and curbside parking policy is determined.

4 Optimal Parking and Reservation Decisions for Last-Mile Delivery

Sara Reed[1], Ann Melissa Campbell[2], Barrett Thomas[2], [1]University of Kansas, Lawrence, KS, [2]University of Iowa, Iowa City, IA, Contact: sara.reed@ku.edu

Parking is a time-consuming component of last-mile delivery. We introduce the Stochastic Last-Mile Parking Problem (SLMPP) to model the search process for parking around a rectangular block that includes the customer location. When the driver finds an available parking spot, a solution to the SLMPP answers the question: should the driver park or drive on? We model the SLMPP as a Markov Decision Process and characterize the structure of the optimal policy. We then extend this model to the SLMPP with Reservations, where the driver decides whether to use a reservation spot outside the search block. Computational experiments identify an optimal fee threshold that the driver should be willing to pay for the reservation spot. We use these managerial insights to provide a trade-off analysis for urban planners' pricing reservation spots.

5 Steiner Traveling Salesman Problem with Online Parking Information: A Stochastic Shortest Path and Reinforcement Learning Framework

Venktesh Pandey[1], Tarun Rambha[2], [1]North Carolina Agricultural and Technical State University, Greensboro, NC, [2]Indian Institute of Science, Bangalore, India

The surge in multimodal curbside usage and e-commerce/food deliveries has led to limited availability of parking spaces, prompting the exploration of adaptive solutions to the delivery vehicle routing problem. In this study, we propose a novel approach that leverages historical and partially-observable real-time parking availability information to find the Hamiltonian tour minimizing the total expected cost. We compare two solution methods: an iterative stochastic shortest path (iSSP) and a scalable reinforcement learning (RL) method based on the underlying Steiner Traveling Salesman Problem. Additionally, accounting for municipality parking constraints and time windows, we quantify the productivity gains relative to traditional pre-trip tours and evaluate the tradeoffs between scalability and optimality of solutions from the iSSP and RL approaches.

Monday, October 16, 4:00 PM - 5:15 PM

ME41

CC-North 225B

Multi-objective Optimization and Applications

Contributed Session

Session Chair: Chelsea Greene, University of Washington, Bedford, NH

1 Optimization Model for Selecting Target Segment in Mass Marketing Campaigns

Cesar Salazar-Santander[1], Alejandro Francisco Mac Cawley[2], Carolina Martinez-Troncoso[1], [1]Pontificia Universidad Catolica de Chile, Santiago, Chile; [2]Pontificia Universidad Catolica de Chile, Santiago, Chile. Contact: amac@uc.cl

Defining a target group for a mass marketing campaign is a non-trivial goal, which depends on the correct definition of the commercial stimuli and the selection of a customer target segment that will maximize the campaign's effectiveness. In this research, we propose a methodology based on a mixed multi-objective optimization formulation that allows determining a minimum continuous customer target segment for massive campaigns to maximize its effectiveness with a maximum budget constraint. The model multi-objective function maximizes the campaign's effectiveness while minimizing the "broadness" of the segments targeted, allowing the detection of the most effective and homogeneous target group possible. The methodology performance was benchmarked against traditional customer segmentation algorithms like K-Means and Greedy selection methodology.

2 Supplier Selection and Order Allocation Using a Multi-Objective Model, Integrated with Machine Learning Methods

Saman Hassanzadeh Amin, Toronto Metropolitan University, Toronto, ON, Canada. Contact: saman.amin@torontomu.ca

Supplier selection and order allocation is an important problem in purchasing and procurement. In this talk, a two-stage approach for supplier selection and order allocation planning is discussed. Stage 1 involves determining the values of the demands based on machine learning methods. In Stage 2, a new multi-objective model is introduced to select the best supplier(s) and to determine the order(s). The results show that the values of demands have effects on both the selected suppliers and the allocated orders to them.

3 A Data-Driven Algorithm to Rellocate Immigrants: A Challengue with Data Changes and Concept Drift

Daniel Romero Rodriguez[1], Gina Galindo[2], Santiago Buitrago[1], Alberto Brito[1], Leonardo Santiago[1], [1]Universidad del Norte, Barranquilla, Colombia; [2]Universidad del Norte, Puerto Colombia, Colombia. Contact: hromero@uninorte.edu.co

A data-driven approach is used to suggest locations for immigrants in a new country. We evaluate different alternatives to cope with data changes and model performance variations. The alternatives include data balancing, training models with the latest data, and mixed strategies. The algorithm and the strategies are evaluated on a testbed with information from Colombia and Venezuelan immigrants.

4 A Multiple Objective Optimization Problem to Allocate Budget for TB and HIV Care Delivery Programs in Diverse Regions

Chelsea Greene, Zelda B. Zabinsky, University of Washington, Seattle, WA, Contact: cgreene3@uw.edu

Tuberculosis (TB) is the leading cause of death among people living with HIV. As a result, administering integrated TB and HIV care in regions where the burden of TB and HIV co-infection is high effectively improves health outcomes. Community-based delivery programs, as opposed to facility-based care, have been shown to increase uptake but are more costly. We present a multiple objective optimization problem to determine the best combinations of delivery programs to administer TB and HIV care in a set of regions, given a budget constraint. We simulate TB and HIV disease progression with a dynamic transmission model to predict health outcomes given diverse regional parameters. We explore the set of Pareto optimal solutions for allocation of budget to delivery programs by region, considering noise in the objective functions inherent to infectious disease modeling.

Monday, October 16, 4:00 PM - 5:15 PM

ME42

CC-North 226A

RAS Student Paper Competition

Award Session

Session Chair: Pengling Wang, Tongji University, Shanghai, China

Monday, October 16, 4:00 PM - 5:15 PM

ME43

CC-North 226B

Multi-modality in Air Transportation

Community Committee Choice Session

Session Chair: Ang Li, 1</sup

1 Airport Express Bus Dispatch Based On Airport Accessibility Maximization

Shriya Karam[1], Ang Li[2], Mark M. Hansen[3], [1]Massachusetts Institute of Technology, Boston, MA, [2]University of California-Berkeley, Emeryville, CA, [3]University of California-Berkeley, Berkeley, CA, Contact: shriyakaram@gmail.com

Through the 2021 $1.2 trillion Bipartisan Infrastructure Law, The U.S. Department of Transportation aims to create and sustain equitable and accessible intercity transportation systems. However, in accessing the intercity transportation system through airports, individuals' ability to travel to airports through a reliable ground transportation mode may inhibit their accessibility to intercity destinations. Using a cohort-based optimization approach, we determine the optimal allocation of a limited supply of express buses to serve an airport from a particular bus station by maximizing accessibility scores of census tracts to airports, accounting for the impact of census tracts' financial disadvantage. The approach and findings of the study provides a framework for examining the impact of ground access improvements based on accessibility as a planning metric.

2 Air Transport Demand in Europe and North-America: Estimation and Application in an Aviation Environmental Policy Game

Gianmarco Andreana[1], Gerben de Jong[2], Nicole Adler[3], [1]Hebrew University of Jerusalem, Jerusalem, Israel; [2]Seo Economics, Amsterdam, Netherlands; [3]Hebrew University, Jerusalem, Israel. Contact: gianmarco.andreana@mail.huji.ac.il

This paper estimates air transport demand for business and leisure segments in the European, North American, and transatlantic markets. Using a nested logit discrete choice model, we find significant differences in demand parameters across different segments and markets, with leisure travelers in North America being more price-sensitive than those in Europe. Additionally, non-price characteristics are valued higher by business passengers than leisure passengers in all markets. We apply our findings to an environmental game that demonstrates the impact of demand differences on the optimal level of environmental taxes in Europe and North America. This paper contributes to the literature on aviation demand, environmental policies for aviation, and game-theoretical approaches in aviation markets.

3 Multimodal UAV-Based Parcel Delivery for Congestion Mitigation

Ang Li, University of California-Berkeley, Emeryville, CA

Urban parcel delivery has emerged as a high growth market, and the resulting delivery traffic can pose great challenges in dense urban areas. There is growing interest in supplanting the conventional model of a dedicated delivery person operating a van to alternatives featuring new classes of vehicles such as drones, autonomous robots, and electric cargo bikes. This work proposes combined delivery strategies using trucks, cargo bikes and drones. We develop and compare multimodal delivery strategies with various mode combinations. Then, we evaluate the benefit of multi-modal delivery in both uncongested and congested transportation networks. Results show that multimodal delivery strategies outperform other strategies in congested situations. We suggest taking advantage of synergistic operation among emerging vehicle types for more efficient parcel delivery.

4 Skyport Location Problem for Urban Air Mobility System

Hyelim Shin[1], Taesik Lee[1], Hyun-Rok Lee[2], [1]KAIST, Daejeon, Korea, Republic of; [2]Inha University, Michuhol-gu, Korea, Republic of. Contact: hyelim.shin@kaist.ac.kr

Skyport, a designated area for take-off and landing of air taxis, is a basic element for an air taxi-based transportation service system. When planning a skyport network, it is important to consider midair congestion between air taxis, as it can increase the risk of collisions and operational complexity. This study proposes a novel hub location problem, which incorporates midair congestion caused by intersecting vehicles along hub-to-hub arcs. The problem is reformulated as a linear formulation by leveraging a property of the original problem, which involves nonconvex bilinear terms. Also, a heuristic algorithm is developed to handle large-scale problems. Analysis of the optimal skyport network designs under various environments shows that the viability of an air taxi service depends on several factors such as collision risk, system cost, and airspace design.

5 Design and Implementation of Urban Air Mobility (UAM) Corridor Systems: A Multi-Disciplinary Approach

XUAN Jiang[1], Hao Yang[2], Shangqing Cao[1], Junzhe Cao[3], Yuhan Tang[4], [1]UC Berkeley, Berkeley, CA, [2]Washinton University, Seattle, CA, [3]University of California, Berkeley, Berkeley, CA, [4]ucberkeley, berkeley, CA, Contact: j503440616@berkeley.edu

This paper presents a comprehensive and multi-disciplinary approach towards the design and implementation of such systems.We propose a novel framework integrating advanced computational models, regulatory considerations, and urban planning principles. The design process begins with the identification of potential aerial routes using Geographic

Information System (GIS) data. Next, we consider the socio-economic factors and local air traffic regulations to optimize these routes. The paper delves into the integration of vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communication systems to ensure the safe operation of aerial vehicles within these corridors. Our proposed framework incorporates the use of electric vertical take-off and landing (eVTOL) aircraft to mitigate these concerns.

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ME44

CC-North 226C

AI and Transfer Learning in Economic Systems

Community Committee Choice Session

Session Chair: Yifan Yu, University of Washington, Seattle, WA

1 Correcting Differential Measurement Error on Outcome in Treatment Effect

Wendao Xue, University of Washington Seattle, Seattle, WA, Contact: wendaox@uw.edu

Measurement error is a ubiquitous element of the literature. There has been a considerable amount of research on correcting measurement errors in regression models, while little research has been conducted on potential outcome models for causal inference. I demonstrate in this paper that differential measurement error on the outcome variable could affect the treatment effect’s performance and reliability. Furthermore, I investigated the identification of the average treatment effect when there are differential measurement errors on outcome variables and proposed an estimator for the average treatment effect. I provide consistency and asymptotic normality results for the proposed estimator and apply them to survey data concerning crime behavior studies.

2 Asymmetric Shapley Value for Augmented Data Valuation

Xi Zheng[1], Xiangyu Chang[2], Ruoxi Jia[3], Yong Tan[1], [1]University of Washington, Seattle, WA, [2]Xi’an Jiaotong University, Xi’an, China; [3]Virginia Polytechnic Institute and State University, Blacksburg, VA, Contact: xzheng01@uw.edu

As data becomes the fuel for technological and economic growth, a fundamental challenge is to quantify the value of data in algorithmic decision-making. Shapley Value, a classic notion from cooperative game theory, has been applied to measure the value of data points in supervised machine learning. Data augmentation techniques are widely used in machine learning tasks to reduce overfitting and boost performance. However, the Shapley Value has some key limitations when valuing augmented datasets; for example, the values ignore causal structure in the data. We propose a novel framework that utilizes Asymmetric Shapley Value for better valuation of augmented datasets and an efficient algorithm based on the K-nearest neighbors (KNN) model family. We demonstrate the utility of our framework in diverse data market settings.

3 Correcting Machine Learning Generated Variable Bias in Regression Models

Jingwen Zhang, wendao xue, Yifan Yu, Yong Tan, University of Washington, Seattle, WA, Contact: jingwenz@uw.edu

In recent times, machine learning generated features are increasingly being used as independent variables in empirical research. However, machine learning algorithms can have measurement errors. Directly plugging such features in the final model may result in biased estimation and hence inaccurate conclusions. In light of this, we examine the problem of correcting bias arising from machine learning algorithms in both linear and partial linear regression models. We propose multiple estimators that utilize two-stage least square method and generalized method of moments to correct such bias. We demonstrate the asymptotic consistency and normality of our estimators. We conduct extensive Monte Carlo simulations and also use Amazon review data to compare the performance of our estimators with other existing methods.

4 Exploring Strategic Behavior with Different Identity of Chatbot: Emotion Expression and Manipulation

Yu Kan, University of Washington, Lynnwood, WA

As organizations increasingly turn to Artificial Intelligence (AI) for addressing customer complaints, understanding the dynamics of user interactions with AI and human agents becomes imperative. In this study, we investigate customers’ strategic behavior when interacting with different agent types. We employ a two-round lab experiment, where participants are randomly assigned to an AI-based agent, a ChatGPT-based agent, a human agent, or an undisclosed identity group. Participants express their level of feeling and decide on the acceptance of proposed solutions by the assigned agent. We observed participants in undisclosed identity group felt less negative but paradoxically expressed more negativity. Our findings contribute to the growing body of research on AI-user interactions, suggesting intriguing dynamics of agent’s identities.

5 Digital Sculptors: Utilizing Generative AI to Boost Online Review Helpfulness

Xingchen Xu[1], Wendao Xue[1], Yifan Yu[1], Lin Jia[2], Yong Tan[1], [1]University of Washington, Seattle, WA, [2]Beijing Institution of Technology, Beijing, China. Contact: yifanyu@uw.edu

This work explores the effectiveness of using generative AI (ChatGPT) to boost online review helpfulness. Providing helpful reviews is the fundamental economic value of online review platforms. Generative AI technologies, such as ChatGPT, may potentially be used by the platforms to rewrite online reviews and boost the perceived helpfulness of existing reviews. Therefore, ChatGPT may be used to monetize existing digital assets of online review platforms.

Monday, October 16, 4:00 PM - 5:15 PM

ME45

CC-North 227A

Deep Learning Applications in OM

Community Committee Choice Session

Session Chair: Antoine Desir, INSEAD, 263 Avenue Daumesnil, France

1 A Practical End-to-End Learning for Inventory Management in E-Commerce

Meng Qi[1], Yuanyuan Shi[2], Yongzhi Qi[3], Chenxin Ma[4], Rong Yuan[4], Di Wu[5], Zuo-Jun Max Shen[6], [1]Cornell University, Ithaca, NY, [2]University of California San Diego, La Jolla, CA, [3]JD.com, Beijing, China; [4]JD.com, Santa Clara, CA, [5]JD.com, Mountain View, CA, [6]University of California Berkeley, Berkeley, CA

We consider a multi-period inventory management problem faced by E-commerce companies. We propose a one-step end-to-end (E2E) framework that uses deep learning models to output the suggested replenishment amount directly from input features without any intermediate step. The E2E model is trained to capture the behavior of the optimal dynamic programming solution under historical observations without any prior assumptions on the distributions of the demand and the VLT. By conducting a series of thorough numerical experiments using real data from one of the leading e-commerce companies, we demonstrate the advantages of the proposed E2E model over conventional PTO frameworks.

2 Deep Learning for Choice Modeling

Xiaocheng Li[1], Kalyan Talluri[2], Hanzhao Wang[1], [1]Imperial College Business School, London, United Kingdom; [2]Imperial College Business School, London, VT, United Kingdom

Choice modeling has been a central topic in the study of individual preference or utility across many fields including economics, marketing, and operations research. While the vast majority of the literature on choice models has been devoted to the analytical properties that lead to managerial and policy-making insights, the existing methods to learn a choice model from empirical data are often either computationally intractable or sample inefficient. In this paper, we develop deep learning-based choice models under two settings of choice modeling: (i) feature-free and (ii) feature-based. Our model captures both the intrinsic utility for each candidate choice and the effect that the assortment has on the choice probability. Synthetic and real data experiments demonstrate different aspects of the proposed models' performances.

3 Using Neural Networks to Guide Data-Driven Operational Decisions

Ningyuan Chen[1], Saman Lagzi[2], Joseph Milner[1], [1]University of Toronto, Toronto, ON, Canada; [2]University of Toronto Rotman School of Management, Toronto, ON, Canada. Contact: ningyuan.chen@utoronto.ca

We propose to use Deep Neural Networks to solve data-driven stochastic optimization problems. Given the historical data of the observed covariate, taken decision, and the realized cost in past periods, we train a neural network to predict the objective value as a function of the decision and the covariate. Once trained, for a given covariate, we optimize the neural network over the decision variable using gradient-based methods because the gradient and the Hessian matrix can be analytically computed. We characterize the performance of our methodology based on the generalization bound of the neural network. We show strong performance on two signature problems in operations management, the newsvendor problem and the assortment pricing problem.

4 Improving Greedy Algorithms for Assortment Optimization Problems with Machine Learning

Antoine Desir[1], Axel Parmentier[2], [1]INSEAD, 263 Avenue Daumesnil, France; [2]Ecole Nationale des Ponts et Chaussées, Champs sur Marne, France. Contact: antoine.desir@insead.edu

Assortment optimization is an important problem that arises in many practical applications such as retailing and online advertising. In this paper, we propose a new data-driven approach to assortment optimization that leverages recent advances in learning machine learning pipelines with combinatorial optimization layers. Under the MNL model, the optimal assortment is revenue ordered. Instead, our approach can be interpreted as a smart greedy algorithm that returns a score ordered assortment, where the scores are learned from data. Since the scores are learned offline, our approach is as fast as a greedy algorithm. Moreover, we conduct extensive numerics and show that it returns near optimal solutions for a variety of choice models and constrained settings.

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ME46

CC-North 227B

Advancing Energy Equity, Climate and Social Justice Using OR

Community Committee Choice Session

Session Chair: Erin Baker, Univ of Massachusetts-Amherst, Amherst, MA

Session Chair: Ogechi Nwadiaru, University of Massachusetts, Amherst, MA

1 Hydrogen in Texas: Fueling a Local, Equitable Energy Transition

Jerry Potts, Sergio Castellanos, University of Texas at Austin, Austin, TX, Contact: jerry.potts@utexas.edu

Hydrogen has emerged as an alternative fuel source to decarbonize hard-to-electrify sectors. As demand increases, the development of the hydrogen supply chain is likely to have substantial impacts on long-term grid planning decisions. In this work, we develop an open-source capacity expansion model to co-optimize the hydrogen supply chain along with the electricity sector in Texas. We identify necessary expansions to hydrogen production, transport, and storage to meet projected hydrogen demand and the expected impact on long-term grid planning across a breadth of economic and policy scenarios. The results of this model are then evaluated based on their environmental and economic impacts to quantify inequitable impacts across communities.

2 Designing Retirement Strategies for Coal-Fired Power Plants to Mitigate Air Pollution and Health Impacts

Wei Peng, Carla Campos, Penn State, University Park, PA

By considering six coal plant retirement strategies for Pennsylvania that vary by targets and priorities, we find the spatial distribution of the air quality impacts depends on which units are shut down and where. In addition, Pennsylvania's coal retirement decisions also influence the power generation and associated air quality impacts in the rest of the PJM region.

3 Assessing the Tradeoff of Efficiency for Autonomy in Powering African Microbusiness Operations

Ogechi V. Nwadiaru[1], Erin Baker[2], [1]University of Massachusetts, Amherst, MA, [2]University of Massachusetts, Amherst, MA, Contact: onwadiaru@umass.edu

In this work we explore, energy insecurity in urban poor productive use settings and attempt to establish an economic case for energy storage as a replacement for existing backup alternatives.

4 Historical Inequities in the Location and Deployment of Energy Infrastructure in the United States

Erin Mayfield, Dartmouth College, Hanover, NH

This presentation evaluates historic inequities in the location and deployment of energy infrastructure using regression and machine-learning based methods. We focus on three case studies the provide differential insights. First, we evaluate systemic inequities on the basis of income, race, and education of greenhouse gas-producing power plants and industrial infrastructure locations. Next, we evaluate monetary and non-monetary drivers of utility-scale solar and wind deployment. Finally, we investigate the socioeconomic, demographic, and political drivers of residential technology adoption (e.g., electric vehicles, distributed solar, heat pumps) in rural areas.

Monday, October 16, 4:00 PM - 5:15 PM

ME47

CC-North 227C

Computational Methods for Uncertainty Quantification II/II

Community Committee Choice Session

Session Chair: Moses Chan, Northwestern University, Evanston, IL

1 Active Learning of a Recursive Non-additive Emulator for Multi-fidelity Computer Experiments

Junoh Heo, Chih-Li Sung, Michigan State University, East Lansing, MI, Contact: heojunoh@msu.edu

In this talk, we introduce the Recursive Non-Additive (RNA) emulator, a flexible model for integrating multi-fidelity computer experiments. Unlike conventional methods, RNA avoids the additive assumption and captures complex relationships using Gaussian process modeling. It efficiently computes the posterior predictive mean and variance in a closed form, enhancing computational efficiency. Furthermore, we introduce an active learning strategy to optimize accuracy while managing computational costs and selecting fidelity levels and input locations. The RNA emulator shows promising potential for enhancing the analysis of complex systems with varying fidelity data.

2 Discovering Active and Co-Active Subspaces for High Dimensional Computer Models

Kellin Rumsey, Los Alamos National Laboratory, NM

Active Subspaces are becoming an increasingly important technique for dimension reduction. Recent research has demonstrated that active subspace calculations can be obtained in closed form, conditional on a Gaussian process surrogate. We produce the relevant calculations for a more general case which can be applied to the GP, recovering previous results as a special case, or applied to the models constructed by other regression techniques including multivariate adaptive regression splines. Using a MARS surrogate has many advantages including improved scaling, better estimation of active subspaces in high dimensions and the ability to handle a large number of prior distributions in closed form. In one real-world example, we obtain the active subspace of a radiation-transport code with 240 inputs and 9,372 model runs in under half an hour.

3 Performance Analysis of Sequential Experimental Design for Calibration of Simulation Models

Ozge Surer[1], Stefan Wild[2], [1]Miami University, Oxford, OH, [2]Berkeley Lab, Berkeley, CA, Contact: surero@miamioh.edu

Simulation models often have parameters that need to be calibrated using observed data. For expensive simulation models, calibration is typically done using an emulator of the simulation model. Using a sequential selection of parameters to build the emulator can drastically improve the efficiency of the calibration process. The rate of the speed up in a sequential design is further affected by other factors such as the run time of a simulation model and the time to select parameters. This work provides a performance analysis study on the difference between sequential and batch-sequential synchronous and asynchronous procedures in experimental design with different acquisition functions.

4 Maximum One-Factor-at-a-Time Designs for Screening in Computer Experiments

Qian Xiao[1], Roshan V. Joseph[2], Douglas M. Ray[3], [1]University of Georgia, Athens, GA, [2]Georgia Institute of Technology, Atlanta, GA, [3]US Army DEVCOM Armaments Center, Picatinny Arsenal, NJ, Contact: roshan@isye.gatech.edu

Identifying important factors from a large number of potentially important factors of a highly nonlinear and computationally expensive black box model is a difficult problem. Morris screening and Sobol' design are two commonly used model-free methods for doing this. In this work, we establish a connection between these two seemingly different methods in terms of their underlying experimental design structure and further exploit this connection to develop an improved design for screening called Maximum One-Factor-At-A-Time (MOFAT) design. We also develop efficient methods for constructing MOFAT designs with a large number of factors. Several examples are presented to demonstrate the advantages of MOFAT designs compared to Morris screening and Sobol' design methods.

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ME48

CC-North 228A

Spatiotemporal Decision Intelligence

Community Committee Choice Session

Session Chair: Ziyue Li, University of Cologne, Kowloon, Hong Kong

Session Chair: Fugee Tsung, HKUST(GZ), Kowloon, Hong Kong

1 Spatial Temporal Data Inference via Self-Supervised Inductive Tensor Decomposition

Man Li[1], Fugee Tsung[2], [1]HKUST, Hong Kong, Hong Kong; [2]HKUST(GZ), Kowloon, Hong Kong. Contact: mlicn@connect.ust.hk

Spatiotemporal data inference is an important task in many domains. Most research on spatiotemporal data analysis has focused on random missing data imputation, while paid little attention to blockout missing and segment missing - recovering signals from unseen sensors and continuous-time missing, and most matrix/tensor completion methods are not inductive. Therefore, we propose a self-supervised probabilistic tensor decomposition model to recover all-type missing signals for spatial temporal data. Random sub-tensors are generated based on the topology structure as training samples and by maximizing the log-likelihood of all reconstructed sub-tensors, unifying basis are extracted which can be transferred to the same type of inference task. Empirical results on real-world spatiotemporal datasets demonstrate the effectiveness of out model.

2 Deep Insights into Noisy Pseudo Labeling on Graph Data

Botao Wang[1], Fugee Tsung[2], [1]Hong Kong University of Science and Technology, Hong Kong SAR, China; [2]HKUST(GZ), Kowloon, Hong Kong

Pseudo labeling is a wide-applied strategy to enlarge the labeled dataset by self-annotating the potential samples during training. However, the incorrect label can be fatal to the spatiotemporal data. The inappropriate pseudo labeling may result in the performance degrading of the base model, especially on graph data where the noise can propagate. Thus, we present the pseudo labeling error analysis that the error is bounded by the confidence threshold and consistency of prediction. Accordingly, we propose a cautious pseudo labeling methodology in which we pseudo label samples with high confidence. The improvement on convergence property of the proposed algorithm is theoretically illustrated. The proposed algorithm consistently improves the base models and outperforms other pseudo labeling algorithms in link prediction and node classification tasks.

3 Spatial-Temporal Anomaly Detection from the Perspective of Graph Relational Learning

Weiqi Zhang, Hong Kong University of Science and Technology, Kowloon, Hong Kong, China

System monitoring and anomaly detection is a crucial task in daily operation. With the rapid development of industrial systems, multiple sensors get involved to represent the system state from different perspectives, which inspires us to detect anomalies considering feature dependence relationship. Thus, we propose a novel Graph Relational Learning Network to detect anomalies from the perspective of between-sensor dependence relationship learning. Variational AutoEncoder serves as the overall framework. Graph Neural Network and stochastic graph relational learning strategy are also imposed to capture the between-sensor dependence. A composite anomaly metric is established with the learned dependence structure explicitly. The experiments on four real-world datasets show superiority in detection accuracy, anomaly diagnosis, and model interpretation.

Monday, October 16, 4:00 PM - 5:15 PM

ME49

CC-North 228B

Multimodal Data Analysis for Interconnected and Distributed Systems

Community Committee Choice Session

Session Chair: Mostafa Reisi, University of Florida, Gainesville, FL

Session Chair: Elif Konyar, University of Florida, Gainesville, FL

1 Multimodal Cooperative Federated Data Fusion

Mohammad Amini, University of Florida, Gainesville, FL

Multimodal data fusion is a technique that combines data from multiple sources to gain a comprehensive understanding of complex systems. However, multi-modal data is often decentralized, and sharing sensitive data can compromise individual privacy. To address this issue, we propose a cooperative federated multimodal data fusion approach that preserves the privacy of data sources. With a federated approach, computations are performed locally on each dataset without requiring direct access to data. The approach has potential applications in healthcare, finance, and transportation, where sensitive data is involved, to enable more effective and secure collaboration among organizations.

2 Online Monitoring and Identifying Correlated Patterns Between Data Streams

Xinmiao Luan, Arizona State University, Tempe, AZ

The development of the manufacturing systems has made it increasingly necessary to monitor the data generated by multiple interconnected subsystems with rapid incoming of samples. Based on online learning techniques, we develop a general online monitoring approach for interconnected system, focusing on a basic scenario on monitoring of two connected subsystems, where each subsystem produces big data streams with several variation patterns in normal working conditions in this work. When special situation happens and new associations occur, a very small amount of computation is sufficient to update the system status and compute the control statistics by using this approach.

3 A Hybrid Prognostic Method for Rotating Machinery by Fusing Direct and Indirect Degradation Characteristics

Haitao Liao, University of Arkansas, Fayetteville, AR

It is often difficult to obtain direct degradation characteristics (DCs), which directly reflect the health of a machine, in real-time. Instead, indirect DCs are easy to collect. Traditional machine learning and model-based prognostic methods may not be precise when handling such data. This work presents a Direct-Indirect DCs Fusion method that combines direct and indirect DCs to predict the remaining useful life of the machine under time-varying conditions. The method accounts for time-varying covariates, converts indirect DCs to direct DCs under moderate sample sizes with a loop-Generative Adversarial Network (GAN), and describes the gradual degradation and sudden shocks in direct DCs. The method outperforms several benchmarks in RUL prediction as demonstrated in an industrial application.

4 Causal Graph Discovery from Self and Mutually Exciting Time Series

Song Wei[1], Yao Xie[1], Christopher Josef[2], Rishikesan Kamaleswaran[3], [1]Georgia Institute of Technology, Atlanta, GA, [2]Department of Surgery, Emory University School of Medicine, Atlanta, GA, [3]Department of Biomedical Informatics, Emory University School of Medicine, Atlanta, GA, Contact: swei70@gatech.edu

We present a generalized linear structural causal model, coupled with a novel data-adaptive linear regularization, to recover causal directed acyclic graphs (DAGs) from time series. By leveraging a recently developed Variational Inequality (VI) formulation, we cast the causal discovery problem as a general convex optimization. Furthermore, we develop a non-asymptotic recovery guarantee and quantifiable uncertainty by solving a linear program to establish confidence intervals. We validate our theoretical results and show the competitive performance of our method via extensive numerical experiments. We show the effectiveness of our approach in recovering highly interpretable causal DAGs over Sepsis Associated Derangements (SADs) while achieving comparable prediction accuracy to powerful ``black-box'' models such as XGBoost.

Monday, October 16, 4:00 PM - 5:15 PM

ME50

CC-North 229A

Energy Systems Integration

Community Committee Choice Session

Session Chair: Dharik Sanchan Mallapragada, MIT Energy Initiative, Massachusetts Institute of Technology, Cambridge, MA

1 The Tradeoffs Between Land-Use Constraints, and Indirect Carbon Emissions with the Development of Hydrogen Infrastructure in the Western Interconnection

Grant T. Aguinaldo, Neha Patankar, Binghamton University, Binghamton, NY, Contact: grant.aguinaldo@gmail.com

With the rising interest in using hydrogen to decarbonize the hard-to-electrify portions of the energy sector comes the need for the infrastructure to produce and transport hydrogen at scale. While past work has shown that solar hydrogen can be continuously produced at an industrial scale, care must be exercised not to ignore the spatial constraints in the indirect carbon emissions when connecting these plants to the grid and the potential for land-use conflicts. Since spatial considerations are necessary when siting a renewable hydrogen plant, a better understanding of the tradeoffs between possible land-use constraints and the embodied emissions from the produced hydrogen is needed. This presentation will highlight ongoing efforts to understand these tradeoffs when developing hydrogen infrastructure in the Western Interconnection.

2 Interactions Between Hybrid Power Plant Development and Local Transmission in Congested Regions

Julie Mulvaney Kemp, Lawrence Berkeley National Laboratory, Berkeley, CA, Contact: jmulvaneykemp@lbl.gov

This presentation will investigate plant-grid dynamics in highly congested regions - which offer insight into future grid conditions - to determine whether variable renewable energy generators, energy storage, and hybrid plants reduce or increase the need for nearby transmission. Whether or not a hybrid plant increases or decreases local transmission value depends on the plant's technological specifications (e.g., degradation costs) and regulatory environment (e.g., restrictions on grid charging). Therefore, advances in storage tech and policy decisions will influence which results will be realized. The financial implications of transmission expansion on hybrid and stand-alone plants will also be addressed. Results are based on real-time nodal price data and location-specific solar and wind profiles for 2018-2021 at 23 wind and solar plant locations in the U.S.

3 Optimizing India's Net-Zero Power System Planning Through Repurposing Coal Power Plants

Yifu Ding[1], Dharik Sanchan Mallapragada[2], [1]MIT Energy Initiative, Massachusetts Institute of Technology, Cambridge, MA, [2]MIT Energy Initiative, Massachusetts Institute of Technology, Cambridge, MA, Contact: yifuding@mit.edu

India's energy demand is projected to increase by 50% by 2040 due to rapid electrification, most through the adoption of air conditioners in the building sector. However, its current power system depends heavily on coal power plants. These plants predominantly rely on low-quality coal, producing significant carbon emissions and air pollution. Despite setting a target of adding 500 GW of renewable energy by 2030, India has yet to propose a phase-out plan for its coal plants. Routine power system planning only focuses on renewable investments and will likely fall into carbon lock-in because of a lack of system flexibility. This talk will present power system planning strategies through repurposing coal power plants, aiming to cancel the coal lock-in effect and achieve the least-cost net-zero system.

4 No Grid is a (Voluntary) Island, Connecting Texas to the Western Grid

Drew Kassel, Joshua Rhodes, Michael Webber, The University of Texas at Austin, Austin, TX, Contact: drew.kassel@utexas.edu

Maintaining grid reliability in Texas is of increasing concern due to the recent failure of the ERCOT grid. Subsequent tight grid conditions have further eroded confidence. Most of the suggested solutions focus on simply building more power plant capacity. This study explores the option of building meaningful amounts of transmission capacity between ERCOT and its western neighbor WECC. For this analysis, we use the open-source capacity expansion model, GenX, to simulate different developmental pathways of ERCOT and WECC, with and without the ability to connect the regions, while simultaneously optimizing cost and avoiding outage events by planning for winter storms. We find that the model shows a strong preference for building a multi thousand-megawatt connection between ERCOT and WECC, resulting in a cheaper and cleaner pathway to maintaining reliability.

5 Reliability Assessment of Power Grid Operations Considering Correlated Dependency from Gas Pipeline Delivery

Zhi Zhou[1], Neal Mann[1], David Sehloff[1], Eric Tatara[2], Sinem Perk[1], Mitchell Krock[1], Akintomide Akinsanola[1], [1]Argonne National Laboratory, Lemont, IL, [2]Argonne National Laboratory, ARGONNE, IL, Contact: zzhou@anl.gov

Decarbonizing the electric grid intensifies the interaction between the grid and natural gas pipelines, both of which and their interplay are vulnerable to extreme weather. This research develops a modeling workflow to assess the joint risks of extreme weather on electricity and gas pipeline systems. The approach considers climate change scenarios, using a probabilistic model to characterize uncertainty of future extreme weather events using output from climate models. Additionally, an extended power grid operational model is utilized to accurately represent weather-affected grid inputs. With this model, the study evaluates grid reliability in terms of resource outage probability and, ultimately, load curtailment probability and expectation. A case study illustrates the methodology using a synthetic grid and pipeline system resembling ISO New England system.

Monday, October 16, 4:00 PM - 5:15 PM

ME51

CC-North 229B

Oil, Gas, and the Future of Energy

Community Committee Choice Session

Session Chair: Benjamin D. Leibowicz, The University of Texas at Austin, Austin, TX

1 Optimal Investment Planning for Oil and Gas Production Networks with Fixed Production Profiles

Donghao Liu[1], Benjamin D. Leibowicz[2], Jonathan F. Bard[3], [1]University of Texas at Austin, Austin, TX, [2]The University of Texas at Austin, Austin, TX, [3]University of Texas, Austin, TX, Contact: q33311131@gmail.com

This talk will be given to solve a newly devised model for oilfield planning problem. The model introduces a fixed production profile for all the wells and an overall investment budget. This model poses a higher demand for algorithm design. A heuristic based decomposition method will be introduced to solve the model efficiently.

2 Coordination Problems and Incentive Pass-Through in Carbon Capture, Utilization, and Storage Development

Abdullah Albeladi[1], Benjamin D. Leibowicz[2], [1]The University of Texas at Austin, Austin, TX, [2]The University of Texas at Austin, Austin, TX, Contact: albeladi@utexas.edu

The deployment of carbon capture, utilization, and storage (CCUS) technologies is crucial for achieving climate change mitigation goals. However, despite the 45Q tax credit incentives, progress has been slow. Our research examines whether coordination problems, where multiple agents must contribute to the development of CCUS infrastructure, could explain the limited deployment. To this end, we construct an equilibrium model of the CCUS market formulated as a mixed complementarity problem, which represents CO_2 capturers, pipeline operators, traders, utilizers, and storers as strategic players. Additionally, we investigate incentive pass-through and assess how 45Q revenues are apportioned to different players in the CCUS market.

3 The Effects of Policy Uncertainty and Risk Aversion on Carbon Capture, Utilization, and Storage Investments

Connor Colombe[1], Benjamin D. Leibowicz[2], Benjamin Mendoza[3], [1]University of Texas at Austin, Austin, TX, [2]The University of Texas at Austin, Austin, TX, [3]The University of Texas at Austin, Austin, TX

Carbon capture, utilization, and storage (CCUS) systems capture CO2 and either put it to productive use (utilization) or safely sequester it underground (storage). While model-based analyses suggest an important role for CCUS in climate change mitigation pathways, CCUS infrastructure investment has been slow to materialize. We hypothesize that the slow pace of CCUS deployment is driven in large part by policy uncertainty regarding government incentives for CCUS and investors' risk aversion. We test this hypothesis by developing a CCUS infrastructure network optimization model formulated as a two-stage stochastic program. Future incentive levels are uncertain and risk aversion is incorporated through an objective function with conditional value at risk. As a case study, we apply our model to the TX and LA Gulf Coast under the 45Q federal tax incentives for CCUS in the US.

4 Integrated Energy System Modeling for Decarbonizing Pjm: Identifying Optimal Strategies for Net-Zero Emissions

Shantanu Tarun Chakraborty[1], Nicole Xiaoyang Shi[1], Dharik Sanchan Mallapragada[1], John E. Parsons[2], Pablo Duenas Martinez[1], [1]MIT Energy Initiative, Massachusetts Institute of Technology, Cambridge, MA, [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: shan2312@mit.edu

This study models a comprehensive energy system for decarbonizing the PJM region. At present, heavy industries in the region are reliant on coal and gas with limited renewables. The integrated model incorporates hydrogen, CCS, and renewables to achieve a low-carbon future. Optimization and capacity expansion models identify optimal strategies for transitioning PJM to net-zero emissions. The study emphasizes the impact of network constraints and spatial distribution of resources. Scenario analysis reveals trade-offs and synergies between technologies. The importance of hydrogen as an energy vector, and CCS's potential to offset emissions and renewable power generation are underscored. This research contributes to understanding investment requirements for a low-carbon PJM system in terms of generation, transmission, and storage resources.

5 Equitable Low-Carbon Transition Pathways for California's Oil Extraction

Ranjit Deshmukh[1], Paige Weber[2], Olivier Deschenes[3], Danae Hernandez-Cortes[4], Tia Kordell[5], Ruiwen Lee[5], Christopher Malloy[3], Tracey Mangin[5], Measrainsey Meng[6], Sandy Sum[5], Vincent Thivierge[5], Anagha Uppal[7], David W. Lea[8], Kyle Meng[9], [1]University of California Santa Barbara, Santa Barbara, CA, [2]University of North Carolina, Chapel Hill, NC, [3]University of California Santa Barbara, Santa Barbara, CA, [4]Arizona State University, Tempe, AZ, [5]University of California Santa Barbara, Santa Barbara, CA, [6]University of California Santa Barbara, Santa Barbara, CA, [7]University of California Santa Barbara, Santa Barbara, CA, [8]University of California Santa Barbara, Santa Barbara, CA, [9]University of California Santa Barbara, Santa Barbara, CA, Contact: rdeshmukh@ucsb.edu

Oil supply-side policies---setbacks, excise tax, and carbon tax---are increasingly considered for decarbonizing the transportation sector. To examine health, labor, and equity impacts of policy-driven decarbonization pathways, we combine an empirical field-level oil production model, an air pollution model, and an employment model to characterize spatially-explicit 2020--2045 decarbonization scenarios from various policies applied to California, a major oil-producer with ambitious decarbonization goals. We find setbacks generate the largest avoided mortality benefits from reduced air pollution and the largest lost worker compensation, followed by excise and carbon taxes. Setbacks also yield the highest share of health benefits and the lowest share of lost worker compensation borne by disadvantaged communities.

Monday, October 16, 4:00 PM - 5:15 PM

ME52

CC-North 230

New Developments in Energy Markets

Community Committee Choice Session

Session Chair: Daniel Bienstock, Columbia University, New York, NY

1 Comparing Profit-Maximizing Offer Behavior of Generators in Centrally Versus Self-Committed Wholesale Electricity Markets

Yuzhou Jiang[1], Ramteen Sioshansi[2], [1]The Ohio State

University, Columbus, OH, [2]Carnegie Mellon University, Pittsburgh, PA, Contact: rsioshan@andrew.cmu.edu

We study the incentive properties of the two primary approaches to incorporating unit-commitment decisions in wholesale electricity markets. One approach is centralized unit commitment, wherein generating firms provide complex multi-part offers that specify their non-convex fixed and variable operating costs. The second approach is self-commitment, whereby firms determine unit-commitment decisions for their generating units individually and submit simple offers for the provision of energy. We find that the profit of the profit-maximizing firm does not differ significantly between the two market designs but that system costs can be higher under a self-committed design.

2 Data-Driven Inverse Optimization for Marginal Offer Price Recovery in Electricity Markets

Zhirui Liang, Johns Hopkins University

This talk presents a data-driven inverse optimization (IO) approach to recover the marginal offer prices of generators in a wholesale energy market. By leveraging underlying market-clearing processes, we establish a closed-form relationship between the unknown parameters and the publicly available market-clearing results. Based on this relationship, we formulate the data-driven IO problem as a computationally feasible single-level optimization problem. The solution of the data-driven model is based on the gradient descent method, which provides an error bound on the optimal solution and a sub-linear convergence rate. The effectiveness of the proposed method is demonstrated in a realistic NYISO 1814-bus system.

3 An Incentive Compatible Mechanism for Alignment of Day-Ahead and Real-Time Markets

Agostino Capponi, Bo Yang, Columbia University, New York, NY

We study whether virtual bidding can achieve its intended purpose of reducing the premium between the day ahead and real-time markets and prevent the underbidding behavior of power generators and load-serving entities. Using a game theoretical model, we show that virtual bidding aligns day ahead and real-time market prices, if there are sufficiently many virtual trades. If virtual bidding is absent, the load-serving entity exerts its market power and underbids in the day ahead market if the extra savings from such an action outweigh the potential losses from a small capacity realization. In contrast, if the prices are aligned, the load-serving entity increases its demand bid in the day ahead market to balance the risks from capacity and demand realizations, and incentivize renewable power suppliers to increase their offers.

4 Assessing Price Distributions in Future Electricity Grid Markets with a Stochastic Production Cost Model

Kaleb Smith, Jacob Mays, Cornell University, Ithaca, NY, Contact: ks885@cornell.edu

This talk considers the evolution of spot price distributions arising in power markets as systems transition to high levels of wind, solar, and storage. In systems dominated by thermal resources with minimal storage, marginal costs and therefore clearing prices are driven by fuel costs, enabling modelers to rely on simplified deterministic formulations to approximate price behavior. Future price formation may instead be increasingly driven by opportunity costs, necessitating a more sophisticated representation of uncertainty and intertemporal constraints. We describe the mechanics of price formation with storage, employ a stochastic production cost model to simulate prices in a modeled future system, and highlight the differences between the simulated prices and those that would arise in a deterministic analysis.

5 Opportunities for Heavy Industry to Exploit Market Structure

Alexandra M. Newman[1], Andrea Brickey[2], Daniel Bienstock[3], [1]Colorado School of Mines, Golden, CO, [2]South Dakota School of Mines and Technology, Rapid City, SD, [3]Columbia University, New York, NY, Contact: anewman@mines.edu

Heavy industry is associated with some of the most energy-intensive operations. Opportunities exist to capitalize on storage technologies and market pricing structures to lower energy costs by shifting certain operations to lower-priced time periods. We demonstrate, via several case studies, how optimizing production schedules can realize these gains.

Monday, October 16, 4:00 PM - 5:15 PM

ME53

CC-North 231A

Learning, Optimization, and Control for Carbon-neutral Electric Grids

Community Committee Choice Session

Session Chair: Sivaranjani Seetharaman, Purdue University, West Lafayette, IN

1 Plug-and-play Control For Resilient Renewable-rich Microgrids

Sivaranjani Seetharaman, Purdue University, West

Lafayette, IN
The large-scale integration of renewable distributed energy resources (DERs) such as rooftop solar panels and wind turbines, has led to architectures where several DERs, storage units, and loads are aggregated into clusters known as microgrids. Such low-cost microgrids can also improve clean energy access to remote and underserved communities. However, microgrids are vulnerable to stability issues due to DERs that can connect or disconnect from the network in an ad-hoc manner. In this context, we will present a new distributed control framework for resilient plug-and-play operation of renewable-rich microgrids. We will utilize the notion of dissipativity to design local controllers such that global network stability and robustness is maintained under arbitrary plug-and-play operations, without requiring any redesign of existing controllers in the network.

2 A Consensus-Based Multi-Agent Reinforcement Learning Framework for Voltage Control with Peer-to-Peer Energy Trading

Andrew Liu[1], Chen Feng[2], [1]Purdue University, West Lafayette, IN, [2]Purdue University, West Lafayette, IN, Contact: andrewliu@purdue.edu

Distributed renewable energy and storage resources via peer-to-peer (P2P) trading can stimulate their adoption and bring lower-cost energy to consumers. While decentralized multi-agent reinforcement learning (MARL) frameworks exist to automate prosumers' bidding strategies in a P2P market, such approaches lack theoretical backing; nor can they account for network constraints. To address these, we propose a consensus-update MARL that enables prosumers to communicate with each other while collectively learning to maintain voltage constraints. Conditions for convergence are established and simulations show the consensus-based MARL can lead to higher profits from P2P trading than a decentralized MARL without communication.

3 Microgrid OS: A Platform for Workplace Decarbonization

Lucien D. Werner, Yiheng Xie, Thuy-Linh Le, Steven H. Low, California Institute of Technology, Pasadena, CA, Contact: lwerner@caltech.edu

Microgrid Operating System (OS) is a software platform that enables energy applications such as demand response, carbon reduction, and peak shaving to operate on top of any microgrid hardware (e.g., batteries, PV, EV charging, flexible load). In this talk we first present its three-layer architecture, consisting of data, modeling, and optimization. We then discuss our deployments of the data and modeling layers in a large-scale testbed on the Caltech campus, addressing the common painpoints of obtaining high-quality timeseries data and network models. Through case studies of resiliency planning and carbon footprint reduction, we demonstrate the necessity of these data and modeling efforts in supporting a range of energy and carbon optimization applications.

Monday, October 16, 4:00 PM - 5:15 PM

ME54

CC-North 231B

ICS Awards Session

Award Session

Session Chair: Thiago Serra, Bucknell University, Lewisburg, PA

1 3 ICS Awards will be Presented

Akshay Gupte, University of Edinburgh, Edinburgh, United Kingdom

Here are the 3 awards, presenters will be added soon.ICS Prize, Harvey Greenberg Research Award, and ICS Student Paper.

Monday, October 16, 4:00 PM - 5:15 PM

ME55

CC-North 231C

On-Demand Transportation Services

Community Committee Choice Session

Session Chair: Philipp Afeche, University of Toronto, Rotman School of Management, Toronto, ON, Canada

1 Autonomous Vehicles in Ride-Hailing and the Threat of Spatial Inequalities

Francisco Castro[1], Jian Gao[1], Sebastien Martin[2], [1]University of California, Los Angeles, Los Angeles, CA, [2]Northwestern University, Evanston, IL, Contact: jian.gao.phd@anderson.ucla.edu

This paper studies how the potential introduction of autonomous vehicles (AVs) in a fleet of human drivers (HVs) may impact the quality of service and the equality of access to transportation on ride-hailing platforms. We formulate a game-theoretical queueing model in which a platform aims to maximize its profit while HVs make strategic joining decisions. Our results demonstrate that the introduction of AVs may deteriorate the service level. We then reveal that the reduction of service level is not homogeneous across areas in a city: while the more profitable high-demand areas, such as downtown areas, may see a high concentration of vehicles and reasonable service levels, remote locations may suffer from a drop in service level. Then, using New York City data, we build a simulation that more closely resembles the operations of a ride-hailing platform.

2 Price-Waiting Trade-Offs in Ride-Hailing Platforms

Katerina Giannoutsou, Andrew Daw, University of Southern California, Marshall School of Business, Los Angeles, CA

We present a model for studying a ride-hailing platform that is faced with price and delay-sensitive riders and drivers, and is considering offering two different service classes which are differentiated in prices and delays. We explore the "price of two sides", show that the preferences of drivers impact the delays the riders experience and demonstrate that achieving the "full optimum" of price differentiation may not be feasible or optimal for a platform under all market conditions.

3 Role Of Mobility-on-Demand In Hybrid Transportation: A Dual Sourcing Approach

Sunil Chopra[1], Sebastien Martin[2], Partha Mishra[2], Karen Smilowitz[1], [1]Northwestern University, Evanston, IL, [2]Kellogg School of Management, Northwestern University, Evanston, IL, Contact: partha.mishra@kellogg.northwestern.edu

Motivated by new hybrid operations in transportation, we study a novel dual-sourcing problem with a trade-off between cost and responsiveness. In our setting, the slower source offers batched service at a fixed rate (e.g., shuttles), while the faster source has unit capacity and operates on demand (e.g., Uber). We assume the fast server's cost-per-capacity is more than that of the slow server. A central planner must control the slow server's service rate and choose when to use the fast server to minimize the cumulative expected waiting and service provision cost. Our key finding reveals that the optimal policy limits total demand to a finite threshold at any time. Beyond this, new demand is instantly directed to the fast source. An interesting implication of this result is that Ubers should only be used to cap the waiting passenger queue in an optimal hybrid operation.

4 Effectiveness Of Supply-Side Financial Incentives In Ride-hailing Networks With Spatial Demand Imbalance And Strategic Drivers

Uta Mohring[1], Philipp Afèche[2], Andre Augusto Cire[3], [1]University of Toronto, Toronto, ON, Canada; [2]University of Toronto, Rotman School of Management, Toronto, ON, Canada; [3]University of Toronto, Toronto, ON, Canada. Contact: uta.mohring@rotman.utoronto.ca

When matching riders with self-interested drivers in a spatial network, ride-hailing platforms face two challenges: (i) there are spatial demand imbalances that require some repositioning of drivers to serve the total rider demand, and (ii) the self-interested drivers strategically decide whether to join the network and if so, whether to wait for the next rider or reposition when not serving riders. We study the effects of supply-side financial incentives on drivers' decentralized repositioning decisions and the resulting repositioning equilibrium and evaluate their effectiveness in achieving the equilibrium under centralized repositioning.

Monday, October 16, 4:00 PM - 5:15 PM

ME56

CC-North 232A

Hybrid Quantum-Classical Methods for Optimization

Community Committee Choice Session

Session Chair: David Bernal Neira, NASA Ames Research Center, Palo Alto, CA

1 Using Quantum and Physics-Inspired Methods for Constrained Optimization: Reformulations, Decomposition Algorithms, Software and Benchmarking

David Bernal Neira, Purdue University, West Lafayette, IN

Optimization problems arise in different areas and solving these problems efficiently is essential for various applications. Quantum computers have the potential to efficiently solve nonlinear and combinatorial problems. However, current quantum computers cannot efficiently address practical problems; they are limited to small sizes and do not handle constraints well. We present different approaches to formulating and solving Quadratic Unconstrained Binary Optimization (QUBO) problems through unconventional computation methods, including but not limited to quantum algorithms, via open-source toolkit in Julia QUBO.jl. Finally, we show a hybrid classical-quantum algorithm to solve mixed-binary quadratically constrained programs via decomposition strategies leading to QUBO subproblems that can be solved by novel hardware (see arXiv:2207.13630)

2 Accelerating Coherent Continuous Variable Machines Using Momentum

Robin Brown[1,2], David Bernal Neira[3,2], Davide Venturelli[2],

Marco Pavone[1], [1]Stanford University, Stanford, CA, [2]Universities Space Research Association, Mountain View, CA, [3]NASA Ames Research Center, Palo Alto, CA, Contact: rabrown1@stanford.edu

Recently, Khosravi et al (2022) proposed a coherent continuous variable machine (CCVM) that encodes continuous variables using the quadrature operators of quantum optical modes, demonstrating improvements over SoTA classical heuristics. The dynamics of the CCVM encourage optimization via optical pulses corresponding to the negative gradient of the objective, however standard gradient descent is known to be trapped by local minima and hampered by poor problem conditioning. In this work, we propose to modify the CCVM dynamics using more sophisticated pulse injections based on techniques such as momentum and ADAM. We show that by using momentum updates rather than gradients for the pulse injections, we improve performance over both the original CCVM variants by increasing the probability of success and reducing the number of simulation timesteps.

3 Specialized Gaussian Process Modifications for Shot-Efficient Quantum-Classical Optimization

Farshud Sorourifar[1], Diana Chamaki[2,3], Norm M. Tubman[2], Joel A. Paulson[4], David E. Bernal Neira[2,3], [1]Ohio State University, [2]NASA Ames Research Center, Moffett Field, CA, [3]USRA Research Institute for Advanced Computer Science, Mountain View, CA, [4]Ohio State University, Columbus, OH

Quantum computing (QC) has been gaining traction due to its potential to address computationally challenging problems. Currently, QC success currently depends on hybrid quantum-classical optimization to build a circuit to represent the problem. however, such problems are difficult to solve; the observations from the circuit are noisy, and QC time is expensive.This work leverages the differences in quantum optimization algorithms to provide a more shot-efficient Bayesian optimization strategy. Specifically, we provide a means to exploit the 2riodicities of the rotation angles and use low-shot circuit observations to warm start the Bayesian optimization. We demonstrate the effectiveness of our proposed approach through an ablation study and show that using both proposed features statistically outperforms the other approaches with high confidence.

4 Iterative Quantum Optimization

Stuart Hadfield[1,2], [12]NASA Ames, Moffett Field, CA

Achieving real-world quantum advantage for hard combinatorial optimization problems remains an elusive goal. A recent paradigm seeks to utilize quantum devices in a novel way, as part of a hybrid quantum-classical loop that iteratively reduces a sequence of smaller problems. Here we describe recent progress on Iterative Quantum Optimization (IQO), providing a unifying framework for several quantum and classical algorithms. We generalize IQO to a much wider class of problems including those with hard constraints, and show how IQO is easily extended to a tree-search variant that incorporates backtracking and branch-and-bound, to enable further effective searching when additional computational resources are available. Finally, we show experimental and numerical evidence that IQO can lead to significantly improved performance on existing noisy quantum hardware.

5 Parameter Setting for Quantum Approximate Optimization of Weighted Problems

Dylan Herman[1], Shree Hari Sureshbabu[1], Ruslan Shaydulin[1], Joao Basso[2], Shouvanik Chakrabarti[1], Yue Sun[1], Marco Pistoia[1], [1]JPMorgan Chase, New York, NY, [2]Department of Mathematics, University of California, Berkeley, Berkeley, CA, Contact: dylan.a.herman@jpmorgan.com

We develop parameter setting heuristics for QAOA applied to weighted problems. First, we derive optimal parameters for QAOA with depth p=1 applied to the weighted MaxCut problem under different assumptions on the weights. Second, for p>1 we prove that the QAOA energy landscape for weighted MaxCut approaches that for the unweighted case under a simple rescaling of parameters. Also, we prove that for p=1 the QAOA objective sharply concentrates around its expectation, which means that our parameter setting rules will hold with high probability for a random weighted instance. We numerically validate this approach on a dataset of 34,701 weighted graphs with up to 20 nodes. Third, we propose a general heuristic rescaling scheme inspired by the analytical results for weighted MaxCut and demonstrate its effectiveness on the portfolio optimization problem as an example.

Monday, October 16, 4:00 PM - 5:15 PM

ME57

CC-North 232B

Quantum Linear Algebra and Optimization

Community Committee Choice Session

Session Chair: Mohammadhossein Mohammadisiahroudi, Lehigh University, Bethlehem, PA

Session Chair: Zeguan Wu, 1</sup

1 Hybrid HHL with Dynamic Quantum Circuits on Real Hardware

Romina Yalovetzky, Pierre Minssen, Dylan Herman, Marco Pistoia, JPMorgan Chase, Manhattan, NY, Contact: romina.yalovetzky@jpmorgan.com

This work advances a hybrid variant of the Harrow-Hassidim-Lloyd (HHL) algorithm that is suitable for noisy intermediate-scale quantum devices. First, we reduce the circuit complexity of the eigenvalue estimation component by leveraging newly available quantum-hardware features for implementing dynamic quantum circuits, such as mid-circuit measurements, qubit reset and reuse, and quantum conditional logic. Second, we introduce a novel method for scaling the linear-system matrix such that the eigenvalue estimation is more accurate. We empirically demonstrate the effectiveness of these Hybrid HHL enhancements by applying this algorithm to small portfolio optimization problems, executed end-to-end on the Quantinuum System Model H1-2 trapped-ion quantum computer.

2 An Inexact Feasible Quantum Interior Point Method for Linear and Quadratic Optimization

Zeguan Wu, Mohammadhossein Mohammadisiahroudi, Brandon Augustino, Xiu Yang, Tamas Terlaky, Lehigh University, Bethlehem, PA, Contact: zew220@lehigh.edu

Quantum linear system algorithms (QLSAs) have the potential to speed up algorithms that rely on solving linear systems. Interior Point Methods (IPMs) yield a fundamental family of algorithms for solving optimization problems. IPMs require the solution of a Newton linear system at each iteration, thus QLSAs can potentially speed up IPMs. Such quantum-assisted IPM (QIPM) provides inexact solution for the Newton linear system due to the noise in contemporary quantum computers. Typically, an inexact search direction leads to an infeasible iterate. In our work, we propose an inexact feasible QIPM (IF-QIPM) and show its advantage in solving linear optimization and linearly constrained convex quadratic optimization problems.

3 Quantum Relaxation for Quadratic Programs over Orthogonal Matrices

Andrew Zhao[1], Nicholas C. Rubin[2], [1]University of New Mexico, Albuquerque, NM, [2]Google, San Francisco, CA, Contact: azhao@unm.edu

Quadratic programming over the (special) orthogonal group encompasses a broad class of optimization problems such as group synchronization, point-set registration, and simultaneous localization and mapping. Such problems are instances of noncommutative quadratic optimization over orthogonal matrices. In this work, we establish an embedding of this class of problems onto a quantum Hamiltonian. Determining extremal states of this Hamiltonian provides an outer approximation, analogous to classical approaches such as semidefinite relaxations. In this talk, I will describe how this relaxation of a classical problem into a quantum one arises naturally, its connections with well-studied problems in quantum physics, and potential avenues for quantum advantage, in particular when tackling problems over the special orthogonal group (i.e., rotation matrices).

4 Quantum Algorithms for Hedging and the Learning of Ising Models

Patrick Rebentrost[1], Yassine Hamoudi[2], Maharshi Ray[3], Xin Wang[4], Siyi Yang[5], Miklos Santha[6], [1]Centre for Quantum Technologies, National University of Singapore, singapore, Singapore; [2]Université de Paris, IRIF, CNRS, Paris, France; [3]Mie University, Tsu city, Japan; [4]Institute for Quantum Computing, Baidu Research, Beijing, China; [5]Centre for Quantum Technologies, National University of Singapore, Singapore, Singapore; [6]Université de Paris, IRIF, CNRS, Centre for Quantum Technologies and MajuLab UMI 3654, National University of Singapore, Singapore, Singapore. Contact: maharshi91@gmail.com

In the Hedge algorithm by Freund and Schapire, an allocation into different strategies is chosen for multiple rounds and each round incurs corresponding losses for each strategy. The algorithm obtains a favorable guarantee for the total losses even in an adversarial situation. This work presents quantum algorithms for such learning tasks. For T time steps and N strategies, we exhibit run times of about $O(\mathrm{poly}(T)\sqrt{N})$ for estimating the losses and for betting on individual strategies by sampling. In addition, we discuss a quantum analog of the Sparsitron, a machine learning algorithm based on the Hedge algorithm. The quantum algorithm inherits the provable learning guarantees from the classical algorithm and exhibits polynomial speedups. The speedups may find relevance in finance and machine learning, for example, for learning generalized linear models or Ising models.

Monday, October 16, 4:00 PM - 5:15 PM

ME58

CC-North 232C

Graph Optimization for Computer Vision

Community Committee Choice Session

Session Chair: Bo Jones, Rice University, Houston, TX

1 Graph-Theoretical Approach to Robust 3D Normal Extraction of LiDAR Data

Wenbo Sun, Arpan Kusari, University of Michigan Transportation Research Institute, Ann Arbor, MI

A major challenge in LiDAR data analysis arises from the irregular nature of LiDAR data that forces practitioners to either regularize the data using some form of gridding or utilize a triangular mesh such as triangulated irregular network (TIN). While there have been a handful applications using LiDAR data as a connected graph, a principled treatment of utilizing graph-theoretical approach for LiDAR data modelling is still lacking. In this presentation, we formulate the normal estimation problem in an optimization framework, where we find the corresponding normal vector for each LiDAR point by utilizing its nearest neighbors and simultaneously enforcing a graph smoothness assumption based on point samples. We provide a simulation study on repeated randomly generated datasets and a case study on a large scale synthetic plane extraction dataset.

2 Uncertainty-Aware Efficient Subgraph Isomorphism Using Graph Topology

Arpan Kusari[1], Wenbo Sun[2], [1]University of Michigan, Ann Arbor, MI, [2]University of Michigan Transportation Research Institute, Ann Arbor, MI, Contact: kusari@umich.edu

Subgraph isomorphism or subgraph matching is a NP-complete problem with edge weights taking real values and being subject to measurement noise and possible anomalies. In the absence of node labels, these subgraph matching methods do not work. We propose a method for identifying the node correspondence between a subgraph and a full graph in the inexact case without node labels in two steps - (a) extract the minimal unique topology preserving subset from the subgraph and find its feasible matching in the full graph, and (b) implement a consensus-based algorithm to expand the matched node set by pairing unique paths based on boundary commutativity. To demonstrate the effectiveness of the proposed method, a simulation and a case study is performed on the Erdos-Renyi random graphs and the image-based affine covariant features dataset respectively.

3 Clique Relaxations for Outlier Rejection in Point Cloud Registration

Bo Jones[1], Illya V. Hicks[2], [1]Rice University, Houston, TX, [2]Rice University, Houston, TX, Contact: bo.jones@rice.edu

For registering two point clouds, past work has demonstrated improvements in registration accuracy when employing an initial preprocessing step in which a consistent set of initial correspondences is selected. This is accomplished by finding a cohesive subgroup in the consistency graph having vertices potential correspondences. Others have used the maximum clique, maximum density subgraph and maximum k-core to determine cohesive subgroups. We investigate the effectiveness of using maximum edge weight clique and other clique relaxations, including k-plex, for this purpose.

4 Robin: A Graph-Theoretic Approach to Reject Outliers in Robust Estimation Using Invariants

Jingnan Shi[1], Heng Yang[2], Luca Carlone[1], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Harvard University, Cambridge, MA, Contact: jnshi@mit.edu

Many estimation problems in robotics and computer vision require estimating unknown quantities in the face of outliers. Outliers are typically the result of incorrect data association or feature matching, and they adversely affect the quality of solutions. This work develops an approach, named ROBIN, to prune outliers. First, we use the theory of invariance to quickly check if a subset of measurements are mutually compatible without explicitly solving the corresponding estimation problem. Second, we develop compatibility hypergraphs, where measurements are modeled as vertices and mutual compatibility as edges. We generalize existing results showing that the inliers form a clique in a compatibility hypergraph and typically belong to the maximum clique. We demonstrate the effectiveness of ROBIN on several geometric perception problems.

Monday, October 16, 4:00 PM - 5:15 PM

ME59

CC-West 101A

Models of Disease Transmission and Prevention in Service Systems

Community Committee Choice Session

Session Chair: Mohammad Delasay, Stony Brook University, Stony Brook, NY

Session Chair: Sherwin Doroudi, University of Minnesota, Minneapolis, MN

1 Stochastic Analysis of Disease Transmission via Infectious Aerosols in the M/G/Infinity Queue

Sherwin Doroudi, Alexander Wickeham, University of Minnesota, Minneapolis, MN, Contact: sdoroudi@umn.edu

We present a stochastic model of disease transmission via infectious aerosols. Our model considers individuals (some infectious and others susceptible) that arrive to and depart from an M/G/infinity queuing system. Infectious individuals release infectious aerosols that decay over time during their sojourn in the system, with these particles possibly persisting in the system even after the individual emitting them departs. Meanwhile, a susceptible customer becomes infected if the concentration-time product of its exposure to infectious aerosols exceeds an exponentially distributed threshold. Using a variety of queueing-theoretic techniques we derive expressions (in terms of integrals and special functions) for the probability that a susceptible customer entering the system becomes infected.

2 A Study on Queueing Topology for Reducing Customer Overlaps in Service Systems

Jin Xu[1], Young Myoung Ko[2], Min Kong[3], Jamol Pender[4], [1]Huazhong University of Science and Technology, Wuhan, China; [2]Pohang University of Science and Technology, Pohang, Korea, Republic of; [3]Anhui Normal University, Wuhu, China; [4]Cornell University, Ithaca, NY, Contact: youngko@postech.ac.kr

During pandemics, effective queue management reduces infection risk. This paper explores queueing topologies and flow control policies, introducing average overlapping time and number of overlapped customers as infection risk metrics. We examine serial and parallel topologies, designing practical flow control schemes for serial systems. The grocery store model reveals a risk-efficiency tradeoff and bounded waiting time. Parallel topology with even splitting results in fewer overlaps but not shorter overlapping time. Join-the-shortest-queue achieves smaller overlapping time and number with slight efficiency loss. We discuss risk preferences, mixed topologies, and service distributions.

3 The System-Specific Basic Reproduction Rate in Queueing Networks

Kang Kang[1], Sherwin Doroudi[2], Mohammad Delasay[3], [1]Evidera, Minneapolis, MN, [2]University of Minnesota, Minneapolis, MN, [3]Stony Brook University, Stony Brook, NY

The system-specific basic reproduction rate is a recently introduced queueing-theoretic metric that measures the risk of disease transmission in small-scale service facilities that can be modeled as queueing systems. The specific computation of this metric is based on capturing the stochasticity in each customer pair's sojourn time overlap. This work considers the derivation of this metric in queueing networks with adequate service capacity. We present a high-level overview of the dynamics of queueing network models and describe our transmission model, which governs disease transmission between customers within these queueing networks. We provide illustrative examples and analytical details.

Monday, October 16, 4:00 PM - 5:15 PM

ME60

CC-West 101B

MIF Life as a Ph.D. Student Panel

Panel Session

Session Chair: Diana Gineth Ramirez-Rios, University at Buffalo, Buffalo, NY
Session Chair: Clara Novoa, Texas State University, San Marcos, TX
Session Chair: Sofía Pérez-Guzmán, Georgia Institute of Technology, Atlanta, GA

1 Moderator

Sofía Pérez-Guzmán, Georgia Institute of Technology, Atlanta, GA

As social and racial injustice disproportionately affects well-being, this panel discussion brings three important stakeholders to share teaching practices with the OR/MS community to create a well-being-focused positive learning environment.

2 Panelist

Christian Hernandez-Negron, University of Massachusetts-Amherst, Amherst, MA

3 Panelist

Paula Andrea Penagos Rodriguez, University of Missouri - St. Louis, Saint Louis, MO

4 Panelist

Himadri Sen Gupta, University of Oklahoma, Norman, OK

5 Panelist

Gulten Busra Karkili, University of Massachusetts Amherst, Amherst, MA

Monday, October 16, 4:00 PM - 5:15 PM

ME61

CC-West 101C

OR Applications in Elections

Community Committee Choice Session

Session Chair: Charles Thraves, University of Chile, Santiago, Chile

1 On the Detection of Outlier Ballot Boxes Using Ecological Inference

Charles Thraves, University of Chile, Santiago, Chile

We present a novel technique to estimate an RxC Ecological Inference model. The model is used to detect outlier ballot boxes in an election where we know the votes obtained by candidates and aggregate demographic information of voters. The Ecological Inference model is used to estimate the voting probabilities, and then these are used to compute the p-values of each ballot box.

2 Measurement of Constituency Size Based on Minimum Campaign Distance and Application to Evaluate the Merger of Electoral Districts

Yuichiro Miyamoto[1], Toshio Nemoto[2], [1]Sophia University, Tokyo, Japan; [2]Bunkyo University, Chigasaki, Kanagawa, Japan

The area and population of an electoral district are main indicators of its constituency size. They are not, however, indicators that can be used to limit the merger of electoral districts for Japan's upper house of councilors. This study proposes the minimum campaign distance (MCD) that is calculated via the Prize collecting Traveling Salesman Problem (PCTSP) as a new indicator for measuring constituency size and examines relevant issues based on actual measurements, with the aim of using this indicator to evaluate such mergers. With characteristics different from those of area and population, the MCD is an indicator that can be used to limit such mergers. We also present the result of the computational experiments. Test instances are generated from the Japanese national census.

3 The Polls and the Presidential Election in 2020 ...And 2024

Arnold I. Barnett, Massachusetts Institute of Technology, Cambridge, MA, Contact: abarnett@mit.edu

In 2020 as in 2016, polls about the presidential election are believed to have performed miserably. But sophisticated aggregators like FiveThirtyEight use the polls as raw materials, making adjustments for their biases and offering probabilistic forecasts. We assess how well FiveThirtyEight fared in 2020. Spoiler alert: the results are surprising.

4 Assessing and Mitigating Security Risks Associated with Voting by Mail

Carmen Haseltine, Laura Albert, University of Wisconsin-Madison, Madison, WI, Contact: haseltine@wisc.edu

In recent years there has been additional scrutiny on the security and reliability risks associated with election processes, particularly absentee voting. However, no analytical tools presently exist to help election officials assess and mitigate risks while balancing key performance metrics. To address this knowledge gap, we develop a discrete time Markov chain model of the vote-by-mail (VBM) process capturing VBM performance, threats, and mitigations. The modeling approach leverages attack graphs that characterize malicious and non-malicious threats. Additionally, the model links attack graphs to security mitigations and impact to VBM processes. The model is constructed using a real-world case study data from Wisconsin.

Monday, October 16, 4:00 PM - 5:15 PM

ME62

CC-West 102A

PSOR Best Video Award Finalists

Award Session

Session Chair: Cagil Kocyigit, University of Luxembourg, Luxembourg, Luxembourg

1 Operations Research in Milk Banking

Rachel Wong, University of Toronto, Toronto, ON, Canada

2 Improving Emergency Department Flow

Jacob Jameson, Harvard University, Cambridge, MA

3 Improving Access to Volunteers

Akshaya Suresh, Yale University, New Haven, CT

4 Disrupting Sex Trading Recruitment Using Community-Based Resources

Baris Tezcan, Northeastern University, Boston, MA

Monday, October 16, 4:00 PM - 5:15 PM

ME63

CC-West 102B

Service Science Best Cluster Paper Award Competition (II)

Award Session

1 Too Many Meetings? Scheduling Rules for Team Coordination

Guillaume Roels[1], Charles J. Corbett[2], [1]INSEAD, Fontainebleau, France; [2]University of California-Los Angeles, Los Angeles, CA

Workers in knowledge-intensive industries often complain of having too many meetings, but organizations still give little thought to deciding when or how often to meet. Using a stylized game-theoretic model, we investigate the efficiency and robustness of various coordination scheduling rules.

We show that small teams allow a more fluid, i.e., worker-driven, approach to scheduling coordination, while larger teams benefit from the addition of time-based controls to reserve some minimal amount of productive time or to enforce coordination after some point. Also, a fixed-interval meeting schedule works well for very large teams. Our research helps formalize the tension between meeting (coordinating) and producing, and indicates how to adapt team coordination scheduling rules to the degree of worker heterogeneity and team size.

2 Asymptotically Optimal Policies for Dynamic Ambulance Dispatch

Cheng Hua[1], Tong Wang[1], Jingwei Zhang[2], Ziyan Zhou[1], [1]Shanghai Jiao Tong University, Shanghai, China; [2]The Chinese University of Hong Kong, Shenzhen, China

3 Helping the Captive Audience: Advance Notice of Diagnostic Service for Hospital Inpatients

Miao Bai, University of Connecticut, Storrs, CT

4 Does the Seller's Response Time Affect the Buyer's Concession? Evidence from eBay Online Bargaining

Wen Zhang, Baylor University, Waco, TX

Monday, October 16, 4:00 PM - 5:15 PM

ME64

CC-West 102C

User-generated Content and Online Review

Community Committee Choice Session

Session Chair: Keumseok Kang, KAIST, Miami, FL

Session Chair: JaeHong Park, Kyunghee University, Seoul, Korea, Republic of

1 Does Rich Information Matter in Online Review Videos?

Bongjin Sohn[1], Heejin Joo[2], Gunwoong Lee[1], [1]Korea University, Seoul, Korea, Republic of; [2]Georgia State University, Atlanta, GA, Contact: bjsohn@korea.ac.kr

This study investigates the reasons behind online users' inclination towards simpler information when assessing complex products through online review videos. By incorporating concepts from information overload and media richness theory, we suggest that users encounter information overload due to the complexity in both the review video and the product itself, which consequently drives them to favor less informative content. From the analysis of 2,050 YouTube review videos focusing on wrist-watch products, the study finds that increased level of information in the review videos has a negative effect on user evaluation, particularly when it comes to technically complex products. These findings offer valuable insights for video creators and platform providers in effectively managing review videos.

2 Examining the Dynamic Growth Pattern of Self-Help Apps: Empirical Study with Dynamic Factor Models

Haeyoon Shin[1], Ho Jung Yoon[2], JaeHong Park[1], [1]Kyung Hee University, Seoul, Korea, Republic of; [2]Sejong University, Seoul, Korea, Republic of. Contact: hy32604@khu.ac.kr

The number of self-help apps has sharply increased in mobile markets. Despite the increasing popularity of self-help apps, previous studies overlooked identifying the factors behind the growth. Especially the growth of mobile apps is a dynamic and multifaceted process, with multiple factors interacting with each other. For example, the number of users, active users, user-generated content, and profits are mutually dependent on each other's growth. So, we aim to unveil the dynamic growth pattern of self-help apps. We empirically predict the profit of the self-help app with Dynamic Factor Models. We use deep learning methods to compare the performance. Our study is the first to explore and predict the growth of self-help apps with various factors' interdependence. This study will help to understand self-help apps' growth, enabling them to make more effective decisions.

3 The Heterogeneous Effect of Media User Generated Contents in the Business Models of Mobile Games: Evidence from Youtube

Seungwook Jin, Keumseok Kang, KAIST College of Business, Seoul, Korea, Republic of. Contact: tdns03@kaist.ac.kr

This research examines the impact of user-generated content (UGC) sentiments on the sales of mobile games, using comments on YouTube as a measure. The study finds that positive UGC sentiments about paid-to-play (P2P) mobile games have a promotional effect on revenue, while UGC sentiments related to free-to-play (F2P) games decrease revenue. Positive UGC sentiments affect downloads and short-term retention, while negative sentiments affect playing time and long-term retention of F2P games.

Monday, October 16, 4:00

PM - 5:15 PM

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CC-West 103A

TIMES Distinguished Speaker: Professor Kamalini Ramdas (LBS)

Award Session

Session Chair: Morvarid Rahmani, Georgia Institute of Technology, Atlanta, GA

1 Distinguished Speaker

Kamalini Ramdas, London Business School, London, United Kingdom

Monday, October 16, 4:00 PM - 5:15 PM

ME66

CC-West 103B

Federated Data Analytics Beyond Deep Networks: Showcasing the Power of Collaboration

Community Committee Choice Session

Session Chair: Raed Al Kontar, University of Michigan, Ann Arbor, MI

1 Heterogeneous Matrix Factorization

Naichen Shi, Raed Al Kontar, Salar Fattahi, University of Michigan, Ann Arbor, MI

In myriad statistical applications, data are collected from related but heterogeneous sources. These sources share some commonalities while containing idiosyncratic characteristics. More specifically, consider the setting where observation matrices from N sources are generated from a few common and source-specific factors. We show that under appropriate conditions on the alignment of source-specific factors, the problem is well-defined and both shared and source-specific factors are identifiable. To solve this problem, we propose a new class of matrix factorization algorithms, called Heterogeneous Matrix Factorization. HMF is easy to implement, and is intrinsically distributed. Through a variety of empirical studies, we showcase the advantageous properties of HMF and its potential application in feature extraction and change detection.

2 Collaborative Sequential Design via Consensus: Showcasing the Power of Collaboration for Optimal Design

Xubo Yue[1], Raed Al Kontar[2], Albert Solomon Berahas[2], [1]University of Michigan, Ann Arbor, Ann Arbor, MI, [2]University of Michigan, Ann Arbor, MI, Contact: maxyxb@umich.edu

Optimal design is a challenging task within many engineering applications. This challenge arises from the need for extensive trial and error efforts, often done through simulations or running field experiments. This paper proposes a new collaborative sequential design framework built upon the consensus mechanism. Clients collaboratively determine their next experimental points through a consensus optimization framework. In the early stages, clients rely more on each other to borrow strength and information to maneuver through the stages with scant data. In the late stages, each client will focus more on individual optimization problems to find a desirable solution. Experiments show that our proposed collaborative framework can accelerate the sequential design process efficiently and effectively.

3 Collaborative Bayesian Optimization via Leader-Conditioned Surrogates

Qiyuan Chen[1], Raed Al Kontar[2], Liangkui Jiang[3], Hantang Qin[3], [1]University of Michigan, Ann Arbor, MI, [2]University of Michigan, Ann Arbor, MI, [3]University of Wisconsin-Madison, Madison, WI

The increased computational power of edge devices has opened a new paradigm of collaborative analytics. This work focuses on collaborative Bayesian optimization (BO) where agents collaborate to efficiently optimize black-box functions without necessitating sensitive data exchange. We introduced a class of leader-conditioned surrogates where agents harness Bayesian optimal designs from strongly performing collaborators to improve and fast-track their optimization process. Our approach presents the first general-purpose collaborative BO framework compatible with any Gaussian process kernel and the most known acquisition functions. Despite our approach's simplicity, we show that it enjoys elegant theoretical guarantees and significantly outperforms state-of-the-art methods, especially when agents feature heterogeneity in their black-box functions.

4 Adversarial Client Detection in Internet of Federated Things with Non-Parametric Subspace Monitoring

Xianjian Xie, Arizona State University, Tempe, AZ, Contact: xxie43@asu.edu

The Internet of Federated Things (IoFT) represents a network of interconnected systems with federated learning as the backbone, facilitating collaborative knowledge acquisition while ensuring data privacy for individual systems. The wide adoption of IoFT, however, is hindered by security concerns, particularly the susceptibility of federated learning networks to adversarial attacks. In this paper, we propose an effective non-parametric approach FedRR, which leverages the low-rank features of the gradient space generated by federated learning to address the adversarial attack problem. Besides, our proposed method is capable of accurately detecting adversarial clients with precise average run length under no attack scenarios.

Monday, October 16, 4:00 PM - 5:15 PM

ME67

CC-West 104A

Optimization for Data Mining and Machine Learning

Community Committee Choice Session

Session Chair: Young-Woong Park, [1]</sup

1 Navigating Responsible University Expansion: The Art of Data-Driven Course Scheduling

Özge Aygül[1], **Shima Azizi[2], Andrew C. Trapp[1], [1]Worcester Polytechnic Institute, Worcester, MA, [2]St. John's University, Queens, NY**

Our study focuses on the multi-objective timetabling problem faced by universities in assigning courses to locations and meeting patterns while planning for long-term resource allocation. We aim to answer the question of how to efficiently use teaching space under yearly enrollment fluctuations due to expansion and contraction. The presence of overlapping instructor preferences and need to maintain responsible classroom densities leads to conflicts that we refer to as *overflow sections*. We propose to dynamically address overflow sections by relaxing capacity and splitting larger sections. To address, we introduce a hierarchical mixed-integer nonlinear program and simulate a variety of scenarios while considering faculty preference and utilization of locations. Our findings can assist universities make informed decisions for responsible long term planning.

2 D-optimal Data Fusion: Exact And Approximation Algorithms

Yongchun Li, Weijun Xie, Georgia Institute of Technology, Atlanta, GA

We study the D-optimal Data Fusion (DDF) problem that aims to select a small number of new data points in the presence of heterogeneous data, to maximize the overall information collected. We show that the DDF problem is NP-hard and has no constant-factor polynomial time approximation algorithm. Therefore, to solve the DDF problem effectively, we design an exact algorithm, aimed at solving the DDF problem to optimality. We further derive a family of submodular valid inequalities and optimality cuts, which can significantly enhance the algorithm performance. We also develop scalable randomized-sampling and local-search algorithms with provable performance guarantees. Finally, we test our algorithms using real-world data on the new phasor-measurement-units placement problem for modern power grids, considering the existing conventional sensors.

3 Improving Clinical Trial Efficiency with a Probabilistic Enrollment Estimation Model"

Dongjin Lee, Rebecca Vislay-Wade, Moderna, Cambridge, MA, Contact: dooungjin@gmail.com

Enrollment estimation is vital for successful clinical trials, as inaccurate estimates can cause delays, insufficient supplies, and resource misallocation. Moderna has developed a state-of-the-art probabilistic model based on the Poisson-gamma model to address these issues. This model accounts for critical variables, providing precise enrollment estimates while considering patient recruitment uncertainty. The approach enables efficient planning and decision-making, with the model updating estimates using Bayesian techniques as new data becomes available. The model's output can be applied to various activities, such as clinical supplies, finance, and manufacturing, optimizing production and reducing waste.

4 Predicting Municipal Solid Waste on the City Scale

Joshua Grassel, Kazi Wahadul Hassan, Adolfo Raphael Escobedo, Arizona State University, Tempe, AZ, Contact: jgrassel@asu.edu

Interest in studying how human systems interact with the environment is growing rapidly. We seek to understand these interactions with the intention of adjusting these systems to decrease our negative impact on both the natural environment and social well being. One such system is solid waste management. This research focuses on municipal solid waste (MSW), and how to predict waste quantity and material characterization in the US. There is still little public visibility on quantities and material breakdown. Existing studies are often either very narrow in scope, e.g. pertaining to a single city for a single year, or summarized so broadly that the data is impracticable. In this research, we gathered data and developed a predictive model to predict MSW quantity by material type down to the city scale.

5 Multi-commodity Hub Location-allocation Model With Synchronous And Asynchronous Flows

Kazi Wahadul Hasan[1], Adolfo Raphael Escobedo[2], Pitu Mirchandani[1], [1]Arizona State University, Tempe, AZ, [2]North Carolina State University, Raleigh, NC

In this research, two separate mixed integer programming (MIP) models have been proposed for multi-commodity network flow problem while incorporating the decision of hubs locations with finite capacity. The application of this model includes the flow of recyclable materials from the garbage bins to the end markets. The first formulation deals with asynchronous flow which means that materials are transported from multiple sources to the hubs following different schedules. This situation is explained by asynchronous waste streams. The second model accounts for the simultaneous material flow to the hub following synchronized schedules. This scenario is illustrated with separation of waste streams at the sources. The models are tested with small- and large-scale dataset and the computational performance of the MIP solvers are recorded.

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ME68

CC-West 104B

Statistical Learning Methods for Causal Inference and Data-Driven Decision Making

Community Committee Choice Session

Transferred Q-Learning

Elynn Chen, New York University, New York, NY

We consider both batch and online Q-learning with knowledge transfer, using samples from a target reinforcement learning (RL) task as well as source samples from different but related RL tasks. The proposed transferred Q-learning algorithm contains a novel re-targeting step that enables vertical information-cascading along multiple steps in an RL task, besides the usual horizontal information-gathering as transfer learning (TL) for supervised learning. We establish the first theoretical justifications of TL in RL tasks by showing a faster rate of convergence of the Q-function estimation in the offline RL transfer, and a lower regret bound in the offline-to-online RL transfer under certain similarity assumptions. Empirical evidences from both synthetic and real datasets are presented to backup the proposed algorithm and our theoretical results.

On Heterogeneous Treatment Effects in Heterogeneous Causal Graphs

Hengrui Cai, Department of Statistics, University of California Irvine, Irvine, CA

Heterogeneity andcomorbidity are two interwoven challenges associated with various healthcareproblems that greatly hampered research on developing effective treatment andunderstanding of the underlying neurobiological mechanism. Very few studieshave been conducted to investigate heterogeneous causal effects (HCEs) ingraphical contexts due to the lack of statistical methods. To characterize thisheterogeneity, we first conceptualize heterogeneous causal graphs (HCGs) bygeneralizing the causal graphical model with confounder-based interactions andmultiple mediators. Such confounders with an interaction with the treatment areknown as moderators. This allows us to flexibly produce HCGs given differentmoderators and explicitly characterize HCEs from the treatment or potentialmediators on the outcome. We establish the theoretical forms of HCEs and derivetheir properties at the individual level in both linear and nonlinear models.An interactive structural learning is developed to estimate the complex HCGsand HCEs with confidence intervals provided. Our method is empiricallyjustified by extensive simulations and its practical usefulness is illustratedby exploring causality among psychiatric disorders for trauma survivors.

Monday, October 16, 4:00 PM - 5:15 PM

ME69

CC-West 105A

Data-driven Analytics and Decision-Making in Big Data Applications

Community Committee Choice Session

Session Chair: Baek Jaeseung, 1</sup

1 Efficient Speed-Oriented Sparse PCA for Dimension Reduction

Yifan Xie[1], Tianhui Wang[1], Junyoung Kim[2], Kyungsik Lee[2], Myong Kee Jeong[1], [1]Rutgers University, Piscataway, NJ, [2]Seoul National University, Seoul, Korea, Republic of. Contact: yifan.xie@rutgers.edu

Sparse Principal Component Analysis (SPCA) is an interpretable alternative to ordinary PCA for high-dimensional data. It enhances sparsity in components, boosting interpretability while reducing susceptibility to noise. Conventional SPCA solves a non-convex optimization problem to identify sparse components, but it can be computationally challenging, especially for high-dimensional data. This paper proposes a speed-oriented SPCA method that sequentially identifies sparse components with minimal angles to ordinary PCA counterparts. The proposed method reduces computational complexity and increases efficiency, particularly for large-scale datasets, while retaining core SPCA attributes. Computational tests demonstrate its viability as an efficient alternative for analyzing data and coping with computational difficulties in conventional SPCA.

2 Multi-Source Cross-Weight Ensemble Method for Virtual Metrology in Semiconductor Manufacturing

Tianhui Wang[1], Jaeseung Baek[2], Yifan Xie[1], Myong Kee Jeong[1], [1]Rutgers University, Piscataway, NJ, [2]Northern Michigan University, Marquette, MI, Contact: tw507@ rutgers.edu

In Industry 4.0, sensors used in monitoring production processes generate massive data for machine learning to enhance efficiency and quality. In semiconductor manufacturing, multi-source data poses challenges for building virtual metrology (VM) models due to varying attributes. Creating separate prediction models for each source leads to a loss of redundancy and reduced tolerance for data uncertainty. We propose a novel boosting method for the prediction of critical dimensions in VM. It integrates data fusion, adapts to multi-source data, and considers the impact of multi-source data during sampling distribution updates. Numerical results demonstrate its superiority over benchmarks, with lower mean squared error and robust performance despite the noise in real-life semiconductor VM data.

3 Data-Driven Newsvendor Literature Review: A Topic Modeling Approach

Adeela Gulzari, University of North Texas, Denton, TX

Retailers who sell perishable items face a challenge in deciding how much to order to balance holding and penalty costs. The classical newsvendor model addresses this issue by assuming that the demand distribution is known. However, data-driven newsvendor methods do not require knowledge of the demand distribution and instead use datasets to find solutions. While extensive research has been conducted on the classical newsvendor model, studies on data-driven newsvendor models are limited. In this review paper, we apply text mining techniques to analyze 185 articles published between 1958 and 2023. The analysis includes summarizing the articles, identifying key topics and terms in the field, and tracking changes in research areas over time.

4 From Local to Global Learning for Data-driven Dynamic Inventory Control: A Practical Application of Prescriptive Analytics

Felix G. Schmidt, University of Würzburg, Würzburg, Germany. Contact: felix.schmidt@uni-wuerzburg.de

Building on weighted sample average approximation, we develop a practical prescriptive analytics approach for the real-world dynamic inventory control problem of a large network of pharmacies with many heterogeneous products. Using contextual feature information, we propose a "global learning" model that is trained simultaneously across all products to specify conditional sample weights. The results of our numerical experiments suggest a significant improvement over models that are trained separately for each product.

Monday, October 16, 4:00 PM - 5:15 PM

ME70

CC-West 105B

Platforms, Firms and Strategic Decisions: Some Key Factors and Measures

Community Committee Choice Session

Session Chair: Vaarun Vijairaghavan, 1</sup

1 Organization of Platform Markets: Coordination, Decision Rights and Information

Nabita Sree Penmetsa, Krishnan S. Anand, University of Utah, Salt Lake City, UT, Contact: nabita@ business.utah.edu

Should decision making in a platform market be centralized or decentralized, i.e., controlled by the platform or by agents? To study this question, we define the coordination structure (CS) of the platform market as the combination of two elements: its decision rights structure ('who decides what') and information endowment ('who knows what'). We model a platform providing services through independent, competing agents, and parameterize the degree of competition among agents. Demand uncertainty can be partly alleviated through information. We model different facets of information endowment, including local and aggregate intelligence, the ability to acquire and share intelligence, and non-transferable specific knowledge of both the platform and agents.

2 Sharing Versus Rental of 'Need-To-Use' Goods

Stefan Napirata[1], Alexander Kupfer[2], Steffen Zimmermann[1], Barrie R. Nault[3], [1]Ulm University, Ulm, Germany; [2]University of Innsbruck, Innsbruck, Austria; [3]University of Calgary, Calgary, AB, Canada. Contact: stefan.napirata@uni-ulm.de

Many firms need specific goods to fulfill their projects. Besides selling such`need-to-use' goods -- those with inelastic demand, some producers also offer a rental option to business customers. Alternatively, customers can borrow these goods via emerging B2B sharing platforms from peer-to-peer lenders that have purchased the good. This leads to producer-platform competition in providing temporary access to `need-to-use' goods. Analyzing producer and platform pricing as well as customers' decisions, we find that only a two-part tariff allows the platform to coexist with the producer. Customers with high need to use purchase and lend, with medium need to use borrow via the platform, and with low need to use rent from the producer. Counterintuitively, we further find that producer-platform competition leads to lower welfare compared to a B2B sharing platform alone.

3 Price Generative AI or Keep It Free

Di Yuan[1], Manmohan Aseri[2], Vibhanshu Abhishek[3], [1]Gies College of Business UIUC, Champaign, IL, [2]Katz Graduate School of Business at University of Pittsburgh, Pittsburgh, PA, [3]UCI Paul Merage School of Business, Irvine, CA, Contact: di.yuan@pitt.edu

The remarkable advancements in generative AI have raised questions about the implications of such technology. As the name suggests, generative AI (GenAI) generates content. Therefore, an important question is how it will affect user-generated content (UGC) platforms. A UGC platform can adopt GenAI to help its content creators, e.g., by providing a ChatGPT plug-in. While GenAI is expected to improve content creation productivity, it could impact content creators differently. We use a game-theoretic model to analyze strategic interactions between content creators. We show that providing GenAI may lead to an exodus of high-quality content creators and a lower profit for the platform. In addition, we find that charging a price for using GenAI not only leads to an additional source of revenue for the platform but also prevents the exodus of high-quality content creators.

4 Information Technology and Accruals

Rahat Jafri, Vaarun Vijairaghavan, University of Calgary, Calgary, AB, Canada. Contact: rahat.jafri@ucalgary.ca

This study investigates the impact of IT on accruals. Accounting earnings are essential for forecasting future cash flows, but accruals can impede the accuracy of such predictions. Accruals are subjective and influenced by accountants' judgment, which the availability and processing of information can shape. We hypothesize that IT can reduce accrual size by improving operational efficiency and increase accrual accuracy by producing more precise accounting estimates. Our preliminary findings support this hypothesis, revealing a negative impact of IT investment on accrual size. Overall, our study provides valuable insights into the potential of IT to improve accounting information for investment decisions.

5 Capacity Planning for Services: The Role of Customer Mental Accounts

Rajiv Mukherjee[1], Sreekumar R. Bhaskaran[2], Sanjiv Erat[3], [1]Texas A&M University, College Station, TX, [2]Southern Methodist University, Dallas, TX, [3]University of California-San Diego, La Jolla, CA

In many industries, consumers who purchase services pay a fixed upfrontfee for access, and then consume the service over a period of time. In this article, we examine the implications of such temporal separation of purchase and consumption on a user's consumption choices, and on the firm's optimal strategy.

Monday, October 16, 4:00 PM - 5:15 PM

ME71

CC-West 105C

Applications of Data Analytics in Emerging IS Issues

Community Committee Choice Session

Session Chair: Jin Sik Kim, The University of Tennessee at Chattanooga, Chattanooga, TN

1 Telehealth and the Management of Chronic Health Conditions in Vulnerable Populations: A Study of Latino Patients with Diabetes in Southern California

Cristina M. De Haro[1], John Billimek[2], Vijay C. Gurbaxani[3], [1]University of California - Irvine, Irvine, CA, [2]University of California - Irvine, Irvine, CA, [3]University of California-Irvine, Irvine, CA, Contact: cdeharoa@uci.edu

We present a retrospective cohort study of patient engagement in telehealth in a large, integrated health system in Southern California. We look at provider visits - before and during COVID-19 -to understand if transitioning to telehealth removes barriers to access to healthcare.

We also evaluate the effect of telehealth on the management of chronic health conditions, such as diabetes, among vulnerable populations, especially Latino patients.

2 Effect of Rival's Status and Performance Signals on User Engagement: Randomized Field Experiment in Mobile Gaming

Tandon Ayushi[1], Swanand Deodhar[2], Abhas Tandon[3], Abhinav Tripathi[3], [1]Mahindra University, Hyderabad, India; [2]Indian Institute of Management, Ahmedabad, India; [3]Word Fighter-2, Bangalore, India. Contact: swanandd@imma.ac.in

There is an ambiguity surrounding status and performance effects on online engagement. Status maybe rooted in past performance, making them interchangeable proxies of latent expertise. In contrast, the status may be decoupled from performance wherein the former drives behavioral outcomes independently. Thus, behavioral effects of status and performance signals remain unclear. We address these questions using a randomized field experiment on a two-player multi-round mobile game. We expose players randomly to rival's status and performance signals and measure the player's engagement. We find that the focal player is more likely to quit the game if the rival exhibits higher in-game performance. However, this effect is contingent on the rival's status and past performance. Further, we find these contingent effects to be predicated on the player's motivation.

3 Overcoming the Novelty Discount: The Roles of Open-Source Development in the Initial Coin Offerings (Icos)

Ziyi Xiong[1], Rong Liu[2], Yan Chen[3], Chihoon Lee[2], [1]The University of Tennessee at Chattanooga, Chattanooga, TN, [2]Stevens Institute of Technology, Hoboken, NJ, [3]University of Missouri-Kansas City, Kansas City, MO

Extensive literature has indicated that investors are biased against novelty in the evaluations of new ventures. However, few studies have focused on identifying avenues to help entrepreneurs and innovators overcome this bias. In addition to confirming the existence of a bias against novelty in initial coin offerings, our research draws on signaling theory to suggest such bias can be mitigated by reducing the technological uncertainty. From an analysis of 1845 new ventures raising funds through initial coin offerings, we find that publishing open-source codes—and especially signaling the activeness, richness and popularity of the development process through the open-source repositories—can alleviate information asymmetry and technical uncertainty, helping dissolve or even reverse the bias against novelty.

4 Exploring the Future of Telemedicine Incorporated with the Generative Artificial Intelligence

Soo Il Shin[1], J.B. (Joo Baek) Kim[2], Olu Mbanugo[1], [1]Kennesaw State University, Kennesaw, GA, [2]University of Tampa, Tampa, FL, Contact: sshin12@kennesaw.edu

Telemedicine (a.k.a. telehealth, e-health, etc.) refers to using telecommunication technologies to provide medical information and services. With the emergence of generative artificial intelligence (AI) and the application of large language models (LLM), telehealth services greet a new era and change its paradigm. Our goal is to 1) explore how people make sense of telemedicine service in applying the generative AI features which possibly replace certain healthcare provider roles and 2) delve into the functionalities of the generative AI impacting the better quality of the telemedicine service. Our research employs one of the well-known generative AI applications (e.g., ChatGPT) to answer research questions. Discussions will follow.

Monday, October 16, 4:00 PM - 5:15 PM

ME72

CC-West 106A

FinTech and AI

Community Committee Choice Session

Session Chair: Lianlian Jiang, TX

1 Can Social Connectedness Inhibit Online Trade? the Effects of Digital Distance on Peer-To-Peer Lending

Amin Sabzehzar[1], Yingxin Zhou[2], Jingbo Hou[3], [1]Tulane University, New Orleans, LA, [2]Georgia State University, Atlanta, GA, [3]Arizona State University, Tempe, AZ

The extant literature has shown offline preferences manifest in online peer-to-peer lending platforms, inhibiting online transactions in those markets. The findings of this research suggest that digital distance, as measured by the rate of Facebook friendship between two countries, can also influence lending actions in bi-country lending. Building on a dataset from Kiva.org, we show that digital distance significantly and negatively affects bi-country lending actions, on top of other distance-related barriers discussed in the literature. The results also shed light on the role of government policy regarding local IT accessibility, showing that the greater level of IT infrastructure, adoption, and freedom on the web can, to an extent, compensate for the negative effect of digital distance on prosocial lending.

2 Stay Reticent or Loquacious? How to Manage Updates in Medical Crowdfunding Campaigns

Chenzhang Bao[1], Wen Zhang[2], Min Kyung Lee[3], [1]Oklahoma State University, Tulsa, OK, [2]Baylor University, Waco, [3]Baylor University, Waco, TX, Contact: chbao@okstate.edu

Medical crowdfunding has become a popular option to raise medical funds. We draw on the two-factor theory to examine the critical role of fundraisers disclosing campaign details and status via updates in driving fundraising. We collect a unique dataset that captures granular details about the fundraising process and implement a combination of econometric and machine learning approaches to test our hypotheses. We observe that initial exposure to updates can greatly reduce uncertainty and foster trust, which impacts habituation and contributes to positive responses from donors. However, excessive updates may become tedious and also spur concerns and doubts, leading to negative impressions. Our study enhances the theorization of information disclosure in the crowdfunding literature and offers implications to solve the aggravated medical expenses crisis.

3 What Doesn't Kill You Makes You Stronger? Evidence from Vampire Attack on Decentralized Exchange

Xiang(Shawn) Wan[1], Xi Zhao[2], Jian Li[2], Xinyu Zang[3], Hsing K. Cheng[3], [1]Santa Clara University, Santa Clara, CA, [2]Xi'an Jiaotong University, Xi'an, China; [3]University of Florida, Gainesville, FL, Contact: xwan@scu.edu

We implement a quasi-experimental design to examine the impact of the vampire attack on the decentralized exchange (DEX) platform by leveraging the vampire attack launched by Sushiswap (the attacker) against Uniswap (the incumbent DEX). We examine both the deposit-side and exchange-side impact of the vampire attack on the operational performance of the liquidity pools on Uniswap. Surprisingly, we find no significant effect of the vampire attack on the liquidity on the deposit side. Moreover, the vampire attack significantly increases the incumbent's trading volume on the exchange side. We further find that cloning the incumbent platform alone will not effectively hurt the incumbent until combined with the tokenized rewards. We provide an in-depth analysis of the underlying reasons for these intriguing results.

4 How Do Human Investors Collaborate with AI Investment Tools in Financial Investments? Evidence from Microlending

Lianlian (Dorothy) Jiang[1], Cathy (Liu) Yang[2], Xitong Li[2], [1]University of Houston, Houston, TX, [2]HEC Paris, Jouy-en-Josas, France. Contact: ljiang@bauer.uh.edu

Using a differences-in-differences design, this paper explores how human investors collaborate with AI investment tools in financial investments after AI investment tools have been adopted by investors. We explore this using detailed data from a leading peer-to-peer microlending platform. We find that individual investors after AI investment tools have been adopted, designate the AI tools to invest in financial investments with lower risk compared to the investments made by investors themselves. We propose a mechanism for this empirical observation-more time and processing capacity freed by AI tools. We argue that investors save more time and processing capacity since some work has been delegated to AI tools. Thus, investors can allocate more time to more challenging investments with higher risk levels.

Monday, October 16, 4:00 PM - 5:15 PM

ME73

CC-West 106B

Funding, Investments, and Supply Chains

Community Committee Choice Session

Session Chair: Jussi Keppo, National University of Singapore, Singapore

Session Chair: Ruiting Zuo, National University of Ssingapore, Singapore, Singapore

1 The Wisdom of Strategically Diverse Crowds

Yanwei Jia[1,2], Jussi Keppo[3], Ville Satopaa[4], [1]Columbia University, New York, NY, [2]Chinese University of Hong Kong, Hong Kong, Hong Kong; [3]National University of Singapore, Singapore, Singapore; [4]INSEAD, Paris, France

We investigate the impact of strategic diversity on predictions made by a group of interacting agents. We define strategic diversity as the heterogeneity of agents' strategic tendencies, such as conformity and contrarianism. We find that strategic diversity can have a negative impact on crowd predictions, as agents' strategic tendencies become more pronounced as the overall level of conformity in the crowd increases. However, we also find that a mild contrarian crowd can induce the best performance for both the typical individual and the group consensus prediction. We propose a new aggregation scheme that assigns greater weight to contrarian viewpoints that contain more independent private information. We show that this aggregator can improve the accuracy of crowd predictions under mild conditions and with a large crowd.

2 Equal Employment Opportunity in Supply Chains

Jing Wu, Chinese University of Hong Kong, Hong Kong, Hong Kong

This paper examines whether principal customer firms infuse EEO policy in their dependent suppliers using a novel workplace EEO measure based on the textual analysis of online job postings. We demonstrate that the suppliers adjust workplace EEO practices to cater to their principal customers. Furthermore, the supplier's adverse workplace EEO incidents will increase the likelihood of supply chain relationship termination, especially when the customer's workplace EEO level is high. At last, we find that higher customer workplace EEO levels boost suppliers' innovation performance, measured by patent quantity and quality, suggesting economic benefits associated with the diffusion of workplace EEO practices along supply chains.

3 A Continuous Time Framework for Sequential Goal Based Investing

Agostino Capponi[1], Yuchong Zhang[2], [1]Columbia University, New York, NY, [2]University of Toronto, Toronto, NY, Canada. Contact: ac3827@columbia.edu

We develop a continuous time framework for sequential goals-based investing, where the objective is to maximize expected weighted utility from goal fundedness. We show that the complexity of the procedure to recover the optimal control can be significantly reduced by rewriting the HJB equation in terms of standard deviation and mean of minimum-variance portfolio returns. We find that it is optimal to fund an expiring goal up to the level where the marginal benefit of additional fundedness is exceeded by the marginal opportunity cost of subtracting wealth from future goals. An investor with all-or-nothing utility is more risk averse towards an approaching goal if she is well funded, but also takes excessive risk if she is not on track with upcoming goals, compared to an investor with flexible goals.

4 Economics of Multi-Tier Supply Chain Financing: Operational Flexibility

Volodymyr O. Babich, Georgetown University, Washington, DC

We compare immediate- and remote-tier supply chain financing by solving for equilibrium among multiple firms and investors, in the model with endogenous credit risk. Interestingly, remote-tier financing is often an inferior choice even if the supply chain firms that provide financing are identical in all financial characteristics. Thus, understanding the supply chain position of firms is essential. We identify several economic forces that affect the decision to use multi-tier financing: credit risk spillover, accumulation of forecast noise, and loss of operational flexibility. We provide conditions for remote-tier financing to be preferred and compare the preferences of individual firms and the supply chain. New technologies, like Blockchain, have removed some of the barriers to multi-tier financing adoption. We show that several crucial barriers remain.

5 Dynamic Pricing for Equity Crowdfunding

Bretislav Hajek[1], Jussi Keppo[2], Steven Kou[3], [1]National University of Singapore, Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore; [3]Boston University, Boston, MA, Contact: bretislav.h@u.nus.edu

Crowdfunding is often used to test demand and raise initial project funds. Equity crowdfunding (i.e., selling company shares) can be facilitated using blockchain and smart contracts. These approaches allow entrepreneurs to optimize a price and a marketing effort in real-time based on incoming demand. Furthermore, the crowdfunding platform charges fees for equity issuances, which creates a principal-agent problem between the entrepreneurs and the platform. We analyze the optimal dynamic strategies of the participants, showing that dynamic equity pricing improves the crowdfunding campaign results relative to the corresponding static pricing.

Monday, October 16, 4:00 PM - 5:15 PM

ME74

CC-West 106C

Applications in Market Design II

Community Committee Choice Session

Session Chair: Yan Chen, Duke University, Durham, NC

1 Prize or Price: A Mechanism for Encouraging Innovation

David Ridley[1], Sandro Brusco[2], Giuseppe Lopomo[3], [1]Duke University, Durham, NC, [2]Stony Brook University, Stony Brook, NY, [3]Duke University, Durham, NC

Under the priority review voucher program, the US Food and Drug Administration (FDA) rewards good deeds with speed for a different drug. Upon FDA approval of a new drug for a neglected disease like Ebola, the developer receives a voucher it can use to speed a drug for a commercial disease like diabetes. Companies have sold vouchers for more than $300 million each, but prices have fallen to $100 million due to increased voucher supply. There are at least two problems with the voucher program: fallen prices for vouchers and high prices for neglected-disease drugs. To increase voucher prices and reduce drug prices, we propose a mechanism in which the FDA only grants vouchers to drugs with high quantities sold. More broadly, we show how to include regulatory speed in mechanism design.

2 Stability, Fairness and the Pursuit of Happiness in Recommender Systems

Gerdus Benade, Nachiketa Sahoo, Boston University, Boston, MA

Top-k personalized recommendations are ubiquitous, but are they stable? Given complete information, do buyers and sellers prefer to participate in matches formed by top-k recommendations rather than pursuing offline matches? When exposures are unconstrained, top-k recommendations are stable. When exposures are constrained e.g., due to limited inventory, stable recommendations need not exist. Maximizing buyer welfare under unit exposure constraints is stable, PO and swap-envy free for orthogonal buyers, identical buyers, and buyers with dichotomous values. Most of these properties are retained for arbitrary exposure constraints. Variants of common recommendation strategies lead to substantial instability and envy in three real-world datasets. Among them, maximizing buyer welfare yields the most stable outcomes and near-zero swap-envy.

3 Income Pools for Superstar Markets

Timothy Chan, Ningyuan Chen, Craig Fernandes, University of Toronto, Toronto, ON, Canada. Contact: craig.fernandes@mail.utoronto.ca

"Superstar" markets have been identified in industries like entrepreneurship, sports, music, and entertainment, where a small group of individuals earn significantly more than their peers. In response, we propose an income pool where individuals agree to share a portion of their future earnings if any one of them reaches a specific salary milestone. We are the first to develop a mathematical model to analyze income pools, focusing on stability. Our model shows that risk-averse agents prefer to join income pools, but no finite-sized stable pool exists. However, given an upper bound on pool size, we can find stable pools, including a single Pareto optimal pool. We also derive a sufficient condition for the stability of epsilon-stable pools. We include a case study of real professional baseball player data that demonstrates a 30% increase in social welfare due to pooling.

4 Market Design for Influencer Advertising Platform

Yan Chen, Duke University, Durham, NC, Contact: yan.chen@duke.edu

We model an advertising platform in which advertisers contract with an intermediary (influencer) to reach targeted users. We analyze the performance of a market in which platform leverages information about the underlying influencer-follower network (i.e., each influencer's reach), under optimal and simple-to-implement pricing strategies. We also compare payoffs of market participants to payoffs in decentralized schemes in which advertisers and influencers engage directly, without full information about the underlying network.

Monday, October 16, 4:00 PM - 5:15 PM

ME75

Session.Location:CC-West 208A

Network Design Under Varied Settings

Contributed Session

1 The Service Network Design Problem Under Uncertain Order Arrival and Demand Using a Rolling Time Horizon

Ryan Tramp[1], Nickolas K. Freeman[2], [1]University of Alabama, Tuscaloosa, AL, [2]University of Alabama, Tuscaloosa, AL, Contact: rjtramp@crimson.ua.edu

Logistic firms handle thousands of individually packaged orders of many different products daily that must be delivered promptly to customers. This issue creates a problem for logistic firms on how best to fulfill orders in a cost-efficient manner while maintaining high levels of customer satisfaction. Stochastic service network design problems (SSNDP) are one set of problems that tackle this tradeoff, with the literature focusing on uncertain demand. While this modeling approach works in most cases, it falters when the firm does not know the amount of each product ordered as well as when the customer will place the order. This research provides an alternate formulation of the SSNDP that considers uncertainty in the amount ordered and the arrival of orders using a rolling time horizon scheme and solving using associated heuristics.

Session Chair: Roger Chen, University of Hawaii at Manoa, Honolulu, HI

2 Long-Term Capacity and Topology Planning for a Large Delivery Network

Cansu Agrali[1], Onur Can Saka[1], Faheem Zafari[1], Daniel Guimarans[1], George Iosifidis[2], Amit Kumar[1], [1]Amazon, Luxembourg City, Luxembourg; [2]TU Delft, Delft, Netherlands

Amazon's delivery network consists of fulfillment centers, delivery stations, and sort centers that act as hubs where volume is sorted and consolidated. In this work, we extend the Hub Location Problem to multiple years to account for opening/closing costs and network flow stability.

The problem is formulated as a Mixed Integer Linear Programming (MILP) model. We apply a set of techniques to reduce complexity and scale up to continent-size network requirements: a) reducing the candidate hub set through clustering, b) reducing the number of decision variables by a set of feasible path constraints, and c) applying an incremental approach to solve the MILP model. Our results prove the scalability of our method based on network size and the length of the time period. We also conduct a sensitivity analysis that highlights the influence of the number of candidate hub locations.

3 Resource Planning in Logistics Parks

Pascal Wolff, Ningbo China Institute for Supply Chain Innovation, MIT Global SCALE Network, Ningbo, China

The importance of logistics parks has grown significantly in recent years as critical nodes in supply chain networks. This research paper focuses on resource planning in logistics parks, using a case study of a logistics park in Southern China. It introduces novel optimization models to efficiently plan resources, particularly workforce, and evaluate resource-sharing potentials among facilities. The paper also identifies future research directions in this domain.

4 Pedestrian Route Choice: Recursive Modeling Approaches

Xiazhi Zhang, Roger Chen, Poya Harirchi, University of Hawaii at Manoa, Honolulu, HI, Contact: rbchen@hawaii.edu

Active travel modes, such as walking, play a central role in transportation planning and analysis. Unlike vehicles, pedestrian travel does not necessarily follow defined fixed roadways and segments. Using a discrete network (even a dense one) to approximate pedestrian movement and congestion may be unsatisfactory. *This paper considers recursive route choice models and the advantages for non-motorized contexts where the underlying network is complex and dense due to a wider range of movement across infrastructures, such as open plazas.* GPS data were collected from a group of volunteers from the University of Hawaii at Manoa yielding about 500 pedestrian trip segments that supports estimating a recursive logit model of route choice.

Monday, October 16, 4:00 PM - 5:15 PM

ME76

Session.Location:CC-West 208B

Sustainable Cities and Urban Transportation

Contributed Session

Session Chair: Zhufeng Fan, Carnegie Mellon University, Pittsburgh, PA

1 A Continuous Approximation Approach for Charging and Rebalancing Micromobility Deviceswith Battery Constraints

Demetra Protogyrou[1], Leila Hajibabai[2], [1]North Carolina State University, Raleigh, NC, [2]North Carolina State University, Raleigh, NC

Shared micromobility devices can be found all over major cities as personal transportation means for residents and tourists. Charging and balancing these devices incur significant costs to stakeholders as devices must either be picked up by the company or must be picked and dropped off at established stations. This study formulates a model that presents the utilization of electric micromobility systems and repositioning them either to another ride or to a charging station. The battery limits are also modeled as capacity constraints. A continuous approximation technique is developed to solve the problem with low computational burden. The numerical experiments are designed to evaluate the solution quality and performance with respect to a benchmark.

2 A Multi-Phase Approach for Solving Dial-A-Ride Problems

YU-SHUAN CHEN, YU-TING HUNG, SHENG-I CHEN, NATIONAL YANG MING CHIAO TUNG UNIVERSITY, HSINCHU, Taiwan. Contact: eva101888.mg11@nycu.edu.tw

The Dial-a-Ride Problem is to determine a minimum-cost vehicle route to satisfy demand and other restrictions. To solve the problem, we propose a multi-phase approach, where the first phase develops heuristics to partition the vertices into clusters based on distances and time window constraints, while the second phase determines the optimal tour to traverse clusters using the mixed integer problem. The last phase finds the shortest path of vertices in each cluster. We use public problem instances to evaluate the performance of the proposed method. The results show that our method can obtain high-quality solutions within a short timeframe.

3 Sustainable Public Bike-Sharing System in Network Redesign

Cheng-Feng Wu[1], David M. Chiang[2], Guan-Tyng Wu[1], MENG-CHEN LIN[3], [1]National Taipei University, Taipei, Taiwan; [2]National Taiwan University, Taipei, Taiwan; [3]Hubei University of Economics, Wuhan, China. Contact: d99741006@ntu.edu.tw

Facility delocation is important for transportation and social sustainability after the bike-sharing system is implemented since the execution should be examined to support the strategy in the network. The delocation in network design is to enhance value creation in a network by reorganising facility locations for efficient allocation of resources. This study presents an optimisation model designed to determine the delocation of bike stations for the redesign of a public bike-sharing system under the evaluation of data in the real world. The results of illustrative examples in this study indicate that the efficiency of operating a public bike-sharing system is enhanced as delocation is involved in the network redesign, thereby increasing the benefits for the user, public and private sector interests, and the sustainability of the public bike-sharing system.

4 A Static Bike Repositioning Problem with Trailers

Pin Yin Chiang, Chin Sum Shui, En Chi Hsu, Yueh Ting Chen, National Yang Ming Chiao Tung University, Hsinchu City, Taiwan. Contact: jpy0813208.c@nycu.edu.tw

Bike-sharing system (BSS) has become a vital part of urban transportation that bike repositioning is necessary to maintain serviceability. When BSS expands, a higher bike station density will locate stations at locations where vehicles can hardly access. So, other modes of repositioning must be adopted. This paper proposes a two-echelon repositioning problem with trucks and man-powered bike trailers to relocate bikes among hardly accessed and normal stations. A mixed integer linear programming model is formulated to minimize total operating cost as the sum of CO_2 emission cost and travel cost. Using an illustrative example from Taiwan, the results show that (1) integrating two vehicle types for relocation can achieve minimum cost; (2) very high CO_2 emission cost can alter the routes; and (3) the total cost decreases when the vehicle capacities increase.

5 Taking a Multimodal Optimization Approach to Equitable Bike Share Station Siting

Zhufeng Fan, Carnegie Mellon University, Pittsburgh, PA

Despite recent popularity, bike share systems face challenges with sparse and inequitable service distribution, particularly in low-income areas. This study presents a method for estimating transit service supply incorporating micromobility, using bus schedules and bike station location data. A bi-objective optimization model, which balances equity and potential bike share demand, is developed to examine how stakeholder equity preferences shape bike share system design. The results reveal bike share systems can markedly enhance public transit supply, especially in areas with bike stations. A high emphasis on equity improves transit access for disadvantaged communities, while a balanced equity preference lessens transit disparities among various disadvantage levels. Numerous stations are needed for effective population coverage.

Monday, October 16, 4:00 PM - 5:15 PM

ME77

Session.Location:CC-West Lecture Hall

Advances in Reinforcement Learning

Contributed Session

Session Chair: Saunak Kumar Panda, University of Houston, Houston, TX

1 Safe Rl Prompting for Llms for Solving Data Management Challenges

Alexander Zadorojniy, IBM Research, Haifa, Israel. Contact: zalex@il.ibm.com

We consider the problem of usage of Large Language Models (LLMs) for data management tasks such as imputation and error detection. As task complexity increases as well as the need for accurate responses, so does the need for well-crafted prompts, which allow LLMs to learn in context. We propose to formulate the problem of prompt tuning as an RL problem. Moreover, we intend to craft prompting in a safe way avoiding dangerous decisions and finally getting Safe RL prompting for LLMs to tackle data management task challenges.

2 Efficient Reinforcement Learning in Unknown Continuous Environments

Mohamad Kazem Shirani Faradonbeh, University, Dallas, TX

One of the most popular dynamical models for continuous environments are linear time-invariant systems that evolve according to stochastic differential equations. A ubiquitous problem in these systems is learning to take actions to minimize a quadratic cost function when the dynamics matrices are unknown. We discuss novel and fast reinforcement learning policies that learn the optimal actions fast. In fact, the proposed policy efficiently balances exploration versus exploitation by carefully randomizing the parameter estimates such that the regret grows as the square-root of time and the number of parameters. Theoretical performance analysis as well as flight-control simulations will be presented to illustrate efficiency.

3 Reinforcement Learning with Non-Contrastive Learning to Enhance Sample Efficiency in Atari

Jaehoon Kim[1], Young Jae Lee[1], Mingu Kwak[2], Youngjoon Park[3], Seoung Bum Bum Kim[1], [1]Korea University, Seoul, Korea, Republic of; [2]Georgia Institute of Technology, Atlanta, GA, [3]LG AI Research, Seoul, Korea, Republic of. Contact: jhoon0418@korea.ac.kr

Deep reinforcement learning has shown impressive performance in solving sequential decision-making problems. However, it requires extensive interactions with image-based environments. To address this challenge, improving sample efficiency has become a promising solution. We propose an approach that combines reinforcement learning with non-contrastive learning, and incorporates environmental dynamics to enhance sample efficiency. Our method also provides an effective learning strategy for state representation, leveraging gated recurrent units to capture temporal information. We demonsrate the effectiveness of the proposed method through experiments on the Atari game benchmark, limiting the environment interactions to 100k steps.

4 Reinforcement Learning for Image Classification

Byeongeun Ko, Seoung Bum Kim, Korea University, Seoul, Korea, Republic of. Contact: byeongeun_ko@korea.ac.kr

We present a reinforcement learning-based approach that leverages data augmentation techniques to improve the accuracy of image classification tasks. We define the essential components of reinforcement learning and create a simulator that enables the model to learn more autonomously when additional learning is required. Our experiments with various benchmark datasets demonstrate that the reinforcement learning-based approach outperforms the conventional convolutional neural networks in terms of classification accuracy, highlighting its potential to effectively address classification problems using reinforcement learning.

5 A Statistical Online Inference Method for Regularized Q-Learning Algorithm

Saunak Kumar Panda[1], Yisha Xiang[1], Ruiqi Liu[2], [1]University of Houston, Houston, TX, [2]Texas Tech University, Lubbock, TX, Contact: spanda@uh.edu

Reinforcement learning algorithms are widely used for decision-making tasks in various domains. However, the performance of these algorithms can be impacted by high variance and instability, particularly in environments with noise or sparse rewards. In this paper we propose a framework to perform statistical online inference for a regularized Q-learning approach called G-learning. We adapt the functional central limit theorem (FCLT) for G-learning under weaker conditions, and then construct confidence intervals for parameters via random scaling. We conduct experiments to perform inference on both G-learning and its traditional counterpart Q-learning using random scaling and other benchmark methods and report their coverage rates on a grid world problem for comparison.

Monday, October 16, 4:00 PM - 5:15 PM

ME78

Session.Location:CC-West 211A

spORts V

Community Committee Choice Session

Session Chair: Scott Nestler, Sumer Sports LLC, Granger, IN

1 Big Data in Esports. an Introduction to Melee and Project Slippi

Matthew Martell, University of Washington

In the last 10 years, data analytics has become a key part of the Esports industry. Even casual fans of many games utilize data to improve their play. One rich and largely untapped Esports data source is project Slippi for Super Smash Brothers Melee. Every game played on the platform is recorded, with frame-by-frame data collected including game state and button presses. We develop a pipeline for analyzing large data sets of this type, such as what would be collected after a large tournament. As a proof of concept, we provide an exploratory data analysis on the effects of proposed anti-stalling rules for major tournaments, with a focus on one of the game's most contentious players, Juan Debiedma, aka Hungrybox.

2 NFL Draft Pick Drivers: How Much Do Team Needs Influence Draft Day Decisions?

Gerardo Gonzalez[1], Jesse Pietz[2], Joe Wilck[3], [1]USAF Academy, USAF Academy, CO, [2]US Air Force (Ret), Colorado Springs, CO, [3]Bucknell University, Lewisburg, PA

National Football League (NFL) teams place tremendous importance in preparing for the league's amateur draft each spring. The teams must decide their draft strategy, evaluate their current roster, and evaluate prospective players as they prepare for this multi-day event every spring. Our talk begins with a multifactor analysis for NFL draft pick evaluation. We then use our analysis to assess the marginal value of a drafted player by position and pick. We conclude by comparing our analysis with observed draft picks to understand the motivation behind draft day decisions in the NFL.

3 Employing Machine Learning and Data Science to Compare Women's and Men's Soccer Competitions

Mohammad Abdullah, John McCarty, Maha Yazbeck, Ramero Rodriguez Buno, Abedallah Al Kader, Sura Alhanouti, Amirreza Talebi, The Ohio State University, Columbus, OH

Machine learning approaches were utilized to characterize some of the optimal strategies in soccer domain to improve the performance of players and coaches decision-making. Features contributing to the success of a shot are investigated. Furthermore, statistical competitions were conducted between male and female players with 14 variables considered. Clustering algorithm was also applied to analyze shot locations and goal-scoring probabilities.

4 Medical Locations and Staffing for a Mass Endurance Event

Abigail J. Crocker, Donghao Liu, Katrina F. Maynor, University of Texas at Austin, Austin, TX, Contact: ajcrocker14@utexas.edu

Mass endurance events pose an inherent risk of injury to their participants and medical team response times directly impact participant outcomes. Therefore, locations of medical stations and space-time distribution of medical personnel require critical consideration. We employ a mixed integer linear program to a half marathon case study, extending the capacitated facility location problem to additionally incorporate movement of medics between fixed medical locations. In an application area dominated by various general guidelines and historical observations for particular race courses, we take an optimization approach which can be applied to various topologies and even new races which lack the benefits of institutional knowledge.

Monday, October 16, 4:00 PM - 5:15 PM

ME79

Session.Location:CC-West 211B

Advances in Optimization

Contributed Session

Session Chair: Alexander Shkolnik, University of California, Santa Barbara, Santa Barbara, CA

1 Buying from a Competitor: A Model of Knowledge Sharing and Innovation

Dominique Lauga[1], Matthew Selove[2], Mohammad Zia[2], [1]University of Cambridge, Cambridge, United Kingdom; [2]Chapman University, Orange, CA

Many firms buy a production input from a competitor. We develop a game theory model in which a firm can buy an input from a competitor or a third party in each period, and in order to innovate, the firm must invest in improving the input and must share the resulting knowledge with its chosen supplier. We find that buying from the competitor: (1) mitigates price competition in the consumer market, and (2) puts the competitor in a stronger negotiating position in the second period if the focal firm invests in innovation. In equilibrium, if the value of the innovation is sufficiently low or sufficiently high, the firm buys from its competitor. However, if the value of innovation lies in an intermediate range, and there is sufficient horizontal product differentiation, then the firm buys from the third party to ensure innovation occurs.

2 The Value of Information and Stochastic Programming: Extensions to Partial and Imperfect Information

Tomasz Slusarczyk, Austin Saragih, Massachusetts Institute of Technology, Cambridge, MA, Contact: tomaszsl@mit.edu

More than fifty years after the seminal paper of Avriel and Williams (1970) on the value of information and stochastic programming, there has been minimal development towards imperfect and partial information. In this paper, we extend this methodology to quantify the value, cost, and benefit of partial and imperfect information gathering in stochastic programming and develop a tradeoff between acquiring many moderately accurate information or few very accurate information and provide an optimal approximation algorithm to solve it. New mathematical and computation results are presented. We also implement the methodology to a capacity planning case study.

3 A Dantzig-Wolfe Decomposition Approach to Solve an Integrated Project and Personnel Scheduling Problem

Brede Sørøy, Anders Nordby Gullhav, Norwegian University of Science and Technology, Trondheim, Norway. Contact: brede.soroy@ntnu.no

We consider an integrated project and personnel scheduling problem with preemption and resource transportation with applications in the construction industry. This is a hard problem, and it takes a long time to solve it to optimality, especially when there are many projects to schedule. In many cases, the direct mixed-integer programming formulation gives a weak dual bound in the branch-and-bound search. Therefore, we propose a Dantzig-Wolfe reformulation of the

problem that includes columns of feasible project schedules. Using this approach yields a tighter formulation, and the optimality gaps are improved.

4 The Contingencies of Knowledge Complexity During the Search Process for Future Innovation

Tara Li, Drexel University, philadelphia, PA, Contact: fl343@drexel.edu

5 Large Deviations of Affine Processes

Alexander Shkolnik, University of California, Santa Barbara, Santa Barbara, CA, Contact: shkolnik@ucsb.edu

We develop an large deviations principle for the general class of affine processes that includes as special cases all Lévy processes, continuous-time branching and Hawke's processes, the Ornstein-Uhlenbeck and Bessel diffusions, Cox-Ingersol-Ross processes and their many generalizations. Our large deviation asymptotics are of the Friedlin-Wentzell type and thus contribute to the study of dynamical systems subject to random perturbations. These perturbation are driven by small-noise diffusions as well by jump noise with paths of (in)finite variations and/or (in)finite jump activity. We establish our results using the Dawson-Gartner projective limits approach as well as the method of exponential martingales. We provide an explicit representation of the large deviations rate function for the case of finite jump activity.

Monday, October 16, 4:00 PM - 5:15 PM

ME80

Session.Location:CC-West 212A

Robust, Bilevel, and Network Optimization

Community Committee Choice Session

Session Chair: Luca Wrabetz, University of Pittsburgh, Pittsburgh, PA

1 Adaptive Shortest-Path Interdiction of Multiple Followers

Luca Wrabetz, University of Pittsburgh, Pittsburgh, PA

We describe a variant of the shortest-path interdiction problem, where a finite number of followers (or more generally, scenarios) exist for the leader to interdict. In other words, there are a finite number of different arc-cost vectors in the network. With this discrete uncertainty set in mind, we pose a robust version of the shortest-path interdiction problem, where the leader can compute multiple interdiction policies to interdict the followers. We reformulate the resulting max-min-max-min problem as an MIP, and extend a Bender's Decomposition approach from the shortest-path interdiction literature to solve our problem. Additionally, we use an exact enumeration algorithm to optimally partition the followers, and compute an optimal policy for each resulting cluster. Finally, we develop a greedy approximation algorithm for our interdiction problem.

2 Network Enhancement via Robust Interdiction Methods

Thanakrit Piyachayawat[1], Ningji Wei[2], [1]Texas Tech University, Lubbock, TX, [2]Texas Tech University, Lubbock, TX

In the classic network interdiction games, the leader (the first decision-maker) has been traditionally introduced as an attacker, aiming to disrupt their opponent's solutions, such as paths, connected components, or spanning trees. In this work, we propose a novel reinterpretation of the leader's role as a network user, focusing on enhancing their network structures while mitigating uncertainties originating from multiple sources. To address this class of problems, we have developed new reformulation methods. We demonstrate that, under both the optimistic and pessimistic perspectives, the optimal robust solutions can be obtained using single-level mixed linear programming formulations. These findings open up avenues for studying and addressing problems with more complex conditions.

3 Designing Optimal Location-Based Discount Policies for Online Retail Distribution with Customer Preferences Uncertainty

Svetlana Riabova, Jose L. Walteros, University at Buffalo, Buffalo, NY, Contact: sriabova@buffalo.edu

As online retail continues to grow, so too will the need for efficient last-mile delivery solutions. Our approach is centred on providing customers with pick-up locations as alternatives for home delivery and offering them discounts to make that choice more attractive. We argue that distributing incentives in a clever way to consolidate deliveries could yield a significant reduction in the retailer's operational costs while still prioritizing customer satisfaction. We consider a bilevel optimization problem that captures the decision-making process of both the retailer and its customers, designed to identify an optimal discount policy. The uncertainty arises from the leader's lack of knowledge of the followers' preferences. We develop a solution framework based on robust optimization that progressively refines the uncertainty sets, as new purchases are observed.

4 Network Design for Supply Resiliency via Connected Dominating Sets

Foad Mahdavi Pajouh[1], Oleg Prokopyev[2], Somayeh Moazeni[3], [1]Stevens Institute of Technology, Hoboken, NJ, [2]University of Pittsburgh, Pittsburgh, PA, [3]Stevens Institute of Technology, Hoboken, NJ

Resilient network system design, aimed at preserving operability in the presence of component failures, is prevalent in practice. Given an undirected graph with weighted vertices, the connected-dominating-set Interdiction problem aims to find a minimum cost subset of edges to be blocked such that the weight of every connected dominating set in the blocked subgraph remains above a threshold level. This paper studies the problem of finding the least cost of constructing additional edges to increase the blocker's minimum-cost to a given value. We discuss the problem's computational complexity and establish conditions to characterize its feasible solutions and to express an IP formulation. We propose several branch-and-bound algorithms for the problem. These algorithms are assessed on randomly generated networks and a network of distribution centers.

Monday, October 16, 4:00 PM - 5:15 PM

ME81

Session.Location:CC-West 212B

Information, Learning and Incentive Management

Contributed Session

Session Chair: Shijth Kumar Payyadakkath Meethale, Solbridge International School of Business, Daejeon, Korea, Republic of

1 The Impact of Gamified Competitive Structures on User Engagement in the Educational Online Platforms

Agnieszka Kloc[1], Rodrigo Belo[2], Ting Li[1], [1]Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands; [2]Nova SBE, Carcavelos, Portugal

We study the impact of leaderboard competition intensity on user engagement in an online learning platform context. Our randomized field experiment with students preparing for the final school exams reveals that students engage more when competition is less intense. Specifically, they are more engaged when competing against groups with more spread-out scores and when they are farther away from both their upward and downward competitors. Moreover, low-confidence students become more active when their upward competitor is farther away, while competitive students decrease activity under the same conditions. Our findings suggest that implementing a competitive feature demands attention to the created competitive conditions and the type of user participating in the competitive environment. A one-size-fits-all approach is not effective in promoting user engagement.

2 Connectedness for On-Demand Learning: A Field Experiment on Social Presence Cues

Azel Shokparova[1], Zagira Asrymbetova[1], Seung Hyun Kim[2], Yeolib Kim[1], [1]Ulsan National Institute of Science and Technology, Ulsan, Korea, Republic of; [2]Yonsei University, Seoul, Korea, Republic of. Contact: azel.shokparova@unist.ac.kr

On-demand learning platforms face a fundamental challenge of enhancing users' learning outcomes and retaining them by constantly motivating them to make progress and complete courses. To address this challenge, we propose a novel approach based on social presence theory that enhances the learner's connectedness to the instructor and platform, leading to increased engagement and progress. Specifically, we examine the efficacy of push notifications with social presence cues related to instructor and humor based on internet memes, by conducting a randomized field experiment. The results indicate that both treatments increase clickthrough and progress rates, but only instructor-initiated interventions retain a positive effect over time. This study provides valuable insights into the effective use of social presence and meme marketing in on-demand learning.

3 Adoption of Ideas from Innovation Contests - Evidence from a Korean Bank

Shijith Kumar Payyadakkath Meethale[1], InHyouk Koo[2], [1]Solbridge International School of Business, Daejeon, Korea, Republic of; [2]Woosong University, Daejeon, Korea, Republic of

Open innovation contests have democratized the innovation process in a firm. Extant research on innovation contests has analyzed characteristics of the contest participants and the design elements of a contest to understand its relationship with contest outcomes. While most of these studies have focused on the idea generation phase of the contest, we focus on the idea selection and adoption phase. This study aims to develop a theoretical framework by using data from an innovation contest at a large banking firm to gain a comprehensive understanding of the adoption process when ideas are sourced from multiple contributors. We draw from innovation diffusion theory to understand the process of idea adoption by a focal firm engaged in open innovation by relying on the evaluation parameters from the real decision process in the organization.

Monday, October 16, 4:00 PM - 5:15 PM

ME82

Session.Location:CC-West 212C

Machine Learning Methods in Healthcare

Contributed Session

Session Chair: Mary Ogidigben, Pennsylvania State University, State College, PA

1 Tracking Early Heart Disease Using Deep Learning for Small and Imbalanced Datasets

Elham Nasarian[1], Danial Sharifrazi[2], Sakshi Pranay Taori[1], Vivek Joshi[3], Kwokleung Tsui[1], Roohallah AlizadehSani[4], Creed Jones[3], [1]Virginia Tech, Blacksburg, VA, [2]Islamic Azad University, Shiraz, Iran, Islamic Republic of; [3]Virginia Tech, Blacksburg, VA, [4]Deakin University, Geelong, Australia. Contact: elhamn20@vt.edu

Heart Disease is a leading cause of mortality in the US, with coronary artery disease (CAD) being the most common form. In this research, we proposed a methodology that uses machine learning and deep learning methods to track stenosis in each coronary artery. Our framework applied autoencoder (AE), SMOTE, and conventional neural networks (CNN) to balance and generate data for more accurate detection in early stages. Our results demonstrated that the accuracy of this proposed method for CAD diagnosis in early stages was 95.36 and was higher than random forest (RF), decision tree (DT), support vector machine (SVM), logistic regression (LR), XGBOOST, and artificial neural networks (ANN). This methodology could be developed in variety healthcare and medicine applications to handle imbalanced and small datasets.

2 Prediction of Cardiovascular Mortality in Nash Liver Transplant Recipients Using Machine Learning

Yasin Fatemi[1], Mohsen Nikfar[1], Amir Oladazimi[1], Haley Hoy[2], Haneen Ali[1], [1]Auburn University, Auburn, AL, [2]University of Alabama Huntsville, Huntsville, AL, Contact: yzf0024@auburn.edu

Cardiovascular disease (CVD) is the leading cause of mortality among non-alcoholic steatohepatitis (NASH) patients who underwent liver transplants. Therefore, early identification of CVD patients is crucial for timely intervention and prevention of adverse outcomes. In this study, a Machine Learning (ML) model was developed to predict the risk of cardiovascular death among 10,872 NASH patients between 1987 and 2022. Logistic Regression (LR), Random Forest (RF), Decision Tree (DT), and XGboost (XGB) as estimators for RFE and SFM were all applied in the study. Additionally, prediction models were developed using Support Vector Machine (SVM), RF, and XGB. Results showed that the best prediction model was XGB with applying SFM-DT features.

3 A Study of Bias in Machine Learning Techniques in Predicting Non-Alcoholic Fatty Liver Disease (NAFLD)

Mary Ogidigben, Soundar Kumara, Pennsylvania State University, University Park, PA, Contact: meo5362@psu.edu

Non-alcoholic fatty liver disease (NAFLD), which affects 25% to 30% of the world's population, is an umbrella term that refers to a range of conditions caused by excess fat in the liver of a person who drinks little to no alcohol. In NAFLD review papers, race and ethnicity have been found to be two of the significant factors contributing to the development of NAFLD. However, in many prediction studies utilizing machine learning techniques, race and ethnicity are not included as significant factors. Therefore, we use machine learning techniques to study whether race and ethnicity are statistically significant to the predicted outcome of a patient having NAFLD.

Monday, October 16, 4:00 PM - 5:15 PM

ME83

Session.Location:CC-West 213A

Operations Management Applications

Contributed Session

Session Chair: Amirhossein Jafarzadeh Ghazi, Ontario Tech University, Toronto, ON, Canada

1 Managing Perishable Inventory when Strategic Customers Form a Reference on Product Availability

Hasan Arslan, Seokjin Kim, Suffolk University, Boston, MA

Consider a retailer selling a perishable product in the presence of strategic customers who use their reference on product availability to time their purchases. Each short period, the retailer determines a stocking quantity before random demand is realized and strategic customers learn from the retailer's stocking quantity to update their reference. We characterize the structural properties of single-period, two-period, and infinite-horizon problems, and conduct numerical studies on an infinite horizon to compare an optimal dynamic policy and the corresponding optimal static

policy which sets a fixed stocking quantity over time. A near-optimal performance of optimal static policy with an average profit gap of less than 1% is remarkable and contrasts with that in the two-period model which may be far worse.

2 A Research Outlook on Supply Chain Sustainability and Product Returns

M. Ali Ulku[1], Ulku Gurler[2], Eyup Emre Berk[2], [1]Dalhousie University, Halifax, NS, Canada; [2]Bilkent University, Ankara, Turkey. Contact: ulku@dal.ca

Consumers may return products for various reasons: The product received may be the wrong color or size, function poorly, damaged during shipment, or purchased impulsively and regretted. Product returns and, thereby, product return policies may profoundly impact sustainable supply chain logistics, adding extra strain on the already challenging reverse logistics operations and eating up resources from forward logistics of supply chains. Moreover, the enormous growth in omnichannel shopping makes studying product returns from consumer behavior and sustainable supply chain perspectives critical. In this short talk, we will draw on some relevant theories and optimality results, discuss practical implications, and point to future research venues for mitigating the impact of product returns on supply chain sustainability through the quadruple bottom line approach.

3 Order Acceptance and Detailed Scheduling in a Job Shop with Discrete and Batch Processing Machines

Dheeban Kumar Srinivasan Sampathi, Purushothaman Damodaran, Northern Illinois University, DeKalb, IL, Contact: dheebankumar141@gmail.com

Customization of products to increase customer satisfaction has resulted in a high mix low volume production. Many manufacturers adopt a Make-To-Order approach to minimize costs and meet customer deadlines. This study deals with processing customer orders with a set of operations on resources in a job shop environment, with linear precedence constraints, deterministic processing times, due dates, job size, and selling price. Jobs may also recirculate. The objective is to maximize profit and ensure that all accepted orders are completed on time. The job shop includes discrete processing machines and a batch processing machine that can process multiple jobs if its capacity is not exceeded. The Mixed Integer Linear Program helps to identify which orders to accept and a detailed schedule for all the accepted orders.

4 Cost Sharing and Revenue Sharing Contracts for Collaborative Quality Improvement in a Supply Chain with Product Recall

Amirhossein Jafarzadeh Ghazi, Nader Azad, Salma Karray, Ontario Tech University, Oshawa, ON, Canada

Quality-related product recalls can be arduous incidents for the entire supply chain. Considering the rising cost of quality, a manufacturer and a retailer may adopt collaborative quality improvement strategies to enhance the performance of a supply chain with a risk of a product recall. We develop a manufacturer Stackelberg game model and investigate whether cost- or revenue-sharing contracts can benefit the supply chain with recall. We also examine the impact of bargaining on designing a collaborative agreement. We find that revenue- and cost-sharing contracts can improve product quality, recall probability, and the manufacturer's and retailer's profits compared to a non-collaborative contract. Furthermore, a revenue-sharing through bargaining contract is best-off in terms of improving quality, recall probability, and the manufacturer's profit.

Monday, October 16, 4:00 PM - 5:15 PM

ME84

Session.Location:CC-West 213B

Stochastic Models for Supply Chain Management

Contributed Session

Session Chair: Seokgi Lee, Youngstown State University, Youngstown, OH

1 Remanufacturing Facility Installation Decisions Under Uncertain New Product Purchasing Cost and Return Products Remanufacturing Cost

Mohammad Ahnaf Sadat, K Jo Min, Iowa State University, Ames, IA, Contact: sadat@iastate.edu

In this paper, we consider a company that currently relies on external purchases to meet customer demand and has the flexibility to install a remanufacturing facility. With the key assumption that the remanufactured products can fully substitute new products' demand, we determine the value of such flexibility and identify the optimal size and timing for installing the remanufacturing facility under the uncertain external purchasing prices and return products' remanufacturing costs. To address this problem, we adopt a profit maximization criterion and employ the real options theory as our modeling framework. Specifically, we utilize a Least-Square Monte Carlo simulation approach to obtain a solution. The study aims to provide valuable insights into the strategic considerations and potential economic benefits of installing a remanufacturing facility.

2 Managing Inventories and Suppliers in Assembly Systems with Random Demand and Supply Capacity

Ramesh Bollapragada[1], Uday Rao[2], Jun Zhang[3], [1]San Francisco State University, San Francisco, CA, [2]University of Cincinnati, Cincinnati, OH, [3]Amazon, Dallas, TX, Contact: rameshb@sfsu.edu

We consider stock positioning in a pure assembly system controlled using installation base-stock policies. When component suppliers have random capacity and end-product demand is uncertain, we characterize the system's inventory dynamics. We show that components and the end product play convex complementary roles in providing customer service. We propose a decomposition approach that uses an internal service level to independently determine near-optimal stock levels for each component. Compared with the optimal, the average error of the decomposition approach is 0.66% across the tested instances. Compared with current practice, this approach has the potential to reduce the safety-stock cost by 30%. Finally, we analytically show how a multi-echelon pure assembly system may be converted into an equivalent two-echelon assembly system to which all our results apply.

3 Energy-Efficient Wheelset Maintenance Scheduling Under Uncertainty: An Approximate Dynamic Programming Approach

Zheng Tian, Tsinghua University, Beijing, China. Contact: tianz19@mails.tsinghua.edu.cn

This research originates from a real-world wheelset maintenance scheduling problem, where two types of uncertainties exist: the arrival time of the wheelset and the needed maintenance time in some operations. In the real world, the maintenance time may last for hours and the electricity consumption is relatively high. Therefore, our objective is to minimize a combination of the total tardiness and the total electricity cost under time-of-use electricity prices. We proposed an approximate dynamic programming approach for this problem, and the performance of our algorithm is validated using the maintenance data from a railway bureau in China. The results show that the proposed algorithm significantly outperforms the method currently used in practice.

4 Distributed Feedback Control Algorithm Combined With Deep Q Learning For Energy-aware Last-mile Delivery

Seokgi Lee, Youngstown State University, Youngstown, OH, Contact: slee10@ysu.edu

As large-scale online markets have exploded in recent years, they have a high split rate of orders as a result of this shift in shopping patterns. Accordingly, consolidating and delivering split orders from the same customer has been addressed as a major problem in leveraging green logistics in online retailing. In this study, the last-mile logistics situations are analyzed to address two interrelated questions: (i) what would be the optimal order and shipment consolidation policy in last-mile delivery, and (ii) what would be the resulting vehicle routing plan that improves operational and service performance. We present an integrated decision-making framework that simultaneously determines vehicle routing plans and consolidation policies. In particular, dynamic control combined with Deep Q learning is introduced and its technical benefits are presented.

Monday, October 16, 5:25 PM - 6:15 PM

MK01

CC-North 120D

Harnessing Data for Operations Forecasting

Keynote Session

1 Harnessing Data for Operations Forecasting

Yael Grushka-Cockayne, University of Virginia, Charlottesville VA, VA

Monday, October 16, 5:25 PM - 6:15 PM

MK02

CC-North 120A

Network Flows and Minimum Cuts in Ranking, Clustering, Machine Learning, Imaging and Diversity Problems

Keynote Session

1 Network Flows and Minimum Cuts in Ranking, Clustering, Machine Learning, Imaging and Diversity Problems

Dorit Simona Hochbaum, University of California-Berkeley, Berkeley, CA

A significant category of integer programming problems, called "monotone" (IPM, Integer Programming Monotone), finds its solution by employing a minimum cut algorithm

on an associated graph. Within this category, numerous well-known clustering problems fall under the umbrella of ratio IPM problems. Remarkably, it has been demonstrated that these and the respective ratio problems can all be resolved using a parametric cut procedure, which exhibits the same computational complexity as a single minimum cut procedure. Other applications of IPM include drug ranking, the identification of active neurons in calcium imaging movies, and a wide array of machine learning and classification tasks.

For several problems classified as NP-hard, the incorporation of modeling flexibility transforms them into efficiently solvable IPM problems. This modeling flexibility is exemplified in scenarios such as the threat detection problem, co-segmentation problem, and text summarization problem. In the context of text summarization, for instance, this flexibility is manifested by replacing the concept of minimum similarity with maximum dissimilarity.

A specialized subset within the realm of NP-hard problems is the "budgeted" IPM problems, which incorporate an additional budget constraint. In the case of budgeted IPM problems, it is established that the entire efficient frontier can be generated through the parametric cut procedure. Furthermore, the breakpoints within the efficient frontier are optimal and facilitate the derivation of high-quality solutions for the respective problem. These problems find applications in diverse fields, including facility dispersion, quadratic knapsack, maximum diversity, and text summarization.

The Markov Random Field (MRF) problem originally emerged in the context of machine vision. For convex deviation functions and bilinear separation, the MRF can be efficiently solved through a parametric cut algorithm with a "best possible" runtime. MRF with general convex functions is equivalent to the convex dual of the minimum cost network flow problem, which is also solved efficiently. Applications of the MRF model span various domains, encompassing image segmentation, customer segmentation, credit risk assessment for countries, student paper competitions, semiconductor yield prediction, isotonic regression, general ranking, and recently, the aggregation of voter preference rankings.

Monday, October 16, 5:25 PM - 6:15 PM

MK03

CC-North 120BC

Leveraging Analytics in Automotive

Keynote Session

1 Leveraging Analytics in Automotive

Jonathan H. Owen, General Motors, Bloomfield, MI

Monday, October 16, 5:25 PM - 6:15 PM

MK04

CC-West 301D

2023 UPS George D. Smith Prize Winner Reprise: Purdue University

Keynote Session

1 UPS Smith Prize

Mohit Tawarmalani, Matthew Lanham, Purdue University, West Lafayette, IN

Monday, October 16, 5:25 PM - 6:15 PM

MK05

CC-West 301ABC

Omega Rho Lecturer: Reflections on the Profession of Operations Research and Some Thoughts on Its Future

Keynote Session

1 Reflections on the Profession of Operations Research and Some Thoughts on Its Future

Jeff D. Camm, Wake Forest University, Winston-Salem, NC

In this lecture, we will reflect on the speaker's 40+ years of experience in operations research, including such notable milestones as the merger of ORSA and TIMS, the Science of Better marketing campaign, the analytics movement, the emergence of big data and data science, and now the realization of artificial intelligence. What did we get right and what were the missed opportunities? We will reflect on the past, suggest some key learnings, and share some ideas on how the profession and INFORMS can thrive in the future.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA01

CC-North 120A

Capturing Emerging Targets and Performing Reconnaissance Over Uncertain Terrain

Tutorial Session

Session Chair: Hari Balasubramanian, University of Massachusetts, Amherst, Amherst, MA

1 Search and Rescue over Uncertain Terrain in Humanitarian and Military Contexts: Capturing Emerging Targets and Performing Reconnaissance

Rajan Batta, John Becker, Esther Jose, Nastaran Oladzad-Abbasabady, University at Buffalo, Buffalo, NY

This tutorial introduces and discusses two topics that are related to the application of search and rescue operations over uncertain terrains, which are common in both humanitarian and military situations. The first topic is focused on search path optimization for recording emerging targets (search victims). After this, the case of camouflaging targets and multiple vehicles is considered, with a focus on how these features complicate the problem and change routing strategies. The second topic is search and exploration problems on transportation networks with unknown characteristics. Prize collection problems on such networks are detailed for the single vehicle case. Examples and computational results are presented. The tutorial ends by presenting emerging topics related to emergency response and reconnaissance applications over uncertain terrains.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA04

CC-North 121A

New Developments in Dynamic Pricing: Optimization and Learning

Community Committee Choice Session

Session Chair: Arash Asadpour, Zicklin School of Business, New York, NY

1 Adaptive Learning for Joint Pricing and Inventory Control

Sharon Wang[1], Yining Wang[2], Boxiao Chen[1], Zhengyuan Zhou[3], [1]University of Illinois Chicago, Chicago, IL, [2]University of Texas at Dallas, Richardson, TX, [3]Stern School of Business, New York University, New York, NY, Contact: bbchen@uic.edu

We consider the joint pricing and inventory control problem for multiple products over a planning horizon of T periods. Demand distribution for one product depends on the prices of all the other products. We consider the situation where neither the demand-price relationship nor the distribution of demand noise is known and develop online learning algorithms that converge at the optimal rate.

2 Extreme Value Theory and the Single Item Dynamic Pricing Problem

Josh Reed, New York University, New York, NY

We consider the single item dynamic pricing problem in an asymptotic regime where the selling horizon tends to infinity. In this regime, the firm is under less pressure to immediately sell its remaining inventory and instead may shift the focus of its pricing strategy to customers whose item valuations lie in the right tail of the item valuation distribution. The statistical theory of extreme values plays a central role in this setting and so we refer to this regime as the extreme value regime. Our main results provide the asymptotics of the optimal expected revenue, selling price and purchasing probability in the extreme value regime. We also compare the performance of the optimal pricing policy against an upper bound derived by the deterministic version of the problem and we provide easy to implement pricing policies that are shown to be asymptotically optimal.

3 Optimization of Booking Limits for Hotel Room Categories

Andrew Vakhutinsky[1], Zijie Zhou[2], [1]Oracle Labs, Burlington, MA, [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: andrew.vakhutinsky@oracle.com

We consider a problem of simultaneously optimizing booking limits for multiple hotel room categories. The problem is formulated to explore a tradeoff between generating revenue by overbooking certain categories and minimizing penalties for exceeding the hotel capacity. Although the problem is similar to the well-known airline revenue management with multiple fair classes, it has several distinctions such as various lengths of stay, which makes the problem significantly more difficult to solve. In order to account for the inaccuracies in the estimation of the reservation cancellation probabilities that used as an input to the problem, it is solved using robust optimization approach. The empirical application of this optimization model is demonstrated by computing recommendations for booking limits based on the real-life reservation data from a middle-size hotel.

4 Dynamic Pricing for Multi-Product Consumer Electronics Trade-In Program

Zhuoluo Zhang[1], Murray Lei[2], Sean Zhou[3], [1]CUHK Business

School, Hong Kong, Hong Kong; [2]Queen's University, Kingston, ON, Canada; [3]Chinese University of Hong Kong, New Territories, China. Contact: yl64@queensu.ca

We study a dynamic pricing problem where a firm sells both new and used products. The firm acquires used products through trade-in programs, where customers sell their used products either for cash or for upgrade credits. The firm further refurbishes the used products and then sells them to consumers. In view of the challenge of solving the optimal pricing policy, we develop two simple and provably effective heuristic policies based on the solution to a deterministic relaxation. In particular, one policy set prices statically before the selling horizon, whereas the second policy dynamically adjusts prices. We give performance bounds for both policies, and show that the dynamic policy significantly improves the static policy. We further generalize our findings to various settings motivated by real-world applications.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA05

CC-North 121B

Choice Models and Revenue Management

Community Committee Choice Session

Session Chair: Sumit Kunnumkal, ISB, India, India

Session Chair: Anton J. Kleywegt, ISyE Georgia Tech, Atlanta, GA

1 Selling and Renting Mechatronics (Digitally Controlled Physical Goods)

Xianfeng Meng, Guang Li, Anton Ovchinnikov, Smith School of Business, Queen's University, Kingston, ON, Canada. Contact: 16xm4@queensu.ca

Firms that sell digital goods routinely utilize free-premium-upgrade business models for product differentiation. When downloading an app, one can try a free version first, then pay to unlock permanent premium functionality or rent additional temporary functionality. Recent technological advances allow physical goods firms to do the same: they can create products with identical hardware that are digitally controlled to allow for similar differentiation. This paper presents a stylized model to explore when physical goods firms should adopt such digitally-enabled product differentiation instead of the traditional product line design with high- and low-end products.

2 Pricing and Assortment Optimization Under a Model with Bulk Returns

Jacob Feldman[1], Sahika Sahan Konur[2], [1]Olin Business School, Saint Louis, MO, [2]Texas State University, San Marcos, TX, Contact: sahika.sahankonur@txstate.edu

We develop a model for bulk product returns and study its corresponding assortment and pricing problems.

3 Assortment Optimization Under Multiple-Discrete Customer Choices

Heng Zhang[1], Hossein Piri[2], Tim Huh[3], Hongmin Li[4], [1]Arizona State University, Tempe, AZ, [2]Haskayen School of Business-University of Calgary, Calgary, AB, Canada; [3]University of British Columbia, Vancouver, BC, Canada; [4]Arizona State University, Tempe, AZ, Contact: hzhan388@asu.edu

We discuss an assortment optimization problem where customers can buy multiple products and multiple units of each product. We adopt the multiple-discrete-choice (MDC) model to model consumer choice, characterize the performance of revenue-ordered assortments, and show that assortment optimization is NP-hard in general. We present an algorithmic framework that delivers near-optimal algorithms for different variations of the problem and can be extended to the mixture of MDC models. We propose approaches to fit data and incorporate uncertainty into the model for assortment purposes. The study provides theoretical foundation and practical guidance for businesses to make realistic decisions about product assortment.

4 Revenue Management with Joint Assortment and Price Optimization Under the Markov Chain Choice Model

Anton J. Kleywegt[1], Hongzhang Shao[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, Contact: steveshao@gatech.edu

We consider a seller who jointly determines the product assortment and the product prices while managing a network of resources with limited capacity. Existing approaches for joint assortment and price optimization cannot incorporate resource constraints. We show that under the Markov chain choice model (including the multinomial logit model), the joint optimization problem can be reformulated as a tractable convex conic optimization problem. We also give sufficient conditions for existence of an optimal solution with constant prices even with constrained resources, and for existence of an optimal solution with both constant assortment and constant prices.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA06

CC-North 121C

Emerging Topics in Revenue Management

Community Committee Choice Session

Session Chair: Deniz Akturk, University of Chicago Booth School of Business, Chicago, IL

Session Chair: Süleyman Kerimov, Rice University, Houston, TX

1 Platform Competition in Two-Sided Networks

John R. Birge, Emin Ozyoruk, University of Chicago, Chicago, IL, Contact: emin.ozyoruk@chicagobooth.edu

We study the impact of competition on ride-hailing platforms. The riders are sensitive to price and delay, and the drivers value high wages and utilization. The efficiency of the platforms improves with the density, and the drivers are randomly located in relation to the riders. The platforms simultaneously choose prices, service standards, and wages. The game admits a tractable form where each platform chooses a full price, enabling us to characterize the equilibrium and establish its existence and uniqueness. The results suggest that the ride-hailing industry benefits from economies of scale -- The unit cost of attracting drivers is decreasing in demand. Multiple platforms can enter and co-exist due to the multihoming drivers and variability in the system. However, a limited number of platforms can achieve economies of density and be profitable.

2 A New Class of Revenue Management Problems with Overbooking and No-Shows: Shoring up Trust Between Shippers and Carriers in Container Shipping

Jacob Feldman[1], Panos Kouvelis[2], [1]Olin Business School, Saint Louis, MO, [2]Washington University in St. Louis, Saint Louis, MO, Contact: jbfeldman@wustl.edu

In the container shipping industry, the story of overbooking is filled with tales of chronic mistrust between shippers and carriers. Specifically, loose and unenforceable contracting practices have led to a failed market where shippers constantly renege on their agreement to produce containers as promised, and as a result, carriers overbook too frequently in an effort to hedge against this no-show behavior. In this paper, we propose and study a deposit-based booking system that draws inspiration from current practices, and we study the carrier’s sequential online booking problem.

3 The Cost of Impatience in Dynamic Matching: Scaling Laws and Operating Regimes

Angela Kohlenberg[1], Itai Gurvich[2], [1]Northwestern University, Evanston, IL, [2]Northwestern University, Kellogg School of Management, Evanston, IL, Contact: angela.kohlenberg@kellogg.northwestern.edu

We study matching queues with abandonment. We identify non-asymptotic and universal scaling laws for the matching loss due to abandonment - the “cost-of-impatience” - of a two-sided queue with impatient customers and servers. We identify four operating regimes that characterize all sets of model parameters; these subsume asymptotic (heavy-traffic) regimes. The scaling laws for each regime reveal the fundamental structure of the cost-of-impatience and show that its order-of-magnitude is fully determined by (i) a “winner take all” competition between two single-sided queues representing extreme combinations of impatience and utilization, and (ii) the ability to “build” inventory on the server side. Practically important is that when servers are impatient, the cost-of-impatience is given by an insightful expression where only the minimum patience rate appears.

4 Approximations for Serving Impatient Users with Stochastic Service Times

Sebastian Perez Salazar, Rice University, Houston, TX

Motivated by serving users in call centers and ride-sharing applications, we consider the discrete-time sequential problem of serving impatient users with stochastic service times by a single server. There are n users, and each user leaves the system with a known probability. At each time step, we serve a user who spends a stochastic amount of time being served. Each user has a known valuation, and the goal is to find a policy that maximizes the expected value collected from the served users. For general stochastic service times, this problem is NP-hard to solve. In this work, we present efficiently computable approximations via linear programming and greedy schemes.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA07

CC-North 122A

Pricing and Selling Strategies

Contributed Session

Session Chair: Kangning Wang, Stanford University, Palo Alto, CA

1 Price Signal in Conspicuous Consumption

Mengqi Zhang, University of Colorado Boulder, Boulder, CO, Contact: mengqi.zhang@colorado.edu

In conspicuous consumption, if consumers lack information on actual demand distribution, they are uncertain about the level of exclusivity for which they are willing to pay a premium. We show that the price set by a monopolistic seller who has full knowledge of demand distribution can serve as a signal for consumers to estimate the level of exclusivity. Conspicuous consumption based on the price signal mechanism exhibits a conventional pattern of selling to fewer consumers at a higher markup. However, the nature of this mechanism tends to cause consumers to underestimate the conspicuous value, resulting in a loss for the seller or even the elimination of conspicuous consumption. Our findings are robust in both contexts where consumer types are subject to binary and continuous distribution.

2 Implications of iBuyer Intermediation on Price Discrimination in the Housing Market

Yuan Cheng, Chris Forman, Peng Liu, Cornell University, Ithaca, NY

We study whether iBuying, a technology-driven business model, attenuate or exacerbate the existing price discrimination in the housing market. Using housing transaction and mortgage data of top iBuying markets, we quantify the impact of iBuyer activities on the price discrimination using a repeat sales framework. We document that Black and Hispanic buyers pay price premia compared to their white counterparts for comparable housing in the studied metro areas. Further we examine iBuyer's role in attenuating the price discrimination in the housing market and investigate the corresponding mechanism.

3 Benefit of Opaque Selling for Inventory Management

Mingyang Fu, Xiaobo Li, National University of Singapore, Singapore, Singapore. Contact: fumingyang@u.nus.edu

In this study, we explore the concept of opaque selling—wherein specific product details are withheld until after purchase—and its benefit on inventory management. We find that the advantages of opaque selling extend beyond merely allocation flexibility. Even in scenarios with minimal or no allocation flexibility, sellers can still derive benefits from opaque selling. We further establish that, in larger markets, a mixed opaque selling strategy effectively balances inventory costs and revenue, thereby improving the profit. Moreover, we show that even in the asymmetric market, slight flexibility introduced through opaque selling can lead to almost constant relative inventory savings as the market size increases.

4 Fair Price Discrimination

Siddhartha Banerjee[1], Kamesh Munagala[2], Yiheng Shen[2], Kangning Wang[3], [1]Cornell University, Ithaca, NY, [2]Duke University, Durham, NC, [3]Stanford University, Stanford, CA

A seller is pricing identical copies of a good to a stream of unit-demand buyers. Each buyer has a value on the good as his private information. The seller only knows the empirical value distribution of the buyer population and chooses the revenue-optimal price. We consider a widely studied third-degree price discrimination model where an information intermediary with perfect knowledge of the arriving buyer's value sends a signal to the seller, hence changing the seller's posterior and inducing the seller to set a personalized posted price. We aim to find signaling schemes that is fair to the buyers, and we show the surprising existence of a novel signaling scheme that simultaneously 8-approximates all welfare functions that are non-negative, monotonically increasing, symmetric, and concave (e.g. the utilitarian social welfare, the Nash welfare, and the max-min welfare).

Tuesday, October 17, 8:00 AM - 9:15 AM

TA08

CC-North 122B

New Directions in Pricing and Revenue Management

Community Committee Choice Session

Session Chair: Kostas Bimpikis, Stanford University, Stanford, CA

Session Chair: Daniela Saban, Stanford University, Palo Alto, CA

1 Blockchain Mediated Persuasion

Kimon Drakopoulos[1], Irene Yuan Lo[2], Justin Mulvany[3], [1]University of Southern California, Data Sciences and Operations, Los Angeles, CA, [2]Stanford University, Stanford, CA, [3]University of Southern California, Los Angeles, CA, Contact: justin.mulvany@marshall.usc.edu

An ex-post informed Sender wishes to persuade a rational Bayesian Receiver to take a desired action, as in the classic Bayesian Persuasion model studied by Kamenica and Gentzkow (2011). However, we consider settings in which Sender cannot reliably commit to a signal mechanism. An alternative approach is to consider a trustworthy mediator that receives a reported state of the world from Sender and then, based on this report, generates a signal realization for Receiver. Such mediation can be implemented via costly blockchain technology. Surprisingly, we show that this cost differentiated mediation succeeds where free mediation fails. By requiring Sender to pay the mediator for different signal realization, we can effectively incentivize them to truthfully report, which in turn allows for beneficial persuasion to take place.

2 Market Fragmentation and Inefficiencies in Maritime Shipping

Kostas Bimpikis, Giacomo Mantegazza, Stanford University, Stanford, CA

Maritime shipping dominates current supply chains, transporting both raw materials and finished goods. However, about 47% of oil tanker and dry-bulk ships sail empty (ballast) at any point in time due to many factors, e.g., that trade flows are imbalanced and the market for transportation is fragmented. We exploit data provided by a maritime analytics firm and establish that consolidating the market for oil tankers can decrease ballasting by as much as 30% through better load-vessel matching. To address practicality and market-power concerns, we also show that organizing vessels into shipping pools of 10-20 units each (2-3% of the total fleet) can cut ballasting by over 25%. This provides another rationale for the growing trend of shipping pools and shows the scope of sustainability gains available solely by optimizing resource allocation in today's supply chains.

3 Designing a Loyalty Program in a Multi-Channel Context

Antoine Feylessoufi[1], Ersin Korpeoglu[1], Mika Sumida[2], [1]University College London, London, United Kingdom; [2]Marshall School of Business, University of Southern California, Los Angeles, CA, Contact: a.feylessoufi@ucl.ac.uk

With the advent of platforms in the hospitality industry, consumers can now often choose between booking a room directly through hotel channels or indirectly through a platform. Platforms may help hotels reach a larger customer base but it comes at the expense of the profit margin. Loyalty programs are a key tool for hotels to mitigate this loss. We investigate the optimal loyalty design program when managing this multi-channel problem using a novel dataset from a hotel chain spanning over 4 years.

4 Algorithmic Pricing, Transparency, and Discrimination in the Gig Economy

Daniel Chen, Gad Allon, Kenneth Moon, University of Pennsylvania, Philadelphia, PA

Algorithms control pricing and match customers and workers in the gig economy. Despite their prevalence, algorithms face several critiques: they lack transparency, can be biased, and can be inefficient. We empirically analyze these issues and show that algorithms lose efficiency from two sources: competition between platforms and misaligned worker incentives. We model workers' strategic responses to variation in pricing and estimate counterfactuals on the effects of minimum wage and transparent pricing policies.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA09

CC-North 122C

Decisions Under Not-So-Perfect Data

Community Committee Choice Session

Session Chair: Sarah Cen, Massachusetts Institute of Technology, Cambridge, MA
Session Chair: Devavrat Shah, Massachusetts Institute of Technology, Cambridge, MA

1 Machine Learning Who to Nudge: Combining Predictive Modeling and Causal Targeting

Susan Athey[1], Niall Keleher[2], Jann Spiess[3], [1]Stanford University, Stanford, CA, [2]Textio, Seattle, WA, [3]Stanford Graduate School of Business, Stanford, CA, Contact: jspiess@stanford.edu

We estimate the value of targeting in a large-scale field experiment with over 53,000 college students, where the goal was to use "nudges" to encourage students to renew their financial-aid applications. Our preferred approach combines a simple causal model of student decisions with a non-parametric machine-learning model that predicts baseline response rates. We compare this hybrid approach to two benchmarks. First, we target based on a causal forest that estimate heterogeneous treatment effects directly. This approach yields sizable benefits over sending nudges to a randomly selected group, but the estimation of treatment effects is so noisy that the return to targeting is 20-50% lower. Second, a purely predictive policy that targets those students with a low predicted probability of renewing financial aid does significantly worse than assigning nudges randomly.

2 No Star is Good News: Rerandomization Based on P-Values (ReP) from Covariate Balance Tests

Anqi Zhao[1], Peng Ding[2], [1]Duke University, Durham, NC, [2]University of California, Berkeley, Berkeley, CA, Contact: az171@duke.edu

Scientific publications often report covariate balance tables with not only covariate means by treatment arm but also the associated p-values from statistical tests of their differences. The practical need to avoid small p-values as indicators of poor balance motivates balance check and rerandomization based on these p-values (ReP) as an attractive tool for improving covariate balance in randomized experiments. Despite the possibly already widespread use of ReP in practice, the literature lacks results about its implications on subsequent inference, subjecting many effectively rerandomized experiments to inefficient analyses. To fill this gap, we examine a range of possibly useful schemes for ReP and recommend the combination of ReP with fully interacted regression to ensure both covariate balance and convenient and efficient inference.

3 Adaptive Estimation of Intersection Bounds
Vira Semenova, University of California, Berkeley, Berkeley, CA, Contact: semenovavira@gmail.com
This paper studies averages of intersection bounds -- the bounds defined by the infimum of a collection of regression functions -- and other similar functionals of these bounds, such as averages of saddle values. Examples of such parameters are Frechet-Hoeffding bounds, Makarov (1981) bounds on distributional effects. The proposed estimator classifies covariate values into the regions corresponding to the identity of the binding regression function and takes the sample average. The paper shows that the proposed moment function is insensitive to first-order classification mistakes, enabling various nonparametric and regularized/machine learning classifiers in the first (classification) step. The result is generalized to cover bounds on the values of linear programming problems and best linear predictor of intersection bounds.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA10

CC-North 123
Decision Making Under Uncertainty
Community Committee Choice Session
Session Chair: Rui Gao, University of Texas at Austin, Austin, TX
Session Chair: Luhao Zhang, The University of Texas at Austin, Austin, TX

1 Constant Approximation for Network Revenue Management with Markovian Correlated Customer Arrivals
Jiashuo Jiang, the Hong Kong University of Science and Technology, Hong Kong, China. Contact: jsjiang@ust.hk
The NRM problem allocates fixed resources to serve customers over a finite horizon stochastically. This paper proposes a more general scenario where customer arrivals over different periods can be correlated by using a system state that evolves over time according to a time-inhomogeneous Markov chain. An LP approximation is derived for the NRM problem under this correlated model, which provides a tighter upper bound on the total reward collected by the optimal policy. A bid price policy is developed using this LP, which guarantees to collect at least 1/(1+L) fraction of the total reward collected by the optimal policy, where L is the maximum number of resources required by a customer. Overall, this work presents a new model, an LP approximation, and a bid price policy for solving the NRM problem with correlated customer arrivals, with a theoretical guarantee on its performance.

2 Entropic Regularization for Adversarial Robust Learning
Jie Wang, Yao Xie, Georgia Institute of Technology, Atlanta, GA, Contact: jwang3163@gatech.edu
This study investigates the problem of adversarial robust learning by applying entropic regularization. Our approach involves reformulating the classical adversarial risk minimization problem as a distributionally robust optimization problem, utilizing the infinite-type Wasserstein distance, and adding entropic regularization to the objective function. Our proposed model offers better tractability results compared to the original formulation. Additionally, we provide statistical guarantees, including the regularization effect and uncertainty quantification of the proposed model. Our numerical experiments demonstrate that our approach outperforms heuristic methodology.

3 Foresee the Next Line: On Customer Behavior and Information Disclosure in Tandem Queues
Jingwei Ji, University of Southern California
Many services consist of multiple stages, where each stage requires some waiting before completion. Although customers may observe the queue in front of them, they usually have no information about the waiting situation in the next queue. Our paper aims to examine the behavior of customers when such information is either provided or not, and to study the value of queue-length information in such systems. We assume a two-stage tandem queueing system, with an admission queue followed by a treatment queue. Customers observe the queue length at arrival to each queue and may join or balk. We first study the fully observable model, in which queue-length information of both queues is available to customers at the time they arrive to the system. We calculate the equilibrium strategy and show that it is not necessarily a function of the total number of customers in the system. Next, we study the partially observable model, in which customers observe each queue length only at arrival

to it, i.e., they do not observe the second queue length when they arrive to the system. We prove the existence of an equilibrium strategy in this model and derive a condition under which the equilibrium is a threshold strategy. For both models, we show that customers who join the system never renege.

4 Residual-Based Distributionally Robust Optimization Under Decision-Dependent Uncertainty

Zoey Zhu, Guzin Bayraksan, Xian Yu, The Ohio State University, Columbus, OH, Contact: zhu.2166@buckeyemail.osu.edu

In this paper, we study a data-driven distributionally robust optimization (DRO) model under decision-dependent uncertainty. We adopt regression models to learn the latent decision dependency and then construct ambiguity sets around the learned model using empirical residuals. Specifically, we build sample-based ambiguity sets, where both the sample values and the distribution probabilities are within a bounded distance of the estimated ones. We investigate the asymptotic optimality and rate of convergence of solutions obtained using this type of ambiguity sets. Through numerical experiments, we validate our theoretical results in the limited data regime.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA11

CC-North 124A

Reinforcement Learning: Statistical Complexity and Applications on Operations

Community Committee Choice Session

Session Chair: Nian Si, Stanford University, Stanford, CA

1 Dyadic Reinforcement Learning

Shuangning Li, Harvard University, Cambridge, MA

Mobile health aims to enhance health outcomes by delivering interventions to individuals. The involvement of care partners often proves crucial in helping individuals managing medical conditions. This presents opportunities to design interventions that target the dyadic relationship--the relationship between a target person and their care partner--with the aim of enhancing social support. In this paper, we develop dyadic RL, an online reinforcement learning algorithm designed to personalize intervention delivery. Here, multiple sets of interventions impact the dyad across multiple time intervals. The developed dyadic RL is Bayesian and hierarchical. We establish a regret bound for dyadic RL and demonstrate dyadic RL's empirical performance through simulation studies on both toy scenarios and on a realistic test bed constructed from prior data.

2 Optimal Sample Complexity Of Reinforcement Learning For Mixing Markov Decision Processes

Shengbo Wang, Jose Blanchet, Peter W. Glynn, Stanford University, Stanford, CA, Contact: shengbo.wang@stanford.edu

We consider the optimal sample complexity theory of tabular RL for controlling the infinite horizon discounted reward in a MDP. Optimal min-max complexity results have been developed for tabular RL in this setting, leading to a sample complexity dependence on □ and □ of the form \tilde □((1-□)^{-3}□^{-2}), where γ is the discount factor and □ is the tolerance solution error. However, in many applications of interest, the optimal policy (or all policies) will induce mixing. We show that in these settings the optimal min-max complexity is \tilde □(t_{mix}(1-□)^{-2}□^{-2})$, where t_{mix} is the total variation mixing time. We further apply our analysis to the average reward setting. Our analysis is based on regeneration-type ideas, that, we believe are of independent interest since they can be used to study related problems for general state space MDPs.

3 Policy Evaluation with General Function Approximation: Efficient Algorithms and Instance-Dependent Guarantees

Wenlong Mou, UC Berkeley, Berkeley, CA

A long-standing puzzle in reinforcement learning (RL) literature is whether RL is harder than statistical learning. The answer is yes-and-no: while regression methods can be applied to RL with function approximation, the geometry of Bellman equation needs to be taken into account. In this talk, I present recent advances in RL that provide non-asymptotic and instance-optimal guarantees. Focusing on function approximation methods for policy evaluation. I establish a novel class of optimal and instance-dependent oracle inequalities for projected Bellman equations, as well as efficient computational algorithms achieving them. The results reveal the additional price of RL compared to regression. Among other results, I will highlight how our novel algorithm tackle existing instability issue known as ``the deadly triad''.

4 Avoiding Model Estimation in Robust Markov Decision Processes

Wenhao Yang, Peking University, Beijing, China

Robust Markov Decision Processes (MDPs) are getting more attention for learning a robust policy which is less sensitive to environment changes. There are an increasing number of works analyzing sample-efficiency of robust MDPs. However, most works study robust MDPs in a model-based regime. In this work, we first transform the original robust MDPs into an alternative form, as the alternative form allows us to use a model-free method to solve the robust MDPs. Meanwhile, we prove the alternative form still preserves the role of robustness. With this new formulation, we devise a sample-efficient algorithm to solve the robust MDPs, including a generative model mechanism and markovian data mechanism, from which we benefit lower memory space $O(|S||A|)$.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA12

CC-North 124B

Advancements in Simulation

Community Committee Choice Session

Session Chair: Xueping Li, University of Tennessee, Knoxville, Knoxville, TN

1 Simulation-Based Evaluation of Dispatching Policies in a Multiple Flow Service System

Yang Sun[1], Yang Li[2], Yuan Ye[2], [1]California Northstate University, Elk Grove, CA, [2]California State University, Sacramento, Sacramento, CA, Contact: yang.sun@cnsu.edu

Many service systems today encounter multiple customer flows. For instance, due to the COVID-19 pandemic, most restaurants now deal with online orders and dine-in customers at the same time. Consequently, service stations within a restaurant, such as the front desk and the kitchen, confront additional complexities when allocating resources and scheduling customer orders. In this research, we use discrete event simulation models and conduct simulation experiments to assess dispatching policies in a service system facing multiple customer flows. Through comparative analysis, the service system can determine the best set of staffing and dispatching decisions that ensure service efficiency and effectiveness under various conditions.

2 Simulation as an Environment (SaaE) - Unleash the Power of Simulation for Machine Learning

Xueping Li, University of Tennessee, Knoxville, Knoxville, TN

In this research, we develop a general framework of using simulation as an environment (SaaE) for machine learning model training. Specifically, we present how to build a connection between a simulation model and a deep reinforcement learning algorithm. Due to the versatility of simulation, this SaaE framework thus allows one to optimize nearly any simulation model, thus combining the power of both simulation and machine learning. A suite of use cases demonstrates the flexibility and effectiveness of this framework.

3 Spatial Digital Twins for Urban Resilience and Emergency Management

Olufemi A. Omitaomu, Oak Ridge National Laboratory, Oak Ridge, TN

The recent advances in digital transformation are enabling the creation of fit-for-purpose digital representations of industrial operations and processes using collected data and information. This presentation describes a vision for prototyping a "Smart Metaverse City" to combine the unique advantage of the Metaverse technology with the two-way connectivity of a digital twin city application. This synergy aims to create a virtual environment for immersive geovisualization to help researchers and the public understand the complex urban system through science-based and data-driven approaches. We demonstrate our vision and discuss its application opportunities through a real-world example, a digital twin city developed at the Oak Ridge National Laboratory, to facilitate participatory, smart, and sustainable urban area management.

4 Gas Stations Outage Simulator for Integrated Oil and Natural Gas Situational Awareness

Brandon Miller, Olufemi A. Omitaomu, Nagendra Singh, Taylor Hauser, Bennett Morris, Oak Ridge National Laboratory, Oak Ridge, TN, Contact: millerba@ornl.gov

Gas stations are vulnerable to extreme weather events and cyber events, which impact their operations and pose risks to their infrastructure, data, and customers. A gas station outage refers to any gas stations experiencing a disruption in or lack of fuel supply. During an outage, stations are unable to provide fuel to customers due to a fuel shortage. Outages occur due to natural disasters, cyber-attacks, pipeline disruptions, etc., and can last for days or weeks. These outages delay first responders and search and rescue, and hinder evacuations during crises. Despite this, there is no singular source of real-time fuel availability data. The tracking tools that do exist rely on crowdsourcing, which is inaccurate at best. To this end, the Stations Outage Simulator (SOS) is a data-driven queueing model that simulates fuel availability during extreme events in near-real-time.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA13

CC-North 125A
Advances in Decision Analysis
Community Committee Choice Session
Session Chair: Canan Ulu, Georgetown University, Washington

1 A Walk Down Memory Lane: How Personal Memories Influence Stock Investment and Information Processing
Alessandra Cillo[1], Giovanni Burro[2], alessandro castagnetti[1], Giovanni Paolo Crespi[3], [1]LIUC University, Castellanza (Va), Italy; [2]Bocconi University, Milan, Italy; [3]Università Cattaneo LIUC, Castellanza, Italy. Contact: acillo@liuc.it
Investing in the stock market is a pivotal decision in household finance. Stock investment is substantially more profitable than investment in other asset classes. We experimentally test stock market participation and how financial memories influence stock investment. After eliciting memories and before the investment task we provide, to some participants, positive and truthful financial information about the stock they are about to invest in. We rationalize our findings in light of a memory-based model that builds upon two main elements of memory recall: similarity and interference.

2 The Discount Rate for Investment Analysis Applying Expected Utility
Manel Baucells[1], Sam Bodily[2], [1]Darden School of Business, Playa Vista, CA, [2]Darden School of Business, Charlottesville, VA, Contact: baucellsm@darden.virginia.edu
In decision analysis, expected utility of discounted cash flows is the traditional approach to incorporate risk aversion into the evaluation of a project. The choice of discount rate, as well as the convergence with the CAPM approach from finance, have always been in question. To address this gap, we adopt a standard setup having both treasuries and the stock market as alternatives to the project. We find a unique rate to discount all final capital---from the project and the market---that allows setting the horizon at the termination of the project. For practitioners who discount only the project's cash flows, while ignoring the market, we propose an adjusted discount rate which, under certain assumptions, correctly compensates for the omission. Under these same assumptions, we verify that the approach agrees with Smith and Nau's integrated roll-back procedure.

3 The Impact of Choice on the Utilization of Ai in Decision-Making
Matthew R. Leitao[1], Jennifer Logg[2], Canan Ulu[3], [1]Georgetown University, Washington, DC, [2]Georgetown University, Washington, DC, [3]Georgetown University, Washington, Contact: mrl118@georgetown.edu
Decision-making plays a pivotal role in shaping the outcomes and success of organizations. With the use of Artificial Intelligence (AI) as decision-makers, organizations can improve the accuracy and efficiency of their decisions enabling businesses to save valuable time, resources, and capital. Our studies explore the relationship between the availability of AI models and decision-makers adoption of AI. By providing decision-makers with diverse sets AI models, we expect to increase their inclination to incorporate AI in decision-making. This research contributes to understanding the importance of AI adoption and its impact on decision quality, operational efficiency, and competitive advantage.

4 Appreciation of Advice from Algorithms and Human-In-The-Loop Systems
Canan Ulu[1], Alessandra Cillo[2], Emanuele Borgonovo[3], Alessandro Ortis[4], Sebastiano Battiato[4], [1]Georgetown University, Washington, DC, [2]LIUC University, Castellanza (Va), Italy; [3]Bocconi University, Milano, Italy; [4]University of Catania, Catania, Italy
We investigate how individuals react to advice coming from a human-in-the-loop system where advisors who give the advice have access to algorithms in comparison to direct algorithmic advice and advice from human advisors who do not have access to algorithms. Our results suggest that people appreciate direct algorithmic advice as much as (sometimes more than) advice from a human-in-the-loop system in forecasting tasks. Both the advice from an algorithm and the advice from a human-in-the-loop system are appreciated more than the advice from other human advisors. The appreciation of direct algorithmic advice is more pronounced when the algorithm produces confident forecasts and wanes when experts are part of the human-in-the-loop system.

5 Biseparable Representations of the Certainty Equivalents
Michal Lewandowski[1], Jacek Chudziak[2], [1]Warsaw School of Economics, Warsaw, Poland; [2]University of Rzeszow, Rzeszow, Poland. Contact: michal.lewandowski@sgh.waw.pl

We consider the following biseparable representation of the certainty equivalent of a binary monetary gamble: $F(x,y;p)=u^{-1}(u(y)+w(p)[u(x)-u(y)])$, where u is the utility function and w is the probability weighting function. We provide a simple set of axioms characterizing this form and a few special cases. In particular, we discuss the rank-dependent case with general w, the rank-independent case with self-conjugate w, and the case of expected utility where w is an identity function. For all these cases, we analyze both the model for all binary lotteries and the case of a limited domain of so-called simple prospects $(x,y_0;p)$ where payoff y_0 is fixed.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA14

CC-North 125B

Socially Responsible and Sustainable Operations

Community Committee Choice Session

Session Chair: Luyi Yang, University of California, Berkeley, Berkeley, CA

1 Seeing Beauty in Ugly Produce: A Food Waste Perspective

Zheng Han[1], Bin Hu[2], Milind Dawande[3], [1]DePaul University, Chicago, IL, [2]University of Texas at Dallas, Richardson, TX, [3]The University of Texas at Dallas, Richardson, TX

The concept of ugly produce involves selling cosmetically unconventional but perfectly edible produce to reduce food waste. While advocates argue that selling ugly produce in retail reduces food waste, skeptics contend that alternative buyers such as restaurants could consume these products. We present a model of a farm selling produce to a retailer and an alternative buyer, which shows that retailing ugly produce can reduce food waste but may also decrease retailer profit, resulting in grocery chains' reluctance to carry these products. However, the study suggests that a dedicated retailer selling ugly produce, competing with a conventional retailer, can achieve the same reduction in food waste. We also highlight the effectiveness of implementing a food landfill tax in reducing food waste.

2 Collective Renewable Power Purchase Agreement (PPA) - Negotiation and Risk Sharing Mechanism

Xiaoxuan Hou, Shi Chen, University of Washington, Foster School of Business, Seattle, WA, Contact: xxhou@uw.edu

Background: Lately, corporate power purchase agreement (PPA) gained popularity among buyers like Google and Amazon as the main vehicle to achieve their renewable goals. Yet signing a PPA remains difficult for small-to-medium-sized corporate buyers, to which collective PPAs emerged as a potential solution. Method: We build Nash bargaining-based economic models to compare the performance of four negotiation mechanisms for these small-to-medium buyers : separate negotiation, agent-based negotiation (different price), agent-based negotiation (same price), and joint negotiation. Results: Agent-based (same price) negotiation results in the largest equilibrium renewable project size. Buyers prefer collaboration over negotiating separately, yet it may be difficult for them to reach an agreement on the exact collaboration mechanism.

3 Labor, Skills, and Product Recovery

Cerag Pince[1], Atalay Atasu[2], [1]Quinlan School of Business, Loyola University Chicago, Chicago, IL, [2]INSEAD, Fontainebleau, France

Motivated by a third-party remanufacturer (3PR) of consumer products, we study the workforce capacity investment problem in product recovery operations. We analyze how a remanufacturing firm should determine its workforce's quantity and type when the number and complexity of units to be processed are random. We characterize the optimal solutions for different workforce strategies and identify the conditions when one strategy dominates the other.

4 Privacy-Preserving Data-Driven Inventory Management

Lorraine Yuan[1], Elena Belavina[2], Karan Girotra[3], [1]Cornell Tech/Cornell University, New York, NY, [2]Cornell University, New York, NY, [3]Cornell Tech/Johnson Cornell University, New York, NY, Contact: hy557@cornell.edu

The use of customer data (demographics, past purchases, etc.) for inventory management can improve firm profits and customer service levels. Yet, large-scale use of such data increases the risks of breaching customers' privacy. This paper develops differential-privacy based privacy-preserving adaptations for three data-driven newsvendor pipelines: the usual two-step predict-then-optimize method, and two newer joint predict-and-optimize methods. We characterize the tradeoff among privacy loss, profits and consumer surplus for the privacy preserving versions of these three approaches. We show that both joint approaches outperform the two-step approach to preserve privacy: Obfuscating customer data can be done with less profit loss by considering downstream optimization problems, we can privatize outputs with less noise and more targeted noise injection.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA15

CC-North 126A

Managing and Modeling Human Capital

Community Committee Choice Session

Session Chair: Mary Davis, 1</sup

Session Chair: Nicholas Pollack, 1</sup

1 Informing United States Air Force Manpower Decisions with Realistic Constraints Using Reinforcement Learning

Garth Terlizzi, Air Force Manpower Analysis Agency, San Antonio, TX, Contact: garth.terlizzi.2@us.af.mil

The United States Air Force (USAF) human capital ecosystem is a closed, complex system that manages over 300,000 active-duty personnel. Historical management practices allowed senior leaders to make decisions about changing future programs without assessing whether personnel could be developed quickly enough to meet these rapidly changing future targets. In this system, data-driven, effective accession planning is crucial to maintaining a healthy balance of skillsets. We demonstrate a reinforcement learning approach to develop high-quality accession plans to adapt to these targets, as well as a structured approach to inform senior leaders about consequences of programmatic decisions to AF personnel management.

2 Resolving Air Force Wide Data Disconnects: Constructing Robust Human-Capital Models Under Improved Data Integration

Nicholas Pollack, San Antonio, TX

The United States Air Force (USAF) operates a largely closed human capital ecosystem, training junior personnel to grow into senior personnel. Thus, managing scarce experience via assignments and promotions is a vital policy topic. Historically, the USAF approach was constrained by heavily siloed data and processes, as well as limited storage and computation. We demonstrate revisions to two sets of policies made possible by recent increases in data efficacy. First, we show work on models to examine the effects of promotions and grade structure on Airman compensation, experience, retention, and career stability. Second, we show approaches to develop sustainable grade structures in response to fluctuating mission requirements.

3 A New Approach to Career Field Matching For Commissioning Air Force Cadets

Daniel Laird, US Air Force Personnel Center, Universal City, TX

Every year, the Air Force Personnel Center (AFPC) assigns graduating cadets from the United States Air Force Academy (USAFA) and various Reserve Officer Training Corps (ROTC) detachments to their career fields, denoted by Air Force Specialty Codes (AFSCs). Due to the innovations made recently to combine both sources of commissioning (USAFA and ROTC) and all three line-officer "accessions groups" (USAF Rated, USSF, and USAF Non-Rated) into one optimization model, AFPC can improve the DAF line-officer accessions process by adjusting the production guidance letter (PGL), which outlines how many new lieutenants AFPC must match to each AFSC per year. This new classification model is equipped to directly incorporate the output of an improved sustainment model chartered by the Air Force Manpower Analysis Agency (AFMAA) that quantifies the tradeoffs of assigning more or fewer new lieutenants into each specific AFSC. By incorporating more information on the manpower needs of each career field, the Air Force officer accessions matching model can make more informed and data-driven decisions on the most efficient allocation of its human capital.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA16

CC-North 126B

Response and Recovery to Disasters and Disruptions

Contributed Session

Session Chair: Harsh Anand, University of Virginia, Charlottesville, VA

1 Utilizing Multimedia Big Data Analytics to Evaluate Transportation Disruptions in near Real Time Following Hurricane Events

Adetola Odebode[1], Ashlea Bennett Milburn[1], Jose Azucena[1], Haitao Liao[1], Serhan Dagtas[2], Xiao Huang[1], Sharafat Hossain[2], [1]University of Arkansas, Fayetteville, AR, [2]University of Arkansas, Little Rock, AR, Contact: aoodebod@uark.edu

Emergency responders are driven by logistical issues like what resources are needed, when and where, and how those resources should be delivered during disaster events. For a disaster response to be successful and effective, situational awareness of the state of the transportation infrastructure along which key movements, such as supply distribution and search and rescue missions must occur, is crucial. To do this, we develop a framework that uses cutting-edge data analytics tools and techniques to route important resources while taking advantage of social media and other data sources for essential and timely information. We present the work in progress toward implementing this framework using Hurricane Harvey as a testbed.

2 A Scenario-Based Optimization Model for Designing Reverse Logistics Network of End-Of-Life Building as Disaster Preparedness

Moddassir Khan Nayeem[1], Omar Abbaas[1], Shahriar Tanvir Alam[2], [1]University of Texas at San Antonio, San Antonio, TX, [2]University of Southern California, Los Angeles, CA, Contact: moddassirkhan.nayeem@my.utsa.edu

The primary goal of the preparedness stage of disaster management is to increase the likelihood of survival for victims. Reconstructing outdated structures is a crucial part of earthquake preparedness. Therefore, the goal of this study is to lessen the impact of earthquakes through the reconstruction of obsolete structures and develop a mixed-integer linear programming (MILP) model for designing a reverse logistics network. This optimization model seeks to maximize expected profit while minimizing landfilling activities by recycling construction materials. The quantity of waste generated at demolition sites is considered uncertain and to hedge against the uncertainty stochastic programming approach is applied.

3 Evaluating the Effectiveness of Hurricane Evacuation Orders by Leveraging Large-Scale Human Mobility Patterns

Harsh Anand, Majid Shafiee-Jood, Negin Alemazkoor, University of Virginia, Charlottesville, VA, Contact: yyf8rj@virginia.edu

Evacuation orders are vital for emergency preparedness, yet their effectiveness in increasing evacuation rates remains uncertain. This study examines the causal effect of evacuation orders using passively collected high-fidelity mobility data. By employing causal inference methods, we estimate the effectiveness of mandatory evacuation orders during Hurricane Dorian across 2,617 census block groups in Florida. We further investigated "shadow evacuation" patterns to understand evacuation order responses in areas without evacuation zones and areas with evacuation zones but no orders. The findings shed light on the efficacy of evacuation orders and their broader implications for community responses.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA17

CC-North 127A

Behavioral Queueing Science

Community Committee Choice Session

Session Chair: Kenneth Schultz, Unaffiliated, Englewood, OH

Session Chair: Armann Ingolfsson, University of Alberta, Edmonton, AB, Canada

1 A Critical Assessment of the Interpretation of Wait Abandonment as a Manifestation of Customer Impatience and Service Failure

Agust Thorbjornsson, Reykjavik University, Reykjavik, Iceland. Contact: agust@framsaekni.is

Based on customer surveys and data from a bank and a utility call center, we investigated whether call abandonments are a manifestation of customer impatience and service failure. We found that 32% of bank and 51% of utility customers abandoned without experiencing impatience, and that customers may have been impatient long before abandoning. This contradicts the assumption made by the "patience" distribution, that customers are initially patient but become impatient and abandon if they wait long enough. Abandonments without impatience seem to largely explain the hazard rate peak, which typically occurs early in the waiting process. Thus, the terms patience distribution and average patience time are misleading. Abandonments seem to have a similar impact on the overall customer experience as the far more likely event of experiencing impatience before receiving service.

2 Calculating Service Rates from Empirically Obtained State-Dependent Mean Service Times

Likang Ding[1], Bora Kolfal[2], Armann Ingolfsson[2], [1]University of Alberta, Edmonton, AB, Canada; [2]University of Alberta, Edmonton, AB, Canada. Contact: likang@ualberta.ca

Queueing models are typically formulated in terms of service rates but recent empirical queueing research focuses on expected service times. We analyze service times in Markovian queueing models with state-dependent service rates. Our primary research question is to analyze the relationship between service rates and expected service times. We provide closed-form solutions to convert service rates into expected service times and vice versa. Contrary to what is sometimes assumed, in general, expected service times are not the inverse of service rates, and service times in state-dependent Markovian systems are not exponentially

distributed. We find conditions under which monotonicity in service rates implies monotonicity in expected service times. Furthermore, we compare the results of our model with state-dependent non-Markovian models in the literature.

3 Model Development and Validation for the Call Center of a Non-Profit Organization

Arash Asgari, Armann Ingolfsson, Saied Samiedaluie, University of Alberta, Edmonton, AB, Canada. Contact: aasgari@ualberta.ca

We develop a novel model to replicate the observed average wait times and abandonment proportions in the call centre of a non-profit organization, in which the agents might become unavailable because of after-call work, meetings, or breaks. Initially, we explored the Erlang-S model, which allows for variability in agents' availability by expanding the parameter set of the commonly used Erlang-A model. Although the Erlang-S model yields improved outputs compared to the Erlang-A model, we achieve more valid results by extending the Erlang-S model to incorporate a two-phase unavailability period for agents. This two-phase approach involves a short period, such as call wrap-up time, followed by a longer period, such as going on a break.

4 The Sooner, the Better? - Behavioral Pitfalls with Pre-Ordering Newsvendors

Anne Dohmen[1], Michael Becker-Peth[2], Stephanie N. Eckerd[1], Lance Saunders[1], [1]University of Tennessee, Knoxville, TN, [2]Erasmus University Rotterdam, Rotterdam, Netherlands. Contact: m.beckerpeth@rsm.nl

Firms launching new product lines need to ensure they have enough product to meet initial orders, but not too much as to have large amounts of excess. Firms will often order "pre-order" raw materials based on long term forecasts to ensure availability of the needed components at product launch. Closer to time of the launch, updated demand parameters may prove that initial orders were inaccurate. Companies can have the opportunity to change their orders after the information is updated to reflect the more accurate forecast. Any changes to initial orders often comes with a 'change fee' to compensate for the effort required by the planner and/or supplier. We investigate how and when decision makers adjust their orders in these circumstances in a laboratory newsvendor experiment.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA18

CC-North 127B

Fairness and Equity in Operations

Community Committee Choice Session

Session Chair: Phebe Vayanos, University of Southern California, Los Angeles, CA

Session Chair: Bill Tang, University of Southern California, Los Angeles, CA

1 Algorithm-assisted Decision Making and Racial Disparities in Housing: A Study of the Allegheny Homelessness Assessment Tool

Lingwei Cheng, Carnegie Mellon University, Pittsburgh, PA

Homelessness is a long-standing challenge in the US, with Black Americans experiencing over three times the lifetime rates of homelessness compared to non-Hispanic whites. Long-term public housing is effective in reducing homelessness, but bias in resource allocation can perpetuate disparities. This study explores the impact of the Allegheny Homelessness Assessment Tool (AHA), an algorithm-based assessment, on racial disparities in housing. AHA predicts adverse outcomes and standardizes assessments using administrative data. Analyzing pre and post-AHA housing data, we find caseworkers align more with risk scores after deployment. Disparities in Permanent Supportive Housing enrollment are reduced post-AHA, with higher rates of service for Black clients in some cases. The influence of caseworkers' overrides of the tool on racial disparities is also examined.

2 Community/Committee'S Choice Submission

Osonde Osoba, 1</sup

3 Learning Optimal Policies for Allocation of Scarce Resources

Bill Tang[1], Cagil Kocyigit[2], Phebe Vayanos[1], [1]University of Southern California, Los Angeles, CA, [2]University of Luxembourg, Luxembourg, Luxembourg. Contact: yongpeng@usc.edu

We study the problem of allocating scarce societal resources of different types to heterogeneous individuals based on their observed covariates. We leverage administrative data collected in deployment to design a policy that maximizes expected outcomes while satisfying budget and fairness constraints. Our proposed policy waitlists each individual for the resource maximizing the difference between their estimated mean treatment outcome and the estimated resource dual-price or, roughly, the opportunity cost of using the resource. Resources are then allocated as they arrive, in a first-come first-serve fashion. We demonstrate that our data-driven policy converges to the optimal out-of-sample policy under technical assumptions. We evaluate the performance of our approach on the problem of designing policies for allocating scarce housing resources in Los Angeles.

4 Fairness in Contextual Resource Allocation Systems: Metrics and Incompatibility Results

Nathanael Jo[1], Bill Tang[1], Kathryn Dullerud[2], sina Aghaei[2], Eric Rice[1], Phebe Vayanos[1], [1]University of Southern California, Los Angeles, CA, [2]USC, Los Angeles, CA, Contact: phebe.vayanos@usc.edu

We study critical systems that allocate scarce resources to satisfy basic needs. These systems often support communities disproportionately affected by systemic racial, gender, or other injustices, so it is crucial to design these systems with fairness considerations in mind. We propose a framework for evaluating fairness in contextual resource allocation systems that can be applied to evaluate the fairness properties of a historical policy, as well as to impose constraints in the design of new (counterfactual) allocation policies. Our work culminates with a set of incompatibility results that investigate the interplay between the different fairness metrics we propose. Our framework can help guide the discussion among stakeholders in deciding which fairness metrics to impose when allocating scarce resources.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA19

CC-North 127C

Analytics for Healthcare Operations

Community Committee Choice Session

Session Chair: Nan Liu, Boston College, Chestnut Hill, MA
Session Chair: Miao Bai, University of Connecticut, Storrs, CT

1 Does Physician’s Choice of when to Perform EHR Tasks Influence Total EHR Workload?

Umit Celik[1], Sandeep Rath[2], Saravanan Kesavan[3], Bradley R. Staats[4], [1]UNC Kenan-Flagler Business School, Chapel Hill, NC, [2]University of North Carolina at Chapel Hill - Kenan Flagler, Chapel Hill, NC, [3]University of North Carolina-Chapel Hill, Chapel Hill, NC, [4]University of North Carolina at Chapel Hill, Chapel Hill, NC, Contact: umit_celik@kenan-flagler.unc.edu

Physicians spend over 5 hours daily on Electronic Health Record (EHR) systems, with additional after-hours work, leading to burnout and appointment delays. This study explores how physicians’ decisions regarding the timing of EHR tasks impact total EHR time and after-work hours. Analyzing data from 150,000 appointments and 74 physicians, the research finds that pre-appointment EHR work reduces overall EHR workload and after-work hours, while post-appointment EHR work decreases after-work hours but increases total EHR time. Increasing idle time between appointments encourages both pre- and post-appointment EHR work. These findings have managerial implications, helping healthcare administrators optimize EHR workflows and appointment schedules to alleviate physician burnout caused by excessive EHR use.

2 Optimizing Bed Assignments in Real-Time for a Hospital Command Center

Arlen Dean[1], Mohammad Zhalechian[2], Mark P. Van Oyen[3], [1]University of Michigan, Ann Arbor, MI, [2]Indiana University, Bloomington, IN, [3]Industrial & Operations Engr., Ann Arbor, MI, Contact: arlend@umich.edu

We report on our research with a large, highly utilized hospital to coordinate bed assignments. These decisions are complicated by patients’ varying care needs and rooms/beds’ distinct features. To overcome these challenges, we develop and implement an optimization model that leverages operational practices with real-time patient and system information.

3 Helping the Captive Audience: Advance Notice of Diagnostic Service for Hospital Inpatients

Miao Bai[1], Nan Liu[2], Zheng Zhang[3], [1]University of Connecticut, Storrs, CT, [2]Boston College, Chestnut Hill, MA, [3]Zhejiang University, Hangzhou, China. Contact: zhengzhang@zju.edu.cn

Inpatients are often treated as on-demand for hospital diagnostic service, and they are notified only when service capacity is available. This arrangement causes significant chaos and inefficiencies in hospital operations. We propose an innovative scheduling approach called ``advance notice’’ to manage hospital diagnostic practice. Patients are placed in a common queue waiting to be called for service, and they will be provided both a fixed preparation time and a guaranteed service time window in advance. It calls for two decisions: who to serve now and who to send advance notices to. We formulate a Markov Decision Process model to optimize these decisions dynamically. Via a novel variable transformation, we reveal the hidden antimultimodular structure of the problem and show how optimal decisions should be adjusted in response to changes in system load.

4 Early Reservation for Follow-Up Appointments when Continuity of Care Matters

Yichuan Ding[1], Diwakar Gupta[2], Shenghai Zhou[3], [1]McGill

University, Montreal, QC, Canada; [2]University of Texas, Austin, TX, [3]Central South University, Changsha, China

Our emperical study shows that high prioritized follow-up (PFU) appointments leads to high level of Continuity of Care (COC). To maintain a certain level of COC, we develop a principal-agent model to inspire doctors do consequently book an appropriate number of PFU appointments. We show that the portion of PFU based contract is the best one among several contracts.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA20

CC-North 128A

OR Applications for Medical Decision-making

Community Committee Choice Session

Session Chair: Daniel Felipe Otero-Leon, University of Michigan, Ann Arbor, MI

1 Optimizing Vaccine Site Selection Considering Queuing Costs: A Game-Theoretical Approach

Peng Dai, Industrial and System Engineering University of Southern California, Los Angeles, CA

Vaccines are crucial for pandemic management, and in the COVID-19 pandemic, drive-through vaccinations were widely used. Vaccination sites should be optimized for residents' convenience, considering both travel and queuing times. We formulate this as an extension of the p-median problem, using Hirotaka's approximation to estimate queue times and formulate a mixed-integer convex optimization problem. We also construct a game-theoretic model to estimate the "price of anarchy," which provides the cost associated when residents can freely choose which vaccination site to attend. Our approach offers new insights into the potential inefficiencies of a decentralized decision-making process in a medical resource allocation network.

2 Finding the Optimal Time for Message-Based Intervention to Medical Students

Zequn Chen, Wesley Javier Marrero, Thomas Thesen, Dartmouth College, Hanover, NH, Contact: zequn.chen.th@dartmouth.edu

Medical students tend to suffer from heavy workload and long study periods, which leads to tremendously mental health issues. We develop an automated mental health intervention system for medical students. Our medical student data contains indexes such as age, sex, race, as well as the corresponding anxiety scores. We leverage student digital data to build predictive model and make the anxiety prediction. Secondly, we define the states and transition probability based on the predictive outcomes. Then we take advantage of the Markov Decision Process to model students' mental state transition process. Finally, we construct the optimal stopping time model to obtain the optimal initial intervention time.

3 Linkage of a Microsimulation to a Location-Optimization Model to Maximize the Clinical and Economic Value of Point-Of-Care Devices in Zimbabwe

Carolina Vivas-Valencia[1], Alyssa Amick[2], Clare Flanagan[2], Karen Webb[3], Andrea Ciaranello[2], Mohammad Jalali[2], [1]The University of Texas at San Antonio, San Antonio, TX, [2]Harvard Medical School, Boston, MA, [3]Organization for Public Health Interventions and Development, Harare, Zimbabwe. Contact: carolina.vivasvalencia@utsa.edu

In this study, we linked microsimulation and allocation models to inform the placement of point-of-care (POC) devices. First, using a model of pediatric HIV (CEPAC), we projected clinical and cost outcomes for different HIV-exposed infants. Second, we integrated the CEPAC model to an expanded location optimization model to examine the placement of POC devices that maximize clinical and economic outcomes.

4 Quantifying The Impact Of Interventions On Covid-19 Transmission: An Open-source Agent-based Modeling Approach

Sebastian A. Rodriguez-Cartes[1], Maria Esther Mayorga[1], Julie L. Swann[1], Julie Simmons Ivy[2], [1]North Carolina State University, Raleigh, NC, [2]University of Michigan, Ann Arbor, MI, Contact: sarodri4@ncsu.edu

When studying the spread of infectious diseases, individuals' actions are essential in preventing contagion across populations. In this study, we aimed to analyze the impact of interventions on COVID-19 transmission when accounting for individual decision-making. We implemented behavioral models to recreate agents' decision to wear a mask and get vaccinated, accounting for critical factors such as personal beliefs, the agent's context, and the system's state regarding infections. We used an open-source agent-based framework for infectious diseases to incorporate these models and analyze different health outcomes. Our results can be used to provide insights about population level outcomes derived from individual conduct. Moreover, we promote open access to the model as it is a flexible tool for studying the transmission dynamics of different infectious diseases.

5 Who Goes Next? Optimizing the Allocation of Adherence-Improving Interventions

Daniel Felipe Otero Leon[1], Mariel Sofia Lavieri[1], Brian T. Denton[2], [1]University of Michigan, Ann Arbor, MI, [2]Industrial and Operations Engineering, University of Michigan, Ann Arbor, MI, Contact: dotero-leon@mgh.harvard.edu

Long-term adherence to medication is a critical factor in preventing cardiovascular disease (CVD). Physicians may recommend adherence improving interventions; however, these are costly and limited in their availability. We developed a binary integer program (BIP) model to select patients for intervention under budget constraints. We further studied a long-term adherence prediction model using dynamic logistic regression (DLR) model to predict the risk of future non-adherence. We trained and tested our model to longitudinal data for CVD in a large cohort of patients seen in the VA health system. We proposed an algorithm that combines the DLR and BIP models to decrease the number of CVD events.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA21

CC-North 128B

Healthcare Analytics and Sequential Decision Making

Community Committee Choice Session

Session Chair: Yonatan Mintz, University of Wisconsin Madison, Madison, WI

Session Chair: Katherine Adams, University of Wisconsin-Madison, Monona, WI

1 Designing Interpretable and Personalized Treatment Assignment for Substance use Among Adolescents and Young Adults

Han Kyul Kim, Phebe Vayanos, University of Southern California, Los Angeles, CA, Contact: hankyulk@usc.edu

Substance abuse among adolescents and young adults is a critical social issue in the United States. Yet, current treatment assignments in most facilities rely on treatment availability rather than data-driven approaches. In this work, we investigate the impact of data-driven treatment assignment using the GAIN dataset, a comprehensive longitudinal dataset capturing real treatment outcomes. By employing causal inference and prescriptive trees, we develop a personalized and interpretable treatment assignment policy. Moreover, we explore a method to ensure fairness in the price of interpretability in the treatment assignment process. This research aims to empower clinicians and social workers by integrating data-driven decision making into treatment allocation, thereby enhancing their capacity to assist adolescents and young adults effectively.

2 Personalized Health Recommendations for Kidney Disease Patients: A Method Integrating Simulation and Markov Decision Processes

Yiwen Cao, Sze-chuan Suen, University of Southern California, Los Angeles, CA, Contact: ycao0253@usc.edu

Personalized screening and disease management plans may improve outcomes for kidney disease patients, as one-size-fits-all policies are still widely adopted in current practice. In this work, we integrate a microsimulation model with a Markov Decision Process (MDP) to maximize lifetime net monetary benefits (which considers both health outcomes and financial costs). This allowed us to capture the performance of treatment plans and expected health outcomes with respect to patient characteristics including gender, health status[S1] , and age. We performed scenario analyses to provide cohort-specific recommendations for treatment plans.

3 Stopping the Revolving Door: MDP-Based Decision Support for Community Corrections Placement

Xiaoquan Gao, Pengyi Shi, Nan Kong, Purdue University, West Lafayette, IN, Contact: gao568@purdue.edu

We study the incarceration-diversion decision problem to reduce jail overcrowding and recidivism rates by leveraging community corrections. We build a large-scale Markov decision process (MDP) model to balance the tradeoffs among congestion, recidivism, and violation. The salient features of the criminal justice setting, including deterministic service times and occupancy-dependent costs, present significant theoretical and algorithmic challenges. We propose a unified approach with system coupling and policy deviation bounding to compare value functions. We establish the convexity of the value function, which provides a theoretical basis for developing an efficient algorithm based on a separation of time scales. We showcase the effectiveness of our algorithm in solving real-world problems through a case study using data from our community partner.

4 Model Based Reinforcement Learning for Personalized Heparin Dosing

Qinyang He, UW-Madison, MADISON, WI

One of the key challenges in sequential decision making is optimizing systems safely in the case of partial information especially when both states and system dynamics are unknown. For instance, the setting of computing heparin doses for patients fits this paradigm since the concentration of heparin in the patient cannot be measured directly and the rates at which patients metabolize it vary greatly between individuals. To address above challenges in heparin dosing we build a predictive model based on pharmacokinetics parameterized individually by patient. Using this personalized model, we can accurately infer patients' states and predict future therapeutic effects. With this learned information, we propose dosing algorithms that robustly keep patients safe in face of observational errors.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA22

CC-North 129A

Drug Shortage Modeling and Analytics

Community Committee Choice Session

Session Chair: Noah Chicoine, Northeastern University, Boston, MA

Session Chair: Zohreh Raziei, Northeastern University, Boston, MA

1 A Deep Reinforcement Learning Aided Inventory Control Approach for Managing Drug Shortages: Impact of Information Sharing

Zohreh Raziei, Ozlem Ergun, Northeastern University, Boston, MA, Contact: raziei.z@northeastern.edu

The COVID-19 pandemic has brought to light the inadequate resilience of pharmaceutical supply chains, resulting in drug shortages and inefficient inventory management. To address this issue, our study proposes a novel approach that employs a multi-agent deep reinforcement learning (DRL) decision support system. This system models agents' behaviors and examines the impact of information-sharing during disruptions in the supply chain. Our proposed framework is applicable to both cooperative and competitive scenarios, allowing for a detailed exploration of the level of granularity required for effective information-sharing. Consequently, our approach highlights the significant role played by unknown order lead times and demand, which are crucial elements of the supply chain during periods of drug shortages.

2 Modeling Optimal Sourcing Policies With Estimated Release Date Information In Hospital Settings

Noah Chicoine, Jacqueline Griffin, Northeastern University, Boston, MA, Contact: chicoine.n@northeastern.edu

During drug shortages, pharmaceutical manufacturers provide health centers with estimated release dates (ERDs), point estimates of when the next product release will be and when the health center should expect to receive inventory replenishment. Previous studies have shown how inaccurate ERD information can affect people's decisions to seek alternative sources for critical medications. To help health care professionals make critical and costly sourcing decisions, we utilize a POMDP learning model and showcase its ability to mitigate costs in real ERD contexts when compared to standard inventory management policies.

3 Reimbursement Policy and Drug Shortages

Xuejun Zhao[1], Justin Jia[2], Hui Zhao[3], [1]Purdue University, West Lafayette, IN, [2]University of Tennessee, Knoxville, TN, [3]The Pennsylvania State University, University Park, PA, Contact: justinjia@utk.edu

In 2005, Medicare changed its drug reimbursement policy from an Average Wholesale Price (AWP) regime to an Average Sales Price (ASP) regime. The years following the change witnessed severe drug shortages. We develop a drug supply chain model and conduct analysis to address the continued debate on the impact of the reimbursement policy on drug shortages. We find that the ASP policy actually possesses resilience to drug shortages due to the policy's unique structure.

4 When Should the FDA Inspect Pharmaceutical Manufacturing Facilities to Better Mitigate Drug Shortages?

Daniel Kosmas, Ozlem Ergun, Northeastern University, Boston, MA, Contact: d.kosmas@northeastern.edu

Deciding when to inspect pharmaceutical manufacturing facilities is a complex problem for the FDA; strict regulation enforcement can force low-profit facilities to close due to excessive maintenance costs, while lax enforcement allows for regulation violations to persist, both of which can cause drug shortages. We propose a finite-horizon POMDP model to assist in determining when to inspect these facilities. We theoretically show that this problem can be reduced to only needing to consider whether or not to inspect immediately. Our numerical results highlight the importance of allocating more resources to high-risk facilities that produce drugs that highly impact public health. We additionally find that optimal inspection time is more sensitive to changes in the penalty from an unexpected disruptive event occurring the longer it has been since the last inspection.

5 Mitigating Drug Shortages in Global Pharmaceutical Supply Chains Under Multiple Types of Strain

Martha L. Sabogal De La Pava[1], Emily L. Tucker[2], [1]Clemson University, Clemson, SC, [2]Clemson University, Clemson, SC, Contact: msaboga@clemson.edu
Pharmaceutical supply chains are affected by decisions made by companies, governments, and society at large. Failures in supply chain operations may lead to drug shortages, which endanger patients' health and affect the costs of healthcare systems. Such failures may reflect fragile supply chains that are designed and managed with mis-specified estimates of uncertain events. We introduce a global supply chain design model that integrates multiple types of strains and study policies to mitigate their effects on a company's economic performance and drug shortages. We study the impact on strategic facility-location decisions and on drug shortages globally and by country income level classification.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA23

CC-North 129B

Location Analysis of Alternative Fuel Vehicles

Community Committee Choice Session

Session Chair: Ibrahim Capar, Bowling Green State University, Bowling Green, OH

1 Electric Vehicle Charging Network Design with Capacity and Service Considerations

Ibrahim Capar[1], Ozgur M. Araz[2], Ismail Capar[3], [1]Bowling Green State University, Bowling Green, OH, [2]University of Nebraska–Lincoln, Lincoln, NE, [3]Texas A&M University, College Station, TX, Contact: icapar@bgsu.edu
Recently, improving the infrastructure for Electric vehicles (EVs) has been a major focus of organizations around the world. In this paper, we present a service network design framework to improve the infrastructure for EVs with quality of service constraints taken into consideration. We present a novel charging station location model with capacity allocation. The model maximizes the EV traffic flow captured and minimizes the average service time for drivers. Our results highlight how charging times at stations affect the quality of service in the whole service system by quantifying the improvements on flow coverage while reducing waiting times. The value of faster chargers in increasing the coverage and reducing the average waiting times is also highlighted in relation to a service provider's budget constraints.

2 Electric Vehicle Fleet Charging Policies: An Optimal Stopping Approach

Ehsan Mahyari[1], Nickolas K. Freeman[2], [1]The University of Alabama, Tuscaloosa, AL, [2]University of Alabama, Tuscaloosa, AL, Contact: emahyari@crimson.ua.edu
We propose a model for deciding when to recall electric vehicles (EVs) for charging. Our model, based on the optimal stopping problem, identifies near-optimal policies, i.e., charge thresholds, to optimize charging decisions. We envision the proposed method being driven by the state of charge information for EVs composing the fleet, which would be actively monitored by Electric Vehicle Charging Management Systems (EVCMS). Embedding such an optimization model in the EVCMS will allow its control unit to make recommendations regarding whether to charge individual EVs or not. Our model minimizes costs and maximizes reliability, enhancing overall efficiency of EV fleet charging. Leveraging real-time charge data and our optimization approach, the EVCMS dynamically adapts and improves decision-making, achieving informed and optimal charging strategies for EV fleets.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA24

CC-North 130

Applications of Stochastic Models in Service Operations

Community Committee Choice Session

Session Chair: Xiaoshan Peng, Indiana University, Bloomington, IN

1 Dynamic Scheduling with Bayesian Updating of Customer Characteristics

Buyun Li[1], Xiaoshan Peng[2], Owen Wu[3], [1]Kelley School of Business; Indiana University, Bloomington, IN, [2]Indiana University, Bloomington, IN, [3]Indiana University, Bloomington, IN, Contact: libu@iu.edu
We study the dynamic scheduling problem in a multi-class queueing process, where the system manager updates their belief about the service rewards and waiting costs of each class using Bayesian method. We propose a state-dependent index, characterized by the busy period of the queue, that can be used as a basis for an optimal index policy when only one class of customer rewards and waiting costs is unknown. Although the index policy is not optimal for more general systems, we numerically test the performance of the policy. To evaluate the performance of our proposed

policy, we design computational tests using various scenarios and compare it with existing policies in terms of key performance metrics.

2 Asymptotically Optimal Appointment Scheduling in the Presence of Patient Unpunctuality

Nikolai Lipscomb, The Institute for Defense Analyses, Alexandria, VA

We propose a method for scheduling a large patient system by examining the fluid limit of a queue-based appointment system that maximizes the expected net revenue. The fluid limit leads to an optimal control problem that, due to the unpunctuality, is difficult to solve analytically. We propose a time-discretized numerical scheme for approximately solving the problem in the form of a quadratic program with a linear number of constraints in the discretization. Using this method, we are able to derive asymptotically optimal appointment schedules under patient unpunctuality. We examine the behavior of these schedules under different unpunctuality assumptions and test the performance of the schedules on real data in a simulation study. Surprisingly, the optimal schedules can involve block booking of patients, even if the unpunctuality distributions are continuous.

3 Operating Three-Sided Marketplaces: Pricing and Spatial Staffing in Food Delivery Systems

Zhe Liu[1], Yiwen Shen[2], Yanwei Sun[1], [1]Imperial College Business School, London, United Kingdom; [2]HKUST, Hong Kong, China. Contact: zhe.liu@imperial.ac.uk

We study a food delivery platform's joint pricing and staffing problem under endogenous participation of three sides: restaurants, customers and deliverers. Using a state-dependent queueing model where service rates depend on the imbalance of all three sides due to spatial frictions, we study the system's equilibrium behavior in heavy traffic and show through asymptotic analysis how platform controls balance capacity utilization and service quality. We characterize the platform's impact on all three sides and show that the platform's value lies in (i) *increased market output* as the platform boosts demand for restaurants and offers faster delivery for customers, and (ii) *delivery resource pooling* that saves the restaurants' logistic costs and increases deliverer utilization.

4 A Stochastic Optimization Model for Service Configuration in Serial Systems with Nonhomogeneous Arrivals

Randy M. Grivel[1], Jorge A. Sefair[2], Ronald G. Askin[3], [1]Arizona State University, Tempe, AZ, [2]University of Florida, Gainesville, FL, [3]Arizona State University, Tempe, AZ, Contact: rgrivel@asu.edu

Many service systems are tasked with scheduling service channels to accommodate random, nonhomogeneous arrivals. We present a stochastic optimization model for the case of a two stage serial system with finite buffer. The model selects schedules for a fixed set of human servers and schedules their break times to minimize customer wait times. A case study of scheduling screening lanes for an airport is presented.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA25

CC-North 131A

Empirical Evaluation of the Effects of Technology and Policy Changes on Healthcare Delivery

Community Committee Choice Session

Session Chair: Jing Dong, Columbia University, New York, NY

Session Chair: Maria R. Ibanez, Kellogg School of Management at Northwestern University, Evanston, IL

1 How Recreational Cannabis Legalization Affects Hospital Operations: Workload Ramifications and Speeding up Care for Other Patients

Max Yakovlev[1], Maria R. Ibanez[2], [1]Kellogg School of Management at Northwestern University, Evanston, IL, [2]Kellogg School of Management at Northwestern University, Evanston, IL, Contact: maksim.yakovlev@kellogg.northwestern.edu

Many US states have legalized recreational cannabis in the last decade. Using a difference-in-differences approach, we study the effect of recreational cannabis legalization (RCL) on hospital operations. We find that RCL alters the workload of hospital staff by changing the patient mix: While there is a null effect on total inpatient admissions, more cannabis-related patients are admitted, increasing workload complexity. More strikingly, hospitals speed up care for non-cannabis patients, with RCL lowering lengths of stay by 2.6%. We attribute this phenomenon to cannabis generating workload for hospital staff that reduces the resources available to other patients. We further find adverse effects on experiential quality of care and medical professionals' compliance. These findings inform hospital managers about the impact of legalization on hospitals.

2 What Can Personal Statements Tell Us? Insights About Physicians' Personality Traits and Clinical Performance

Susan F. Lu[1], Jianing Ding[1], Karthik Kannan[2], [1]Purdue University, West Lafayette, IN, [2]University of Arizona, Tucson, AZ

In this study, we investigate the impact of physicians' personality traits on their clinical performance, and we find that leveraging personality traits offers a promising pathway toward understanding physician behavior and their clinical performance. Specifically, we use physicians' personal statements posted on an online physician review platform and extract 2,073 physicians' personality traits from the unstructured physician personal statement following the Big Five model of personality. To address non-random matching between patients and physicians, we adopt a quasi-random setting to study patients with accidental injuries who arrived at emergency departments (EDs) in Florida.

3 The Interplay Between Hospital Reputation and Experiential Quality Rating

Ankita Shirahatti[1], Anita L. Tucker[2], [1]Questrom School of Business, Boston, MA, [2]Boston University, Boston, MA, Contact: ashiraha@bu.edu

Patients have more information about hospitals and potential care that ever before. Two major sources such information include government-published ratings of hospital quality (e.g. CMS stars and HCAHPS ratings) alongside reviews from community members published on online platforms (e.g. ZocDoc, Google, and Facebook). Using datasets of scraped online reviews of hospitals and admissions to hospitals in MA, we extract prevalent features of patient experience and sentiment towards those features to better understand the effects of online reviews on hospital demand. We further use this information compare safety-net hospitals to non-safety-net hospitals and better understand the link between reputation and utilization patterns for hospitals with varying patient-payer-mixes.

4 The Effects of Senior Living Communities on Healthcare Utilization and Outcomes

Carri Chan[1], Ann Bartel[1], Minje Park[1], Fanyin Zheng[2], [1]Columbia Business School, New York, NY, [2]Columbia University, New York, NY, Contact: cwchan@gsb.columbia.edu

This research investigates the impact of senior living communities, specialized housing arrangements for the elderly, on healthcare utilization and outcomes of Medicare enrollees. With the growing aging population, the number of senior living communities is rapidly increasing in the United States. The study findings provide insights into the effect of senior living facilities on healthcare costs and patient outcomes. We also discuss policy implications that suggest the potential benefits of senior living communities in reducing Medicare expenditures.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA26

CC-North 131B

Risk Management in Reinforcement Learning

Community Committee Choice Session

Session Chair: Parshan Pakiman, University of Illinois-Chicago, Chicago, IL

Session Chair: Selvaprabu Nadarajah, University of Illinois at Chicago, Chicago, IL

1 Operational Risk Management: Optimal Inspection Policy

Youngsoo Kim[1], Yuqian Xu[2], [1]University of Alabama, Tuscaloosa, AL, [2]UNC-Chapel Hill Kenan-Flagler Business School, Chapel Hill, NC, Contact: ykim106@ua.edu

In light of the importance of operational risk and its current regulation in the financial services industry, we study how a financial firm should design inspection policies to manage operational risk losses based on a continuous-time principal-agent model framework. We first consider two commonly used inspection policies, namely, random and periodic policies. We find that random policy is not always optimal, and it is dominated by periodic policy if the inspection cost is low. Also, we construct a hybrid policy that strictly dominates random policy and weakly dominates periodic policy, which suggests that a proper reduction of the random element in the inspection policy, in the manner of our proposed hybrid policy, can always improve its performance.

2 Self-Adapting Risk Management in Demand Learning

Parshan Pakiman[1], Boxiao Chen[1], Selvaprabu Nadarajah[1], Stefanus Jasin[2], [1]University of Illinois Chicago, Chicago, IL, [2]University of Michigan, Ann Arbor, MI

We study the dynamic pricing of a product over a finite horizon in the presence of demand-model ambiguity. A retailer sets prices at pre-specified times (e.g., weekly) such that each price level can apply to many customers. Therefore, the retailer faces a significant risk of loss in total revenue if many arrivals observe a suboptimal price based on an incorrect demand model. We develop a pricing policy that learns the true demand model based on the online arrival of demand data and trades off between minimizing risk and maximizing expected revenue. We develop regret bounds for our policy and show that it outperforms benchmarks prioritizing either risk minimization or revenue maximization.

3 Assignment-Delay Mechanisms for UAV Airspace Assignment

Paul Friedrich[1], Ludwig Dierks[2], Sven Seuken[1], [1]University Zurich, Zurich, Switzerland; [2]Kyushu University, Nishi-ku, Japan. Contact: dierks@ifi.uzh.ch

The number of unmanned aerial vehicles (UAV) flights is forecast to grow rapidly. However, it is not yet well understood how to best assign airspace to UAV's. Most jurisdictions currently assign flights on a First-Come-First-Serve (FCFS) basis, however we find that such assignments risk market failure once airspace becomes congested. In this paper, we formalize the airspace assignment problem as a Markov-Decision-Process and demonstrate how finding optimal policies is infeasible. We restrict our attention to the class of incentive-compatible assignment-delay mechanisms that assign UAV operators their most preferred available flight path but can delay assignment. We demonstrate how already single parameter mechanisms from this class improve outcomes over FCFS and demonstrate how better policies can be learned from past data or during market operation.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA27

CC-North 131C

Empirical Retail Operations

Community Committee Choice Session

Session Chair: Stanley Lim, Michigan State University, East Lansing, MI

Session Chair: Chloe Kim Glaeser, University of North Carolina at Chapel Hill Kenan-Flagler Business School

1 Design of Curated Subscription Services in Retailing: Role of Transparency and Selection Process

Yuanyuan Ding, Karen L. Donohue, Necati Ertekin, University of Minnesota, Minneapolis, MN

Curated subscription services, where customers periodically receive a customized set of products, are gaining traction as a new retail business model. Industry reports reveal that customers subscribe to such services for a variety of reasons, ranging from the convenience of outsourcing shopping tasks to a desire for a fun surprise. While the design of these services is evolving, two important pre-delivery features are often considered: whether to provide transparency into the product collection and, if so, what level of consumer involvement to build into the selection process. We will conduct a lab experiment to provide insight into which set of features are most appropriate for different customer segments.

2 Reducing Food Waste in U.S. Food Banks: The Role of Distribution Strategies

Fan Zou[1], Pelin Pekgun[2], Luv Sharma[2], Sanjay L. Ahire[2], [1]Florida State University, Tallahassee, FL, [2]University of South Carolina, Columbia, SC

Food banks serve an important role in addressing food insecurity by matching the supply of excess food with the demand of the food-insecure population. We provide the impact of a direct distribution strategy, an increased trucking capacity or an increased pantry size on the level of food waste in the distribution process, which can help food banks make more informed decisions on where to invest their limited resources to reduce food waste.

3 Enhancing the Competitiveness of the Nanostore Channel: Manufacturer-Enabled Provision of Value-Added Digital Services

Rafael Escamilla[1,2], Jan C. Fransoo[1], Robert Rooderkerk[3], [1]Tilburg University, Tilburg, Netherlands; [2]Kuehne Logistics University, Hamburg, Germany; [3]Erasmus University-Rotterdam School of Management, Rotterdam, NY, Netherlands. Contact: r.escamilla@tilburguniversity.edu

The core, strategic channel for consumer-packaged goods manufacturers in emerging markets has been slow to digitize. Yet, digitization promises important operational benefits for manufacturers and nanostores alike. In this project, we investigate how the provision of manufacturer-enabled value-added digital services by nanostore shopkeepers influences shopkeepers' transactional behavior. For this, we partnered with a large, multinational manufacturer leading a strategic an initiative allowing nanostores to offer value-added digital services. Leveraging detailed transactional sell in data, we investigate the overall benefits to the manufacturer, by examining its sell in to both adopting nanostores as well as neighboring stores located in close proximity.

4 Image-Based Similarity for Demand Forecasting

Junyi Sha[1], David Simchi-Levi[2], Michelle Wu[3], [1]MIT, Cambridge, MA, [2]Massachusetts Institute of Technology, Cambridge, MA, [3]MIT Institute for Data, Systems, and Society, Cambridge, MA, Contact: jsha@mit.edu

We present our research in collaboration with a large European fashion retail where we focused on demand forecasts at the style level. We show how we combined text data, structured data, and product images in generating our forecast. In this process, we introduce a new concept of similar products to improve forecast accuracy.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA28

CC-North 132A

Data and Operations

Community Committee Choice Session

Session Chair: Karan Girotra, Cornell Tech/Johnson Cornell University, New York, NY

Session Chair: Xiaoyue Yan, Cornell University, Ithaca, NY

1 Data-driven Decisions In Supply Chains: Contracts, Algorithms And Efficiency

Xiaoyue Yan[1], Elena Belavina[2], Karan Girotra[3], [1]Cornell University, Ithaca, NY, [2]Cornell University, New York, NY, [3]Cornell Tech/Johnson Cornell University, New York, NY, Contact: xy393@cornell.edu

We study the performance of revenue sharing and wholesale price contracts in supply chains where firms make data-driven inventory/pricing decisions. In these supply chains, each tier uses historical and contemporaneous data on demand and demand-relevant covariates to directly arrive at their optimal decisions, as opposed to the traditional paradigm where demand estimates are first exogenously specified, followed by a separate optimization stage. We find that when there is a lot of historical data, or there are several covariates that tend to have positive skew and high variance, wholesale-price contracts tend to unexpectedly yield higher supply chain profits than revenue-sharing contracts—a stark contrast with well-known findings in the supply chain literature.

2 Planning Bike Lanes with Data: Ridership, Congestion, and Path Selection

Sheng Liu[1], Auyon Siddiq[2], Jingwei Zhang[3], [1]University of Toronto, Toronto, ON, Canada; [2]University of California-Los Angrles, Los Angeles, CA, [3]UCLA, Los Angeles, CA, Contact: jingwei.zhang.phd@anderson.ucla.edu

We study the bike lane planning problem considering its conflicting effects in reducing and increasing traffic congestion. In an extensive case study in Chicago, we estimate adding 25 miles of prescribed bike lanes can lift cycling mode share from 3.6% to 6.1%, with at most an 9.4% increase in driving times.

3 Attribute-Based Pricing: A Novel Formulation and Convergent Algorithms

Mengzhenyu Zhang[1], Chris Ryan[2], Wei Sun[3], Shivaram Subramanian[4], Markus Ettl[5], [1]UCL, London, United Kingdom; [2]UBC, Vancouver, BC, Canada; [3]IBM T. J. Watson Research Center, Yorktown Heights, NY, [4]IBM, Frisco, TX, [5]IBM Research, Yorktown Heights, NY, Contact: zhenyu.zhangmeng@ucl.ac.uk

Attribute-based pricing---giving a price to potential product attributes individually and allowing customers to choose the attributes that form the final product---has been shown to improve customer satisfaction in the hospitality industry. In this paper, we consider the problem of finding optimal attribute prices to maximize the expected revenue from selling to a customer who chooses one product from a set of products that differ by only a few attributes. Because of complicated substitution effects among the final products that share common attributes, expected revenue is not concave in attribute prices. Nonetheless, we provide an algorithm to solve the attribute pricing problem and show that it converges to a stationary point that provides a high-quality solution to the problem.

4 Reinforcement Learning For Pricing And Inventory Control Under Censored Demand

Korel Gundem[1], Gah-Yi Ban[2], Zhengling Qi[3], [1]George Washignton University, Washington, DC, [2]Imperial College Business School, London, United Kingdom; [3]The George Washington University, D.C., Contact: korelgundem@gwu.edu

Learning optimal inventory and pricing strategies from the censored batch data posits a unique challenge in practice. In this paper, we adopt the framework of offline reinforcement learning (RL), adapting the idea of a pessimistic Fitted Q-Iteration (FQI) algorithm to learn the optimal inventory control and pricing policy in the censored demand scenario. Specifically, we propose to learn two different optimal Q-functions, which address the violation of Markovian assumption due to the censored demand. We then show that our algorithm can find the optimal optimal with a finite sample regret guarantee under some mild conditions. Lastly, we conduct a simulation study to showcase the effective performance of our method. Overall, our work offers a new solution and insight for the inventory-pricing territory.

5 Data-Driven Clustering and Feature-Based Retail Electricity Pricing with Smart Meters

N. Bora Keskin[1], Yuexing Li[2], Nur Sunar[3], [1]Duke University, Durham, NC, [2]Johns Hopkins Carey Business School, Baltimore, MD, [3]UNC Kenan-Flagler Business School, Chapel Hill, NC, Contact: bora.keskin@duke.edu

We consider an electric utility company that serves N customers over T periods. In each period, the company observes the customers' consumption and high-dimensional features on customer characteristics and exogenous factors. The space of features is partitioned into clusters based on similarity, and in each cluster, there is a distinct relationship between consumption and features. The company knows neither the underlying cluster structure nor the corresponding consumption models. We design a data-driven clustering-and-pricing policy to learn these elements on the fly and prove that our policy achieves near-optimal profit performance in terms of N and T. We also conduct a case study on a real-life data set from a utility company in the U.S., and we show that our policy significantly outperforms the historical decisions of the utility company.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA29

CC-North 132B

Socially Responsible and Sustainable Operations

Community Committee Choice Session

Session Chair: Can Zhang, Duke University, Durham, NC

1 When Should the Off-Grid Sun Shine at Night? Optimum Renewable Generation and Energy Storage Investments

Christian Kaps, Simone Marinesi, Serguei Netessine, The Wharton School, Philadelphia, PA, Contact: marinesi@wharton.upenn.edu

We develop a model of strategic capacity investment in both renewable generation and storage to match demand with supply in off-grid use-cases, while relying on fossil fuel as backup. Since the model is intractable, we derive two tractable approximations that provide bounds on the optimal solutions. Utilizing real-life data from three geographically-diverse islands, we find that one of our simplified models yields investment capacities remarkably close to the optimal decisions. We then leverage properties of the model to identify the strategic relation between the two investment decisions, as well as derive a simple yet effective heuristic to determine which storage technology, within a given portfolio, can turn a profit in the broadest set of market conditions, and thus is likely to be adopted first.

2 Institutional Voids and Electric Vehicles: Exploring the Contingent Role of Supply Chain Capabilities and Organizational Intention

Fatima Gillani[1], Muhammad Shakeel Sadiq Jajja[2], [1]Nottingham Trent University, Nottingham, United Kingdom; [2]Lahore University of Management Sciences, Lahore, Pakistan. Contact: ssj@lums.edu.pk

The purpose of this study is to explore the impact of institutional voids that exist in supply chains of developing economies and how they impact the initiatives of firms related to the adoption of Electric Vehicles (EVs). The study also unearths the role of supply chain capability as a contingent factor that enables sense making and management of uncertainties thus minimizing or combating the impact of institutional voids. This results in positive change in intention and initiatives related to EVs provision in the market and adoption respectively. The supply chain capabilities and organizational intention to enter EVs market further impact the firm's EVs initiatives. We empirically examine these relationships using data from incumbent firms in the Pakistani automotive value chain. The data is analyzed using structural equation modeling.

3 Contracting for Sustainability Practices in Smallholder Supply Chains

Yuan Shi[1], Joann de Zegher[2], Yanchong (Karen) Zheng[3], [1]MIT, Cambridge, MA, [2]MIT Sloan, Cambridge, MA, [3]Massachusetts Institute of Technology, Cambridge, MA, Contact: yuansh@mit.edu

We study contract design for sustainable practices by farmers in an environment with uncertain agricultural product price and limited resources. We utilize a novel principal-agent model where the principal aims to implement a sustainable practice while farmers allocate their limited resources between sustainability and agricultural production. Our results identify a simple and nearly optimal cost-based premium contract that is cost-efficient and robust to price fluctuations. Using data from Indonesia's palm fruit market, we estimate that the proposed contract could lead to a cost reduction of over 20% compared to common yield-independent contracts. Our findings emphasize the importance of incorporating sustainability incentives directly into agricultural markets, rather than implementing them alongside agricultural production as separate initiatives.

4 Rent-To-Own Contracts in Developing Economies

Jose A. Guajardo[1], Elaheh Rashidinejad[2], Gonzalo Romero[3], [1]University of California-Berkeley, Berkeley, CA, [2]Rotman School of Management, Toronto, ON, Canada; [3]Rotman, University of Toronto, Toronto, ON, Canada.

Contact: jguajardo@berkeley.edu
We study consumer's payment behaviour under Rent-to-Own business models in developing economies where income uncertainty and hassle costs exists. We use a dynamic programming model to examine different contract designs that firms selling off-grid energy products offer to their customers to minimize expected time to ownership and improve social welfare.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA30

CC-North 132C

Renewable Energy and Climate Change

Community Committee Choice Session

Session Chair: Karthik Murali, Oregon State University, Corvallis, OR

1 Additionality of Carbon Offsets: Project-Specific vs. Standardized Baselines

Safak Yucel[1], Vishal Agrawal[2], Soudipta Chakraborty[3], [1]Georgetown University, Washington, DC, [2]Georgetown University, Washington, [3]University of Kansas, Lawrence, Contact: safak.yucel@georgetown.edu

Despite their popularity in combating climate change, the fundamental concern for carbon offsets is additionality: whether or not the emissions reduction represented by an offset would have occurred without the revenue from its sale. That is, an offset is additional if it is due to actual reduction in emissions. To assess additionality, a registry calculates emissions reduction, i.e., the difference between business-as-usual emissions and the emissions upon project completion. Given that business-as-usual emissions is unobservable for the registry, it assigns a baseline to a developer through two methods: Under the project-specific method, the developer self-reports its business-as-usual emissions; under the standardized method, the registry assigns a common baseline to all developers. We compare economic and environmental implications of these two methods.

2 An Effective Stationary Policy for Managing Residential Energy Storage

Na Rea Cho[1], Youngsoo Kim[1], Karthik Murali[2], Mesut Yavuz[1], [1]University of Alabama, Tuscaloosa, AL, [2]Oregon State University, Corvallis, OR

We formulate the homeowner's cost-minimization problem as a stochastic program in the presence of time-of-use tariffs and sellback credits. We show that an effective stationary policy consists of a fill-up-to threshold invoking strategic purchasing in the off-peak period and a sell-down-to threshold requiring strategic selling in the peak period. We develop an efficient heuristic to determine these thresholds. The proposed policy achieves 94% of the cost reductions attainable with perfect information. Through case studies, we show strategically managing home energy storage using a simple stationary policy makes this technology significantly more attractive even in communities where it would add no value if managed passively. We demonstrate how this policy can be adjusted to and perform well under seasonally-varying demands and time-of-use pricing over the year.

3 Subsidizing Circularity Under Costly Recycling and Material Scarcity

Nilsu Uzunlar[1], Alan Scheller Wolf[1], Siddharth Singh[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]University College London, London, United Kingdom. Contact: nuzunlar@andrew.cmu.edu

Considering technological enhancements, policy incentives, and the reduction in costs, it is estimated that clean energy adoption will increase rapidly in the near future. Unfortunately, this increased adoption faces two significant hurdles. First, existing installations are projected to be retired earlier than their estimated usable lifetime, creating a significant waste problem considering the economically unviable green disposition options. Second, producers are already having a difficult time acquiring crucial raw materials for product manufacturing. We explore how policy initiatives and investments may be able to ameliorate both of these problems.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA31

CC-North 221A

A Panel Discussion on Successfully Entering the Data Profession

Panel Session

Session Chair: Zohar Maia-Aliya Strinka, Analytics Strategies, Thornton, CO

1 Successfully Transitioning into the Data Profession

Zohar Maia-Aliya Strinka, Analytics Strategies, Thornton, CO, Contact: zstrinka@gmail.com

Many aspects of the data field have existed for decades including Operations Research. However, there is a large breadth of skills needed to succeed in the data profession and most formal training programs only cover a limited subset such as operations research, data science, statistics, or computer science. In order to successfully transition into the data field, would be data professionals need to bridge the gap from their educational background to the full set of skills needed. In this discussion, we will cover some of this gap and what future data practitioners can do to bridge it.

2 Panelist

RALPH Asher, Data Driven Supply Chain LLC, Minneapolis, MN

3 Panelist

Lili Zhang, Hewlett Packard Enterprise, San Jose, CA

4 Panelist

Gregg J. Schell, CNA, Arlington, VA

5 Panelist

Louis Louis Luangkesorn, Highmark Health, Pittsburgh, PA

Tuesday, October 17, 8:00 AM - 9:15 AM

TA32

CC-North 221B

Large Scale Network Design at Amazon

Community Committee Choice Session

Session Chair: Cristiana L. Lara, Amazon, Bellevue, WA
Session Chair: Xiaoyan Si, Amazon, Seattle, WA

1 Re-Engineering Amazon’s Logistics Network to Optimize for Speed, Cost, and Selection

Shahbaaz Mubeen Mamadapur, Amazon, Bellevue, WA

During the pandemic, Amazon’s network grew rapidly as we added more warehouses, trucks, and labor to keep pace with the demand surge. Prior to 2023, Amazon operated a national shipping model which was not scalable. In 2023, Amazon regionalized its domestic US network wherein the US is divided into 8 regions. Each region is designed to be highly self-sufficient and covers its own demand as much as possible. In this talk, we discuss the challenges faced when operating a national network model and our approach to transition it into a regional model.

2 Regionalized Fulfillment - Region Sizing and Resource Allocation

Yuan Li, Amazon, Bellevue, WA

Due to Amazon’s rapid growth, the complexity of its US fulfillment network has surged. The national fulfillment strategy we once relied on is no longer feasible for scalability. To address this, we propose breaking the network into smaller, self-sufficient regions. Each region would handle the majority of its demands locally from facilities within the region, leading to faster deliveries. This presentation offers an overview of how we define these regions and allocate resources such as fulfillment centers, ship and storage capacities, to meet region demands effectively.

3 Structure of Fulfillment Networks: Distributed to Hierarchical Structure with Hub-And Spoke Behavior

Kaushik Sinha, 1</sup

Evolution of distributed fulfillment networks (aka national fulfillment models) to hierarchical, hub and spoke structure (aka regional fulfillment model) shows interesting network signatures that guide network performance. This can be leveraged for intentional network design and alter its behavior to align with intended strategic outcomes. In this talk, we demonstrate the distinctive network signatures, their impact on network flow dynamics and how individual regional flow dynamics can be viewed through the lens of almost equitable partitions and associated graph-theoretic measures.

4 Inventory-Aware E-Commerce Network Design

Semih Atakan, Amazon.com, Seattle, WA, Contact: atakans@amazon.com

Over the years, Amazon’s fulfillment operations have experienced significant growth, leading to several structural changes in its fulfillment network. In the initial part of the presentation, we delve into this journey and highlight the transition of the fulfillment network from a point-to-point structure to a hub-and-spoke model, ultimately arriving at its current “post-regionalization” state. In the subsequent portion of the talk, we discuss the significance of inventory and its role in designing an efficient e-commerce fulfillment network. Lastly, we outline the family of optimization models that can be employed to capture the inventory state and produce a desirable network structure.

5 Velocity-aware Inventory Placement

Cristiana L. Lara[1], David Mildebrath[2], [1]Amazon, Bellevue, WA, [2]Amazon, Seattle, WA, Contact: larcrist@amazon.com

Amazon offers millions of unique items for sale on its website. The popularity of these items is not evenly distributed, and the mean weekly demand for different products on Amazon spans multiple orders of magnitude. Because of this enormous scale and selection, deciding how to optimally place inventory throughout our fulfillment network is very challenging. Directly modeling all products is intractable, and down-sampling products does not adequately capture the behavior of the long tail. We propose a scalable method for modeling both head and tail demand, and placing the inventory to best utilize our network assets. Our model matches the ship and storage capacity of nodes in our network with the velocity profile of demand in order to minimize fulfillment cost. We use this framework to derive insights on the relationship between placement strategy and customer experience.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA33

CC-North 221C

Recent Advances in Mixed-Integer Nonlinear Programming

Community Committee Choice Session

Session Chair: Rui Chen, [1]</sup

1 Branch-and-bound for D-optimality with Fast Local Search and Variable-bound Tightening

Gabriel Ponte[1], Marcia Fampa[2], Jon Lee[1], [1]University of Michigan, Ann Arbor, MI, [2]Universidade Federal-Rio de Janeiro, Rio de Janeiro, Brazil

We develop a branch-and-bound algorithm for the D-optimality problem, a central problem in statistical design theory, based on two convex relaxations, employing variable-bound tightening and fast local-search procedures, testing our ideas on randomly-generated test problems.

2 Integer Programming Games For Invasive Species Prevention

Hyunwoo Lee, Robert Hildebrand, Esra Toy, Virginia Tech, Blacksburg, VA, Contact: hyunwoolee@vt.edu

We study the prevention of aquatic invasive species (AIS) in approximately 12,000 Minnesota through joint resource allocation of counties and approach the problem via integer programming games and bi-level optimization. We employ the Budgeted Maximum Coverage Problem (BMCP) to optimize the allocation of AIS inspection centers, delving into distinct strategies between state and county levels. State-level decision-maker pursues maximal inspections at the state via pooled budget, while county-level counterparts prioritize inspections at the counties using their designated budgets. By considering each county's self-interest, we formulate the N-player game for BMCP, particularly exploring edge-weighted BMCP within directed and undirected graphs. Notably, within undirected bipartite graphs, the N-player game has a Pure Nash Equilibrium (PNE).

3 Regularized MIP Model for Optimal Power Flow with Battery

Dahye Han, Georgia Tech

Battery operation is modelled with binary variables due to its complementary nature of charging and discharging. Such MILP formulation are relaxed to an LP formulation for simplicity when applying the battery in the context of power system problems. Concerns have been raised that such LP relaxation results in impractical solutions. In the study, we propose a new MILP model called Regularized MIP for battery operation in the optimal power flow problem. We prove that the model has zero-integrality gap under mild assumptions. Furthermore, the optimal solution from this model is always feasible to the original problem and close to the optimal solution of the original problem. These nice properties allow application of the model in much complex settings. We present results on two-stage stochastic programming and trilevel min-max-min problem with binary variables in all levels.

4 The Mixed-Integer Nonlinear Decomposition Toolbox in Pyomo

Zedong Peng[1], David Bernal Neira[2], Ignacio E. Grossmann[3], [1]Purdue University, West Lafayette, IN, [2]NASA Ames Research Center, Palo Alto, CA, [3]Carnegie Mellon University, Pittsburgh, PA, Contact: peng_zedong@126.com

This work presents the Mixed-Integer Nonlinear Decomposition Toolbox in Pyomo (MindtPy), which supports different decomposition algorithms to solve both convex and nonconvex Mixed-Integer Nonlinear Programs(MINLP). For convex MINLP problems, MindtPy provides the Extended Cutting Plane method, Outer-Approximation method, a novel Regularized Outer-Approximation method and the Feasibility Pump method. For nonconvex MINLPs, MindtPy provides both a local and a global Outer-Approximation method. Besides iteratively solving the MIP problem and the fixed NLP problem, MindtPy also supports the so-called single-tree implementation of decompositions algorithms. More importantly, MindtPy also integrates the above algorithms with advanced techniques such as solution pool, tabu-list, and Auto-Persistent Pyomo Solver Interfaces to perform better.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA34

CC-North 222A

Advanced Methods for Nonconvex Nonlinear Programming

Community Committee Choice Session

Session Chair: Dimitri Papadimitriou, 1</sup

1 Queueing-Based Mixed-Integer Nonlinear Optimization Models for Network Design: Models, Reformulations, and Algorithms

Miguel Lejeune, George Washington University, Arlington, VA

We present several queueing-based optimization models to design networks in which the objective is to minimize the response time. The networks are modelled as collections of interdependent M/G/1 or M/G/K queueing systems. The optimization models take the form of nonconvex MINLP problems with fractional and bilinear terms. We derive a reformulation approach and propose new optimality-based bound tightening (OBBT) techniques. In particular, we propose new MILP and feasibility OBBT models that can derive multiple variable bounds at once. The proposed approach is applied to the drone-based delivery of external defibrillators to out-of-hospital cardiac arrests and naloxone to overdoses. Computational experiments based on real-life ascertain the computational efficiency of the approach and its impact on the probability of survival of patients.

2 On Proximal Method For Problems With Inexact Stochastic Oracles

Yin Liu[1], Sam Davanloo[2], [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, Columbus, OH, Contact: liu.6630@osu.edu

Many recent machine learning applications require solving optimization problems in the absence of exact stochastic oracles. For instance, in many such applications, having access to an unbiased oracle is impossible or requires significant computation.This talk focuses on composite optimization problems with objective functions in the form of the sum of a smooth and non-smooth function where the smooth function can only be evaluated through an inexact stochastic oracle.We propose Bregman-type stochastic optimization algorithms and establish theoretical guarantees on their computational complexities. We also provide numerical studies validating our findings.

3 On the Importance of On-Manifold Optimization Techniques for Rigid Body Pose

Brennan S. McCann, Morad Nazari, Embry-Riddle Aeronautical University, Daytona Beach, FL, Contact: mccannb4@my.erau.edu

Simultaneous analysis of rotational and translational motion of the rigid body presents challenges for optimal control and path planning. Two common pose representations are the special Euclidean group SE(3) and dual quaternions. The attitude representation on SE(3) is a rotation matrix on the special orthogonal group SO(3), whereas the attitude representation in dual quaternions is a quaternion. Generally, both pose representations above are Lie groups and Riemannian manifolds. Therefore, on-manifold techniques are employed here for pose optimization problems to avoid unnecessary constraints intended to preserve properties inherent to the pose representation.

4 Global Optimization of Nonsmooth Weakly Convex Functions via Simulated Annealing

Tim Tsz-Kit Lau[1], Han Liu[2], Jean-Christophe Pesquet[3], [1]Northwestern University, Evanston, IL, [2]Northwestern University, Evanston, IL, [3]CentraleSupélec, Université Paris-Saclay, Gif sur Yvette, France. Contact: timlautk@gmail.com

We study the problem of finding global minima of a nonsmooth and weakly convex function via simulated annealing. More specifically, we study a discretization of the continuous-time simulated annealing process. While almost all existing works assume Lipschitz smoothness of the function so that its gradient exists and is continuous, we relax this stringent assumption and allow it to be nonsmooth. We instead find the global minimizers of its Moreau envelope since it is more well-behaved. We hence propose a preconditioned version of the discrete simulated annealing algorithm based on the Moreau envelope and establish its global convergence guarantee. Numerically, we illustrate the efficacy of the proposed algorithm with simple low-dimensional examples and large-scale applications to statistics and machine learning.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA35

CC-North 222B

ONR Program Review: Nonlinear Optimization

Community Committee Choice Session

Session Chair: David Phillips, Office of Naval Research, University of New Mexico, Catonsville, MD

1 On First-Order Primal-Dual Algorithms for Minimax Problems

N. Serhat Aybat, Penn State University, University Park, PA, Contact: nsa10@psu.edu

We overview our recent research results on the stochastic accelerated primal-dual (SAPD) method for solving convex-concave minimax problems using a stochastic first-order oracle. We characterize the bias-variance trade-off for SAPD and provide tight bounds for the expected distance and gap metrics leading to (near) optimal rate results; we also give high-probability bounds for SAPD to describe/control the tail event behavior of the iterate sequence. Furthermore, we discuss how SAPD can be embedded in an inexact proximal point method to solve weakly convex-(strongly) concave minimax problems achieving the best known complexity bounds for this class. Finally, we discuss how to incorporate a backtracking scheme to compute a stationary point for the stochastic nonconvex minimax problems without requiring to know Lipschitz constants of the coupling function.

2 Lower Complexity Bound of First-Order Methods for Affinely Constrained Nonconvex Nonsmooth Problems

Yangyang Xu, Rensselaer Polytechnic Institute, Troy, NY

For affinely constrained nonconvex nonsmooth problems, the upper-bound complexity results of first-order methods have been established. A lower bound result is still lacking though there is for smooth problems. In this talk, I will present one lower bound result of first-order methods for a special class of affinely constrained nonconvex nonsmooth problems. Our results show that the nonsmooth term makes the problems significantly harder than smooth counterparts. Additionally, I will present a new inexact proximal gradient algorithm and show that it is worst-case optimal within the considered function class. Hence, our lower bound is tight to a class of affinely constrained nonconvex nonsmooth problems.

3 Policy Gradient: Estimation, Convergence and Beyond Cumulative Rewards

Mengdi Wang, Princeton University, Princeton, NJ

In offline RL, estimating the value or gradient of a policy often suffers from distribution shift. We will review the statistical theory of off-policy policy evaluation and consider the problem off-policy policy gradient estimation. We present a Policy Gradient Bellman Equation and shows how to leverage Q function approximator for policy gradient estimation via a double fitted iteration. We show that the double fitted iteration is equivalent to a model-based plug-in estimator. Further, the PG estimation error bound is determined by a restricted chi-square divergence that quantifies the interplay between distribution shift and function approximation. Next, we show how to extend policy gradient method and its convergence analysis to RL beyond cumulative rewards.

4 Random Methods for Large-Scale Optimization

Angelia Nedich, ASU, Tempe, AZ

A new class of methods is considered for problems with a large number of constraints such as those arising in estimation and classification, reinforcement learning, and artificial intelligence. We consider a class of algorithms that use randomization to cope with the large number of constraints. We present our recent results for a problem with many linear constraints, which is treated by a penalty method using one-sided Huber-loss function. We study the infeasibility properties of the solutions to the penalized problems, propose a random incremental penalty method, and investigate its convergence properties. In particular, we show that the iterates converge to a solution of the original problem almost surely and in expectation, and establish convergence rate of the method in terms of the expected function values.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA36

CC-North 222C

Differentiable Programming with Applications in Power and Energy Systems

Community Committee Choice Session

Session Chair: Robert Mieth, NJ

Session Chair: Jan Drgona, [1</sup]

1 Grid-Siphyr: An End-To-End Physics-Informed Framework for Integer Optimization in Power Systems

Rabab Haider[1], Anuradha Annaswamy[2], [1]MIT, Cambridge, MA, [2]MIT, Cambridge, MA, Contact: rhaider@mit.edu

Classical approaches for integer optimization remain prohibitively slow for dynamic applications where fast and frequent decision making is required. Data driven methods offer speed, but out-of-the-box implementations typically cannot enforce hard constraints or address mixed integer variables. To close this gap, we propose SiPhyR, a physics-informed end-to-end learning to optimize framework that integrates system constraints, operating principles, and an integer rounding function into a differentiable learning framework. We deploy SiPhyR for grid reconfiguration, an emerging paradigm where the grid topology and distributed solar dispatch are optimized for system efficiency. Results show Grid-SiPhyR can learn to optimize while preserving feasibility and enjoying scalability. Further, it supports grid efficiency, operability, and clean energy goals.

2 Folded Optimization for End-To-End Model-Based Learning

Ferdinando Fioretto, James Kotary, Syracuse University, Syracuse, NY, Contact: nandofioretto@googlemail.com

Integrating constrained optimization models in deep networks has advanced both fields, but backpropagation through optimization mapping poses challenges due to the lack of a closed form. Unrolling, a common approach, uses automatic differentiation through an iterative solver but can face accuracy and efficiency issues. Analytical differentiation avoids these problems but has rigid requirements. This talk offers insights into backpropagation of unrolled optimizers, leading to a system for generating equivalent and efficiently solvable analytical models. It also presents a unified view of unrolling and analytical differentiation in constrained optimization mappings. Experiments show the approach's potential in computation and expressiveness across structured prediction and decision-focused learning tasks.

3 Solving Hard Power Grid Problems Using End-To-End Learning: A Case Study for Wildfire Risk Mitigation

Deepjyoti Deka, Los Alamos National Laboratory, Los Alamos, NM

Resilient power grid operation has become crucial in the face of worsening events like flood, hurricanes and forest fires. In addition to physical constraints, resilient grid optimization considers multiple operational uncertainties (renewable generation, grid damage) and control variables (topology switching, on/off of emergency generators) that complicate the model. This talk describes the benefits of using Machine learning (ML), particularly end-to end learning for computationally efficient solution to grid resiliency. We will discuss two use-cases for end to end learning. The first will pertain to selection of finite wildfire scenarios to solve wildfire risk-aware grid optimization using ML. The second use case will use end-to-end learning to speed-up global optimization in power grids with discrete control variables.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA37

CC-North 223

Decision Rules for Dynamic Decision Making

Community Committee Choice Session

Session Chair: Eojin Han, Southern Methodist University, Dallas, TX

1 Nonlinear Decision Rules Made Scalable by Nonparametric Liftings

Eojin Han[1], Omid Nohadani[2], [1]Southern Methodist University, Dallas, TX, [2]Benefits Science Technology, Arlington, MA, Contact: eojinh@smu.edu

Decision rules provide approximate solutions by restricting decisions to simple functions of uncertainties in dynamic robust optimization. In this paper, we consider a nonparametric lifting framework where the uncertainty space is lifted to higher dimensions to obtain nonlinear decision rules. We propose two nonparametric liftings, which derive the nonlinear functions by leveraging the uncertainty set structure and problem coefficients. Both methods integrate the benefits from lifting and nonparametric approaches, and hence, provide scalable decision rules with performance bounds. Numerical comparisons with competing methods demonstrate superior computational scalability. These observations are magnified in multistage problems, suggesting practical applicability of the proposed nonparametric liftings in large-scale dynamic robust optimization.

2 Two-Stage Decision Rules for Multistage Adaptive Robust Optimization

Maryam Daryalal[1], Ayse Nur Arslan[2], Merve Bodur[3], [1]HEC Montreal, Montreal, QC, Canada; [2]Institut de Mathematiques de Bordeaux, Talence, France; [3]University of Toronto, Toronto, ON, Canada. Contact: maryam.daryalal@hec.ca

In this talk, for a broad class of multistage adaptive robust optimization problems, we present the class of two-stage decision rules that impose a predefined structure on a subset of the decision variables in future stages, with the goal of building an approximate model that returns feasible first-stage solutions. The result is a two-stage robust optimization (2ARO) approximation of the original multistage problem, leading to novel techniques that reveal new theoretical and practical avenues. We show that in some special cases, constraint-and-column generation algorithm converges (finitely/asymptotically) to the exact solution of the 2ARO problem, otherwise the K-adaptability approach is applicable. We demonstrate the performance of our solution framework over multistage versions of newsvendor, location-transportation, and capital budgeting problems.

3 Optimize-via-predict: Conditions for Out-of-sample Optimality in Data-driven Optimization

Gar Goei Loke[1], Taozeng Zhu[2], Ruiting Zuo[3], [1]Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands; [2]Dongbei University of Finance and Economics, Dalian, China; [3]The Hong Kong University of Science and Technology, Guangzhou, China. Contact: loke@rsm.nl

Under the context of data-driven optimization, we consider out-of-sample optimality over the sampling distribution, and propose prescriptive solutions as a decision rules mapping data sets to decisions. We prove sufficient conditions for out-of-sample optimality and present an optimization problem that solves for such a candidate solution, which can be computed efficiently. Finally, we illustrate our model on the newsvendor model, and find strong performance when compared against alternatives in the literature

4 Integrating EV Fleet Flexibility into Robust Optimal Planning of Local Power Grids

Linda Punt, Gar Goei Loke, Yashar Ghiassi, Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands. Contact: punt@rsm.nl

The unpredictable and flexible nature of electric vehicle (EV) demand poses both a challenge and an opportunity to distributed power networks. Accounting for this flexibility during the planning phase is critical to prevent overprovisioning. This requires supply-demand matching at all nodes and at all times, where decisions are the link capacities and per-node storage capacity. However, the stochastic nature of EV demand in time, space, and quantity complicates this task. We address this problem by modeling the aggregate of EVs and presenting a two-stage multi-period moments uncertainty robust optimization model. Using real data from a local grid, we demonstrate that our model can reduce grid investment costs by taking advantage of EV fleet flexibility.

Tuesday, October 17, 8:00 AM - 9:15 AM

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CC-North 224A

Non-Smooth and Bilevel Convex Optimization

Community Committee Choice Session

Session Chair: Nam Ho-Nguyen, The University of Sydney, The University of Sydney, Australia

Session Chair: Dabeen Lee, Institute for Basic Science (IBS), Pittsburgh, PA

1 First-Order Methods for Bi-Level Optimization

Shimrit Shtern, Lior Doron, Technion - Israel Institute of Technology, HAIFA, Israel. Contact: shimrits@technion.ac.il

Simple bilevel problems are optimization problems in which we want to find an optimal solution to an inner function that minimizes an outer objective function. Such problems appear in many machine learning and signal processing applications. We present the ITerative Approximation and Level-set EXpansion (ITALEX) approach that is designed for bilevel problems with norm-like outer functions, which are not required to be either smooth or strongly convex. ITALEX alternates between expanding the level-set of the outer function and approximately optimizing the inner problem over this level-set. Using first-order methods such as proximal gradient and generalized conditional gradient to optimize the inner function, we prove that ITALEX has a feasibility convergence rate of O(1/k) and an optimality convergence of O(1/√k), which are the best known rates for this setting.

2 Projection-Free Non-Smooth Convex Programming

Kamiar Asgari[1], Michael Neely[2], [1]University of Southern California, Los Angeles, CA, [2]University of Southern California, Los Angeles, CA 9008, CA, Contact: kamiaras@usc.edu

This paper presents a sub-gradient based algorithm to solve constrained non-smooth convex optimization without taking projections onto the feasible set. The well studied conditional gradient methods (also known as Frank-Wolfe type algorithms) also avoid projections. However, they are only designed to handle smooth objective functions. The proposed algorithm treats non-smooth problems and achieves an □-suboptimal feasible solutions after O(□^-2) iterations (which matches existing lower bounds). The algorithm yields similar performance in expectation when the deterministic sub-gradients are replaced by stochastic sub-gradients.

Other proposed projection-free algorithms for non-smooth problems are based on conditional gradient methods. Our new algorithm is however derived from the (stochastic) projected sub-gradient descent method.

3 Non-Smooth, Holder-Smooth, and Robust Submodular Maximization

Dabeen Lee, KAIST, Daejeon, Korea, Republic of. Contact: dabeenl@kaist.ac.kr

We study the problem of maximizing a continuous DR-submodular function that is not necessarily smooth. We prove that the continuous greedy algorithm achieves an [(1-1/e) OPT-epsilon] guarantee when the function is monotone and Holder-smooth, meaning that it admits a Holder-continuous gradient. For functions that are non-differentiable or non-smooth, we propose a variant of the mirror-prox algorithm that attains an [(1/2)OPT-epsilon] guarantee. We apply our algorithmic frameworks to robust submodular maximization and distrbutionally robust submodular maximization under Wasserstein ambiguity. In particular, the mirror-prox method applies to robust maximization to obtain a single feasible solution, and for distributionally robust maximization, we deduce and work over a reformulation whose objective function is Holder-smooth.

4 Projection-Free Convex Bilevel Optimization

Khanh-Hung Giang-Tran[1], Nam Ho-Nguyen[1], Dabeen Lee[2], [1]The University of Sydney, Sydney, Australia; [2]Korea Advanced Institute of Science and Technology, Daejeon, Korea, Republic of. Contact: nam.ho-nguyen@sydney.edu.au

We study convex bilevel optimization, where an upper-level convex function is minimized over the set of minimizers of another lower-level convex function. While various first-order algorithms exist for solving this problem, they rely on projection-type operations. In this work, we propose algorithms which instead employ linear optimization oracles, which can be advantageous in various settings. We draw on connections between bilevel optimization and exact regularization, primal-dual methods and online convex optimization to derive convergence guarantees of our methods.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA39

CC-North 224B

Innovative Material Handling Systems

Community Committee Choice Session

Session Chair: Jennifer A. Pazour, Rensselaer Polytechnic Institute, Troy, NY

1 Drone-Assisted Material Handling for Smarter Manufacturing

Julio Jiménez-Sarda[1], Daniel F. Silva[2], Alice E. Smith[3], [1]Auburn University, Auburn, AL, [2]Auburn University, Auburn, AL, [3]Auburn University, Birmingham, AL

Amidst labor shortages, increasing land prices, and other aspects of the post-pandemic world, our logistics chain must take the next technological leap. Automated material handling equipment often requires valuable floor space and specialized layouts. Uncrewed aerial vehicles (UAVs) present a flexible and potentially cost-effective alternative. To explore the potential benefits and challenges of such systems, we used a version of the CVRP to model a realistic manufacturing environment. As a proof-of-concept, we outfitted a commercially available drone with pickup-and-carry capabilities. We found that, even with limited carrying capacity, there are potential benefits compared to ground-based material handling systems. Additionally, we identified potential challenges and safety considerations when developing our pickup and carrying mechanisms.

2 Deploying Robotic Resources in Redesigned Retail Stores Supporting Omnichannel Services

Joyjit Bhowmick[1], Sebastian Köhler[2], Georg Fischer[2], Kai Furmans[3], Jennifer A. Pazour[1], [1]Rensselaer Polytechnic Institute, Troy, NY, [2]Karlsruhe Institute of Technology, Karlsruhe, Germany; [3]KIT, Karlsruhe, Germany. Contact: joyjittspl@gmail.com

The proliferation of e-commerce services shifts the in-store logistics once done by shoppers to retailers. And how best to support both online and in-store customer channels efficiently and seamlessly is a current challenge for retailers. We develop an agent-based simulation framework to evaluate redesigned retail store layouts supporting both customer types and which integrate data collected from lab experiments deploying a newly designed modular robotic platform to assist with the logistical tasks. This framework is used to identify the feasible range of attributes of the robotic platform as well as the decision trade-offs in terms of customer satisfaction and store performance.

3 Inventory and Order Fulfillment Policies for Ship-From-Store Omnichannel Strategy

Vishal Bansal[1], Arnab Bisi[2], Debjit Roy[3], Prahalad Venkateshan[4], [1]Indian Institute of Management Calcutta, Kolkata, India; [2]Johns Hopkins University, Baltimore, MD, [3]Indian Institute of Management Ahmedabad, Ahmedabad, India; [4]Indian Institute of Management Ahmedabad, Vastrapur, Ahmedabad, India

An omnichannel retailer with a distribution center and a retail store has to make important, interlinked decisions - (1) how much inventory to keep at the retail store, and (2) where to fulfill the online demand from and how much. In this work, we model the integrated inventory replenishment and online demand allocation decisions for an omnichannel retailer employing the ship-from-store strategy. We analyze this problem for both single-period and multi-period settings. We extend the analytical framework of the single-period problem by providing a finite-horizon MDP formulation for the multi-period problem. Our findings suggest that for a single-period setting, decentralized inventory replenishment and demand allocation system maximizes the profit of the omnichannel retailer for low values of the incentive.

4 Retail on Autonomous Wheels: A Time-Sensitive Traveling Salesman Problem

Zhuolun Dong[1], Junyu Cao[2], Wei Qi[3], [1]University of Texas at Austin, Austin, TX, [2]The University of Texas at Austin, Austin, TX, [3]Tsinghua University, Beijing, China. Contact: dongzhuolun@utexas.edu

Driven by the potential of wheeled retail stores, we present a model, theory, and insights into their operations. We consider a new business model where a wheeled mobile retail store transverses across the service region, seeks suitable locations to perch at, and fulfills local demand. We propose and analyze a model that incorporates the time-sensitive factors (local demand and freshness) into the TSP, which we call the "time-sensitive TSP". The model focuses on the strategy of the mobile store to maximize the total reward. We derive the upper and lower bounds of the optimal reward in the asymptotic regime using the continuous approximation approach. Numerical studies are conducted to demonstrate the performance of the model framework. Our findings suggest that mobile retail has the potential to be more profitable compared to stationary retail.

Tuesday, October 17, 8:00 AM - 9:15 AM

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CC-North 225A

Logistics of Supply Chain Disruptions

Community Committee Choice Session

Session Chair: Bahar Cavdar, Texas A&M University, College Station, TX

1 Restoration of Infrastructure Networks Under Incomplete Information

Subhojit Biswas, Bahar Cavdar, Joseph Geunes, Texas A&M University, College Station, TX, Contact: subhojit.biswas@tamu.edu

Restoring power to a disrupted distribution network requires dispatching crews to affected areas in an effort to diagnose and repair all faults in the power network, with a goal of minimizing population-weighted disruption time. The resulting disruption time depends on crew routing decisions on the corresponding transportation network, as well as on the fault locations and distribution network structure. A lack of information on the nature and locations of power network faults compounds the difficulty of solving this already complex combinatorial problem. Given a set of nodes without power, as well as a probability that each node is faulty, we seek a node visit sequence that minimizes weighted service disruption time. We model this problem as an MDP and propose an approximate dynamic programming solution approach that employs state-space-reduction techniques.

2 Harnessing Prognostics and Health Management for Multi-Vehicle Routing and Maintenance

Iman Kazemian[1], Murat Yildirim[2], [1]Wayne state university, Detroit, MI, [2]Wayne State University, Detroit, MI, Contact: hj5980@wayne.edu

Vehicle prognostics and health management is a central problem in fleet management that focuses on harnessing sensor data for predicting vehicle-specific failure risks. Effectively harnessing these predictions within a fleet management problem requires optimal integration of these vehicle-specific failure risks within fleet-level routing and maintenance by considering a multitude of complex operational interactions. In this talk, we propose a unified framework that integrates sensor-driven vehicle prognostics into a joint multi-vehicle routing and maintenance optimization model. Our framework leverages real-time sensor-drive failure predictions to enable informed decisions about maintenance and routing. The proposed model outperforms conventional maintenance models by reducing costs, improving productivity, and minimizing downtime.

3 A Model for Fortifying Distribution Network Nodes Subject to Disruptions

Pelin Kesrit, Bahar Cavdar, Joseph Geunes, Texas A&M University, College Station, TX, Contact: pelkechrid@gmail.com

We consider a distribution network for delivering a natural resource or physical good to a set of nodes, each of which serves a set of customers, in which flow disruptions may occur. Each node receives flow through a path from one or more source nodes so that a node experiences a disruption if it occurs at any node on that path. All nodes are subject to a future disturbance of an uncertain degree of severity, for which we determine a fortification level that enables the node to withstand. We maximize the expected number of customers who do not experience a disruption, given a limited fortification budget. We formulate the problem as a mathematical program, characterize the properties of optimal solutions, and provide methods for determining optimal fortification levels under various assumptions on the probability distribution of the disturbance severity and the network structure.

4 Repair Crew Routing for Infrastructure Network Restoration

Bahar Cavdar[1,2], Qie He[3], Feng Qiu[4], [1]Texas A&M University, College Station, TX, [2]Rensselaer Polytechnic Institute, Troy, NY, [3]Amazon, Santa Clara, CA, [4]Argonne National Laboratory, Lemont, IL, Contact: bcavdar@tamu.edu

Abstract:
We study a repair crew routing problem to restore a disrupted power network where technical crew travels to a number of sites to repair damaged equipment with minimum total service disruption time. We call this problem the Power Restoration Traveling Repairman Problem. The main challenge in this problem is that the service disruption time in a location depends on the interaction of the routing sequence with both networks, i.e., the road network and the power grid. To solve the problem, we develop an exact method based on bi-directional dynamic programming. We then improve the method by reducing the search space with solution upper and lower bounds, and threshold rules derived from the precedence relations in the power network. We also propose efficient heuristic variants of the method. We present computational results to compare our method with benchmark heuristics.

Tuesday, October 17, 8:00 AM - 9:15 AM

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CC-North 225B

Co-Design and Coordination of Mobility Systems

Community Committee Choice Session

Session Chair: Zardini Gioele, ETH Zurich

1 Integrating Load Bundling and Pricing for Decarbonizing Freight Operations

Maxime Bouscary[1], Aron Brenner[1], Alexandra Li[1], Mazen Danaf[1], Saurabh Amin[2], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]MIT, Cambridge, MA, Contact: mbscry@mit.edu

A major challenge in decarbonizing the trucking industry is to reduce deadhead (empty miles) under tight reliability constraints. Here we propose to leverage today's digital brokerage platforms that facilitate matching between shippers and carriers to jointly design load bundles and pricing strategies to tradeoff between expected reduction in empty miles and total served load. Crucially, we account for the strategic behavior of carriers in terms of their accept/reject decisions and spatial positioning to be matched with desirable loads. We also account for reliability preferences of shippers (e.g., tight versus flexible appointment windows). Our results demonstrate that jointly recommending and pricing load bundles can maximally reduce expected empty miles while limiting the probability of unserved load to a small value.

2 Joint Design of Transportation Systems and User Schedules

Matt Tsao, Lyft, CA

We propose a community detection approach for schedule staggering to reduce congestion in transportation systems. Transportation systems experience congestion in large part due to positive correlation in user demand. If people need to be at work by 9:00am, there will be high demand and congestion in the network around this time. Schedule staggering aims to reduce congestion by perturbing user schedules (e.g., change work hours to 10am-6pm for some fraction of the population), thereby decorrelating them. However, the perturbations must be done in a way that does not disrupt the couplings between users' schedules. We use community detection to determine how to stagger user schedules while preserving the dependencies between schedules.

3 Transit Line Planning and Optimization in Multimodal Transportation Networks

Duan Ning, Cornell University, NY

As mobility-on-demand services revolutionize urban transportation by providing convenient transportation choices to the general population, they also motivate the re-design of traditional transit service to better integrate with a multi-modal environment. Recent attempts include using heuristics or data-driven approaches to handle the problem. However, there has been limited work on general optimization frameworks for the planning multimodal transportation system in a systematic and tractable manner. We study the problem of designing efficient transit line routes and frequencies to serve demand given the availability of complementary first- and last-mile on-demand services in the network. Using integer programming and column generation, we demonstrate the usefulness of our approach on a case study with real data from New York City.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA42

CC-North 226A

Railway Train platoons: Control and Optimization

Community Committee Choice Session

Session Chair: Fan Pu, Texas A&M

Session Chair: Zhikai Wang, 1</sup

1 Passenger-Oriented Metro Train Scheduling with the Virtual Coupling Technology

Zhikai Wang, 1</sup

The imbalanced distribution of passenger demand in temporal and spatial dimensions brings great challenges to the train scheduling problem. To address the above problem, this paper proposes an integrated optimization model to solve the train scheduling problem considering the virtual coupling technology. The objective of this model is to balance the offered capacity and passenger demand. Moreover, some non-linear constraints are introduced to formulate the un/couple process of trains. Then, this model is transformed into an integer programming (IP) model which can be solved by the CPLEX optimizer. Finally, a case study is developed to verify the effectiveness of the train scheduling model. The computational results show that the balance between passenger demand and offered capacity is improved after applying the virtual coupling technology.

2 Adaptive Fault-Tolerant Fixed-Time Cruise Control for Virtually Coupled Train Set

Di Wang, Beijing, China

This paper studies the problem of fixed-time cruise control for VCTS. Firstly, by analyzing the dynamic evolution of the VCTS in an actual environment, a second-order VCTS train-following dynamic model is formulated with considering actuator faults, uncertain resistance, unknown disturbances, and control input saturation. Then, a novel barrier functions-based fixed-time sliding model control method is proposed to deal with the state constraints. To deal with parametric uncertainty, adaptive fault-tolerant control and core function technologies are integrated into the same framework. Furthermore, by using a function approximation method to handle the control input saturation, an adaptive fault-tolerant fixed-time cruise controller is designed. Finally, the effectiveness of the proposed method is validated in simulation analysis.

3 A Branch-And-Cut Approach for the Scheduling of Train Platoons in Urban Rail Networks

Simin Chai, Beijing Jiaotong University, Beijing, China. Contact: smchai@bjtu.edu.cn

In this study, we investigate the scheduling of train platoons for urban rail networks with time-dependent demand to mitigate passenger inconvenience. We propose a mixed-integer linear programming (MILP) model that simultaneously optimizes the train-platoon (de)coupling strategies, arrival/departure times at each station, and the running orders of trains, while considering limited rolling stock resources at the depots and the safety of trains at cross-line zones. To tackle computational challenges in real-world instances, we develop a customized branch-and-cut solution algorithm, based on the analysis of mathematical properties of our MILP model, to generate (near-)optimal solutions more efficiently. Real-world case studies based on the operational data of Beijing metro network are conducted to verify the effectiveness of our approach.

4 A Technical Demonstration of Virtual Coupling in Metros

Xiaolin Luo, Beijing Jiaotong University, Beijing, China. Contact: luo_xiaolin713@163.com

The development of a technical demonstration project of virtual coupling in China will be presented. First, the aims of this demonstration will be discussed. Then, the protection and cooperative train control methods, as two key technologies for virtual coupling, will be presented. Finally, field-test results will be provided to show the performance of virtual coupling.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA43

CC-North 226B

Sustainable Aviation

Community Committee Choice Session

Session Chair: Jeremy Coupe, 1</sup

1 Airline Flight Network Expansion with Strategic Aircraft Leasing Decisions

M. Selim Akturk[1], Alper Atamturk[2], Ozge Safak[3], [1]Bilkent University, Ankara, Turkey; [2]Berkeley Analytics, Berkeley, CA, [3]University of Bath, Bath, United Kingdom. Contact: akturk@bilkent.edu.tr

The ability to match fleet capacity to increasing passenger demand is a crucial factor affecting the airlines' profit. This work develops a mathematical model for the airlines to determine the optimal number of leased aircraft while simultaneously generating a schedule with new market routes to make a reliable estimate on the operational costs and revenue. Since the fuel and carbon emission costs are the most significant components of operational costs, this work links the strategic aircraft leasing decisions to the operational aircraft assignment decisions. Consequently, we consider not only the seat capacity of the aircraft alternatives in response to new demand but also the fuel efficiency of the aircraft along with the uncertainty due to airport congestion as a function of airlines' decisions on flight departure times.

2 Capacity Finder: Strategic Departure Reroute Recommendations for Sustainable Aviation

Aditya Saraf, Ryan Laroza, ATAC, Santa Clara, CA

When inclement weather closes down departure routes/ fixes in multi-airport, metroplex environments, it results in large taxi out delays with flights waiting in long departure queues on airport surfaces with engines on. This creates unnecessary fuel-burn and emissions. ATAC, in collaboration with NASA's ATD-2 and Digital Information Platform (DIP) projects, has developed a capability called the NAS Capacity Finder Service (NCFS) that innovatively integrates real-time data processing, machine learning, and multi-objective optimization capabilities to solve this complex problem. NCFS provides guidance on delay, fuel, and emissions-saving departure reroutes in upcoming departure banks to airline and FAA stakeholders.

3 Simulating Evtol Energy Consumption and Operation

Eric S. Miller, National Renewable Energy Lab, Golden, CO, Contact: Eric.Miller@nrel.gov

Electric Vertical Takeoff and Landing Aircraft (eVTOL) are an emerging technology advancing rapidly, and likely to be commercially available in the next five years. eVTOLs are not expected to replace an existing mode of transportation, rather, they are expected to provide a new service called urban air mobility (UAM). To gain some insight into the positive and negative impacts of UAM, NREL created the Future Aerospace Vehicle Energy Simulation (FAVESim) tool, which uses a physics-based model to estimate energy consumed by eVTOLs flying fixed routes, and an agent-based model to simulate the interaction of eVTOLs with vertiports, passengers, and electric grid infrastructure. The tool is used to estimate how many passengers can be served in a day, how long they have to wait for flights, and how much power and energy will be required to charge the eVTOL aircraft.

4 Airline Network Planning Considering Climate Impact: Assessing New Operational Improvements

Mahdi Noorafza[1], Bruno Santos[1], Zarah Zengerling[2], Sharpanskykh Alexei[1], [1]TU Delft, Delft, Netherlands; [2]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Hamburg, Germany. Contact: b.f.santos@tudelft.nl

We developed a multi-objective airline network and schedule design framework to facilitate the modeling of climate-aware airline operational improvements. While considering financial and climate response objectives, we modeled intermediate stop-overs and lower flight altitudes as operational improvements. We analyzed the impact of considering climate impact in the planning of operations of three different airline types: one main-hub-and-spoke (KLM), one smaller multi-hub airline (TAP), and one low-cost carrier (easyJet). Results show that airlines could lower environmental impact by 10-36% when considering climate response objectives.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA44

CC-North 226C

Generative AI for Business Analytics: New Paradigm, New Challenges

Community Committee Choice Session

Session Chair: Denghui Zhang, Stevens Institute of Technology, Hoboken, NJ

1 Learning to Generate with Small Data

Hua Wei, Arizona State University, AZ

This talk explores the strategies of data generation under the real-world setting of small data, i.e., the real-world data could be sparse and hard to obtain. The objective is to improve the accuracy and efficiency of data generation by training machine learning models to learn from real-world data. Specifically, this talk will introduce some of our latest work on traffic data, and the follow-up generative model and control model facing the small data.

2 Will ChatGPT Encourage Plagiarism and IP Infringement?

Denghui Zhang, Stevens Institute of Technology, NJ

This topic explores whether ChatGPT, a powerful language model, encourages plagiarism and IP infringement. It discusses the risks associated with relying solely on ChatGPT for content creation, highlighting how easy text generation may tempt users to plagiarize or infringe copyrighted material. Addressing this issue requires understanding responsible AI usage and adhering to ethical guidelines. By examining the implications of ChatGPT on plagiarism and IP infringement, this topic aims to foster a discussion on balancing AI capabilities and maintaining content integrity and legality.

3 Making Sense of Bot Moderation in Online Communities with Large Language Models

Zihan Chen, Lei Zheng, Feng Mai, Stevens Institute of Technology, Hoboken, NJ

Online communities employ diverse bots to moderate user activities, from identifying aberrant behaviors to fostering creativity. Although these bots provide automation, optimize workflows, and boost productivity, they also induce disruptions and unintended consequences detrimental to community survival. In this study, we harness Large Language Models to examine community perceptions, interpretations, and use of bots for various moderation tasks within online communities. By identifying key factors that influence decisions around bot adoption, we deliver novel insights into AI's role and effective bot governance in decentralized online communities. This research enriches the understanding of AI's societal impacts and aids in crafting efficient, accountable AI-based moderation tools for future use.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA45

CC-North 227A

Learning Algorithm in Managing Service Systems

Community Committee Choice Session

Session Chair: Pengyi Shi, Purdue University, West Lafayette, IN

1 Branch-And-Price for Prescriptive Contagion Analytics

Michael Lingzhi Li, Harvard Business School, Boston, MA

Predictive contagion models are ubiquitous in epidemiology, social sciences, engineering, and management. This paper formulates a prescriptive contagion analytics model where a decision-maker allocates shared resources across multiple population segments, each governed by continuous-time dynamics. These problems feature a large-scale mixed-integer non-convex optimization structure with ordinary differential equations as constraints. We develop a branch-and-price methodology based on: (i) a set partitioning and column generation decomposition; (ii) a state-clustering algorithm for the pricing problem; and (iii) a tri-partite branching scheme to circumvent non-linearities. Extensive experiments demonstrate algorithm scalability, and it can save up to 12,000 extra saved lives over a three-month horizon in a COVID-19 vaccination campaign.

2 An Operational Perspective to Online Content Moderation

Tingrui Shi[1], Amir Anastasios Alwan[2], Rene A. Caldentey[3], Amy R. Ward[4], [1]The University of Chicago, Chciago, IL, [2]University of Chicago Booth School of Business, Pewaukee, WI, [3]The University of Chicago, Chicago, IL, [4]The University of Chicago Booth School of Business, Chicago, IL, Contact: tshi1@chicagobooth.edu

The rapid growth of social media users in recent years has led to an increase in the prevalence of harmful content on social media platforms, making online content moderation more important than ever. Content moderation systems nowadays highly rely on artificial intelligence (AI) due to the unprecedented scale of such systems. However, human reviewers are still essential for moderating ambiguous content and providing labels for the training of AI models. We use a Bayesian learning framework to model the AI's classification accuracy as a function of the labeling activities conducted by human reviewers. We derive a fluid approximation for our model and investigate the operational problem of optimally allocating the capacity of the human reviewers in order to minimize long-term misclassification and holding costs.

3 Approximate Dynamic Programming for Multiclass Scheduling Under Slowdown

Jing Dong[1], Berk Gorgulu[2], Vahid Sarhangian[3], [1]Columbia University, New York, NY, [2]University of Toronto, Toronto, ON, Canada; [3]University of Toronto, Toronto, ON, Canada. Contact: bgorgulu@mie.utoronto.ca

In many service systems, service times of customers can be correlated with waiting times. Scheduling under such dependency is challenging as a Markovian state description requires keeping track of all customers' waiting history. We propose an approximate dynamic programming algorithm for multi-class scheduling with wait-dependent service times. Our algorithm can generate policies with simple structures and achieve strong performance which we illustrate in a healthcare setting using real data.

4 Inpatient Overflow Management with Proximal Policy Optimization

Jim Dai[1], Pengyi Shi[2], Jingjing Sun[3], [1]Cornell University & CUHK-Shenzhen, Ithaca, NY, [2]Purdue University, West Lafayette, IN, [3]Chinese University of Hong Kong, Shenzhen, Shenzhen, Guangdong Province, China

Overflow patients to non-primary wards can effectively alleviate congestion in hospitals, while undesired overflow also leads to issues like mismatched service quality. Therefore, we need to trade-off between congestion and undesired overflow. This overflow management problem is modeled as a discrete-time Markov Decision Process with large state and action space. To overcome the curse-of-dimensionality, we decompose the action at each time into a sequence of atomic actions and use an actor-critic algorithm, Proximal Policy Optimization, to update policy. Moreover, we tailor the design of neural network which represents policy to account for the daily periodic pattern of the system flows. Under hospital settings of different scales, the PPO policies consistently outperform some commonly used state-of-art policies significantly.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA46

CC-North 227B

Publishing in INFORMS Transactions on Education

Panel Session

Session Chair: Stefan Creemers, IESEG, Aarschot, Belgium

1 Moderator

Stefan Creemers, IESEG, Aarschot, Belgium

Editors and recent authors share their experience in how to publish in INFORMS Transactions on Education.

2 Panelist

Stefan Creemers, IESEG, Aarschot, Belgium

3 Panelist

Jeroen Belien, KU Leuven, Brussel, Belgium

4 Panelist

Dries Goossens, Ghent University, Gent, Belgium

5 Panelist

Craig Fernandes, University of Toronto, Toronto, ON, Canada

Tuesday, October 17, 8:00 AM - 9:15 AM

TA47

CC-North 227C

Sensor-Driven Forecasting, Operations and Maintenance in Energy Systems

Community Committee Choice Session

Session Chair: Murat Yildirim, Wayne State University, Detroit, MI

1 A Sensor-Driven Operations and Maintenance Planning Approach for Grid-Tied PV Solar Plants

Sakir Karakaya[1], Murat Yildirim[2], [1]Ministry of Science, Industry and Technology, Ankara, Turkey; [2]Wayne State University, Detroit, MI, Contact: sakir.karakaya@sanayi.gov.tr

This study proposes an integrated operations and maintenance planning model for PV solar plants, which are geographically distributed in different locations, to maximize total profit by minimizing total maintenance costs. The model harnesses sensor-driven data reflecting the degradation occurred in the performance of each unit including PV arrays, inverters, and transformers. It is characterized as a two-stage stochastic program in which demand and unit degradation are handled as uncertain; and optimal maintenance crew routing, preventive and corrective maintenance, and power generation decisions are made simultaneously. The experimental results show that the proposed model outperforms periodic and reliability-based maintenance policies in terms of optimum solution values obtained.

2 A Degradation Embedded Stochastic Optimization Framework For Maintenance And Inspection In Energy Systems

Muhammet Ceyhan Sahin[1], Deniz Altinpulluk[2], Murat Yildirim[1], Shijia Zhao[3], Feng Qiu[4], [1]Wayne State University, Detroit, MI, [2]Wayne State University, Clinton Township, MI, [3]ANL, Westmont, IL, [4]Argonne National Laboratory, Lemont, IL

This paper introduces a holistic framework for enhancing maintenance and inspection scheduling of marine energy systems. By integrating real-time sensor data, predictive analytics, and an innovative optimization model, the framework minimizes costs, extends asset lifespan, and boosts availability. It effectively handles degradation uncertainties through optimized maintenance, crew routing, and inspection. Experimental results on a 20-asset marine energy system validate its superiority over traditional methods.

3 A Physics-Guided Machine Learning Model for Wind Energy Forecasting and Its Value to Offshore Wind Operations

Feng Ye[1], Joseph Brodie[2], Travis Miles[3], Ahmed Aziz Ezzat[4], [1]Rutgers University, Piscataway, NJ, [2]AKRF Inc., New York, NY, [3]Rutgers University, Piscataway, NJ, [4]Rutgers University, Piscataway, NJ, Contact: fy97@soe.rutgers.edu

This presentation will consist of two parts: First, we present a physics-guided machine learning model for offshore wind energy forecasting, called AIRU-WRF. Second, we demonstrate how AIRU-WRF can be used as input to optimal short-term operations and maintenance decisions in offshore wind farms. Our experiments have been extensively tested using real-world data from the offshore wind energy areas in the NY/NJ Bight where several GW-scale offshore wind projects are soon to be operational.

4 A Robust Optimization Framework for Condition-Based Operations and Maintenance

Murat Yildirim[1], Deniz Altinpulluk[1], Farnaz Fallahi[1], Mohammad Javad Feizollahi[2], [1]Wayne State University, Detroit, MI, [2]Georgia State University, Atlanta, GA

We formulate a novel robust optimization model to manage operations, maintenance and degradation in multi-component systems. Our approach embeds degradation models within a robust optimization formulation to explicitly capture complex degradation uncertainties due to component-to-component interactions and operational loading. Comprehensive case studies demonstrate that the proposed approach offers significant improvements in reliability and cost.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA48

CC-North 228A

Engineering-Informed Machine Learning for Additive Manufacturing

Community Committee Choice Session

Session Chair: Weizhi Lin, University of Southern California, Los Angeles, CA

Session Chair: Qiang Huang, University of Southern California, Los Angeles, CA

1 Process-Informed Small-Sample Learning of 2D Freeform Shapes in Additive Manufacturing Using Printing Primitives

Weizhi Lin[1], Yuanxiang Wang[2], Qiang Huang[2], [1]University of Southern California, Los Angeles, CA, [2]University of Southern California, Los Angeles, CA, Contact: weizhili@usc.edu

Additive manufacturing (AM) poses challenges for accuracy control due to complex geometries and limited training samples. This study proposes a small-sample learning approach for 2D freeform shapes through a process-informed dimension reduction strategy. The infinite-dimensional product space is transformed into a finite-dimensional printing primitive space via design segmentation. These primitives, comprising of smooth curve segments and non-smooth corners, effectively capture smooth deviation patterns and sharp transitions in shape profiles. Rather than analyzing the entire shape deviation, the model focuses on modeling printing primitive deviations, considering process-informed covariates including curvature, size, and location effects. The 2D shape deviation profile is then reconstructed by connecting predicted primitive deviations.

2 Physics-Informed Data-Driven Modeling for Generalizable Geometric Error Prediction and Compensation in Two-Photon Lithography

Sixian Jia[1], Jieliyue Sun[2], Andrew Howes[2], Michelle Dawson[2], Kimani C. Toussaint[2], Chenhui Shao[1], [1]University of Illinois at Urbana-Champaign, Urbana, IL, [2]Brown University, Providence, RI, Contact: sixianj2@illinois.edu

Two-photon lithography (TPL) is an additive manufacturing technique for creating micro-and nano-scale three-dimensional (3D) structures. Geometric compliance is crucial for ensuring the quality and functionality of TPL-produced 3D structures. This talk will present a novel, generalizable data-driven modeling framework based on physical principles to predict and compensate for geometric errors across structure designs and process parameters. The modeling framework decomposes geometric features into a global trend determined by process parameters and a local variation term representing small-scale spatial effects. Experimental results obtained from a large-scale experimental design will be presented to demonstrate the effectiveness of the proposed framework in terms of modeling accuracy, generalizability, and geometric compliance improvement.

3 Explainable AI for Layer-Wise Emission Prediction in Selecting Laser Melting

Vidita Gawade[1], Yuebin Guo[2], Weihong (Grace) Guo[1], [1]Rutgers, The State University of New Jersey, Piscataway, NJ, [2]Rutgers University-New Brunswick, Piscataway, NJ

The dynamic behavior of melt pools in select laser melting is very challenging to model using physics-based and conventional black-box data-driven models. Explainable Artificial Intelligence is developed in this work to advance the understanding of convoluted links of non-sequential process physics, online time series sensing data, and process anomaly (e.g., overheating in the melt pool). A Deep Neural Network-Long Short-Term Memory (DNN-LSTM) model integrates the process parameter knowledge with process history information through online sensing data. Three methodologies, namely, Shapley Additive Explanations (SHAP), Integrated Gradients (IG), and Local Interpretable Model-Agnostic Explanations (LIME) are implemented and compared to enable local and global model interpretation, transparency, and generalizability of the DNN-LSTM model.

4 Enhancing Data Privacy for Metal-Based Additive Manufacturing via Generative Diffusion Modeling

Durant Fullington, Starkville, MS

The objective of this research is to develop a de-identification mechanism for metal-based additive manufacturing (AM) process data, utilizing a generative diffusion modeling framework. The need for AM process data privacy stems from the growth of collaborative data sharing framework, used to develop robust *in-situ* anomaly detection models. However, data sharing frameworks can compromise the confidential design information within the AM process data. The proposed diffusion modeling approach provides a novel methodology by infusing print path de-identification measures into the image augmentation, resulting in a surrogate image with design information masked. This allows for more precise data de-identification and the ability to maintain data usability for anomaly detection, as the reconstructed images maintain similarity with the prior data distribution.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA49

CC-North 228B

Collective Intelligence and Ambiguity Models

Contributed Session

Session Chair: Tri-Dung Nguyen, University of Kent, Canterbury, United Kingdom

1 Harnessing Collective Intelligence Under a Lack of Cultural Consensus

Necdet Gurkan[1], Jordan Suchow[2], [1]Stevens Institute of Technolgy, Hoboken, NJ, [2]Stevens Institute of Technology, Hoboken, NJ, Contact: ngurkan@stevens.edu

We present a nonparametric Bayesian model that extends Cultural Consensus Theory, a mathematical framework for inferring group consensus, by introducing a latent construct that maps between pre-trained deep neural network embeddings of an entity and the consensus belief amongst one or more subsets of respondents regarding those entities. We applied our extended CCT to various domains, including risk perceptions of technologies, leadership perception, first impressions of faces, and humor perception Compared to existing methods, our approach better leverages the underlying structure and interconnectedness of beliefs, contributing to a more comprehensive understanding of collective intelligence and serving as a potential foundation for consensus-aware information technologies.

2 Metawisdom of the Crowd: How Choice Within Aided Decision Making Can Make Crowd Wisdom Robust

Jon Atwell[1], Marlon Twyman[2], [1]Stanford University, Stanford, CA, [2]Stanford University, Stanford, CA

Decision support systems present individuals with decision aids--discrete presentations of relevant information, frames, or heuristics--to enhance the quality and speed of decision making, but have the potential to bias group judgments by limiting predictive diversity. We redescribe the wisdom of the crowd as often starting with the choice of decision aids and define “metawisdom of the crowd” as when collective choice of aids leads to higher crowd accuracy than randomized assignment to the same aids, a comparison that accounts for the information content of the aids. In two experiments we find strong evidence of metawisdom. It comes about through diverse errors arising through the use of diverse aids, not through widespread use of the aids that induce the most accurate estimates; the microfoundations of crowd wisdom appear in the first choice.

3 Multidisciplinary Learning Through Collective Performance Favors Decentralization

John Meluso, Laurent Hébert-Dufresne, University of Vermont, Burlington, VT, Contact: john.meluso@uvm.edu

Members of multidisciplinary teams often complete distinct, interrelated pieces of larger tasks. This makes it difficult for individuals to separate the performance effects of their own actions from the actions of interacting neighbors. In this work, we show that individuals can also learn from network neighbors through artifacts (like performance metrics). When individuals innovate (“exploring” searches), dense networks hurt performance by increasing uncertainty. In contrast, dense networks help performance when individuals refine work (“exploiting” searches) by efficiently finding optima. We find that decentralization improves multidisciplinary team performance across a battery of 34 tasks, suggesting new design principles for multidisciplinary teams.

4 An Application of Smooth Ambiguity Model to Determine Value of Data

Saurabh Bansal[1], Ying He[2], [1]Penn State University, University Park, PA, [2]University of Southern Denmark, Odense, Denmark. Contact: yinghe@sam.sdu.dk

The performance of data-driven optimization and classification protocols typically depends on the quantity of data available. We use the Smooth Ambiguity Model to provide a new quantification of this performance. This quantification can help managers determine how much data to collect. We illustrate the application of this development in an industry setting.

5 Operations Research Games Under Uncertainty and Distributional Ambiguity

Tri-Dung Nguyen[1], Xuan Vinh Doan[2], [1]University of Kent, Canterbury, United Kingdom; [2]University of Warwick, Coventry, United Kingdom. Contact: tn264@kent.ac.uk

The aim of this paper is to address a fundamental challenge of incorporating uncertainty into cooperative games, particularly operations research games. We introduce a new solution concept of (robust) least chance decisions for cooperative games under uncertainty and distributional ambiguity, which is motivated by the concept of least core solutions for deterministic cooperative games. We develop a framework to find those decisions and compute their (robust) least chance dissatisfaction for cooperative games under normally distributed uncertainty and moment-based distributional ambiguity. We demonstrate how the framework can be applied to several operations research games including resource-sharing games, project selection games, and general linear production games with detailed analytical results.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA50

CC-North 229A

Ensuring an Equitable Energy Transition

Community Committee Choice Session

Session Chair: Parth Vaishnav, University of Michigan, Ann Arbor, MI

1 Quantifying Confidence in Electricity Rate Plan Recommendations for Low-to-Moderate Income Homes in Detroit

Xavier Farrell, Johanna L. Mathieu, University of Michigan, Ann Arbor, MI

Electricity Rate Plan Recommender Systems (EPRS) are a class of tools developed to help electrical utility customers find rate plans that could save them money on their utilities. ERPS generate recommendations using past home energy usage data or other home specific features such as appliance ownership and occupancy. However, the homeowner's future electricity usage characteristics cannot be precisely predicted, and therefore, the same must be said about their future savings (or losses) obtained by adopting an EPRS recommendation. Thus, the homeowner must ask, how confident can they be that the recommended rate plan will incur the least cost relative to the alternatives. To answer this question, this work applies least-squares temperature dependent load modelling techniques and statistical bootstrapping methods to estimate confidence intervals for the next year's expected savings for each recommendation. The method is then applied to one year of hourly smart meter data for 800+ households in Detroit, MI. The confidence interval for the expected savings of each household is then validated against the each household's true savings in the following year as computed from the following year's energy usage data.

2 Introducing Environmental Justice Considerations into Grid Planning Models via Air Pollution Modeling to Develop Equitable Decarbonization Pathways

Jordan French, Sergio Castellanos, University of Texas at Austin, Austin, TX, Contact: jordanfrench@utmail.utexas.edu

Capacity expansion models have proven valuable for developing cost-optimized decarbonization portfolios for grid systems; however, air pollution and environmental justice impacts are often neglected or oversimplified. This work attempts to address this gap in the literature by pairing an open-source capacity expansion model with a pollutant dispersion model, to develop decarbonization pathways for California and Texas grids and model proposed natural gas plants' NOx emissions. The plants with the greatest environmental justice impacts are then restricted in another iteration of capacity expansion modeling, demonstrating the use of environmental justice constraints in the development of equitable grid decarbonization pathways.

3 Equity Benefits of Strategic Home Electrification

Kevin Kircher, Purdue University, West Lafayette, IN, Contact: kircher@purdue.edu

Replacing natural gas appliances by efficient electric alternatives can reduce greenhouse gas emissions and air pollution from residential buildings. A home that fully electrifies can also disconnect from the gas pipeline network, saving hundreds of dollars per year in connection fees. However, a gas utility's operating and maintenance (O&M) costs do not, in general, decrease as electrified homes disconnect gas service. Uncoordinated electrification can lead gas utilities to spread the same O&M costs over fewer homes, increasing connection fees for the homes that remain. This is an equity problem, as earlier adopters of modern electric appliances tend to be wealthier and whiter. This talk will illustrate how strategically electrifying at the neighborhood level can improve equity outcomes by enabling staged shut-down of pipeline sections.

4 Identifying Equitable Pathways to Heating Electrification in Rural, Northern Communities

Ana Dyreson[1], Chelsea Schelly[2], Dave Bohac[3], Roman Sidortsov[2], Adnan Hilal[1], Lester Shen[3], Josh Quinnell[3], [1]Michigan Technological University, Houghton, MI, [2]Michigan Technological University, Houghton, MI, [3]Minnesota Center for Energy and Environment, Minneapolis, MN, Contact: adyreson@mtu.edu

Beneficial electrification is considered imperative for widespread decarbonization of the economy, and planning this transition must consider the distribution of impacts across society. We focus on the impacts of electrification in rural, northern, communities, specifically to address the reliable and equitable transition of space heating to electricity and the use of rural land for wind, solar, and storage development. To assess the impacts on real communities, we work with three clusters of counties, one each in northern Minnesota, Wisconsin, and Michigan, with an emphasis on including the voices of Indigenous and post-industrial communities. This presentation describes the project's community engagement approach and the initial findings around perceptions and preferences around electric heat pumps and readiness of single-family homes for electrification.

5 Distributional Pricing and Impacts of Retail Electric Deregulation

Noah Dormady, The Ohio State University, Columbus, OH, Contact: dormady.1@osu.edu

Considerable research time and attention has been given to optimizing wholesale electricity markets and bulk power systems. However, very little attention is paid to consumer impacts for end users in retail energy markets. Retail electric deregulation, or 'retail choice' is considered a market-based policy that enables competition in retail markets. This paper evaluates the efficiency and distributional results from retail choice markets in a large retail deregulated state. It reports on database development consisting of every daily retail choice offer by every marketer in every investor-owned utility territory in Ohio for nearly ten years. It compares procurement auction-based pricing with the retail choice construct. A comparative distributional analysis is performed.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA51

CC-North 229B

Policy-Enabling Models in the Power Sector

Community Committee Choice Session

Session Chair: Afzal Siddiqui, Stockholm University, Kista, Sweden

1 Dynamic Incentives for Flexible Electric Vehicle Charging

Nicolò Daina, Columbia University, New York City, NY, Contact: nd2741@columbia.edu

In the transition to full-electric road transportation, utilities, distribution system operators and policy makers need to ensure full coordination with the power grid. This requires flexibility in electric vehicles (EV) charging. Recent surveys of current UK and US EV drivers, highlighted that there is a general interest in smart charging programs, but there are concerns about partially losing control of the charging operation and that financial incentives are key. These attitudes are likely to be stronger amongst the general drivers' population, who is about to switch to electric cars. We present here a choice-based dynamic pricing/incentive approach to promote flexibility in EV charging choices, fully integrated with EV charging scheduling. Unlike typical choice-based demand management, our approach operates with real-time requests without pre-booking.

2 Equilibrium Uniqueness in a Wholesale Electricity Market with Renewable Generation and Demand Uncertainty

Ben Chaiken[1], Joseph Edward Duggan[2], [1]Parametric Portfolio Associates, Seattle, WA, [2]University of Dayton, Dayton, OH, Contact: bfchaiken@gmail.com

This work explores the uniqueness of Nash-Cournot equilibria in wholesale electricity markets with both thermal and renewable generation in the presence of demand uncertainty. We derive criteria guaranteeing a unique equilibrium for an energy market where each firm owns a share of renewable generation and analyze the effects of increasing renewable generation on the multiplicity of equilibria. This extends the

uniqueness results proven by Lagerlöf (2006) to a market model that incorporates renewable generation in the manner of Acemoglu et al. (2017).

3 An Analysis of Mitigating Measures for Inc-Dec Gaming in Market-Based Redispatch

Felipe VdS Araujo, Audun Midttun Systad, Jens Løken Eilertsen, Ruud Egging, NTNU, Trondheim, Norway. Contact: felipe.van.de.s.araujo@ntnu.no

Market-based redispatch enables the participation of more providers of flexibility in electricity markets. However, this design may allow for strategic behaviour by market participants. One strategy, inc-dec gaming, has been shown to aggravate electricity transmission congestions and reduce overall social welfare. We investigate mitigating actions against strategic behaviour in market-based redispatch. To test the impact of those actions, we developed a bi-level two-stage stochastic framework to represent day-ahead and balancing electricity markets. The agents' behaviour is modelled as an equilibrium problem with equilibrium constraints and solved through diagonalisation. The adverse effects on social welfare are in part reversed by the mitigating measures while at the same time introducing a trade-off between the welfare of the participants.

4 Build Back Better? Transmission Planning in an Imperfectly Competitive Power Sector with Environmental Externalities

Farzad Hassanzadeh Moghimi[1], Trine K. Boomsma[2], Afzal Siddiqui[1], [1]Stockholm University, Kista, Sweden; [2]University of Copenhagen, Copenhagen, Denmark. Contact: farzad@dsv.su.se

The power sector's decarbonisation requires an increase in variable renewable energy (VRE) capacity, which introduces production intermittency. The Nordic countries possess flexible capacities, but their incentives may not align with society's interests in a deregulated industry. To address this, we use a bi-level optimisation framework for transmission planning in a VRE-dominated power system. Our research aims to mitigate market imperfections and develop welfare-enhancing policy insights by answering two questions: (1) How should transmission planning be adapted to reduce the impact of market power in a 2030 decarbonisation scenario? (2) How are transmission capacities, generation adoption, and CO2 emissions affected if the damage cost from CO2 emissions is not fully reflected in the CO2 price?

Tuesday, October 17, 8:00 AM - 9:15 AM

TA52

CC-North 230

Optimization and Machine Learning in Power Systems

Community Committee Choice Session

Session Chair: Minseok Ryu, Argonne National Lab

1 Differentially Private Algorithms for Synthetic Power System Datasets

Vladimir Dvorkin, Audun Botterud, Massachusetts Institute of Technology, Cambridge, MA

While power systems research relies on the availability of real-world network datasets, data owners (e.g., system operators) are hesitant to share data due to security and privacy risks. To control these risks, we develop privacy-preserving algorithms for the synthetic generation of optimization and machine learning datasets. Taking a real-world dataset as input, the algorithms output its noisy, synthetic version, which preserves the accuracy of the real data on a specific downstream model or even a large population of those. We control the privacy loss using Laplace and Exponential mechanisms of differential privacy and preserve data accuracy using a post-processing convex optimization. We apply the algorithms to generate synthetic network parameters and wind power data.

2 Employing Optimization Tools Developed by the Machine Learning Community to Solve Large Scale Power Flow Optimization Problems

Samuel Chevalier, Belgium

A number of highly successful optimization algorithms designed for training neural networks have emerged from the Machine Learning (ML) community in recent years. Such algorithms, however, are seldom used for solving the constrained optimization problems which are ubiquitous in power systems. In this talk, we report on the successes and challenges associated with solving large scale security constrained power flow optimization problems using two popular ML optimizers: Adam and L-BFGS. These tools are used in conjunction with a variety of penalization, projection, and clipping routines in order to find feasible, high-quality solutions to highly complex power system optimization problems.

3 Data-Driven Linearization for Optimal Power Flow

Terrence W K Mak, Monash University, Melbourne, Australia. Contact: Terrence.Mak@monash.edu

With increasing penetration of renewable and continuous development of smart grids, faster control and optimization techniques are needed. Recently, machine learning has been widely studied to speed up the computation of optimization tasks. Even though deep learning techniques can be extremely accurate, designing/tuning deep learning architectures for the whole problem is nontrivial and retraining these architectures to cope with changing operational/engineering decisions may not be feasible on the field. Instead of learning the whole problem, the work investigates on extracting and learning a ***common subproblem - the nonlinear power flow.*** Data augmentation and learning frameworks will be presented, and linear approximation for the original problem will be discussed. Preliminary results on AC optimal power flow and load restoration problems will be shown.

4 Forecasting and Asset Bundling for Renewable Energy

Hanyu Zhang[1], Mathieu Tanneau[2], Pascal Van Hentenryck[1], [1]ISyE Georgia Tech, Atlanta, GA, [2]Georgia Tech, Atlanta, GA

Renewable energy raises new challenges in forecasting and market-clearing operations for power systems. Their volatility and the sheer number of distributed renewable assets create significant challenges that have not been encountered before. This presentation reviews recent progress in forecasting wind and solar energy sources and in preparing these forecasts for use in stochastic optimization. In particular, the presentation reviews the use of transformer architectures for forecasting large-scale time series arising in renewable energy, as well as novel optimization algorithms for bundling time series.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA53

CC-North 231A

New Modeling Perspectives for Low Carbon Power Systems

Community Committee Choice Session

Session Chair: Olivier Massol, IFP School, Rueil-Malmaison, France

Session Chair: Tim Schittekatte, MIT, Cambridge, MA

1 Exploring the Mechanics of Hybrid Markets for Electricity

Alexis Lebeau[1], Olivier Massol[2], [1]CentraleSupélec & EDF, Palaiseau, France; [2]IFP School, Rueil-Malmaison, France. Contact: alexis.lebeau@edf.fr

The idea that electricity market design models should evolve in the context of the energy transition is gaining momentum. In particular, it is argued that the traditional Energy-Only Market model needs to be complemented with a long-term framework for investments and retirements. The process of defining how this long-term framework should be implemented is only being initiated, however, and market designers have many dimensions and possible options to explore. As a contribution to this endeavor, this paper analyzes one possible hybrid design option relying on long-term contracts and phase-out compensations through a quantitative exercise based on optimization and dynamic simulations.

2 SDDP Models of Demand Response : A Promising Framework and Applications to Europeans Case Studies

Julien Ancel[1], Olivier Massol[2,1], [1]LGI, CentraleSupélec, Paris, France; [2]IFP School, Rueil-Malmaison, France. Contact: julien.ancel.2018@polytechnique.org

Demand Response (DR) is frequently mentioned as a key source of flexibility in renewable-energy-dominated power systems.
This work shows how SDDP, a computationally efficient solution technique designed by (Pereira and Pinto, 1991), may be used to model DR in an efficient way, enabling to bypass tractability issues at the expense of some convexity constraints in the model design. Traditional SDP models fail to account for the temporal granularity and far-off horizons necessary to account for all aspects of DR value.
The estimation of optimal hourly operations of a RES-dominated power system that minimize the expected total system cost over an entire year is proposed. This stochastic model allows several sources of DR from diverse end-uses to be incorporated. It is applied to West European situations, representing existing systems or prospective future systems.

3 Community/Committee'S Choice Submission

Alva J. Svoboda, PG&E, Oakland, CA, Contact: alva.svoboda@gmail.com

Post-transition daily electricity markets will rely on carbon-free energy and dispatchable storage to meet forecast demands. We argue that the California day ahead and real time market designs, although developed for fossil-fuel driven generation resources, may be equally well-suited to a carbon-free resource mix.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA54

CC-North 231B

Decision Diagrams for Optimization

Community Committee Choice Session

Session Chair: Anthony Karahalios, [1]</sup

1 Domain-Independent Dynamic Programming: Generic State Space Search for Combinatorial Optimization

Ryo Kuroiwa[1], J. Christopher Beck[2], [1]University of Toronto, Toronto, ON, Canada; [2]University of Toronto, Toronto, ON, Canada. Contact: jcb@mie.utoronto.ca

We propose Domain-Independent Dynamic Programming (DIDP), a novel model-based paradigm for combinatorial optimization based on dynamic programming (DP). In DIDP, a problem is formulated as a DP model and a generic solver solves it. In recent work, we have introduced Dynamic Programming Description Language (DyPDL), a formalism to define a DP model, and developed a generic solver, CAASDy, based on state space search. In subsequent work, we have also developed anytime solvers, which quickly find a feasible solution and continuously improve it to optimality. Empirical evaluations show that our solvers outperform mixed-integer programming and constraint programming in multiple combinatorial optimization problems.

2 A New Formulation for Parallel Machine Scheduling Using Decision Diagrams

Roel Leus[1], Daniel Kowalczyk[2], Christopher Hojny[3], Stefan Ropke[4], [1]KU Leuven, Leuven, Belgium; [2]University of Leuven, Leuven, Belgium; [3]TU Eindhoven, Eindhoven, Netherlands; [4]Technical University of Denmark, Herlev, Denmark

We present a new formulation for parallel machine scheduling with a regular objective function and without idle time. The formulation is constructed with the help of a decision diagram that represents all job sequences that respect specific ordering rules. These rules rely on a partition of the planning horizon into, generally non-uniform, periods and do not exclude all optimal solutions, but they constrain solutions to adhere to a canonical form. The new formulation has numerous variables and constraints, and hence we apply a Dantzig-Wolfe decomposition in order to compute the linear programming relaxation in reasonable time; the resulting lower bound is stronger than the bound from the classical time-indexed formulation. We develop a branch-and-price framework that solves several instances from the literature for the first time.

3 Column Elimination: Solving Discrete Optimization Problems Using Arc Flow Formulations

Anthony Karahalios, Willem-Jan van Hoeve, Carnegie Mellon University, Pittsburgh, PA, Contact: akarahal@andrew.cmu.edu

Column Elimination is a recently developed method for solving discrete optimization problems. The method has shown competitive results for solving graph coloring and vehicle routing problems when compared to branch-and-cut-and-price. This presentation outlines the general column elimination method. We show how to model a discrete optimization problem as an arc flow formulation that can be solved by column elimination, highlight differences with column generation based methods, and present experimental results for three fundamental combinatorial optimization problems.

4 Network Flow Models for Robust Binary Optimization with Selective Adaptability

Ian Yihang Zhu, Merve Bodur, Timothy Chan, University of Toronto, Toronto, ON, Canada

Adaptive robust optimization problems have received significant attention in recent years. In this talk, we propose a new set of reformulation techniques for two-stage adaptive robust binary optimization problems with objective uncertainty (ARBO). We focus, without loss of generality, on ARBO problems with “selective adaptability”, which describe a common class of linking constraints between first-stage and second-stage solutions. We employ decision diagrams to derive various constrained network flow models that provide exact and approximate reformulations of the ARBO problem. In contrast with existing solution methods, these models are easier to implement and solve with standard mathematical programming solvers. We show through a set of numerical experiments that these models offer a number of computational advantages.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA55

CC-North 231C

Ride-Share Applications

Contributed Session

Session Chair: Kirit Ghosh, Indian Institute of Management, Calcutta, Kolkata, India

1 Assortment Optimization Under the Generalized Markov Chain Choice Model for Revenue Management of Parking Reservation Service

Pengyu Yan[1,2], Haoyu Xie[2], Sentao Miao[3], Xiaoqiang Cai[4], Kaize Yu[2], [1]Yangtze Delta Region Institute (Huzhou),University of Electronic Science and Technology of China, Huzhou, China; [2]University of Electronic Science and Technology of China, Chengdu, China; [3]McGill University, Montreal, QC, Canada; [4]The Chinese University of Hong Kong, Shenzhen, China. Contact: 202121150122@std.uestc.edu.cn

This paper addresses a revenue management problem for a parking reservation service platform (APP) that offers parking lots to drivers for destinations in surrounding areas. The drivers choose parking lots based on pricing and occupancy rates, and make reservations with certain probabilities, with the option to transfer to another lot with a transferring probability. To model the drivers' comparison and choice behaviors, we adopt a generalized Markov chain choice model. Based on this, we study an assortment optimization problem to maximize the expected revenue of the platform. Unlike existing research on consumers' choice behavior, this study incorporates comparative choices into the model and proposes a polynomial-time algorithm that is proven to be optimal. Numerical experiments demonstrate the effectiveness and efficiency of the proposed model and algorithm.

2 Managing Uberization: Strategies for an Automobile Manufacturer in the Presence of Strategic or Loyal Consumers

Kirit Ghosh, Indian Institute of Management, Calcutta, Kolkata, India. Contact: kiritg19@iimcal.ac.in

'Uberization,' which refers to on-demand services through platforms, has impacted the automobile industry immensely. This paper studies the impact that the firms which offer on-demand ride-hailing or renting services have on a car manufacturer, with consumers being strategic or loyal to the manufacturer. We develop a two-period model with varying usage and show that ride-hailing is more detrimental to the manufacturer under certain conditions. The manufacturer's optimal strategies include collaborating with the uberizing firm or floating its own platform, even with an incentive offered to the users, depending on certain conditions. We propose a fixed fee in addition to revenue sharing based on platform fee, leading to a win-win situation.

2 Driver Persuasion and Fleet Redeployment

Yingda Zhai[1], Andrew B. Whinston[2], [1]National University of Singapore, Singapore, Singapore; [2]University of Texas-Austin, Austin, TX, Contact: yingdazhai@nus.edu.sg

We study optimal information design for efficient fleet redeployment in ride-sharing market. A market designer, who is better informed on the demand distribution, can provide private signal to sway driver's beliefs and induce efficient routing coordination. We characterize the optimal persuasion scheme under a credible persuasion in a repeated Bayesian coordination game. Compared to surge pricing, the information design improves matching efficiency with lower cost.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA56

CC-North 232A

On Solving Large-scale Optimization on GPU

Community Committee Choice Session

Session Chair: Kibaek Kim, Argonne National Laboratory, Lemont, IL

1 On the Geometry and Refined Rate of Primal-Dual Hybrid Gradient for Linear Programming

Jinwen Yang[1], Haihao Lu[2], [1]University of Chicago, Chicago, IL, [2]University of Chicago Booth School of Business, Chicago, IL, Contact: jinweny@uchicago.edu

Linear programming (LP) is a fundamental class of optimization problems with various practical applications. Recently, there is a new trend of researches on using first-order methods (FOMs) for LP with the goal to further scale up LP by taking advantage of distributed computing. A notable example is the implementation of PDLP, an FOM LP solver that is based on primal-dual hybrid gradient (PDHG). Despite its numerical success, the theoretical understanding of PDHG for LP is far from complete; its existing complexity result depends on the global Hoffman constant of the KKT system, which is known to be very loose and uninformative. In this work, we aim to develop a fundamental understanding of the geometric behaviors of PDHG for LP as well as a refined complexity rate that is not relied on the global Hoffman constant. We show that there are two major stages of PDHG for LP: in Stage I, PDHG identifies active variables and the length of the first phase that is driven by a certain quantity which measures the closeness to degeneracy; in Stage II, PDHG effectively solves a homogeneous linear inequality system, and the complexity of the second stage is driven by a well-behaved local sharpness constant of the system. This finding is closely related to the concept of partial smoothness in non-smooth optimization, and it is the first complexity result of partial smoothness without the non-degeneracy assumption. Our results suggest that degeneracy itself does not slow down the convergence, but near-degeneracy does.

2 Community/Committee'S Choice Submission
François Pacaud, [1</sup]

3 Solving Unit Commitment with ACOPF on GPU
Kibaek Kim, Argonne National Laboratory, Lemont, IL
We present a GPU algorithm for solving unit commitment with alternating current optimal power flow (UC-ACOPF). The algorithm is based on alternating direction method of multiplier that enables our novel decomposition of UC-ACOPF for many small computations on GPU. We compare the numerical results from solving the test problems on CPU and GPU.

4 Solving Large-Scale Nonlinear Optimization on GPU by HiOP
Nai-Yuan Chiang, Jingyi Wang, Cosmin Petra, Lawrence Livermore National Laboratory, Livermore, CA
HiOp is a suite of HPC optimization solvers for some large-scale nonconvex nonlinear programming problems (NLPs). It is a lightweight HPC solver that leverages application's existing data parallelism to parallelize the optimization iterations by using specialized linear algebra kernels. Using RAJA portability abstraction layer, HiOp can solve large-scale NLPs entirely on GPU, i.e., user input model, algorithm, and linear solvers all deal with data on GPU. We will present the latest implementation of HiOp and some numerical studies from power system applications in this talk.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA57

CC-North 232B

Applications on Individual consumption and financial decision making

Contributed Session

Session Chair: Wenqi Zhou, Duquesne University, Pittsburgh, PA

1 Doing Well by Being Well: Corporate Wellness Programs and Incentives to Exercise
Yongqin Lei, Ivey Business School, Western University, London, ON, Canada. Contact: ylei.phd@ivey.ca
Many employers provide wellness programs that offer financial incentives to employees for exercising, as healthier employees are generally more productive and incur lower health insurance costs covered by employers. However, wellness programs are not always effective because people may renege on their commitments to exercise. We then investigate the optimal design of wellness programs regarding the structure and size of financial incentives.

2 Digital Consumption and Consumer Self-Control
Zheng Wu, Jiong Sun, Purdue University, West Lafayette, IN, Contact: wu1252@purdue.edu
The harmful effects of digital over-consumption become increasingly severe. The goal of our research is to analytically examine how consumers exercise self-control and how for-profit firms' pricing schemes (subscription versus pay-per-use) and product design strategies affect their profit, consumer surplus, and consumers' long-term health. Our findings indicate that firms' pricing schemes and their impact on consumers' long-term well-being are dependent on consumer characteristics and the nature of product category being consumed.

3 Examining Individuals' Retirement Planning Behavior - The Contributions Of Proactive Decision-making
Florian Blösl[1], Johannes Ulrich Siebert[1], Reinhard Erich Kunz[2], Jana Siebert[3], [1]Management Center Innsbruck, Innsbruck, Austria; [2]Bauhaus-Universität Weimar, Weimar, Germany; [3]n/a, Innsbruck, Austria. Contact: florian.bloesl@mci.edu
The influence of financial literacy and numeracy on retirement planning behavior is well-established. A second strand of research focuses on the impact of psychological determinants on retirement planning behavior. Our understanding of which forces lie underneath such psychological determinants still needs to be improved. By considering proactive decision-making, a construct recently developed in behavioral operations research, we intend to provide valuable inputs to the current discourse. Based on hypotheses derived from theory, we expect proactive decision-making to positively impact psychological determinants. These psychological determinants further shape individuals' retirement planning behavior. In conclusion, we contribute to the emerging psychology literature in behavioral finance.

4 The Societal Impact of Ridesharing Through Gig-Economy Employment: Opportunities and Equality
Ayush Sengupta, University of Connecticut, Storrs, CT, Contact: ayush.sengupta@uconn.edu

We investigate the widely debated discussion on the overall social and economic welfare that ridesharing platforms generate through gig-economy employment. The online gig economy may help alleviate financial stressors in the economy and benefit society by providing employment and income with less bias and improving people's financial situation. However, an adverse impact on welfare may arise through a reduction in wages, a stagnation of career growth and income progressions, increasing disparities in the workforce, and reduced job opportunities in the associated traditional industries. We answer this question empirically by examining the impact of Uber's entry on income inequality, geographic migration, and community health. Our findings offer insights for policymakers to devise policies to improve social welfare and alleviate social and economic inequality.

5 Privacy Decisions: The Roles of Individual'S Mindset and the Default Setting

Wenqi Zhou, Georgiana Craciun, Duquesne University, Pittsburgh, PA, Contact: zhouw@duq.edu

Recent privacy scandals have stirred increased interest in understanding consumers' decisions on privacy protection and disclosure. This research compares the privacy decisions of individuals with two different mindsets: *maximizers* who strive for the best possible choice, and *satisficers* who accept a good enough option. An online experiment was conducted to manipulate mindsets and default privacy settings. The results show that individuals lean towards the default privacy setting, particularly maximizers. For example, when asked to choose a privacy option for "post on your private page", satisficers are 3.16 times more likely and maximizers are 8.21 times more likely to choose 'Everyone' when presented with the 'Everyone' default (vs. 'Only Me' default).

Tuesday, October 17, 8:00 AM - 9:15 AM

TA58

CC-North 232C

Recent Advances in Network Optimization: Theory and Applications

Community Committee Choice Session

Session Chair: Ningji Wei, Texas Tech University, Lubbock, TX

1 Finding the Most Degree-Central Shortest Path in a Weighted Graph

Johnson Phosavanh[1], Dmytro Matsypura[2], [1]The University of Sydney, Sydney, Australia; [2]The University of Sydney, Sydney, Australia. Contact: johnson.phosavanh@sydney.edu.au

The degree centrality of a path, defined to be the number of nodes connected to it, can be used to measure the relative importance of a path in the network. In this study, we consider the problem of finding the most degree central shortest path in a graph with weighted edges. This extends on recently published work studying the unweighted version of this problem. By modifying Dijkstra's algorithm, we show that the weighted version of the problem is solvable in polynomial time, and this new algorithm is more efficient than the existing algorithm for unweighted graphs. We conduct a numerical study of our algorithm on synthetic and real-world networks, and we compare our results to the existing literature.

2 A Human-Trafficking Bilevel Network Interdiction Problem

Daniel Lopes da Silva[1], Thomas Sharkey[2], Yongjia Song[2], [1]Clemson University, Clemson, SC, [2]Clemson University, Clemson, SC, Contact: dlopesd@clemson.edu

We introduce a human-trafficking based bilevel network interdiction problem where the follower's (trafficker) objective is to maximize network flow whereas the leader's (an anti-trafficking agent) objective is to minimize the number of arcs from a special set with flow on them. We develop single-level reformulations for both, the optimistic and pessimistic cases, and discuss complexity, challenges, and computational results.

3 An Integrated Framework to Improve the Resiliency of Electricity Distribution Systems Exposed to Wildfires

Prasangsha Ganguly[1], Sayanti Mukherjee[2], Jose L. Walteros[3], [1]University at Buffalo, Buffalo, NY, [2]University at Buffalo - The State University of New York, Buffalo, NY, [3]University at Buffalo, Buffalo, NY, Contact: prasangs@buffalo.edu

We develop an optimization framework for designing strategic wildfire prevention policies that involve preemptive practices, such as electricity infrastructure hardening and public safety power shutoffs. Unlike existing studies that consider the pre- and post-wildfire event decisions separately, our approach models the interaction between the preemptive strategic actions, the wildfire propagation, and the post-event operational decisions in a unified framework. We propose a tri-level network interdiction model to mitigate the worst possible disruption due to a wildfire. We observed that the hardening strategies are fundamental to improving the resilience of the overall electricity infrastructure, and the public safety power shutoff events are beneficial to reduce the detrimental effects on the electricity infrastructure.

4 Leveraging Decision Diagrams to Solve Two-Stage Stochastic Programs with Binary Recourse and Logical Linking Constraints

Moira MacNeil, University of Toronto, Toronto, ON, Canada

We convexify the second-stage of two-stage stochastic programs (2SPs) with binary recourse using binary decision diagrams (BDDs) in order to use Benders decomposition algorithm. We first generalize an existing BDD-based approach to allow settings where logical expressions of the first-stage solutions enforce constraints in the second stage. We propose a complementary problem where second-stage objective coefficients are impacted by logical expressions of the first-stage decisions, and develop a distinct BDD-based algorithm to solve this novel problem class. We incorporate conditional value-at-risk and propose, to our knowledge, the first decomposition method for 2SPs with binary recourse and a risk measure. We apply these methods to a novel stochastic dominating set problem and present numerical results to demonstrate the effectiveness of the methods.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA59

CC-West 101A

Infectious disease prevention and control using non-pharmaceutical and/or pharmaceutical interventions

Community Committee Choice Session

Session Chair: Buse Eylul Oruc Aglar, [1</sup]

1 Evaluation of Covid-19 Transmission and the Impact of Mitigation Measures in Cruise Ships Using an Agent-Based Model

Akane Fujimoto Wakabayashi[1], Pinar Keskinocak[1], Sarah Bowden[2], [1]ISyE Georgia Tech, Atlanta, GA, [2]Center for Disease Control and Prevention, Atlanta, GA, Contact: afujimoto@gatech.edu

Cruise ship operations were heavily disrupted during the COVID-19 pandemic. Close quarters and dense populations of domestic and international travelers are an environment where viruses can spread easily. The cruise industry and public health partners continue to develop guidelines to control the spread of disease in this setting.

We developed an agent-based model to simulate COVID-19 spread in cruise ship settings and evaluate the effectiveness of various combinations of mitigation measures, such as masking and routine SARS-CoV-2 testing. We assumed different demographics and social network interactions for passengers and crew. The results provide insights for public health decision-makers and the modeling framework can inform other modeling activities that rely on similar data streams.

2 Model to Estimate Hiv-Care Benefits from Treating Depression in Persons with Hiv in the United States

Md Hafizul Islam, Centers for Disease Control and Prevention (CDC), Atlanta, GA

Depression is prevalent among persons with HIV (PWH) and is associated with poorer adherence and lack of viral load suppression (VLS). Adequate treatment of depression can improve retention in HIV care and medication adherence. However, depression among PWH is not adequately diagnosed or treated. In this work, we describe adaptation of Progression and Transmission of HIV (PATH 3.0), a U.S. agent-based dynamic stochastic simulation model, to incorporate a continuum of depression care. We estimated the impact on VLS of an enhanced depression diagnosis and care scenario compared to a status quo scenario, following assumptions based on the literature. Our findings showed that fully diagnosing and adequately treating depression among all PWH would result in a nearly 5% increase in expected rate of VLS in the United States over ten years, supporting national prevention goals.

3 The Economic Burden of Chronic Hepatitis C Infections in the United States, 2010-2019

Hasan Symum[1], Taiwo Abimbola[1], William Thompson[2], Michelle Van Handel[1], [1]Centers for Disease Control and Prevention, Atlanta, GA, [2]Centers for Disease Control and Prevention, Atlanta, GA

Over 2 million people in the U.S. have hepatitis C virus (HCV) infection, which can lead to serious medical complications and substantial economic burden. This study aims to update the estimated economic burden of hepatitis C in the U.S., including lifetime direct medical costs. Incidence-based cost methods were used to calculate expected lifetime medical cost per case with and without sequelae. Using claims data and the provider perspective, direct medical costs were estimated using inpatient, outpatient, and emergency department encounters. Cost per case of treated and untreated hepatitis C after first medical encounter and diagnosis were followed through disease stages (i.e., fibrosis stage, liver disease, liver transplantation) were produced. Updated costs of hepatitis C can inform resource allocation decisions for the U.S. hepatitis C elimination strategy.

4 Non-Stationary Spatio-Temporal Point Process Modeling for High-Resolution Covid-19 Data

Zheng Dong[1], Shixiang Zhu[2], Yao Xie[3], Jorge M. Mahiques[4], Francisco J. Rodríguez-Cortés[5], [1]Georgia Institute of Technology, Atlanta, GA, [2]Carnegie Mellon University, Pittsburgh, PA, [3]Georgia Institute of Technology, Atlanta, GA, [4]Universitat Jaume I, Valencia, Spain; [5]Universidad Nacional de Colombia, Medellín, Colombia. Contact: zdong76@gatech.edu

Most COVID-19 studies commonly report figures of the overall infection at a state- or county-level, which tends to miss out on fine details of virus propagation. In this work, we analyze a high-resolution COVID-19 dataset in Cali, Colombia, that records the precise time and location of every confirmed case. We develop a non-stationary spatio-temporal point process equipped with a neural network-based kernel to capture the heterogeneous correlations among COVID-19 cases. The kernel is carefully crafted to enhance expressiveness while maintaining model interpretability. We also incorporate exogenous influences imposed by city landmarks. Our approach outperforms the state-of-the-art in forecasting COVID-19 cases with the capability to offer vital insights into the spatio-temporal interaction between individuals concerning the disease spread in a metropolis.

5 Modeling the Vaccination Interventions to Control the Spread of Circulating Vaccine-Derived Poliovirus Type 2 Outbreaks

Yuming Sun[1], Pinar Keskinocak[1], Stephanie Kovacs[2], Lauren N. Steimle[1], Steven Wassilak[2], [1]Georgia Tech ISyE, Atlanta, GA, [2]CDC, Atlanta, GA, Contact: ysun608@gatech.edu

Polio is a debilitating disease which can cause paralysis. The global polio eradication program responds to polio outbreaks using oral poliovirus vaccine (OPV). However, the attenuated live virus in OPV can, in rare cases, revert to regain neurovirulence and cause outbreaks in areas with low population immunity. We built a compartmental model to capture dynamics of poliovirus transmission involving OPV virus reversion. We evaluated different outbreak response strategies and quantified the impact of distributing limited vaccines doses across subpopulations considering age groups and geography. We performed a numerical study in northern Nigeria given its ongoing poliovirus transmission.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA60

CC-West 101B

Well Informed PhD Retreat

Panel Session

Session Chair: Jessye Talley, Morgan State University, Baltimore, MD

1 Moderator

Jessye Talley, Morgan State University, Baltimore, MD

Obtaining the doctorate includes a rigorous course load, unrealistic expectations and hours upon hours of intense stress. This perpetuated cycle of toxic practices also includes the student neglecting their personal well-being in pursuit of the degree. This self-sacrifice often continues past graduation and is seen in new professors. The WELL INFORMED Mentorship Program presents a panel and activities to help doctoral student to create a new healthy, and effective normal within the academy.

2 Panelist

Orissa Massey, MD

3 Panelist

Karen T. Hicklin, University of Florida, Gainesville, FL

Tuesday, October 17, 8:00 AM - 9:15 AM

TA61

CC-West 101C

Humanitarian and Non-Profit Operations

Community Committee Choice Session

Session Chair: Eunae Yoo, Indiana University, Bloomington, IN

1 Fleet Composition Management of Humanitarian Organizations in Response to Armed Conflicts

Telesilla Olympia Kotsi[1], Maria Besiou[2], Alfonso Pedraza-Martinez[3], [1]The Ohio State University, Columbus, OH, [2]Kuehne Logistics University, Hamburg, -, Germany; [3]Indiana University, Bloomington, IN, Contact: kotsi.1@osu.edu

We investigate transportation expenses of a humanitarian organization (HO) that operates in armed conflict settings. We combine a multi-year proprietary data set to study fleet decisions of vehicle rentals and subcontracting. Rentals are relatively expensive but do not permit security breaches because nonprofit authorized staff members drive the rented vehicles. Subcontracting is relatively cheap but permits security breaches because subcontracted drivers outside the nonprofit drive the cars. We use econometric models to find that in areas of armed conflict the HO prefers vehicle rentals to subcontracting.

2 Anti-Corruption and Humanitarian Aid Management in Ukraine

Paola Martin[1], Owen Wu[1], Larysa Yakymova[2], [1]Indiana University, Bloomington, IN, [2]Yuriy Fedkovych Chernivtsi National University, Chernivtsi, Ukraine. Contact: owenwu@indiana.edu

The flow of humanitarian aid in response to Russia's invasion of Ukraine was unprecedented. Regulating aid delivery to prevent loss and misuse due to corruption is crucial. However, strengthening anti-corruption efforts is costly. This cost is part of the total financial aid and it therefore comes at the expenses of people in need. In this study, we analyze this tradeoff in Ukraine's humanitarian aid management. Using game theory, we model the interaction between a government agency and distribution managers. The optimal inspection intensity balances benefits and costs, maximizing the amount of humanitarian aids delivered to the beneficiaries.

3 Sharing the Schedule: Nonprofit Staffing for Volunteers and Employees

Mariana Escallon Barrios, Karen Smilowitz, Northwestern University, Evanston, IL

Recent research in volunteer management has explored how online scheduling platforms can be used to balance volunteer preferences with organizational needs. Strategically assigning staff to the schedule can help to improve supply/demand balance while keeping volunteers engaged. We explore two scheduling strategies, considering organizational and volunteer satisfaction metrics. We present a numerical study to compare the policies under different scenarios of supply, demand, and volunteers' preferences.

4 Crypto Rewards in Fundraising: Evidence from Crypto Donations to Ukraine

Xue (Jane) Tan[1], Yong Tan[2], [1]Southern Methodist University, Dallas, TX, [2]University of Washington, Seattle, WA, Contact: janetanxue@gmail.com

Leveraging the crypto donations to a Ukrainian fundraising plea that accepts Ether (i.e., the currency of the Ethereum blockchain) and Bitcoin (i.e., the currency of the Bitcoin blockchain) over a seven-day period, we analyze the impact of crypto rewards. Separately, we find that crypto rewards have a positive impact on the donation count but a negative impact on the average donation size for donations from both blockchains. Comparatively, we further find that the crypto rewards lead to an 812.48% stronger donation count increase for Ethereum than Bitcoin, given that the crypto rewards are more likely to be issued on the Ethereum blockchain. We also find a 30.1% stronger decrease in average donation amount from Ethereum for small donations (<=$250); the rewards pose similar impacts on the average donation size for the two blockchains for large donations (>$250).

Tuesday, October 17, 8:00 AM - 9:15 AM

TA62

CC-West 102A

Scheduling in Practice

Community Committee Choice Session

Session Chair: Emrah Cimren, Amazon, Issaquah, WA

1 Optimizing New Hire Event Appointments

Emrah Cimren, Cheng Yuting, Amazon, Seattle, WA

In the hourly job application process at the Amazon's hiring web site, a candidate creates an application, accepts a contingent offer, consents to a background check, and books an in-person office hour called New Hire Event. This study describes the development and evaluation of scheduling system based on mixed-integer optimization for the New Hire Event appointment planning.

2 On-Line Scheduling for the 1-Machine Preempt-Restart Problem

Sheng Guo, Marc E. E. Posner, The Ohio State University, Columbus, OH, Contact: posner.1@osu.edu

A lower bound on the relative error for the online 1-machine sum of completion time preempt-restart problem was found in 1997. While improvements have been made, the competitive ratio is not known. We find a best possible online algorithm. In doing so, we improve the current bound by 0.006.

3 Scheduling for Minimizing the Input Buffer Size

Bertrand Lin[1], Shunji Tanaka[2], [1]National Yang Ming Chiao Tung University, Hsinchu, Taiwan; [2]Kyoto University, Kyoto, Japan

We investigate a single-machine scheduling problem to minimize the size of a finite-capacity input buffer. In this problem, each job is assigned to the machine at its release date and started immediately or sent to the input buffer to wait for processing. The problem in this study is to find a schedule that minimizes the required size of the input buffer. Its strong NP-hardness will be shown first, and next, a pseudo polynomial timedynamic program will be developed for the ordinary NP-hard special case. Three integer programming models are presented using different formulation approaches. Numerical experiments appraise the effectiveness of the formulations.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA63

CC-West 102B

Service Models for Senior Care

Community Committee Choice Session

Session Chair: Kejia Hu, Vanderbilt University

Session Chair: Yixuan Liu, 1</sup

1 Effectiveness of Telemedicine in Stroke Care: An Empirical Study on a Telestroke Network

Sriram Venkataraman[1], Brandon Lee[2], Lawrence Fredendall[3], Kejia Hu[4], [1]University of South Carolina, Columbia, SC, [2]University of Dayton, Dayton, OH, [3]Clemson University, Clemson, SC, [4]Vanderbilt University, Nashville, TN, Contact: sriram.venkataraman@moore.sc.edu

Using proprietary data from a telestroke network, we study the impact of telestroke on a patient's length of stay (LOS) and patient quality. We find that patients using the telestroke facility have, on average, shorter LOS in the focal hospital and have better quality outcomes. In addition, we explore heterogenous effects.

2 On-Demand Healthcare Platforms: Impact of Q&A Service on Online Consultations and Offline Appointments

Yixuan Liu[1], Ashish Agarwal[2], Guoming Lai[3], Weihua Zhou[4], [1]China Europe International Business School (CEIBS), Shanghai, China; [2]University of Texas at Austin, Austin, TX, [3]The University of Texas at Austin, Austin, TX, [4]Zhejiang University, Hangzhou, China. Contact: yixuanliu@ceibs.edu

The emerging on-demand healthcare platforms connect patients with healthcare practitioners to provide quick access to medical services. These platforms can offer a Q&A service to the patients to seek more information before they seek care online or offline. Using rich panel data from an on-demand healthcare platform in China, we investigate the impact of such a Q&A service on demands for online consultations and offline appointments. Our findings indicate that the Q&A service has a complementary effect on the demand for both channels. Furthermore, we demonstrate that the spillover effects of the Q&A service vary across different medical specialties and among providers of different professional titles. Finally, our results show that the use of the Q&A service reduces the need for future consultations and information-seeking behavior.

3 Does Information Technology Mitigate the Healthcare Geospatial Disparity? an Examination of Healthcare Information Exchange

Yao Zhao[1], Dongwon Lee[2], Hillol Bala[3], [1]HKUST, Kowloon, Hong Kong; [2]HKUST, Kowloon, Hong Kong; [3]Indiana University, Bloomington, IN, Contact: yzhaocq@connect.ust.hk

Healthcare Information Exchange (HIE) enables healthcare providers to share patients' medical information. While HIE is touted as a potential solution to address healthcare geospatial disparities, its impact on reducing inequality between urban and rural hospitals remains unclear. Using data envelopment analysis (DEA) to construct health professionals' productivity measure and applying the difference-in-differences approach, we reveal that hospitals with HIE adoption experience a significant increase in health professionals' productivity. However, this effect is only pronounced in urban hospitals but not rural hospitals, suggesting that HIE adoption might exacerbate healthcare geospatial inequalities. Besides, we find that HIE adoption improves communication and clinical decision-making quality among urban but not rural health professionals.

4 Structural Equation Modeling to Improve the Experience of Kiosk use in the Elderly: A Study Based on Survey Analysis Results

Junho Lee, Hosun Rhim, Korea University Business School, Seoul, Korea, Republic of. Contact: jheric98@korea.ac.kr

With the advent of the information age, many stores are expanding the use of self-ordering machines (kiosks). This study aims to analyze the factors that cause discomfort for elderly people, who are vulnerable to using such machines. A survey will be conducted among the elderly population, and Structural equation modeling (SEM) will be used to identify the fundamental factors that affect their use of kiosks. This will help develop strategies to alleviate the barriers faced by the elderly population in adopting digital technology.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA65

CC-West 103A

New Business Model Innovation

Community Committee Choice Session

Session Chair: Burcu Tan, University of New Mexico

1 Strategic Investments for Platform Launch and Ecosystem Growth: A Dynamic Analysis

Burcu Tan[1], Edward G. Anderson[2], Geoffrey Parker[3], [1]University of New Mexico, Albuquerque, NM, [2]University of Texas-Austin, Austin, TX, [3]Dartmouth College, Hanover, NH, Contact: btan@unm.edu

We study a two-sided platform startup's optimal new product development investment and pricing decisions over a multi-period life-cycle. We characterize optimal dynamic policies for different monetization models (commission vs 1- or 2-sided subscriptions) and ecosystem regimes including business-to-consumer vs. business-to-business, varying same-side and cross-side externalities, and product development agility.

2 Economic and Environmental Implications of Ride-Hailing and the Vehicle Age Limit Requirements

Vishal Agrawal[1], Ioannis Bellos[2], Natalie Ximin Huang[3], [1]Georgetown University, Washington, [2]George Mason University, Fairfax, VA, [3]University of Minnesota, Minneapolis, MN, Contact: huangx@umn.edu

We study an important decision for ride-hailing platforms, namely, imposing a vehicle age limit. The limit influences not only the price and service quality of ride-hailing, but also its competition with the primary and secondary car sales markets. We explore both the economic and environmental implications of this decision.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA66

CC-West 103B

Machine Learning Applications in Operational Problems

Community Committee Choice Session

Session Chair: Yaron Shaposhnik, University of Rochester, Chicago, IL

1 Convex Surrogate Loss Functions for Contextual Pricing with Transaction Data

Max R. Biggs, University of Virginia, Charlottesville, VA

We study an off-policy contextual pricing problem where a seller has access to transaction data with historical prices offered and whether individual customers purchased. This contrasts with the well-studied setting in which samples of the customer's valuation (willingness to pay) are observed. We propose convex loss functions, in particular a generalization of the hinge and quantile loss functions adapted to the pricing setting, that provide expected revenue guarantees when optimized. We avoid estimating an intermediate demand function, which aside from being indirect, may lead to a challenging non-linear revenue optimization problem if complex machine learning models are used. In contrast, when linear pricing policies are desired, our proposed loss functions result in a tractable convex revenue optimization problem.

2 Learning to Solve Two-Stage Robust Optimization Problems

Jean Pauphilet, London Business School, London, United Kingdom

Two-stage optimization problems, like the joint inventory placement and shipping problem, are notoriously hard to solve because future decisions depend on the realization of uncertain parameters (e.g., demand). Inspired by the ML paradigm, we use data and unsupervised learning techniques to design provably optimal schemes for two-stage adjustable robust optimization problems that converge orders of magnitude faster than existing schemes.

3 Quantile Regression with a Strictly Convex Objective

Xiaojia Guo, Robert H. Smith School of Business, University of Maryland, College Park, College Park, MD, Contact: xjguo@umd.edu

Some algorithms, such as extreme gradient boosting (xgboost), allow for a customized objective function and require the function to be strictly convex. These algorithms use Newton's method to find point forecasts by minimizing a strictly convex loss function. In this paper, we introduce a strictly convex loss function for quantiles that can be used in these algorithms. The loss function we propose is a (smooth) convexification of any member of the class of proper scoring rule for a quantile, such as the pinball loss function. We demonstrate the use of our loss function on several publicly available datasets. The results suggest that quantiles estimated by xgboost using our convexified loss function may be more accurate than those estimated by other leading methods.

4 Physician Rostering Problem with Downstream Capacity Constraints

Yashi Huang[1], Arik Senderovich[2], Yaron Shaposhnik[1], [1]University of Rochester, Rochester, NY, [2]York University, Toronto, ON, Canada. Contact: yhu126@simon.rochester.edu

We study a physician rostering problem whereby providers are scheduled to weekly sessions during which they examine and consult patients. The sessions serve as a central coordination mechanism which determines the timing of preparatory as well as treatment activities that are scheduled around exams. We collaborate with a large hospital that specializes in cancer treatment, and develop an interactive interface that predicts demand for resources as well as optimizes the roster to improve load-balancing. We conduct numerical experiments to assess the potential improvement that can be obtained by optimizing the roster.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA67

CC-West 104A

High-Dimensional Tensor Data Analytics

Community Committee Choice Session

Session Chair: Bo Shen, New Jersey Institute of Technology, Newark, NJ

1 Privacy-Preserving Tensor Decomposition for Health Data Analysis

Meng Zhao, University OF Florida, Gainesville, FL

Electronic health records (EHRs) have been one of the most important sources of information about patients. In this paper, we proposed a novel federated tensor factorization model for computational phenotyping from health data without sharing patient-level data. We developed secure data harmonization and federated computation procedures. Using this method, the multiple hospitals iteratively update tensors and transfer secure information to a central server, and the server aggregates the information to generate phenotypes. The evaluation of both simulations and real medical datasets demonstrates that our method resembles the centralized training model (based on combined datasets) in terms of accuracy while respecting privacy.

2 Tensor Gaussian Process with Contraction for Multi-Channel Imaging Analysis

Yang Chen, University of Michigan, Ann Arbor, MI

Multi-channel imaging data is a prevalent data format in scientific fields such as astronomy and biology. The structured information and the high dimensionality of these 3-D tensor data makes the analysis an intriguing but challenging topic for statisticians and practitioners. The low-rank scalar-on-tensor regression model, in particular, has received widespread attention and has been re-formulated as a tensor Gaussian Process (Tensor-GP) model with multi-linear kernel in previous work. We extend the Tensor-GP model by integrating a dimensionality reduction technique with a Tensor-GP for a scalar-on-tensor regression task with multi-channel imaging data. We validate our approach via extensive simulation studies and applying it to the solar flare forecasting problem.

3 Jointly Modeling and Clustering Tensors in High Dimensions

Biao Cai, 1</sup

We consider the problem of jointly modeling and clustering populations of tensors by introducing a high-dimensional tensor mixture model. To effectively tackle the high dimensionality of tensor objects, we employ plausible dimension reduction assumptions that exploit the intrinsic structures of tensors. In estimation, we develop an efficient high-dimensional ECM algorithm that breaks the intractable optimization in the M-step into a sequence of conditional optimization problems. Our theoretical analysis is challenged by both the non-convexity in the EM-type estimation and having access to only the solutions of conditional maximizations in the M-step. We demonstrate that the proposed HECM algorithm, with an appropriate initialization, converges geometrically to a neighborhood that is within statistical precision of the true parameter.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA68

CC-West 104B

Explainable Artificial Intelligence for Business Analytics

Community Committee Choice Session

Session Chair: Salih Tuntun, 1</sup

1 Understanding Factors Affecting Crash Injury Severities in Multi-Vehicle Crashes Using Explainable Analytics

Ismail Abdulrashid[1], Kazim Topuz[2], [1]The University of Tulsa, Tulsa, OK, [2]The University of Tulsa, Tulsa, OK, Contact:

ismail-abdulrashid@utulsa.edu

Transparent models aid decision-makers in comprehending their judgments and fostering confidence in analytics. This study proposes a comprehensive descriptive, predictive, and prescriptive model to explain the severity of automobile accidents. In addition, we utilize a variety of cutting-edge techniques to address data-related issues, select features, develop predictive modeling, optimize parameters, and separate explanations from models (i.e., model-agnostic interpretation techniques). Our findings provided domain experts with novel insights into accident severity. The output of our model is an understandable representation of crash severity factors. The findings' implications for traffic control stakeholders, policymakers, automakers, the government, and regulators are discussed.

2 Screening Patients for Mental Disorders with New XAI Approach

Salih Tutun[1], Anol Bhattacherjee[2], Kazim Topuz[3], Ali Tosyali[4], Gorden Li[5], [1]Washington University in St. Louis, Chesterfield, MO, [2]University of South Florida, Tampa, FL, [3]University of Tulsa, Tulsa, OK, [4]Rochester Institute of Technology, Rochester, NY, [5]Bosch Center of Artificial Intelligence, Sunnyvale, CA

Mental disorders impact nearly one billion people globally and resulting in significant economic burdens. With a shortage of psychiatrists, experts call for innovative technology to efficiently screen patients. We develop the MDscan, a novel algorithm for screening ten mental disorders using SCL-90-R data. It offers transparency with an explainable, enhancing trust in AI applications for clinical use. Key features include: (1) using proper clinical protocols with psychological data, (2) employing an XAI approach that can not only predict diseases but also explain what features led to that prediction, and (3) generating a full-color diagnostic image that maps ten mental disorders similar to that of radiological images. Field data demonstrates MDscan's 20 percent average improvement, while maintaining high explainability.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA69

CC-West 105A

Advances in Time Series Data Mining

Community Committee Choice Session

Session Chair: Adam Meyers, University of Miami, Miami, FL

1 Recurrence Plot Quantification Analysis for Time Series Mining

Adam Meyers, University of Miami, Miami, FL, Contact: axm8336@miami.edu

A recurrence plot (RP) visualizes the times at which a dynamical system revisits areas of its phase space, and recurrence quantification analysis (RQA) quantifies the patterns shown in a RP. RQA provides a means of quantitative analysis of highly nonlinear and nonstationary time series while not requiring certain distributional assumptions and reduces the impact of noise on signal analysis through time delay embedding. Despite these advantages, the potential of RQA for time series mining has not been fully explored. This talk will discuss how bivariate RQA methods, which compare two distinct time series, can be utilized for nonlinear temporal similarity assessment. Bivariate RQA, including cross and joint RQA, will be compared against widely used methods such as dynamic time warping, both in terms of methodology and in performance on several time series datasets.

2 Enhancing Bearing Fault Diagnosis in Manufacturing Through Vibration Signal Feature Extraction and 2D Image Embedding with CNN Models

Yongmin Kim, Hyunsoo Yoon, Yonsei University, Seoul, Korea, Republic of. Contact: dsym2894@yonsei.ac.kr

In the realm of manufacturing, a bearing defect can disrupt an entire system. However, recent research employing deep learning for defect diagnosis has faced challenges related to integration of both raw signals and textual information. Moreover, the interpretation of these results has been difficult. To address these limitations, we propose an innovative framework that entails extracting features from vibration signal features, embedding them into 2D images, and leveraging CNN models for analysis. Our method outperforms other competing methods and enhances result interpretation via Grad-CAM. It significantly improves the accuracy and efficiency of bearing fault diagnosis, making it applicable in practical industrial settings.

3 Personalized Choice Model for Forecasting Pricing Scenarios with Observational Data - the Case of Attended Home Delivery

Ozden F. Gur Ali[1], Pedro Amorim[2], [1]Koc University, Istanbul, Turkey; [2]INESC-TEC, Porto, Portugal. Contact: oali@ku.edu.tr

Personalization in discrete choice models substantially increases individual-context level choice prediction accuracy. But naïve personalization with regularization to handle high-dimensional data often results in misleading price sensitivity estimates. Orthogonalization of the outcome and price with respect to confounders avoids the problem. We introduce features that relate an alternative to potential consideration sets to allow non-proportional substitution patterns and improve accuracy. The proposed method avoids positive price sensitivity and is twice as accurate as the non-personalized MNL at the individual-context level in the attended home delivery slot choice.

4 Spectral Clustering with Dependent Excitations for Temporal Networks

Subhadeep Paul[1], Lingfei Zhao[1], Hadeel Soliman[2], Kevin Xu[3], [1]The Ohio State University, Columbus, OH, [2]University of Toledo, Toledo, OH, [3]Case Western Reserve University, Columbus, OH, Contact: paul.963@osu.edu

Temporal networks observed through timestamped relational events data are commonly encountered in applications, including online social media, human mobility, financial transactions, and international relations. Temporal networks often exhibit community structure and strong dependence patterns among node pairs. We combine high-dimensional, mutually-exciting Hawkes processes with the stochastic block model to model community structure and node pair dependence. We obtain an upper bound on the misclustering error of spectral clustering of the event count matrix as a function of the number of nodes and communities, time duration, and a quantity measuring the amount of dependence in the model. The theoretical results provide insights into the effects of dependencies in the mutually-exciting Hawkes processes on the accuracy of spectral clustering.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA71

CC-West 105C

Information Systems and Consumers

Community Committee Choice Session

Session Chair: Shengjun Mao, University of California-Irvine, Irvine, CA

1 Offline Franchisees Boost Customer Trust on the Onlinebrand: Evidence from Online Retailer Franchiser

Shengjun Mao[1], Fei Ren[2], [1]The University of Hong Kong, Hong Kong, China; [2]Peking University, Beijing, China

This study explores cross-channel effects of adding an offline channel to online retailers via franchising, wherein physical stores are operated under the brand name of the online retailer but are possessed by individual owners. Using a panel dataset from a giant online retailer, we adopt a difference-indifferences (DID) approach to identify the causal effects of opening offline franchisee stores on sales and customer purchase of the online retailer. The results show that opening franchisee stores does not cannibalize sales of the online retailer but increase purchases especially of light buyers. We also inspect the mechanism and find that customers with physical stores opening nearby are more likely to make a payment online in advance, suggesting that simple presence of offline stores boost the credibility of the online retailer.

2 Crowdsourcing Contests: A Choice Among Multiple Contests

Lior Fink[1], Sharon Rabinovitch[1], Ella Segev[2], [1]Ben gurion university of the negev, Beer Sheba, Israel; [2]Hebrew University of Jerusalem, Jerusalem, Israel. Contact: ella.segev@mail.huji.ac.il

Given the proliferation of platforms for crowdsourcing contests, we combine game theoretic and experimental research to determine what affects a solver's decision which of the multiple ongoing contests to participate in and how much effort to exert. In the literature on crowdsourcing contests there are inconsistent findings about the behavioral effects of increasing the prize awarded by the organizer on solvers. We aim to resolve these inconsistencies by analyzing user behavior in a controlled experimental setting in which users can exert real effort in multiple online contests that vary only in their prizes. We show that both participation and effort are non-monotonic with the prize, that the low-prize contest was the most effective for the organizers, and that increasing the prize of the low-prize or high-prize contest actually decreased the benefits for organizers.

3 A Graphical Point Process Framework for Multi-Touch Attribution

Qian Chen[1], Jun Tao[2], James W. Snyder Jr.[2], Arava Sai Kumar[2], Amirhossein Meisami[2], Lingzhou Xue[3], [1]Pennsylvania State University, STATE COLLEGE, PA, [2]Adobe Inc., San Jose, CA, [3]Penn State University, State College, PA, Contact: quc20@psu.edu

Marketers employ various online advertising channels to reach customers and are particularly interested in attribution -- measuring the degree to which individual touchpoints contribute to an eventual conversion. We aim to tackle the problem with finer granularity by conducting attribution at the customer purchase path level. To this end, we develop a novel graphical point process framework to study the direct conversion effects and the full relational structure among numerous types of touchpoints simultaneously. Utilizing the temporal point process of conversion and the graphical structure, we further propose graphical attribution methods to allocate proper path-level conversion credit, called the attribution score, to individual touchpoints or corresponding channels for each customer's path to purchase.

1 Impact of Customer-Initiated Recommendations on Binge Consumption of Digital Content

Hanbing Xue[1], Jinan Lin[2], Natasha Zhang Foutz[3], Yongjun Li[1], [1]University of Science and Technology of China, Hefei, China; [2]UC Irvine, Irvine, CA, [3]University of Virginia, Charlottesville, VA

This research empirically investigates the impact of customer-initiated recommendations on intra-day and inter-day binge consumption of e-book content. Leveraging granular reading records of 142,000 customers, customer-initiated recommendations as natural experiments, and Difference-in-Differences (DiD) analysis, we discover novel heterogeneous impacts of customer-initiated recommendations on binge across time, recommendation types (e.g., popularity- vs personalization-based, human vs AI), and customer segments. The findings offer strategic guidance to digital content platforms regarding for instance how to balance shorter-term engagement and longer-term customer retention.

4 Moviebert: Learning Latent Traits Through Language Models to Tackle the Cold-Start Problem

Ming Gu, UCI, Irvine, CA

Pre-trained language models using large-scale datasets have been proven to have state-of-the-art performance in various downstream natural language processing tasks like text classification, named entity recognition, machine translation, question answering, and sentiment analysis. However, whether they can help with consumer preference understanding remains untapped. This paper tries to bridge this void by developing a MovieBERT model that learns the latent features of movies from public access text data like plots and descriptions from studios and mapping the hidden features with user preference data from Movielens. We validate the model performance on a holdout sample and find this branch of language models capable of predicting movie success in different user groups, suggesting a potential to tackle the cold-start problem in recommender systems.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA72

CC-West 106A

Digital Platform and AI

Community Committee Choice Session

Session Chair: Shun Ye, George Mason University, Fairfax, VA

1 Negative Emotions, Impoliteness, and Fundraising Success in Educational Crowdfunding

Yasamin Hadavi[1], Xunyi Wang[1], Robin Wakefield[1], Stacie Petter[2], [1]Baylor University, Waco, TX, [2]Wake Forest University, Winston-Salem, NC

We examine the factors impacting crowdfunding success in a donation-based educational crowdfunding context. In particular, we focus on the effects of expressed impoliteness and negative emotions in the crowdfunding project description on fundraising success and the moderating role of a contextual factor, socioeconomic status, on those effects. Using a proprietary dataset from a leading educational crowdfunding platform and survival analyses, we find there is a negative effect of the expressed impoliteness on the likelihood of fundraising success, but the expression of negative emotions is positively associated with fundraising success. Additionally, the school's socioeconomic status positively relates to fundraising success, and it moderates the relationship between impoliteness/negative emotions on fundraising success.

2 Impact of AI on Reviews and Outcomes

Rachit Kamdar, Siva Viswanathan, University of Maryland, College Park, MD, Contact: rkamdar@umd.edu

The importance of online reviews in reducing information asymmetry and disseminating information has been widely acknowledged in the academic literature. However, the under-provision of reviews remains a persistent challenge for online platforms. In this study, we investigate the use of AI technology to facilitate review writing and answer three critical research questions of who uses AI-generated text, how users utilize such text, and the impacts of AI-generated text on review outcomes. Our findings reveal a bias among negative reviewers to adopt AI-generated text. Furthermore, we find that AI-adopting users become more polar in their opinions following the adoption. Our study also demonstrates that reviews with AI-generated text are more diverse and shorter in length. However, the helpfulness of reviews decreases after the usage of AI-generated text.

3 What Makes Successful Entrepreneurs in Online Crowdfunding? Unraveling the Role of Educational and Professional Background

Shuai Zhang[1], Zhiyi Wang[1], Lusi Yang[2], [1]University of Colorado Boulder, Boulder, CO, [2]Georgia State University, Atlanta, GA, Contact: shuai.zhang-1@colorado.edu

Crowdfunding has emerged as a transformative avenue for democratizing entrepreneurship and investment activities through digital platforms. In traditional venture capital, the founder's prior background has consistently been regarded as a crucial factor for entrepreneurship and investment decisions. However, our understanding of how the prior background of founders manifests in online crowdfunding is limited. In this study, we draw on the literature on human and social capital, and examine how founders' educational and professional background affects crowdfunding outcomes. By combining empirical data from the leading crowdfunding platform and professional network, we theorize and empirically test the heterogeneous effects of educational and professional backgrounds and the interplay between them.

4 Examining the Impact of Marketplace Introduction in Crowdsourcing Contest Platforms

Fanshu Li, Pallab Sanyal, Shun Ye, George Mason University, Fairfax, VA, Contact: fli15@gmu.edu

Businesses leverage crowdsourcing platforms as a valuable resource to address challenging problems and fulfill their business needs. While holding contests has long been popular in crowdsourcing platforms, the introduction of the "Marketplace" feature offers an alternative approach by providing instant access to a wide range of readily available solutions. In this study, we examine how the introduction of the Marketplace affects market dynamics and outcomes in a crowdsourcing platform. Our findings show that the introduction of the Marketplace leads to a win-win situation for both solvers and businesses. More experienced solvers are attracted to sell their solutions directly in the Marketplace to address clients' immediate needs; meanwhile, less experienced solvers who remain in contests experience an increase in their winning probabilities.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA73

CC-West 106B

Financial Frictions and Machine Learning

Community Committee Choice Session

Session Chair: Chen Yang, The Chinese University of Hong Kong, Shatin

Session Chair: Nan Chen, Chinese University of Hong Kong, Shatin N T, NA, Hong Kong

1 Optimal Dividend Strategy with Endogenous Bankruptcy Boundary Under Chapter 11

Steven Kou[1], Jianwei Lin[2], H. Mete Soner[3], Chen Yang[4], [1]Boston University, Boston, MA, [2]Putian University, Putian, China; [3]Princeton University, Princeton, NJ, [4]The Chinese University of Hong Kong, Shatin, China. Contact: kou@bu.edu

The Chapter 11 bankruptcy grants a distressed company a grace period to recover before eventual liquidation. We study Chapter 11 bankruptcy strategies for a company with an endogenous dividend strategy. The model is formulated as a two-stage optimization problem. We show that the optimal dividend strategy is of barrier type and derive its closed-form solution. Compared to the existing Chapter 11 literature with exogenous dividend strategies, we found that while the presence of Chapter 11 bankruptcy still results in higher shareholders' value, it can have the side effects of encouraging more aggressive dividend strategies, which leads to earlier liquidation. Furthermore, such side effects are stronger when Chapter 11 allows for a longer grace period or provides the shareholders with a great incentive benefit.

2 Optimal Investment in the Presence of Limit Order Book

Nan Chen[1], Min Dai[2], Qiheng Ding[3], Chen Yang[4], [1]Chinese University of Hong Kong, Shatin N T, NA, Hong Kong; [2]National University of Singapore, Singapore, Singapore; [3]The Chinese University of Hong Kong, Hong Kong, China; [4]The Chinese University of Hong Kong, Shatin, Hong Kong

We study an optimal investment problem of a CARA investor trading in a market operated with a block-shaped limited order book (LOB), which synergizes three key features of market microstructure: the bid-ask spread, the market depth, and a finite market resilience. Under a Bachelier process for the dynamic of the fundamental value of the asset, we develop explicit characterization on the investor's optimal trading strategy. As an important extension of this model, an asymptotic expansion of the optimal trading strategies in the presence of return-predicting signals are also derived. The theoretical and numerical results unveil how an investor should strike a balance among several competing goals such as achieving the optimal risk exposure currently, incorporating signals about the future, and minimizing trading costs.

3 Non-Concave Utility Maximization with Transaction Costs

Shuaijie Qian, Harvard University, Cambridge, MA, Contact: e0046854@u.nus.edu

We consider the non-concave utility maximization problem, which appears in plenty of areas in finance, with transaction costs. Technically, we propose a proper terminal condition and lay the corresponding theoretical foundation of viscosity solutions. This terminal condition implies that any transaction close to maturity provides a marginal contribution to the target. We find that non-concave utility + transaction costs can prevent the portfolio from unbounded leverage and also result in richer action regions than classical transaction costs problems with concave utilities.

4 Designing Structured Products on Traded Accounts

Zihao Song, The Chinese University of Hong Kong, Hong Kong SAR, China

Structured products on traded accounts are financial products whose payoff depends on a trading account managed by the buyer. In this paper, we study how to design these products from the perspectives of both buyers and sellers, and our model features both the transaction costs in the trading account and the buyer's risk aversion. The buyer's problem is formulated as a singular stochastic control problem with a nonconcave objective, and the seller's contract design strategy is characterized as a Stackelberg game. We design a numerical procedure to study it. We find that the risk-averse buyer's willing price is much smaller than the risk-neutral price in the literature, and the buyer's optimal trading strategy is significantly more complicated. For the seller's perspective, it is optimal to offer a contract to less risk-averse buyers meanwhile with lower market volatility.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA74

CC-West 106C

Learning and Decision-making for Marketplaces

Community Committee Choice Session

Session Chair: Wanning Chen, University of Washington, Bellevue, WA

Session Chair: Amandeep Singh, 1</sup

1 Optimal Exploration is No Harder than Thompson Sampling

Zhaoqi Li, University of Washington, Seattle, WA, Contact: zli9@uw.edu

This paper proposes an efficient algorithm for pure exploration in linear bandits using sampling and argmax oracles. Given a set of arms in R^d, the pure exploration problem aims to return the arm with the maximum reward through noisy measurements. Existing optimal methods scale in the size of the arm set by requiring either costly projections for each arm or explicitly maintaining an active subset of the arm set at each time. In general, computing projections and maintaining a subset may be expensive and unfeasible in many settings. Our approach overcomes both limitations through *sampling* from an appropriate distribution over parameters combined with an argmax oracle. It achieves computational efficiency similar to Thompson sampling but guarantees the optimal instance-dependent rate asymptotically, unlike Thompson sampling, which is suboptimal for pure exploration.

2 Low-Rank Matrix Recovery with Non-Quadratic Loss: Projected Gradient Method and Regularity Projection Oracle

Lijun Ding, University of Wisconsin -- Madison, Madison, WI, Contact: lijunbrianding@gmail.com

Most low-rank matrix recovery theories focus on quadratic loss, which enjoys favorable properties such as restricted strong convexity/smoothness (RSC/RSM) and well conditioning over all low rank matrices. However, many interesting problems involve more general, non-quadratic losses, which do not satisfy such properties. In this paper, we show that a critical component in provable low-rank recovery with non-quadratic loss is a regularity projection oracle. Accordingly, we analyze an (averaged) projected gradient method equipped with such an oracle, and prove that it converges globally and linearly. Our results apply to various non-quadratic low-rank estimation problems, including one bit matrix sensing/completion, individualized rank aggregation, and more broadly generalized linear models with rank constraints.

3 Algorithmic Governance of Two-Sided Platforms: The Case of Short Video Recommendation

Jinghui Zhang[1], Xuan Bi[2], Qiang Wei[1], Mochen Yang[2], [1]Tsinghua University, Beijing, China; [2]University of Minnesota, Minneapolis, MN

We study how two-sided platforms can tackle governance problems with algorithmic tools (in addition to economic incentives). Taking short video platforms as the context, we design an integer program allowing the platform to achieve two key governance objectives: maximizing ad revenue while mitigating exposure disparity among producers. We conduct evaluations on a public dataset from KuaiShou (a leading short video platform in China), and find that our approach can generate content recommendations that lead to both higher platform revenue and lower producer exposure disparity, as compared to the common practice of greedy recommendation. Further analyses reveal interesting dynamics between recommendation strategies and governance outcomes.

4 Community/Committee'S Choice Submission

Arpit Agarwal, 1</sup

5 The Art of Transfer Learning - An Adaptive and Robust Pipeline

Boxiang Wang[1], Yunan Wu[2], Chenglong Ye[3], [1]University of Iowa, Iowa City, IA, [2]The University of Texas at Dallas, Dallas, TX, [3]University of Kentucky, Lexington, KY, Contact: chenglong.ye@uky.edu

Transfer learning is an essential tool for improving the performance of primary tasks by leveraging information from auxiliary data resources. In this work, we propose Adaptive Robust Transfer Learning (ART), a flexible pipeline of performing transfer learning with generic machine learning algorithms. We establish the non-asymptotic learning theory of ART, providing a provable theoretical guarantee for achieving adaptive transfer while preventing negative transfer. Additionally, we introduce an ART-integrated-aggregating machine that produces a single final model when multiple candidate algorithms are considered. We demonstrate the promising performance of ART through extensive empirical studies on regression, classification, and sparse learning. We further present a real-data analysis for a mortality study.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA75

Session.Location:CC-West 208A

On the Vehicle Routing Problem

Contributed Session

Session Chair: Merarsylan Meraliyev, SDU University, Almaty, Kazakhstan

1 Accelerating Column Generation via Column Management and Smart Graph Reduction for Solving Vehicle Routing Problems

Qiyao Duan, Mingyao Qi, Tsinghua University, Shenzhen, China. Contact: qimy@sz.tsinghua.edu.cn

Column generation (CG) is a widely used and powerful iterative technique for solving a wide range of combinatorial optimization problems, such as the Vehicle Routing Problem with Time Windows (VRPTW). Two critical difficulties of CG are column management for the Master Problem and the NP-hardness of the Sub Problem. In this paper, we present two novel learning-based approaches to overcome the two aforementioned challenges, thus accelerating CG. We first propose a reinforcement learning column manager to select promising columns from the generated ones to maintain a strong formulation of Master Problem. We then develop a graph neural network driven node selection model that accurately identifies the nodes that are most likely to be included in the optimal solution of the Sub Problem. Experiments demonstrate that the proposed approaches boost the CG significantly.

2 Two-Stage Learning to Branch in Branch-Price-And-Cut Algorithms for Solving Vehicle Routing Problems Exactly

Zhengzhong You, The University of Florida, Gainesville, FL

We propose a novel two-stage learning-to-branch framework for vehicle routing problems (VRPs) within branch-price-and-cut algorithms. Unlike traditional branch-and-cut methods, this framework addresses the challenges of variable generation and indirect variable branching. Stage one utilizes effective features from the graph to identify promising branching candidates. Stage two employs computationally expensive features to predict high-quality final branching decisions. This two-stage learning-based branching (2LBB) strategy outperforms traditional strategies, showing improvements in both speed and efficiency when tested on benchmark CVRP and VRPTW instances.

3 Machine Learning to Solve Vehicle Routing Problems: A Survey

Aigerim Bogyrbayeva, Meraryslan Meraliyev, Taukekhan Mustakhov, Bissenbay Dauletbayev, Suleyman Demirel University, Kaskelen, Kazakhstan. Contact: meraryslan.meraliyev@sdu.edu.kz

This paper provides a systematic overview of machine learning methods applied to solve NP-hard Vehicle Routing Problems (VRPs). Recently, there has been a great interest from both machine learning and operations research communities to solve VRPs either by pure learning methods or by combining them with the traditional hand-crafted heuristics. We present the taxonomy of the studies for learning paradigms, solution structures, underlying models, and algorithms. We present in detail the results of the state-of-the-art methods demonstrating their competitiveness with the traditional methods. The survey indicates the advantages of the machine learning based models that aim to exploit the symmetry of VRP solutions. The paper outlines the future research directions to incorporate learning-based solutions to overcome the challenges of modern transportation systems.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA76

Session.Location:CC-West 208B

Analysis of Delivery Speed in Online Retailing

Contributed Session

Session Chair: Shuhan Kou, University of Maryland, College Park, College Park, MD

1 To Launch Online Community Group Buying or Not: The Channel Choice of E-Commerce Platform

Jianghua Wu[1], Longdi Chen[2], Yuhong He[3], [1]Renmin University of China, Beijing, China; [2]Renmin University of China, Beijing, China; [3]California State University-Fullerton, Fullerton, CA

In addition to the existing same-day delivery, many e-commerce platforms(e.g, Meituan and Freshhema) have launched online community group buying which reduces last-mile delivery. The platform orders products from suppliers and assigns a leader of the group to promote products in a community. This pre-order strategy may bring up conflict to the current channel with same-day delivery. This study aims to explore how customer acceptance of the group buying, the commission rate for the leader, and the operational cost difference across two channels affect the platform's channel choice and the group leader's effort.

2 Inventory Redistribution for Promotional Products with Demand Learning

Mahsa Abbaszadeh Nakhost[1], Gudrun Kiesmüller[2], Stefan Minner[1], [1]Technical University of Munich, Munich, Germany; [2]Technical University of Munich, Heilbronn, Germany. Contact: mahsa.nakhost@tum.de

We address a lateral transshipment problem among N retailers who sell a promotional product for which historical data is lacking and has a long lead-time. Such products have a single ordering opportunity and exhibit highly uncertain, non-stationary demands. We model the demand with a non-homogeneous Poisson Process with an unknown mean and update the demand distribution before the one-time transshipment using Bayesian methodology. We prove that the expected profit after transshipment is L -Concave in relation to the value of transshipment. Our numerical analysis reveals there is a single time of transshipment that maximizes profit. We evaluated our methodology in a real-world case study and found that it significantly improved profit.

3 Discount or Speed?: An Analysis of Reward Offer in Exchange for No-Rush Shipping

Pavarit Issarathipya[1], Thunyarat (Bam) Amornpetchkul[2,1], [1]National Institute of Development Administration, Bangkok, Thailand; [2]Santa Clara University, Santa Clara, CA, Contact: tamornpetchkul@scu.edu

This research investigates how a no-rush shipping reward program, which offers a discount or a reward to a customer who chooses no-rush shipping for her online purchased items, can be utilized by an online seller to reduce shipping and expediting costs. The seller's optimal decisions regarding whether to offer a no-rush shipping reward program on any items and whether to ship each item separately or together at a normal or expedited speed are characterized. Our results show that the number of items that the seller should offer the no-rush shipping reward program decreases as the amount of reward required to induce a customer opt-in increases. This research suggests that a no-rush shipping reward program can help online sellers reduce operating and shipping costs as well as the environmental impact, while also meeting customers' expectation.

4 The Probabilistic Rural Postman Problem

Shuhan Kou[1], Bruce L. Golden[2], Luca Bertazzi[3], [1]University of Maryland, College Park, College Park, MD, [2]University of Maryland, College Park, College Park, MD, [3]University of Brescia, Brescia, Italy. Contact: shkou@umd.edu

A delivery person is responsible for package deliveries in an area. However, in practice, not all customers require a delivery everyday. Thus, we cast our problem as the probabilistic rural postman problem (PRPP). The aim of this problem is to determine the a priori tour with the minimum expected length for a given set of edges or arcs that may have positive demand. In this work, we formally define the PRPP and discuss several properties, including how it's related to the deterministic counterpart: the rural postman problem (RPP).

Tuesday, October 17, 8:00 AM - 9:15 AM

TA77

Session.Location:CC-West Lecture Hall

Creative Applications of AI

Contributed Session

Session Chair: Nicolas Bustos, University of South Florida, Tampa, FL

1 Automatic Discovery and Generation of Visual Design Characteristics: Application to Visual Conjoint

Ankit Sisodia[1], Vineet Kumar[2], Alex Burnap[1], [1]Yale University, New Haven, CT, [2]Yale School of Management,

New Haven, CT, Contact: ankit.sisodia@yale.edu

Visual design impacts consumer preferences significantly, but quantifying these characteristics is difficult. We offer an automatic method to identify and quantify these features from image data using a disentanglement approach. Our method, unlike others, doesn't require supervision or prior knowledge of design characteristics. It uses structured product characteristics for disentanglement, unveiling human-interpretable and independent attributes. Applied to watches, we discovered six such characteristics. With visual conjoint analysis, we understood consumer preferences for these features. Our method can also generate novel designs to meet various consumer segments' ideal points.

2 Exploring the Impact of AI-Generated Artwork on Learning and Creativity in Online Art Communities

Ahreum Kim, Yingda Lu, University of Illinois-Chicago, Chicago, IL, Contact: akim239@uic.edu

This study examines the impact of AI-generated artwork on online art communities, focusing on learning, collaboration and creativity. The use of prompt engineering in AI artwork shapes its characteristics, enabling artists with varying technical skills to participate and expanding professionalism and stages of artwork sharing. The study investigates how AI-generated artwork affects knowledge sharing in various stages of artwork creation, including learning, creating, discussing, and sharing. Through data-driven analysis, we aim to understand the role of AI in online art communities and provide managerial implications.

3 Will It Be Cost-effective to Automate Human Tasks with AI? Evidence from Computer Vision

Maja S. Svanberg[1], Wensu Li[1], Martin Fleming[2], Brian C. Goehring[3], Neil Thompson[1], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]The Productivity Institute, Glen Ellyn, IL, [3]IBM's Institute for Business Value, New York, NY

If Artificial Intelligence (AI) systems replace job tasks done by human workers too quickly, it could generate substantial unemployment. Previous estimates stating that about half of tasks are at-risk of AI automation have focused on whether these tasks could be done by AI. But just because a task could be automated does not mean it will be. Requiring cost-effectiveness profoundly changes how quickly AI task replacement occurs in the U.S. economy.

For our analysis, we focus on the deployment of AI computer vision systems, where previous work allows us to estimate their cost. We find that, at today's costs, 82% of at-risk vision tasks would not be economical to automate because the benefits for the firm would not justify the development and operations costs of such a system. We explore conditions under which the share of cost-effective task rises.

4 Improving Translation of Visible to Thermal Images Using Gan in Adverse Weather Conditions

Nicolas Bustos[1], Mehrsa Mashhadi[1], Susana Lai-Yuen[2], Sudeep Sarkar[1], Tapas K. Das[2], [1]University of South Florida, TAMPA, FL, [2]University of South Florida, Tampa, FL, Contact: bustos@usf.edu

Under adverse weather conditions, object detection using multimodal imagery and data fusion methods reports better performance than solely using visible images. However, there is limited availability of public datasets that contain multispectral images with weather and time-of-the-day labels. We use CycleGAN, a Generative Adversarial Network, to create aligned image pairs by performing translation from 3-channel RGB to 1-channel thermal images and vice versa. We also transfer missing weather labels in the paired images and use these in fusion algorithms for assessing object detection performance.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA78

Session.Location:CC-West 211A

spORts Keynote: Sport Gambling Analytics

Community Committee Choice Session

Session Chair: David Bergman, University of Connecticut, Storrs, CT

1 spORts Keynote: Sport Gambling Analytics

David Bergman, University of Connecticut, Storrs, CT

Tuesday, October 17, 8:00 AM - 9:15 AM

TA79

Session.Location:CC-West 211B

Advances in Optimization Under Uncertainty

Contributed Session

Session Chair: David L. Woodruff, University of California-Davis, Davis, CA

1 Adjusted Wasserstein Distributionally Robust Estimator Statistical Learning

Yiling Xie[1], Xiaoming Huo[2], [1]Georgia Tech, ATLANTA, GA, [2]ISyE Georgia Tech, Marietta, GA, Contact: yxie350@gatech.edu

We propose an adjusted Wasserstein distributionally robust estimator---based on a nonlinear transformation of the Wasserstein distributionally robust (WDRO) estimator in statistical learning. This transformation will improve the statistical performance of WDRO because the adjusted WDRO estimator is asymptotically unbiased and has an asymptotically smaller mean squared error. The adjusted WDRO will not reduce the out-of-sample performance guarantee of WDRO. Sufficient conditions for the existence of the adjusted WDRO estimator are presented, and the procedure for the computation of the adjusted WDRO estimator is given. Specifically, we will show how the adjusted WDRO estimator is developed in the generalized linear model. Numerical experiments demonstrate the favorable practical performance of the adjusted estimator over the classic one.

2 On the Conservative Fields of Optimal Value Functions

Chen Jiang[1], Ying Cui[2], [1]University of Minnesota, Minneapolis, MN, [2]University of Minnesota, Minneapolis, MN, Contact: jian0649@umn.edu

Understanding the properties of optimal value functions is crucial in developing effective numerical algorithms for various optimization problems, including min-max, two-stage, and bi-level optimization. In this talk, we delve into the examination of first-order variational properties associated with the value functions for bi-parametrized nonlinear optimization problems. We characterize the conservative fields of these optimal value functions while refraining from assuming the uniqueness of optimal solutions or multipliers. The derived results offer a theoretical basis for employing (stochastic) gradient descent methods to tackle intricate hierarchical optimization problems involving varying constrained sets.

3 Software for Data-Based Stochastic Programming Using Bootstrap Estimation

David L. Woodruff, Xiaotie Chen, University of California-Davis, Davis, CA, Contact: dlwoodruff@ucdavis.edu

We describe software for stochastic programming that uses only sampled data to obtain both a consistent sample-average solution and a consistent estimate of confidence intervals for the optimality gap using bootstrap and bagging. The underlying distribution whence the samples come is not required.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA80

Session.Location:CC-West 212A

Stochastic Models and Networks

Contributed Session

Session Chair: Iaroslav Kriuchkov, Aalto University, Espoo, Finland

1 Stochastic Finite Volume Method for Uncertainty Management of Gas Network Flows

Saif Rahaman Kazi, Sidhant Misra, Anatoly Zlotnik, Svetlana Tokareva, Jake Harmon, Pieter Swart, Los Alamos National Laboratory, Los Alamos, NM, Contact: skazi@lanl.gov

We develop a finite volume representation of uncertainty in solutions of hyperbolic partial differential equation systems on graph-connected domains with nodal coupling and boundary conditions. The representation is used to state the physical constraints in stochastic optimization problems subject to uncertain parameters. The method is based on the Stochastic Finite Volume (SFV) approach, and can be applied for uncertainty management of fluid flow over actuated transport networks. The method is examined for steady-state optimization subject to probabilistic constraints for a single pipe, and is also extended to higher dimensional uncertainty on general network structures.

2 Risk-Averse Stochastic Programming for High-Impact, Low-Probability Events with Applications to Flash Flooding Climate Change Risk

Beau Groom, University of Tennessee, Knoxville, TN, Contact: bgroom1@vols.utk.edu

Traditional stochastic programming (SP) assumes either a known probability distribution or uncertainty set. Both risk-neutral (expected value) and risk-averse (chance-constrained or robust optimization) postures largely ignore low-probability, high-impact events. This work relaxes both assumptions to propose a novel SP model for high-impact, low-probability events and applies it to the projected increase in flash flooding events due to the effects of climate change. The magnitude and location of this flooding is highly uncertain, meaning each road segment has a low flooding probability. However, these events have both short-term (traffic delays) and long-term (road degradation) effects that must be considered in investment planning.

3 A Primal-Dual SDDP Algorithm

Vincent Guigues[1], Vincent Leclere[2], François Pacaud[3], Benoit Tran[2], [1]FGV, Rio de Janeiro, Brazil; [2]Ecole des ponts ParisTech, Champs sur Marne, France; [3]Ecole des Mines, Paris, France. Contact: vincent.leclere@enpc.fr

The Stochastic Dual Dynamic Programming (SDDP) algorithm is a dynamic programming algorithm that iteratively constructs polyhedral approximations of cost-to-go functions for convex multistage stochastic programs. It is widely used in the energy community, especially for hydro-management problems. The primal SDDP algorithm, used since 1991, constructs outer approximations of the cost-to-go functions, while recent works proposed a dual SDDP algorithm constructing inner approximations. Finally, building on level-bundle methods, it has been shown that we can use inner approximation to regularize the SDDP algorithm. Here, we present a primal-dual SDDP algorithm that run both a primal and a dual SDDP algorithm, using dual information to level-regularize and thus improving convergence.

4 Convex Quantile Regression Approach to Fundamental Diagram Estimation

Iaroslav Kriuchkov[1], Timo Kuosmanen[2], [1]Aalto University, Espoo, Finland; [2]University of Turku, Turku, Finland. Contact: iaroslav.kriuchkov@aalto.fi

The fundamental diagram has been a backbone for traffic modeling for almost a century. With the increasing availability of sensor data, stochastic models describing density-flow relation started to draw attention. We introduce a state-of-the-art convex quantile regression with bags (CQRb), a stochastic nonparametric method to estimate the density-flow relationship. The proposed method does not depend on any prior functional form assumptions, and the estimated function conforms to the main properties of the fundamental diagram. We compare the performance of the proposed method with that of a deterministic parametric one and illustrate the application on data from roads in Finland.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA81

Session.Location:CC-West 212B

Economics and Computation

Contributed Session

Session Chair: John McCarty, The Ohio State University, Columbus, OH

1 Useful PoW Mechanism Design: Economic and Energy Efficiency for Blockchain Systems

Zishuo Zhao, University of Illinois Urbana-Champaign, Urbana, IL, Contact: zishuoz2@illinois.edu

In blockchain systems, Proof-of-Work (PoW) is an essential cryptographical protocol in which miners compete to compute random challenges for writing access of blocks. While a major disadvantage traditional PoW is large overheads of computation and energy consumption with no beneficial use, the Proof-of-Useful-Work (PoUW) introduces PoW challenges that computes useful problems. We study the mechanism design of the PoUW market between challenge providers and miners in order to achieve social efficiency in both cryptocurrency and computational resources.

2 An Entropy-Based Data Reduction Method for Data Preprocessing

Rocco Cassandro, Zhaojun Li, Western New England University, Springfield, MA, Contact: rocco.cassandro@wne.edu

We propose an entropy-based data reduction (EBDR) algorithm for data pre-processing based on information theory. This method aims to explore high-purity dataset subsets in which the values of an attribute are directly linked to specific class labels. Experimental results demonstrate the efficiency of EBDR algorithm on differently-sized datasets. Moreover, to demonstrate EBDR's effectiveness on classification performance, we test it on a wide cross-section of the KDDCUP 1999 dataset using C4.5 Decision Tree (C4.5 DT). The experiment results show that the size of C4.5 DT can be greatly reduced while the accuracy is maintained, and the type II error gets lower.

3 New Algorithms for the Fair and Efficient Allocation of Indivisible Chores

Jugal Garg[1], Aniket Murhekar[2], John Qin[3], [1]UIUC, Urbana, IL, [2]University of Illinois, Urbana-Champaign, Champaign, IL, [3]University of Illinois - Urbana Champaign, Urbana, IL, Contact: johnqin2@illinois.edu

We study the problem of fairly and efficiently allocating indivisible chores among agents with additive disutility functions. We consider the widely-used envy-based fairness properties of EF1 and EFX, in conjunction with the efficiency property of fractional Pareto-optimality (fPO). Existence (and computation) of an allocation that is simultaneously EF1/EFX and fPO are challenging open problems, and we make progress on both. We show existence of an allocation that is (i) EF1+fPO, when there are three agents, (ii) EF1+fPO, when there are at most two disutility functions, (iii) EFX+fPO, for three agents with bivalued disutility functions.

These results are constructive, based on strongly polynomial-time algorithms. We also investigate non-existence and show that an allocation that is EFX+fPO need not exist, even for two agents.

4 Vote Delegation in DAO

Ali Ahmed[1], Brian Lee[2], [1]University of Wisconsin Eau Claire, Eau Claire, WI, [2]Pennsylvania State University, University Park, PA, Contact: ahmeda@uwec.edu

In this paper, we aim to investigate the voting process in Decentralized Autonomous Organization (DAO). Since large token holders can control the voting outcome of a proposal and lead to plutocracy, many DAOs allow vote delegation among community members. We study how the vote delegation serves the interest of the community. More specifically, we analyze if voters with high delegated voting power follow the majority vote on a DAO proposal. By using a dataset from a prominent virtual reality platform, we show that voters with high delegated voting power strategically time their votes and support the leading outcome of a proposal.

5 Using Interpretable AI Methods to Identify Recent Cyber Vulnerabilities with Exploits

John McCarty[1], Amirreza Talebi[1], Theodore T. Allen[2], [1]The Ohio State University, Columbus, OH, [2]Ohio State University, Columbus, OH

We describe the importance of finding "super-critical" vulnerabilities relating to the race between hackers and defenders. Also, the features that predict the existence of exploits and alternative approach are described. Then, we show how optimal classification trees based on a sampling scheme support insights and bounding on a large dataset.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA82

Session.Location:CC-West 212C

Innovative Operations for Social Goods and Sustainability

Contributed Session

Session Chair: Srinivasa Prasanna, IIIT-Bangalore, Bengaluru, India

1 When Doing Good May Backfire: Smallholder-Farmer Selection into Yield-Improvement Programs

Utku Serhatli[1], Guillaume Roels[2], [1]Nova School of Business and Economics, Lisbon, Portugal; [2]INSEAD, Fontainebleau, France. Contact: utku.serhatli@novasbe.pt

In agricultural-intensive economies, manufacturers often help smallholder farmers improve their yields through training and yield-improvement programs. However, and perhaps paradoxically, some farmers feel that these programs can lower their profit, in part due to a decrease in commodity prices. Using a Cournot model, we show that a) these programs can push prices down, which may indeed decrease the profits of some farmers, b) the objectives of minimizing market prices and protecting farmer well-being might be conflicting, and c) certifying more efficient farmers may perform well in terms of both individual and aggregate farmer well-being.

2 From Efficiency Analysis to Sustainability Identification: A Review, Path Forward and Empirical Application to Belgian Railways

Ahmed-Youssef Oukassou[1], Raluca Parvulescu[2], Marijn Verschelde[2], Nicky Rogge[3], [1]IÉSEG School of Management, Lille, France; [2]IÉSEG School of Management, Lille, France; [3]KU Leuven, Brussels, Belgium. Contact: a.oukassou@ieseg.fr

Data Envelopment Analysis is a widely used method in operations research and management science for evaluating the relative efficiency of decision-making units. A widely recognized downfall is its sensitivity to outliers and extreme observations. To overcome this issue, a large literature has focused on identifying outliers to robustify performance identification. In this paper, we show that outliers provide meaningful information on unsustainable production. This is crucial, given the increasing focus on the downsides of over-performance on employees (e.g., staff sickness and burnouts, safety issues) in the advent of Industry 5.0. We provide an extensive review, path forward, and empirical application on digital railway control rooms to investigate different methods of learning from outlying observations to construct a sustainable frontier.

3 Measuring the Impact of Logistics Development in Cities: A Social Sustainability Approach

Carla A. Tejada, Alison Conway, The City College of New York, New York, NY, Contact: ctejada001@citymail.cuny.edu

The development of logistics infrastructure in cities is growing, intending to meet the expectations of fast demand. In this study, we measure the impact of logistics facilities' proximity to urban areas from a social sustainability approach. We measure the social vulnerability in warehouse permitting areas, analyze the quality of jobs over ten years, and measure the job creation near facilities.

Results show that warehouses are generally located in vulnerable areas. Workforce indicators show a rise in the number of jobs in most industries related to the movement of goods but a limited increase in yearly earnings. Finally, the number of logistics jobs near logistics facilities has not increased significantly. Results are expected to inform future planning for delivery activity at citywide levels and raise awareness of logistics facilities' social impact.

4 Drone Logistics in Agricultural Technology

Srinivasa Prasanna, IIIT-Bangalore, Bengaluru, India. Contact: gnsprasanna@iiitb.ac.in

We discuss logistics of drones used in precision agriculture, in India. Drones enable timely inputs - water, fertilizer, pesticides, ..., timely harvesting, and real time data collection. While road and rail are well matched to bulk transport, drones are well suited for timely crop condition assessment, emergency spraying, transport of perishable items like flowers, ..

We address the problem, by scheduling a heterogeneous fleet of drones to perform these tasks at scale. We handle 1000's of drones, densely packed (trajectory separation < 1 m), under dynamic inter-drone separation constraints. We use a modified MILP formulation for scheduling the drones on airways. respecting Inter-drone separation, flight dynamics and range, and location of charging stations (for electric drones). Results show scalability to 1000's of drones, & GB/s data collection, a first of its kind,

Tuesday, October 17, 8:00 AM - 9:15 AM

TA83

Session.Location:CC-West 213A

Learning and Operations Management Applications

Contributed Session

Session Chair: Kenichi Shimizu, University of Alberta, Edmonton, AB, Canada

1 A Large Scale Linear Programming Model to Optimize Operational Efficiency of a Semiconductor Fabrication Plant with Multiple Lines

Jinyoun Lee, Junsang Yuh, Kihong Kim, Samsung Electronics/Mechatronics Research, Hwaseong-si, Korea, Republic of

Due to the immense size and re-entrant flow shop characteristics of a semiconductor fabrication plant (FAB), improving efficiency and optimizing productivity of a FAB are becoming ever more important. In this paper, a mathematical model is presented to optimize the operational efficiency of a FAB. Linear programming is used to model a FAB, and the production level is maximized while accounting for realistic constraints such as equipment arrange and work in process. The rolling horizon method is utilized to reduce the computation time for such a large-scale problem. Four experiments are conducted to test the validity and practicality of the model, and the results of the experiments are compared to the actual FAB data. The analysis result also showed that the model can be used for detecting bottlenecks, which is an additional point of improvement from a managerial perspective.

2 The Spread of a Post of an Influencer Viral Marketing on Twitter - a Branching Process Approach

Youhyun Lee[1], Liangfei Qiu[2], Hyungsik Moon[3], [1]UF, Gainesville, FL, [2]University of Florida Warrington College of Business Administration, Gainesville, FL, [3]USC, LA, CA, Contact: youhyun.lee@ufl.edu

This research investigates how an influencer's tweet that promotes a product spread among Twitter users. Once an influencer uploads a marketing tweet, his followers (the first generation) view it, and parts of them can retweet it, and show it to their followers. This process continues until no user in a later generation retweets the tweet. We suggest a branching process model that predicts the number of retweets from each group of followers based on the analyzing data we crawled through the Twitter server. The model let us measure the viral marketing effect on Twitter based on the impression number and viewers' interests, helping firms to expect a return from their expenditure on influencer marketing on the social network service platform.

3 Scalable Estimation Of Multinomial Response Models With Uncertain Consideration Sets

Kenichi Shimizu[1], Siddhartha Chib[2], [1]University of Alberta, Edmonton, AB, Canada; [2]Washington University in St. Louis, St. Louis, MO

Estimation of consideration set models faces a curse of dimensionality because the number of parameters associated with choice set formation processes increases exponentially in the number of available alternatives. In this paper, we propose a scalable estimation while allowing for flexible dependence structure of considerations. We utilize economic reasoning to introduce sparsity into the collection of choice sets. We estimate our model using Markov Chain Monte Carlo (MCMC), for which the sampling algorithm is built on simple and intuitive steps.

Tuesday, October 17, 8:00 AM - 9:15 AM

TA84

Session.Location:CC-West 213B

Supply Chain Risk Assessment

Contributed Session

Session Chair: Xingyu Li, Ford Motor Company, Dearborn, MI

1 Global Supply Chain Network Analysis and Its Resilience

James (Anxin) Lian[1], lu zhong[1], Ziang Wang[2], Jianxi Gao[1], [1]Rensselaer Polytechnic Institute, Troy, NY, [2]The Hong Kong Polytechnic University, Hong Kong, Hong Kong

Supply chain analysis mainly focuses on a bilateral relationship, a static network, or subnetworks extracted from an industry. This paper examines supply chain networks' resilience based on a worldwide complex dynamic setting. With the 2008 -09 financial crisis as the case study, we identify not only firm-level factors but also network structures that mitigate disaster disruptions.

2 Valuation of Supply Chain Firms with Financially Distressed Retail Partner

Zugang Liu[1], Jia Wang[2], [1]Penn State- Hazleton, Hazleton, PA, [2]Rowan University, Glassboro, NJ

The current asset valuation approaches do not consider dynamic interactions between supply chain firms. However, the interconnections of supply chain firms affect their cash flows which are the fundamental factor determining firm valuations. In particular, supply chain relationships can become critical when there are financially distressed firms. This research develops an asset valuation approach which considers the relationship between supply chain partners as well as the stochastic nature of the credit risk. Our approach analyzes valuations of firms in supply chain networks by integrating game theory with credit risk model and valuation model in finance. We apply the approach to study firms with financially distressed retail partners, and present analytical results as well as numerical examples.

3 Supply Chain Restructuring: Nearshoring in Response to Regional Value Content Requirements

Jonathan Hsu, Washington University in St. Louis, St. Louis, MO

Regional trade agreements (RTAs) have emerged as a prominent trade policy tool, employing requirements on regional value content (RVCs) to enforce the utilization of goods produced within member countries. This paper examines the impact of RVCs within the United States, Mexico, and Canada Agreement (USMCA) on firm sourcing decisions. We show that RVCs incentivize firms to redirect imports from third countries towards USMCA members. Stricter RVCs produce more pronounced shifts in imports, while firms encounter considerably higher overall import costs as a result of these shifts. The most notable nearshoring trends occur in less complex products that are relatively easier to shift within the supply chain. Our findings uncover empirical evidence on the effectiveness of RVCs in promoting supply chain diversification and restructuring.

4 Supply Chain Risk Assessment for Automotive Industry Using Deep Survival Analysis

Xingyu Li, Vasiliy Krivtsov, Don Zhang, Chaoye Pan, Dmitry Snovalnikov, Ford Motor Company, Dearborn, MI

The ever-increasing vulnerability of the supply chain posed the need for automotive manufacturers to closely monitor the risks in their supply base and adjust their sourcing and production decisions accordingly. However, precise information on ongoing supply chain disruptions is often unavailable, making it challenging to evaluate and adapt to risks validly. To address such challenges, we propose a deep survival model to infer the underlying supply chain disruptions from the changes in supplier behaviors, inventory levels, and external stressors. In an application of a large U.S. automotive company, our model successfully predicts time-to-shortage for various auto parts and supports the company in risk-averse and resilient decision-making.

Tuesday, October 17, 9:45 AM - 10:35 AM

TP01

CC-West 301ABC

Plenary: The Power of Platforms to Transform Health Care

Plenary Session

1 The Power of Platforms to Transform Health Care

John Halamka, Mayo Clinic, Rochester, MN

True transformation of the health care sector requires us to move from pipeline thinking to a platform approach. To do this, we must capture diverse data sources at scale, constantly derive new insights from that data and create closed-loop solutions in a highly repeatable model. This presentation will focus on the work of Mayo Clinic Platform to create this model through privacy-protecting, federated, deidentified data behind glass that protects both data and intellectual property and the partnerships required to enable the greatest impact.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB01

CC-North 120A

Pharmaceutical Supply Chains and Drug Shortages

Tutorial Session

Session Chair: Ebru Korular Bish, University of Alabama, Tuscaloosa, AL

1 Pharmaceutical Supply Chains and Drug Shortages

Hui Zhao, The Pennsylvania State University, University Park, PA

While pharmaceutical (pharma) industry is vital to the economy and its supply chain efficiency directly affects the quality and cost of patient care, pharma supply chains have been largely under-researched in the healthcare field, compared to the thrived research in medical services/hospital operations by the INFORMS community. At the same time, the pharma industry faces complicated and unique economics and regulation environment. In this tutorial, we aim to provide a base understanding of the very complex pharmaceutical supply chain and present challenges it faces. Using drug shortages (a persistent and significant problem facing the pharma industry, government, and the society) as well as other examples, we demonstrate that the richness and uniqueness of the pharma supply chain provides great opportunities for research with impact.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB03

CC-North 120D

Mathworks/Palgrave Macmillan

Technology Tutorial

1 Techno-Economic Analysis with MATLAB: Analyzing the Impact of EV Charging on the Power Grid

Chris Lee, MathWorks, Natick, MA, Contact: chrislee@mathworks.com

With more and more electric vehicles connecting to the power grid every day, there are concerns that existing grid infrastructure will be strained beyond acceptable operational limits. We can address these concerns by bringing operations, pricing, and forecasting into techno-economic models of power systems in MATLAB. Using these models, we can assess feasibility, risk, optimal operations, and profitability of charging infrastructure.

In this tutorial, we consider a scenario where a system operator can command individual electric vehicle battery units to both store and supply electricity while connected to the grid. The operator applies techno-economic optimization in MATLAB to the charging profiles to minimize electricity cost while accounting for system requirements and constraints, such as limits on state of charge, grid supply, and charge/discharge rate. The optimization provides a fast and automated approach for leveraging all of the units connected to the grid for overall system benefit. Charging profiles are then assessed for the impact on voltage and power flow levels using a grid-level simulation.

2 Unleash the Future: AI-Powered Insights and Services for Researchers and Authors

Janina Krieger, Springer, New York, NY, Contact: janina.krieger@springer.com

AI Unveiled: Discover the magic behind AI technology and how it's transforming the landscape of research and writing. Gain insights into the latest advancements that are reshaping the way we approach academic exploration.

AI as your Research Partner: Imagine having an AI collaborator that helps you navigate the sea of information effortlessly. Learn how AI can assist researchers in sifting through vast datasets, identifying trends, and generating valuable hypotheses, propelling your research to new heights.

Global Collaboration: Uncover the potential of AI in bridging geographical gaps and fostering cross-border collaboration. Explore our AI-powered translation tool that enable seamless communication and idea exchange among researchers and authors from around the world.

Future Forward: Get a sneak peek into the future of AI and its evolving role in research and writing. Gain a visionary perspective on how AI might redefine creativity, innovation, and knowledge dissemination in the years to come.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB04

CC-North 121A

Data Driven Algorithms: New Paradigms

Community Committee Choice Session

Session Chair: Will Ma, Columbia University, New York, NY
Session Chair: Omar Besbes, Columbia University, New York, NY
Session Chair: Omar Mouchtaki, Columbia University, New York, NY

1 Decision-Aware Data Aggregation

Vishal Gupta, University of Southern California, Los Angeles, CA

Facing multiple stochastic optimization problems each with limited data, data aggregation is a natural approach. For instance, in revenue management, clustering similar products using k-means setting a single price for the cluster is common. Most aggregation heuristics follow an "estimate-then-optimize" paradigm, disregarding the downstream optimization problem's structure.
We propose decision-aware algorithms for data aggregation that adapt to the downstream optimization problem. Our proposals are tractable and outperform estimate-then-optimize approaches. We provide theoretical analysis demonstrating the superior performance of these approaches as the number of problems increases, even when the data per problem is constant.

2 Policy Optimization for Personalized Interventions in Behavioral Health

Jackie Baek[1], Justin J. Boutilier[2], Vivek Farias[3], Jonas Oddur Jonasson[4], Erez Yoeli[3], [1]NYU Stern School of Business, New York, NY, [2]University of Wisconsin - Madison, Madison, WI, [3]MIT, Cambridge, MA, [4]MIT Sloan School of Management, Cambridge, MA

We study the problem of optimizing personalized interventions for patients to maximize some long-term health outcome, in a setting where interventions are costly and capacity-constrained. We present a new algorithm we dub DecompPI that approximates one step of policy iteration. Implementing DecompPI simply consists of a prediction task from offline data, alleviating the need for online experimentation. Theoretically, we show that under a natural set of structural assumptions on patient dynamics, DecompPI surprisingly recovers at least 1/2 of the improvement possible between a naive baseline policy and the optimal policy. Through an empirical case study on a mobile health platform for improving treatment adherence for tuberculosis, we find that DecompPI can provide the same efficacy as the status quo with approximately half the capacity of interventions.

3 On Adaptive Experimentation and Learning

Mohsen Bayati, Stanford University, Stanford, CA

In this talk we study computational, optimization, and statistical challenges of adaptive experiment and learning.

4 From Contextual Data To Newsvendor Decisions: On The Actual Performance Of Data-driven Algorithms

Omar Besbes, Will Ma, Omar Mouchtaki, Columbia University, New York, NY, Contact: om2316@gsb.columbia.edu

We study a data-driven contextual Newsvendor problem and the performance implications of relevance and quantity of data. We consider a model in which demand observed in similar contexts have similar distributions and analyze the performance of a broad class of policies which weigh data according to their similarity in a contextual space. We develop a series of results that lead to an exact characterization of the worst-case expected regret of these policies. This exact analysis enables to unveil new quantitative and qualitative insights on their learning behavior which were not captured by state-of-the-art general-purpose bounds.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB05

CC-North 121B

Learning Non-parametric Choice Models

Community Committee Choice Session

Session Chair: Antoine Desir, INSEAD, 263 Avenue Daumesnil, France

1 A Nonparametric Stochastic Set Model: Identification, Optimization, and Prediction

Yi-Chun Akchen[1], Dmitry Mitrofanov[2], [1]University College London, London, United Kingdom; [2]Boston College, Chestnut Hill, MA

The identification of choice models is crucial for understanding consumer behavior and informing operational strategies. The identification of parametric choice-based demand models is typically straightforward. However, nonparametric models like ranking-based models, which are highly effective and flexible in explaining customer choice, may encounter the challenge of the dimensionality curse, hindering their identification. In this paper, we develop a new class of nonparametric models that is not subject to the problem of nonidentifiability. Our model assumes bounded rationality of consumers, which results in symmetric demand cannibalization and intriguingly enables full identification. We further show that the proposed model demonstrates competitive prediction accuracy compared to the state-of-the-art benchmarks in a real-world case study.

2 Nonparametric Demand Estimation in the Presence of Unobserved Factors

Sandeep Chitla[1], Srikanth Jagabathula[2], Ashwin Venkataraman[3], [1]New York University, New York, NY, [2]NYU Stern School of Business, New York, NY, [3]University of Texas at Dallas, Richardson, TX, Contact: ashwin.venkataraman@utdallas.edu

In many applications of discrete choice modeling, there exist unobserved factors (UFs) driving the consumer demand that are not included in the model. Ignoring such UFs when fitting the choice model can produce biased parameter estimates and ultimately lead to incorrect policy decisions. Existing approaches such as the classical BLP estimator make strong parametric assumptions to deal with this challenge, and therefore can suffer from model misspecification issues. We propose a novel estimator for dealing with UFs in the mixtures of logit model that is nonparametric, i.e., does not impose any parametric assumptions on the mixing distribution or the underlying mechanism generating the UFs. We theoretically and numerically characterize the benefit of our estimator compared to BLP, and showcase the value of accounting for UFs on real-world grocery sales transaction data.

3 A Mallows-type Model For Preference Learning From (ranked) Choices

Yifan Feng[1], Yuxuan Tang[2], [1]NUS Business School, Singapore, Singapore; [2]National University of Singaporee, Singapore, Singapore. Contact: yuxuan.tang@u.nus.edu

In preference learning, participants choose an ordered list of top k preferred items from different display sets. We develop a distance-based ranking model to represent this choice behavior, similar to the Mallows model but using the Reverse Major Index distance function. The model has a simple closed-form expression for ranked choice probabilities, enabling consistent parameter estimation. We showcase the model's generalization power, robustness, and computational efficiency with real data sets.
We study the link between feedback structure richness (k) and collection efficiency. In a sequential experimental design problem, a company presents display sets and requests customers' top-k ranked choices to identify the top candidate using minimal samples. We find that informational efficiency increases with k, but a small k=2 often achieves near or full optimality.

3 Active Learning for Non-Parametric Choice Models

Fransisca Susan[1], Negin Golrezaei[2], Ehsan Emamjomeh-Zadeh[3], David Kempe[4], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Massachusetts Institute of Technology, Lexington, MA, [3]Meta Platforms, Inc., Seattle, WA, [4]University of Southern California, Los Angeles, CA, Contact: fransiscasusanwu@gmail.com

We study the problem of actively learning a non-parametric choice model based on consumers' decisions. We present a negative result showing that such choice models may not be identifiable. To overcome this, we introduce a directed acyclic graph (DAG) representation of the choice model, capturing as much information as could information-theoretically be identified. We then design an efficient active-learning algorithm to estimate the DAG representation, which runs in polynomial time when the set of frequent rankings is drawn uniformly at random. We show that our algorithm can better recover a set of frequent preferences on both synthetic and publicly available datasets on consumers' preferences, compared to the corresponding non-active learning estimation algorithms, demonstrating the value of our algorithm and active-learning approaches more generally.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB06

CC-North 121C

Recent Innovations in E-commerce Fulfillment

Community Committee Choice Session

Session Chair: Linwei Xin, University of Chicago, Chicago, IL

1 Omnichannel Fulfillment at Target

Aravind Govindarajan, Target Corporation, Santa Clara, CA

In this talk, we provide an overview for Target's omnichannel fulfillment, and the various decision systems involved in conducting the fulfillment operations, ranging from inventory placement and positioning, order promise, order allocation, and last mile transportation. We discuss how key simulation systems help improve decision making at scale for the various systems involved in omnichannel fulfillment.

2 Better Round-Robin Matching for Walmart Spark Drivers

Duygu Soylemez[1], Linwei Xin[2], Yuan Zhong[3], [1]The University of Chicago Booth School of Business, Chicago, IL, [2]University of Chicago, Chicago, IL, [3]University of Chicago / Booth School of Business, Chicago, IL, Contact: dsoyleme@chicagobooth.edu

Walmart Spark is a platform where third party drivers deliver online orders. One of the delivery models they use is round-robin. This model tries to match a bunch of orders with drivers before a predetermined time, T, which can be interpreted as the end of round robin before price surging or sent to DoorDash. Every period until T, unmatched orders are sent to unmatched drivers such that every order is sent to at most one driver and a driver receive at most one order in a period. The aim is to determine which order should be sent to which driver in every period to maximize the expected profit considering acceptance probabilities. Current practice is based on solving the weighted bipartite matching problem for a single period. We provide an optimal solution for single order problem under some assumptions and offer algorithms with better performance than the myopic policy that is in use.

3 Inventory Distribution in a Regionalized Network

Xiaoyan Si, Amazon, Bellevue, WA

Amazon's rapid network growth over the last few years has lead it to management complexity and efficiency challenges. In 2023, Amazon rearchitected its US fulfillment to move from a national network to a regionalized network by creating eight interconnected regions in smaller geographic areas. Each of these regions has broad, relevant selection to operate in a largely self-sufficient way, while still being able to ship nationally when necessary. The success of this structural change relies on many aspects of Amazon's supply chain management. In particular, designing a robust inventory distribution network to get the right products into the right region is the key for achieving high degree of self-sufficiency in each region. In this talk, we discuss different designs of Amazon's inventory distribution network in the context of its new regionalized fulfillment network.

4 Real-Time Personalized Order Holding

Mohammad Reza Aminian[1], Will Ma[2], Linwei Xin[3], [1]The University of Chicago, Booth School of Business, Chicago, IL, [2]Columbia University, New York, NY, [3]University of Chicago, Chicago, IL, Contact: linwei.xin@chicagobooth.edu

One common practice in online retailing is to delay real-time order fulfillment decisions to consolidate orders. Instead of immediately dispatching an order to a warehouse for picking/packing, the order is held in a virtual pool for a short amount of time. If the same customer places another order shortly afterward, then a substantial amount of costs can be saved by picking/shipping the orders together. A recent industry innovation is to make personalized order holding decisions based on the estimated chance of order consolidation. In this paper, we study the problem of how to make personalized order holding decisions in real-time. We propose intuitive and practical online algorithms and derive performance guarantees. We also conduct numerical experiments to complement our theoretical results.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB07

CC-North 122A

Artificial Intelligence in Operations

Community Committee Choice Session

Session Chair: Xiao-Yue Gong, MIT, Cambridge, MA

1 Contextual Bandits and Optimistically Universal Learning

Moise Blanchard[1], Patrick Jaillet[2], [1]MIT, Cambridge, MA, [2]M.I.T., Cambridge, MA, Contact: moiseb@mit.edu

We study learnability for contextual bandits and provide consistent algorithms for large families of data processes. We show that achieving consistency irrespective of the reward function—universal consistency—is possible for large classes of non-i.i.d. processes. For stationary contextual bandits, we give tight characterizations of learnable processes and provide algorithms that achieve universal consistency whenever possible. Hence, if they fail to be universally consistent then no other algorithm would succeed either. In particular for finite action spaces, we show that there is no generalizability cost from standard supervised learning to contextual bandits. For non-stationary bandits, however, such ideal algorithms do not exist: it is impossible to balance population-level fitting and instance-level/personalized fitting with bandit feedback.

2 Regret Distribution in Stochastic Bandits: Optimal Trade-Off Between Expectation and Tail Risk

David Simchi-Levi[1], Zeyu Zheng[2], Feng Zhu[3], [1]Massachusetts Institute of Technology, Cambridge, MA,

[2]University of California, Berkeley, Berkeley, CA, [3]MIT, Cambridge, MA, Contact: fengzhu@mit.edu

We study the trade-off between expectation and tail risk for regret distribution in the stochastic multi-armed bandit problem. We fully characterize the interplay among three desired properties for policy design: worst-case optimality, instance-dependent consistency, and light-tailed risk. We show how the order of expected regret exactly affects the decaying rate of the regret tail risk for both the worst-case and instance-dependent scenario. A novel policy is proposed to characterize the optimal regret tail risk for any regret threshold. Moreover, we discover an intrinsic gap of the optimal tail rate under the instance-dependent scenario between whether the time horizon is known a priori or not. Interestingly, when it comes to the worst-case scenario, this gap disappears. Finally, we show that similar results hold under models with structured non-stationarity.

3 Bandits Atop Reinforcement Learning: Tackling Online Inventory Models with Cyclic Demands

Evelyn Xiao-Yue Gong, Carnegie Mellon University, Pittsburgh, PA

Motivated by a long-standing gap between inventory theory and practice, we study online inventory models with unknown cyclic demand distributions. We design provably efficient reinforcement learning (RL) algorithms that leverage the structure of inventory problems. Our RL policies achieve optimal regret for the lost-sales model and the episodic multi-product backlogging model, matching the regret lower bound that we prove in this paper. Our policies remove the regret dependence on the cardinality of the state-action space for inventory problems, which is an improvement over existing RL algorithms. We conducted experiments with a real sales dataset from Rossmann. Our policy converges rapidly to the optimal policy and dramatically outperforms the best policy that models demand as i.i.d. instead of cyclic.

4 Community/Committee'S Choice Submission

Rui Miao[1], Zhengling Qi[2], Cong Shi[3], Lin Lin[4], [1]UC Irvine, Irvine, CA, [2]The George Washington University, D.C., [3]University of Michigan at Ann Arbor, Ann Arbor, MI, [4]Duke University, Durham, NC, Contact: rmiao2@uci.edu

Pricing based on individual customer's characteristics is a widely used strategy to maximize sellers' revenues. This work studies offline personalized pricing under endogeneity using an instrumental variable approach. We propose a new policy learning method using invalid and continuous instrumental variables that allow direct effects on the outcome. Relying on the structural models of revenue and price, we establish non-parametric identification of an optimal pricing strategy under endogeneity with the help of continuous and invalid instrumental variables. Based on this new identification, we then construct an adversarial min-max estimator and learn an optimal pricing strategy from the offline data. Finally, we demonstrate the effectiveness of the our method via extensive simulation studies and a real data application from a US online auto loan company.

5 Efficient Cloud Server Deployment Under Demand Uncertainty

Konstantina Mellou[1], Rui Peng Liu[2], Evelyn Xiao-Yue Gong[3], Beibin Li[1], Thomas Coffee[2], Jeevan Pathuri[4], David Simchi-Levi[5], Ishai Menache[4], [1]Microsoft Research, Redmond, WA, [2]Amazon, Seattle, WA, [3]Carnegie Mellon University, Pittsburgh, PA, [4]Microsoft, Redmond, WA, [5]Massachusetts Institute of Technology, Cambridge, MA

A main challenge faced by cloud service providers is to ensure that they are ready to accommodate the growing demand for compute resources. Towards that goal, providers need to deploy cloud servers agilely for uncertain future demand under many practical business constraints, without incurring unnecessarily large operational costs. In this talk, we introduce the cloud server deployment problem, formulate the underlying optimization problem as a two-stage stochastic program and develop exact algorithms to efficiently obtain an optimal solution. We test our proposed algorithms with real production traces from Microsoft Azure and demonstrate their effectiveness in cost reductions.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB08

CC-North 122B

Data-driven Methods for Quality Control

Contributed Session

Session Chair: John Becker, University at Buffalo, Buffalo, NY

1 A Semantic Segmentation Model for Measuring Wire Rod Temperature and Predicting Overall Hardness

SEOKKYU PYO[1], DONGHEE LEE[2], [1]M.S. student / Dept. of Industrial Engineering, SKKU, Seoul, Korea, Republic of; [2]Associate Professor/ Dept. of Industrial Engineering, SKKU, Seoul, Korea, Republic of. Contact: galaxy0521@g.skku.edu

Wire rod hardness is crucial for product quality, with cooling rate being the most significant factor. However, measuring cooling rate is challenging due to the wire rod's shape and conveyor belt noise. To address this issue, a model was developed to extract temperature from thermography. This, along with a hardness prediction model, was used to predict the wire rod hardness. The method can extract the temperature of the entire wire rod automatically, complementing quality inspection relying on sampling. A domestic steel company confirmed its efficacy.

2 Discovering True Optimal Solutions from Response Surface Models with Errors

Hyunho Kim[1], Jong-Seok Lee[2], [1]Sungkyunkwan University, Suwon, Korea, Republic of; [2]Sungkyunkwan University, Suwon, Korea, Republic of. Contact: retna319@skku.edu

This research focuses on response surface optimization using a monotonic neural network to estimate the response surface. Because the response surface estimated by training a neural network from data must contain a prediction error, the optimal solution determined from this response surface cannot be considered true optimal. To address this, we propose a method to identify the true optimal solution when there is a monotonic relationship between input factors and the response. By modifying the objective function based on the difference between target and predicted values, our approach iteratively searches for the optimal solution. Numerical experiments on synthetic examples confirmed the effectiveness of our method in finding true optimal solutions.

3 Semi-Supervised Learning for Classification of Transverse Temperature Defects in Hot-Rolled Products

Kyungsoo Kim[1], Seoung Bum Kim[2], [1]Korea university, Seoul, Korea, Republic of; [2]Korea University, Seoul, Korea, Republic of. Contact: kyungsoo@korea.ac.kr

We propose a semi-supervised learning model to classify transverse temperature defects in materials during hot rolling. Thermal imaging cameras are used to measure and store the temperature data during hot rolling process. Typically, classification models are used to classify defects in the thermal images. However, training classification models requires labeled data, which can be time consuming. To address this labeling issue, we propose using a semi-supervised learning model that leverages both labeled and unlabeled data for training. Our experimental results confirm that the semi-supervised learning methods outperform the supervised learning methods for the accurate detection of transverse temperature defects during hot rolling.

4 Nonparametric Adaptive Age-Replacement with Censored Data

Puyao Ge[1], Vidyadhar Kulkarni[2], [1]UNC Chapel Hill, Chapel Hill, NC, [2]University of North Carolina-Chapel Hill, Chapel Hill, NC, Contact: puyao@live.unc.edu

We consider the distribution-free age-replacement problem with censored lifetimes. We first develop a nonparametric adaptive algorithm that is a variant of the stochastic gradient descent method to minimize the expected net cost per machine. Then we combine this algorithm with the Kaplan-Meier estimator to minimize the long run expected cost per unit of time.

5 On Generalizing Information Collection Problems

Nastaran Oladzadabbasabady[1], John Becker[1], Esther Jose[1], Rajan Batta[2], [1]University at Buffalo, Buffalo, NY, [2]University at Buffalo (SUNY), Buffalo, NY, Contact: becker6@buffalo.edu

In today's data-driven world, collecting information efficiently is crucial. We generalize this and propose a well-formulated model that can be applied to a wide range of information collection problems. To solve an information collection problem on a graph, we introduce a two-phase approach. In the first phase, we pre-process the graph to determine how much information can be collected at different parts of the graph. In the second phase, we use a mixed-integer linear programming (MILP) model to maximize the amount of valuable information collected by traversing the edges of the graph within a given time limit. Our model has practical applications for any problem where an agent, sensor, or decision maker is collecting information from a space and can accommodate additional assumptions such as information degradation and threat or detection avoidance.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB09

CC-North 122C

Recent Advances in Stochastic Processing and Matching Networks

Community Committee Choice Session

Session Chair: Siva Theja Magluri, Georgia Tech

Session Chair: Sushil Varma, Georgia Institute of Technology, Atlanta, GA

1 Asymptotically Optimal Matching Policy

Jiankui Yang[1], David D. Yao[2], Heng-Qing Ye[3], [1]Beijing University of Posts and Telecommunications, Beijing, China; [2]Columbia University, New York, NY, [3]Hong Kong Polytechnic University, Hong Kong, China

We study a system with multiple classes of components (jobs, customers, orders, etc.) that arrive following (possibly correlated) renewal processes. Each class has its own matching regime---what jobs from other classes are needed to form a match. The decision is whether to match the jobs that are currently present and hence remove them from the queues, or to wait for further arrivals with the hope to form better matches later. The objective is to minimize a convex holding cost. We propose a matching policy, and show that it is asymptotically optimal: under the diffusion scaling, it achieves the limiting performance of the optimal reflection control of a Brownian motion.

2 Fair Scheduling of Heterogeneous Customer Populations

Justin Mulvany[1], Ramandeep Randhawa[2], [1]University of Southern California, Los Angeles, CA, [2]USC Marshall School of Business, Los Angeles, CA

When managing congested service systems, it is common to use priority rules based on some operational criteria. In this paper, we consider the societal implications of such individual-focused priority policies, when individuals are considered as members of broader population groups. We find that optimal resource allocation policies such as the cμ-rule in scheduling can lead to significant inequity across population groups. We propose policies that can mitigate this inequity and can generate completely equitable outcomes across populations with little, or at times, even no additional system cost. Thus, we find that it can be possible to achieve more equitable outcomes while ensuring operational efficiency.

3 Dynamic Resource Allocation: Algorithmic Design Principles and Spectrum of Achievable Performances

Akshit Kumar[1], Omar Besbes[1], Yash Kanoria[2], [1]Columbia University, New York, NY, [2]Columbia Business School, New York, NY, Contact: akumar25@gsb.columbia.edu

Motivated by online matching markets and network revenue management (NRM) problems with many types (e.g., fulfillment optimization), we study dynamic spatial matching (DSM) in which supply and demand live in d dimensional space and need to be matched with each other dynamically. If demand and supply have different spatial distributions, the matching constraint has bite and greedy matching fails. We introduce a unifying and practical algorithmic principle for NRM and DSM dubbed SOAR: Simulate, Optimize, Assign, Repeat, which repeatedly simulates the future to enable good matching decisions. For particularly challenging NRM and DSM models, SOAR with multiple simulated sample paths at each stage achieves near optimal regret.

4 Care: Resource Allocation Using Sparse Communication

Gal Mendelson[1], Kuang Xu[2], [1]Technion, Haifa, Israel; [2]Stanford Graduate School of Business, Stanford, CA, Contact: galmendelson@gmail.com

We propose a new framework for studying effective resource allocation in a load balancing system under sparse communication using state approximations. We show that using a server-side-adaptive communication protocol, the load balancer can obtain good queue-length approximations using a communication frequency that decays quadratically in the maximum approximation error. Furthermore, we prove that the load balancer achieves asymptotically optimal performance whenever the approximation error scales at a lower rate than the square-root of the total processing capacity. Using simulations, we find that the proposed policies achieve good performance while reducing communication rates by as much as 90%.

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TB10

CC-North 123

Advancements in Service Systems Featuring Queuing Analysis, Parallel Processing, Dynamic Control, and Capacity Allocation

Community Committee Choice Session

Session Chair: Eugene Furman, Alba Graduate Business School, American College of Greece, Toronto, ON, Canada

1 Dynamic Control of Service Systems with Returns

Timothy Chan, Simon Yuxuan Huang, Vahid Sarhangian, University of Toronto, Toronto, ON, Canada

We study a queueing system with returns where at each service completion epoch, the decision maker can choose to reduce the probability of return for the departing customer at a cost that is convex increasing in the amount of reduction in the return probability. We characterize the structure of optimal long-run average and bias-optimal transient control policies for associated fluid control problems. Our results provide insights on the design of post-discharge intervention programs aimed at reducing hospital readmissions.

2 Parallel Server Systems in Extended Heavy Traffic

Rami Atar[1], Eyal Castiel[2], Marty I. Reiman[3], [1]Technion, Haifa, Israel; [2]Georgia Tech, Atlanta, GA, [3]Columbia University, Maplewood, NJ, Contact: rami@technion.ac.il

The standard setting for studying parallel server systems at the diffusion scale is based on the heavy traffic condition, which assumes that the underlying static allocation linear program (LP) is critical and has a unique solution. We argue that the unique solution condition rules out an important class of systems. We introduce the extended heavy traffic condition, where the LP is merely assumed to be critical. Multiplicity of LP solutions dramatically changes the nature of the problem, where, in order to achieve asymptotic optimally at the diffusion scale, the system state must be controlled not only at the diffusion scale but also at the fluid scale.

3 Analysis of Two-Sided Queues with Different Levels of Delay Information

Mehmet Aydemir[1], Mohammad Delasay[2], Siddharth Singh[3], Mustafa Akan[4], [1]Walmart Global Tech, Dallas-Fort Worth Metroplex, TX, [2]Stony Brook University, Stony Brook, NY, [3]University Collage London, London, United Kingdom; [4]Carnegie Mellon University, Pittsburgh, PA, Contact: mohammad.delasay@stonybrook.edu

We model an on-demand platform as a two-sided queueing system and study its delay information disclosure policy when the platform serves two classes of strategic users (consumers and providers) who seek matches to each other using the platform. Users on each side decide whether to join the system or balk based on their expected delay to be matched, conditional on the information provided by the platform to them. We consider different delay information-sharing regimes and compare the matching rates (a proxy for the platform's profit) under these regimes.

4 Capacity Allocation for Clouds with Parallel Processing, Batch Arrivals, and Heterogeneous Service Requirements

Eugene Furman[1], Arik Senderovich[2], Shane Bergsma[3], J. Christopher Beck[4], [1]Alba Graduate Business School, American College of Greece, Athens, Greece; [2]York University, Toronto, ON, Canada; [3]Huawei Cloud, Markham, ON, Canada; [4]University of Toronto, Toronto, ON, Canada. Contact: efurman@alba.acg.edu

Allocating sufficient capacity to cloud services is a challenging task, especially when demand is time-varying, heterogeneous, contains batches, and requires multiple types of resources. We model such system as a multi-class queueing network with parallel processing and multiple types of resources, where arrivals (i.e., virtual machines and containers) follow time-varying patterns and require at least one unit of each resource for processing. We introduce a diffusion approximation of the offered load and investigate its fidelity. Then, we develop a heuristic that leverages this approximation to determine capacity levels that satisfy probabilistic SLAs. Using a data set of cloud computing requests from Huawei Cloud, we show that our heuristic policy results in a 20% capacity reduction and better service quality as compared to a benchmark that reserves resources.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB11

CC-North 124A

Fairness in Decision-Making

Community Committee Choice Session

Session Chair: Sean Sinclair, Cornell University, Ithaca, NY

1 Sequential Fair Resource Allocation Under a Markov Decision Process Framework

Parisa Hassanzadeh[1], Sihan Zeng[2], [1]JPMorgan Chase & Co, Palo Alto, CA, [2]Georgia Institute of Technology, Atlanta, GA

We study the sequential decision-making problem of allocating a divisible resource to agents that reveal their stochastic demands over a finite horizon. Our goal is to design fair allocation algorithms that exhaust the available resource. We propose a new algorithm, SAFFE, that makes fair allocations with respect to all demands revealed over the horizon by accounting for expected future demands at each arrival time. By formulating the problem as an MDP, we show that the allocation made by SAFFE optimizes an upper bound of the Nash Social Welfare fairness objective. We further introduce SAFFE-D, which improves SAFFE by balancing the trade-off between the revealed demands and the future potential demands based on the uncertainty in future demands. We bound its gap to optimality using concentration bounds, and empirically compare SAFFE-D against baseline approaches.

2 Fairness and Budget Flexibility: Advancements in Restless Multi-Armed Bandits for Real-World Planning

Paula Rodriguez Diaz, Harvard University, Cambridge, MA

Restless multi-armed bandits (RMABs) have gained prominence as a model for resource allocation in real-world applications such as anti-poaching patrol scheduling, maternal and child care, and medication treatment adherence. However, existing RMAB models overlook the presence of heterogeneous workers with varying costs, budgets, and intervention effects, limiting their applicability. To overcome this, we propose two advancements: multi-worker restless bandits (MWRMAB) and flexible budget restless multi-armed bandits (F-RMABs). MWRMAB extends the RMAB framework by considering heterogeneous workers, aiming to maximize expected reward while ensuring fairness in workload distribution while F-RMABs introduce flexible budgeting, enabling the distribution of surplus resources across planning steps.

3 Stochastic Online Fisher Markets: Static Pricing Limits and Adaptive Enhancements

Devansh Jalota, Stanford University, Stanford, CA, Contact: djalota@stanford.edu

In a Fisher market, users spend a budget of (artificial) currency to buy goods that maximize their utilities while a central planner sets prices on capacity-constrained goods to clear the market. However, the efficacy of pricing schemes to achieve an equilibrium typically relies on complete knowledge of users' budgets and utilities and requires transactions to happen in a static market where all users are present simultaneously. Thus, we study an online incomplete information variant of Fisher markets, wherein users with privately known utilities and budgets enter the market sequentially. In this context, we study the limits of classical static pricing approaches and develop adaptive pricing algorithms with improved performance guarantees, including one that adjusts prices solely based on observations of user consumption, i.e., revealed preference feedback.

4 Fairness Auditing in Urban Decisions Using Lp-Based Data Combination

Mesrob Ohannessian, University of Illinois Chicago, Chicago, IL, Contact: mesrob@uic.edu

Auditing for fairness in decisions often relies on a secondary source, e.g., the Census, to inform about protected attributes that are missing in the primary source. To avoid assumptions, a recent line of work has suggested finding the entire range of fairness valuations consistent with both sources. We show that, for continuous decisions, this could lead to loose audits, perceived more optimistically than they ought to be. We propose an efficient linear programming formulation to handle continuous decisions, by finding the fairness range based on data and giving it finite-sample guarantees. We apply it to 311 Chicago City Services data to demonstrate its ability to tightly assess fairness. (Joint work with Jingyi Yang and Joel Miller, UIC.)

Tuesday, October 17, 10:45 AM - 12:00 PM

TB12

CC-North 124B

Advancements in Simulation

Community Committee Choice Session

Session Chair: Henry Lam, Columbia University, New York, NY
Session Chair: Shengyi He, Columbia University, New York, NY

1 Unbiased Gradient Estimation for Intractable Performance Measures

Jeffrey Wang[1], Chang-Han Rhee[2], [1]Northwestern University, Chicago, IL, [2]Northwestern University, Chicago, IL, Contact: xiaotianwang2025@u.northwestern.edu

We propose a new approach to unbiased estimation of the gradients of the stationary means associated with parametrized families of Markov chains. Our new estimators are particularly efficient when the Markov chains have long regeneration cycles. Our estimators are based on constructing coupling which only requires an oracle to evaluate the transition density and its gradient at a given data point without any additional knowledge about the density function itself. Numerical experiments confirm the good performance predicted by the theory.

2 Statistical Optimality in Low-Computation Uncertainty Quantification

Shengyi He, Henry Lam, Columbia University, New York, NY, Contact: sh3972@columbia.edu

The gigantic computation demand of modern simulation and machine learning models has deemed some common uncertainty quantification tools overly expensive. Alternatives that operate under very low computation budgets, such as data splitting and some new resampling approaches, have growing importance in this situation. However, it is open which of these approaches are statistically optimal under computation budgets. We investigate this problem via a large-sample analog of uniformly most accurate unbiased confidence intervals from a dual view of hypothesis testing. We show that standard batching, but also certain schemes using uneven-size batches or overlapping batches, as well as the recently proposed cheap bootstrap method, are optimal. We also discuss these approaches' higher-order properties to understand their behaviors in the smaller-sample regimes.

3 When Can Regression-Adjusted Control Variate Help? Rare Events, Sobolev Embedding and Minimax Optimality

Jose Blanchet[1], Haoxuan Chen[2], Yiping Lu[2], Lexing Ying[3], [1]Stanford University, Stanford, CA, [2]Stanford University, Stanford, CA, [3]Stanford University, Stanford, CA, Contact: haoxuanc@stanford.edu

We study the use of a nonparametric estimator as a control variate for reducing the variance of Monte Carlo (MC) sampling. Specifically, we seek to uncover the key factors that influence the efficiency of control variates by examining a prototype estimation problem that involves simulating the moments of a Sobolev function based on random observations. An information-theoretic lower bound is built for this problem. We also study a specific quadrature rule that uses a nonparametric regression-adjusted control variate to reduce the variance of MC simulation. We demonstrate that such quadrature rule can improve the MC rate and achieve the minimax optimal rate under a sufficient smoothness assumption, which rules out the existence of rare events due to the Sobolev Embedding Theorem. Finally, we show that a truncated version of MC can be minimax optimal when rare events exist.

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TB13

CC-North 125A

Optimization and Resilience: Enhancing Community Resilience Against Natural Hazards

Panel Session

Session Chair: Himadri Sen Gupta, University of Oklahoma, Norman, OK

1 Moderator

Himadri Sen Gupta, University of Oklahoma, Norman, OK, Contact: hgupta@ou.edu

This panel session discusses the latest advances in optimization techniques to enhance community resilience against natural hazards. The panelists explore the use of social networks, infrastructure, and multi-objective optimization techniques in disaster response planning, emergency management, and risk analysis. The role of decision analysis in promoting community resilience is also highlighted, emphasizing its integration with optimization techniques for better decision-making. This multidisciplinary approach provides practical recommendations and insights for practitioners, researchers, and policymakers to address complex challenges in community resilience.

2 Panelist

Anna B. Nagurney, University of Massachusetts Amherst, Amherst, MA

3 Panelist

Andres Gonzalez, University of Oklahoma, Norman, OK

4 Panelist

Kenneth Harrison, National Institute of Standards and Technology (NIST)

5 Panelist

Louise K. Comfort, University of Pittsburgh, Pittsburgh, PA

Tuesday, October 17, 10:45 AM - 12:00 PM

TB14

CC-North 125B

Strategic Behavior in Social Operations

Community Committee Choice Session

Session Chair: Manu Goyal, University of Utah, Salt Lake City, UT

Session Chair: Nitin Bakshi, University of Utah, Salt Lake City, UT

1 Fairness in Pollution Regulation

Krishnan S. Anand[1], Francois C. Giraud-Carrier[2], [1]University of Utah, Salt Lake City, UT, [2]Weber State University, Ogden, UT

Fairness in pollution regulation is an important and much-debated question, especially given multiple stakeholders with conflicting objectives, including polluting firms, industry lobby groups, consumers, environmentalists, doctors and the government. While there is a vast literature on the notion of fairness in general, we use the term precisely to mean that the polluter pays for the entire pollution damage it causes, and no more-- the so-called ‘polluter pays’ principle. We develop a novel pollution-control mechanism that we use as a benchmark of fairness. We then assess the fairness of Cap-and-Trade and Taxes against this benchmark.

2 Team Operations and Peer Reporting: Pulling the “Andon Cord” on Loyalty

Nitin Bakshi, Manu Goyal, University of Utah, Salt Lake City, UT, Contact: nitin.bakshi@eccles.utah.edu

Team operations are plagued by shirking (moral hazard) aggravated by free riding. Shirking by peers is not reported by agents who are loyal. Using the framework of dynamic games, we show that if a teammate is loyal even with a tiny probability, shirking becomes rampant and is unreported even by peers who are not loyal. We demonstrate that loyalty, an exalted value, can backfire due to the strategic externalities that it imposes on other members of the team. Interventions that destigmatize peer reporting (e.g., pulling the Andon cord in TPS) can potentially alleviate this problem.

3 The Competition in Online Reputation: A Mean Field Game Approach

Mingwen Yang[1], Vijay S. Mookerjee[2], Cheng Nie[3], Yonghua Ji[4], [1]University of Washington, Seattle, WA, [2]University of Texas- Dallas, Richardson, TX, [3]Iowa State University, Ames, IA, [4]University of Alberta, Edmonton, AB, Canada

Online reputation is critical for the success of a business. Sellers make efforts to improve their online reputation to attract more future customers. In this paper, we model the sellers' competition in product ratings using a mean field game model, where we consider a large number of sellers in a market. Each seller makes an effort to improve the product ratings, and having ratings close to those of other competitors benefits each seller in the market (mutual attraction). Using data from Airbnb, we estimate the parameters in the mean-field game model. We can demonstrate that the proposed model can explain the rating competition in the market.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB15

CC-North 126A

Role of Forecasting in Operations

Contributed Session

Session Chair: Long Zhao, NUS Business School, Singapore, Singapore

1 A Unified Demand Forecasting Framework for Ecommerce Advertising Products

Zhengchao Yang, Mithun Ghosh, Anish Saha, Darren Xu, Konstantin Shmakov, Kuangchih Lee, Walmart, Sunnyvale, CA

Demand forecast plays a critical role in sales planning and management of advertising business, which requires accurate prediction of the expected advertising product demand at scale for Walmart eCommerce. However, uncertainty in customer behaviors, supply chain disruptions, demand surges and plummets, lack of historical records and patterns can make the forecasts inadequate. In our work, we introduce a framework that incorporates various machine learning modeling methodologies, including statistical models and deep learning-based transfer learning models, etc., as well as evaluation methods to help make robust demand forecasts for all advertising products and accounts in a hierarchical structure. At the end, we also discuss our experimental findings and demonstrate the effectiveness and efficiency of our proposed framework.

2 A Bayesian Framework for Forecasting Spare Part Failures

Firat Kilci[1], Genaro J. Gutierrez[2], Saurabh Bansal[3], [1]The University of Texas at Austin, Austin, TX, [2]The University of Texas at Austin, Austin, TX, [3]Penn State University, University Park, PA

This study focuses on developing an efficient framework to forecast spare part failures for a global computer manufacturer. Our results show that in addition to the number of computers in use, age, warranty expiration, season, and location-specific factors (like Monsoon season in coastal India) impact the number of failures. Furthermore, using a Bayesian approach, we find that transferring statistical information from an older product significantly improves forecast accuracy. The benefit is most pronounced during the initial 24-month period of the product's life cycle. Lastly, we discuss the implications of this forecasting methodology on the supply chain and inventory management.

3 A Simulated Annealing Approach to Designing Optimal Decision Trees for Classification, Prescriptive, and Survival Analysis

Suleeporn (Yui) Sujichantararat[1], Dimitris Bertsimas[2], [1]MIT EECS, Cambridge, MA, [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: ssuji@mit.edu

Binary decision tree is a highly interpretable machine learning model as humans can easily understand how a prediction is made by answering a series of binary questions. Interpretable AI has provided a powerful framework for constructing optimal decision trees by utilizing multiple random warm starts and local search to iteratively improve each warm start until a locally optimal decision tree is found. However, local search does not guarantee global optimality. Hence, we propose to incorporate simulated annealing into decision tree construction as some worse transformations could lead to a better final model. We focus on three problem domains including classification, prescriptive and survival analysis to produce OCT-SA, OPT-SA and OST-SA which further improve on OCT, OPT, and OST by probabilistically allowing a tree to move to a tree with a worse objective value.

4 Getting More Wisdom out of the Crowd: The Case of Competence-Weighted Aggregates

Enrico Diecidue[1], Thomas Langer[2], Michael Goedde-Menke[3], Andreas Jacobs[2], [1]INSEAD, Fontainebleau, France; [2]University of Muenster, Muenster, Germany;

[3]University of Munster, Munster, Germany

This paper shows that group discussions can serve as an instrument to improve individuals' calibration, which in turn strongly increases the accuracy of competence-weighted, statistical aggregates. We conduct an experiment in which participants estimate quantities and report their self-perceived competence for various judgment problems. In addition, they engage in group discussions with other judges on unrelated judgment tasks. We find that prior to participating in the group discussions, judges' self-perceived competence and their estimation accuracy are poorly aligned. However, the information exchange facilitated by the group discussions improved judges' calibration, raising the accuracy of competence-weighted aggregates on subsequent judgment problems to prediction market levels and beyond.

5 Constructing Quantiles via Forecast Errors: Theory and Empirical Evidence

Zhi Chen[1], Long Zhao[2], [1]National University of Singapore, Singapore, Singapore; [2]NUS Business School, Singapore, Singapore. Contact: longzhao@nus.edu.sg

One simple approach to construct probabilistic forecasts is to leverage historical point forecast errors to create quantiles around the point forecast. We develop a theoretical framework to understand how the bias and variance of an estimator affect its overall performance. We find that unbiasedness is not optimal, and the bias towards the center of the distribution is more costly than towards the tails. Besides, higher estimator variance leads to worse performance. These bias-variance insights allow for comparisons among a wide range of estimators. For example, with limited samples, we find that sample quantile is inferior to normal approximation for tail quantiles in both bias (in the more costly direction) and variance. We empirically validate our theoretical findings using the M5 accuracy competition submissions.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB16

CC-North 126B

Fairness in Optimization Models from Operations Management

Community Committee Choice Session

Session Chair: Anil Aswani, UC Berkeley, Berkeley, CA

Session Chair: Yoon Lee, UC Berkeley, Berkeley, CA

1 Incorporating Fairness into Incentive Design in Principal-Agent Models with Adverse Selection and Moral Hazard

Yoon Lee, Ilgin Dogan, Anil Aswani, Zuo-Jun Max Shen, UC Berkeley, Berkeley, CA, Contact: yllee@berkeley.edu

Existing approaches to incentive design often overlook the important aspect of fairness, which can lead to adverse consequences for certain groups based on race, gender, or other characteristics. In this study, we address this limitation by introducing fairness into optimization problems within principal-agent models. Specifically, we focus on scenarios involving adverse selection and moral hazard. We formulate quantitative definitions of fairness and derive the policy structure for optimal fair contracts. By discussing the underlying intuition behind these contracts, we highlight the impact of fairness on incentive design. Furthermore, we present a numerical case study to illustrate the practical implications of incorporating fairness considerations in the design process.

2 Optimization Hierarchy for Fair Statistical Decision Problems

Anil Aswani[1], Mahbod Olfat[2], [1]UC Berkeley, Berkeley, CA, [2]University of California-Berkeley, Berkeley, CA

A growing literature has begun to develop fair statistical techniques, but these are often specialized to one model context and based on ad hoc arguments. This paper develops an optimization hierarchy, which is a sequence of optimization problems with an increasing number of constraints, for fair statistical decision problems. Because our hierarchy is based on the framework of statistical decision problems, this means it provides an approach for developing and studying fair versions of hypothesis testing, decision making, estimation, regression, and classification. We use tools from variational analysis and random set theory to prove that higher levels of this hierarchy lead to a type of fairness consistency. We demonstrate numerical effectiveness of our hierarchy using several data sets, and we use our hierarchy to fairly perform automated dosing of morphine.

3 The Predictive Power of the Microbiome: Does Learning Translate across Studies?

Giana Cirolia, UC Berkeley, Berkeley, CA, Contact: giana@berkeley.edu

The human gut microbiome is home to trillions of bacteria which play a profound role in host physiology. These natural commensals are essential to human immune regulation, digestion and metabolic health. Disturbances in this complex community have been linked with pathologies such as diabetes, obesity, depression, asthma and inflammatory bowel disease (IBD).However, despite correlations being drawn between microbiome composition and disease status, there are considerable inconsistencies between the observational studies which link specific microbiomes and health conditions. This work aims to address the question: Are species predictive of disease status across multiple studies, encompassing different geographies and social groups.

4 Portfolio Approximations and Fairness in Combinatorial Optimization

Swati Gupta[1], Jai Moondra[2], Mohit Singh[3], [1]ISyE Georgia Tech, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, [3]Georgia Institute of Technology, Atlanta, GA, Contact: jmoondra3@gatech.edu

Inspired by fairness notions, we look at ordered optimization for discrete optimization problems on real vector spaces (such as all path vectors in a graph), where we are given a weight vector and the cost of a vector in the domain is the dot product of the weight vector with the sorted domain vector. This generalizes the classic min-sum (such as shortest path) and the min-max (such as makespan minimization) objectives. We study solution portfolios for ordered optimization where we ask for a small set of vectors in a fixed domain that are approximately optimal for each ordered optimization problem, generalizing the special case when one domain vector is approximately optimal for all ordered optimization objectives. We show various upper and lower bounds for minimum portfolio sizes for various problems including shortest paths, matchings, routing, and parallel scheduling.

5 Redesigning Congestion Pricing for Improving Efficiency and Equity: An Empirical Study of San Francisco Bay Area

Kshitij Kulkarni, UC Berkeley, Berkeley, CA, Contact: kshitijkulkarni@berkeley.edu

Tolling is widely adopted as an effective measure to mitigate traffic congestion. However, two major challenges remain in practice: (i) classical tolling mechanisms such as marginal cost pricing are socially suboptimal when travelers have heterogeneous willingness-to-pay, and when tolls must be constrained; (ii) tolling limits the road accessibility of low income travelers. To tackle these challenges, we present a new tolling mechanism that accounts for travelers' heterogeneous willingness-to-pay and constraints on the tolls. In our empirical study of the San Francisco Bay Area, we estimate the average willingness-to-pay of travelers from real traffic data. We then re-design toll prices and demonstrate that our design improves both efficiency -- by reducing average travel time, and equity -- by reducing the difference in travel time experienced by the populations.

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TB17

CC-North 127A

Worker Productivity, the Human-Algorithm Connection, and the “Future of Work

Community Committee Choice Session

Session Chair: Ruth Beer, Baruch College, CUNY, New York, NY

1 Is Transparency Enough? the Effect of Historical Pay Information on Negotiations

Xiaoyang Long[1], Hengchen Dai[2], Dennis Zhang[3], [1]University of Wisconsin-Madison, Madison, WI, [2]UCLA Anderson School of Management, Los Angeles, CA, [3]Washington University in St Louis, ST LOUIS, MO, Contact: xiaoyang.long@wisc.edu

A commonly cited cure for pay inequality is pay transparency, because access to peer pay is believed to prompt underpaid individuals to negotiate. We analytically and empirically study how historical peer pay information influences pay negotiations and pay inequality. We show that pay transparency may induce workers with high self-perceived abilities (who are likely already highly-paid) to ask for more, which may in turn exacerbate pay inequality among hired workers. Thus, pay transparency may not always be a panacea for pay inequality. We discuss measures that can be taken along with pay transparency to combat pay inequality.

2 Stopping the Revolving Door: An Empirical and Textual Study of Crowdfunding and Teacher Turnover

Samantha Meyer Keppler[1], Jun Li[2], Andrew Wu[2], [1]University of Michigan, Ann Arbor, MI, [2]Ross School of Business, University of Michigan, Ann Arbor, MI, Contact: srmeyer@umich.edu

Organizations that provide better worker support have better worker retention. In K--12 public education, teachers commonly feel unsupported by their schools and districts as a result of the gap between top-down, one-size-fits-all resource allocation models and teachers' individual resource needs. In this study, we examine whether a recent trend in education ---teacher crowdfunding platforms---effectively fills this gap and improves retention. We find funded projects on DonorsChoose significantly reduce attrition (leaving the public school system) rates of funded teachers by 1.7 percentage points (pp). Resources which more substantially help teachers enact their professional identities as teachers by personalizing their classrooms and/or their teaching pedagogy have the strongest effect.

3 Payment Algorithm Transparency on On-Demand Service Platforms

Swanand Kulkarni[1], Basak Kalkanci[2], Chris Dalton Parker[3], [1]Georgia Tech, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, [3]American University, Washington

On-demand service platforms have been experimenting with algorithms to determine compensation for their workers. While some use commission- or effort-based algorithms that are intuitive to workers, others, in their efforts to better match customer demand, have transitioned to algorithms where pay is not strictly tied to effort, but depends on other, potentially exogenous factors. Platforms have also kept these algorithms opaque. Workers' reactions to such practices, however, are not systematically examined or understood. Through incentivized experiments, we examine how a pay algorithm's intuitiveness to workers, its transparency, and a change that reduces the algorithm's intuitiveness affect workers' engagement with the platform and perceptions of the platform. Results reveal that transparency is highly effective in managing workers' experience.

4 AI Assistance and Service Usage

Yao Cui[1], Zhaohui Jiang[2], Qi Li[3], [1]Cornell University, Ithaca, NY, [2]Carnegie Mellon University, Pittsburgh, PA, [3]Chinese University of Hong Kong, Shenzhen, China. Contact: yao.cui@cornell.edu

As companies continue to incorporate artificial intelligence (AI) into their services, understanding the impact of AI on user behavior becomes increasingly important. In this paper, we investigate how AI assistance affects consumers' service usage, taking into account users' varying skill levels. We partner with an international on-demand car-rental platform and conduct a field experiment through a technology upgrade involving an AI-powered driver monitoring and feedback system. Our findings reveal that users with low or high skill levels increase their service usage due to AI assistance, while users with medium skill levels do not. We further demonstrate that AI creates value in different ways for low-skilled and high-skilled users. These results highlight the need for customized solutions to maximize the value of AI for different segments of users.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB18

CC-North 127B

Operational Challenges in Emergency Transportation and Health Delivery Systems

Community Committee Choice Session

Session Chair: Gonzalo Romero, Rotman, University of Toronto, Toronto, ON, Canada

1 Ambulance Allocation in a Patient-Centered Emergency Medical Service System

Eric Stratman, Justin J. Boutilier, Laura Albert, University of Wisconsin-Madison, Madison, WI, Contact: egstratman@wisc.edu

Changes to U.S. regulations now permit some emergency medical service (EMS) providers to treat patients at the scene of an incident or a destination other than an emergency department. These new treatment pathways prioritize patient-centered care and reduce the cost of emergency care; however, it is unclear how EMS resources should be deployed to support these goals. We bridge this gap. We develop a framework to find the optimal deployment, fleet mix, and allocation strategies for an EMS system with multiple treatment pathways. Our work expands existing facility location research by modeling uncertainty in a patient's condition and the actions taken once a patient's true needs are learned. We summarize managerial insights and demonstrate the importance of adapting EMS strategy for this innovation.

2 Human in the Loop Automation: Ride-Hailing with Remote (Tele-) Drivers

Saif Benjaafar, Zicheng Wang, Xiaotang Yang, University of Minnesota, Minneapolis, MN, Contact: yang4767@umn.edu

By putting the human back "in the loop," tele-driving has recently emerged as a more viable alternative to fully automated vehicles, with ride-hailing (and other on-demand transportation-enabled services) being an important application. We examine the impact of tele-driving on the efficiency of ride-hailing. Among our findings, we show that having fewer (tele-) drivers than vehicles can surprisingly improve performance (mitigating the wild goose chase phenomenon) or stabilize an otherwise unstable system.

3 Operational Challenges in Emergency Service Platforms in Developing Countries

Pieter van den Berg[1], Andre Du Pin Calmon[2], Andreas Gernert[3], Stef Lemmens[4], Gonzalo Romero[5], [1]Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands; [2]Scheller College of Business, Georgia

Institute of Technology, Atlanta, GA, [3]KLU, Hamburg, Germany; [4]Rotterdam School of Management, Erasmus University Rotterdam, Rotterdam, Netherlands; [5]Rotman, University of Toronto, Toronto, ON, Canada. Contact: gonzalo.romero@rotman.utoronto.ca

Many developing economies lack the health-emergency infrastructure of developed countries. Our industry partner Flare (Nairobi, Kenya) coordinates existing ambulance providers through a platform. Flare aggregates the available ambulance capacity and demand for emergency services. Since ambulance platforms make use of independent providers, the ambulance fleet can only be partially controlled.

4 Breaking Silos in Mobile Health Delivery: A Resource Allocation Perspective

Thomas Breugem[1], Tim Sergio Wolter[2], Luk N. Van Wassenhove[3], [1]Tilburg University, Tilburg, Netherlands; [2]INSEAD, Fontainebleau, France; [3]INSEAD, Fontainebleau Cedex, France. Contact: t.breugem@tilburguniversity.edu

We consider a resource allocation problem faced by health and humanitarian organizations deploying mobile outreach teams to serve marginalized communities. These teams can provide a single service or an assortment of services during each visit. Combining services is likely to increase operational efficiency but decrease the relative benefit per service per visit, as operations are no longer tailored to a single service. The aim of this study is to analyze this benefit-efficiency trade-off. Our results show the benefit-efficiency trade-off can be assessed based on high level parameters. We show demand alignment is a key driver of this trade-off. We apply our results to Praesens Care, a social enterprise start-up developing mobile diagnostic laboratories, and verify our insights using real-world data.

5 Design of Community Maternal and Neonatal Health Programs Using the Lives Saved Tool: A Constrained Optimization Approach

Baris Ata[1], Muna Jama[2], Naoko Kozuki[2], Robert Montgomery[3], Elaine Scudder[2], Caitlin Tulloch[2], [1]University of Chicago, Chicago, IL, [2]International Rescue Committee, New York City, NY, [3]University of Chicago, North Pole, AK

We approach the choice of interventions for a community maternal and neonatal health (MNH) program by constructing a constrained optimization model for health program design and applying it to the Somalia setting, identifying the highest-impact combination of interventions in severely resource-constrained environments. After consultations with Somalian stakeholders to establish the resource requirements for 25 MNH interventions we used the Lives Saved Tool (LiST) to calculate the number of projected lives saved. We use optimization techniques to sort through feasible combinations of interventions satisfying the resource constraints to determine the package that leads to the most projected lives saved in Somalia. We include sensitivity analysis to show how the optimal combination of interventions shifts as the resource budgets and other parameters are changed.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB19

CC-North 127C

Racial and Gender Bias in Healthcare Research

Panel Session

Session Chair: Gian-Gabriel P. Garcia, Georgia Institute of Technology, Atlanta, GA

Session Chair: Behshad Lahijanian, Georgia Institute of Technology, Atlanta, GA

1 Moderator

Gian-Gabriel P. Garcia, Georgia Institute of Technology, Atlanta, GA

Diversity, equity, Inclusion (DEI) is an inherently complex issues, and everyone makes their trade-off between perfect equality and dealing with historical inequality. Researchers always suffer from these biases between different genders, races, and under-represented minorities. This gender bias is more critical in human life. What's missing is an in-depth understanding of how women and men of different races respond differently to medications and other therapies, as well as other variables that profoundly influence human health. In this panel discussion, we will discuss these biases in healthcare research.

2 Panelist

Karen T. Hicklin, University of Florida, Gainesville, FL

3 Panelist

Julie Simmons Ivy, University of Michigan, Ann Arbor, MI

4 Panelist

Yonatan Mintz, University of Wisconsin Madison, Madison, WI

5 Panelist

Gian-Gabriel P. Garcia, Georgia Institute of Technology, Atlanta, GA

Tuesday, October 17, 10:45 AM - 12:00 PM

TB20

CC-North 128A

Analytics for Healthcare Value Optimization at Mayo Clinic

Community Committee Choice Session

Session Chair: Esma S. Gel, University of Nebraska-Lincoln, Lincoln, NE

Session Chair: Thomas Kingsley, Mayo Clinic, Rochester, MN

1 ICU Datamart: Tool to Support Value Based Practice

Vitaly Herasevich, Mayo Clinic, Rochester, MN

With development of computer science and technology, computer technologies have been widely used in ICU to help providers improve clinical care quality. Adoption of electronic patient information systems in past decade gives hospitals tools to to automate the analysis of clinical data to get valuable insights about practice. Presenter will discuss experience with building a automatic near-real time central database (ICU Datamart) for collection and storing information from heterogeneous and distributed information sources, containing information about ICU patients at Mayo Clinic for purpose of quality improvement, decision support and clinical research.

2 Community/Committee'S Choice Submission

Rajeev Chaudry, Mayo Clinic

3 Community/Committee'S Choice Submission

James Newman, 1</sup

4 Mayo Clinic's COVID-19 Clinical Cohort Knowledge Solution

John O'horo, Mayo Clinic, Rochester, MN

During the COVID-19 pandemic, Mayo Clinic established a series of registries to track patients, care paths and outcomes. Establishing common definitions for research and operational use cases allowed for a unified framework for gathering patient data and implementing new best practices as they became available. This registry allowed for translation of research study eligibility into best practice advisories as new therapeutics and standards of care became available. We describe this approach to a 'clinical cohort knowledge solution,' and advocate for using this framework for agile and efficient responses to future emergencies.

5 Improving Hospital Census Management with Artificial Intelligence

Alex Ryu, Thomas Kingsley, Mayo Clinic, Rochester, MN

Increased hospital bed demand and decreased staff availability have led to unprecedented challenges with hospital overcrowding, particularly since COVID-19. To address these issues, our hospital system began exploring artificial intelligence approaches to forecasting bed demand and expediting patient triage in our emergency department (ED). We explored regularized linear regression and Markov chain modeling to forecast bed demand, and implemented a gradient-boosted tree model to predict patient-level need for hospital admission from the ED. Both tools were associated with specific downstream actions. Our admission prediction model is currently in a randomized, controlled trial to investigate its effect on hospital and ED efficiency.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB21

CC-North 128B

Analytical Modeling to Inform Health Policy

Community Committee Choice Session

Session Chair: Qiushi Chen, Penn State University, University Park, PA

Session Chair: Yu-Hsin Chen, Pennsylvania State University, University Park, PA

1 Advancing Healthcare Decision-making: Leveraging Data-driven Models for Optimal Insurance Selection and Service Enhancement

Behshad Lahijanian, Georgia Institute of Technology, Atlanta, GA, Contact: blahijanian3@gatech.edu

Selecting an appropriate health insurance plan from a plethora of options can be complex, considering the diverse plans available and their cost distribution throughout the year. In this study, we introduce a stochastic program model to aid in health insurance selection by incorporating different network types. Our model enables individuals to comprehend, compare, and choose the optimal health insurance plan that aligns with their individual needs. Additionally, we propose a solving algorithm to minimize total costs, including both covered and uncovered expenses, over the course of a year. By utilizing this approach, individuals can make informed decisions, resulting in improved financial outcomes and enhanced healthcare coverage.

2 MDP-Based Screening Policy Optimization for Hospital-Acquired Infections: A Case Study of MRSA Surveillance Among Exposed Roommates in Canadian Hospitals

Esma Akgun, F. Safa Erenay, Sibel Alumur, University of Waterloo, Waterloo, ON, Canada. Contact: eakgun@uwaterloo.ca

In this study, we develop an MDP (Markov Decision Process) model to optimize screening strategies for preventing hospital-acquired infections, with a focus on MRSA (Methicillin-Resistant Staphylococcus Aureus) surveillance among exposed roommates in Canadian hospitals. Our model takes into account the spread of MRSA within the hospital room structure and evaluates multiple performance measures, including quality-adjusted life years, cost, the number of colonized patients, and missed MRSA cases. Through our evaluation, we can determine the most effective screening policies to limit MRSA transmission and prevent hospital-acquired infections. Our results offer valuable insights to healthcare professionals to enhance screening protocols and prevent the spread of MRSA in hospital settings.

3 Visiting Nurses Assignment and Routing for Hybrid Telehealth Service Networks

Tan Yu, Yongpei Guan, Xiang Zhong, University of Florida, Gainesville, FL

As telehealth utilization skyrockets, there has been a paradigm shift to a decentralized care delivery modality integrating both in-person and telehealth services provided at different layers of the care delivery network, i.e., central hospital, satellite clinics, and patient homes. The operations of such decentralized care delivery need to take into consideration patients' preferences and satisfaction and rely on multiple types of nurses who can support and facilitate telehealth with physicians in clinics and patient homes. We formulate an optimization problem to simultaneously satisfy patients' care needs and reduce operating costs. We propose a bi-level approximation that exploits the structure of the hybrid telehealth system and develop column generation-based approaches to identify the decision rules for clinic selection and nurse scheduling.

4 Design of Covid-19 Staged Alert Systems with Wastewater Surveillance: A Retrospective Case Study

Guyi Chen[1], Shuotao Diao[2], David Morton[1], [1]Northwestern University, Evanston, IL, [2]University of Southern California, Los Angeles, CA, Contact: guyichen2024@u.northwestern.edu

Community mitigation strategies can reduce transmission of SARS-CoV-2. We seek to derive a COVID-19 mitigation strategy to retrospectively ensure healthcare capacity with minimal closures. Wastewater surveillance is cost-effective and sustainable even during non-pandemic times and can capture symptomatic and non-symptomatic individuals. More importantly, a wastewater signal can precede other signals such as hospital admissions.We use wastewater surveillance to inform toggling between mitigation stages. We propose an optimized staged-alert system with a wastewater signal using Cook County in Illinois as a case study.

5 Optimize Referral Decisions for Early Diagnosis Under Limited Service Capacity: An Application in Autism Screening

Yu-Hsin Chen[1], Qiushi Chen[1], Whitney Guthrie[2], [1]Penn State University, University Park, PA, [2]The Children's Hospital of Philadelphia, Philadelphia, PA

Early diagnosis is crucial to the treatment outcome of Autism Spectrum Disorder (ASD), a developmental disorder that affects 1 in 44 children in the US. While universal screening has been advocated for early diagnosis of ASD, it has been widely debated concerning the screening tool's poor accuracy and the limited diagnostic service capacity. To improve the early diagnosis of ASD under limited service capacity, we develop a non-convex mixed integer quadratic program that determines the optimal risk-based diagnostic referral decision at different ages. The model is solved to optimality using branch and bound algorithm and McCormick relaxation. Finally, we evaluate the performances of different referral policies with individual-level discrete event simulation, and analyze the impact of service capacity and length of diagnostic waitlist on the early diagnosis outcomes.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB22

CC-North 129A

Recent Advances in Radiation Therapy

Community Committee Choice Session

Session Chair: Kimia Ghobadi, Johns Hopkins University, Baltimore, MD

Session Chair: Masoud Zarepisheh, Memorial Sloan Kettering, New York, NY

1 Low Dimensional Radiotherapy Treatment Planning Using Low-Rank Plus Sparse Matrix Embedding and Wavelets

Masoud Zarepisheh[1], Mojtaba Tefagh[2], [1]Memorial Sloan Kettering, New York, NY, [2]Sharif University of Technology, Tehran, Iran, Islamic Republic of

This study aims to leverage the dimensionality reduction tools to improve the speed and quality of radiotherapy planning. The dimensionality reduction has a rich history in statistics and has recently re-emerged as a powerful tool to deal with the problems arising in the fields of big-data and machine learning. The optimization problems arising in radiotherapy also suffer from the curse of dimensionality (e.g., many machine parameters, voxels). We show how matrix/tensor decomposition, in particular low-rank plus sparse decomposition, and wavelets can be employed to significantly improve the computational efficiency and plan quality. We also propose a novel algorithm for the low-rank plus sparse matrix decomposition and demonstrate the effectiveness of the new algorithm on radiotherapy problems as well as background separation problems in computer vision.

2 Simultaneous Reduction of Number of Spots and Energy Layers in Intensity Modulated Proton Therapy for Rapid Spot Scanning Delivery

Anqi Fu[1], Vicki T. Taasti[2], Masoud Zarepisheh[3], [1]Memorial Sloan Kettering, New York, NY, [2]Maastro, Maastricht, Netherlands; [3]Memorial Sloan Kettering, New York, NY, Contact: anqif@alumni.stanford.edu

We propose a method to improve the delivery efficiency of proton therapy by reducing the number of spots and energy layers using reweighted l_1 regularization. We formulate the treatment planning problem as a convex problem with an objective containing a plan quality term and a weighted l1 regularization term. We iteratively solve this problem, updating the weights to promote sparsity of the spots and layers. We assess the algorithm on four head-and-neck patients and find that reweighted l_1 regularization reduces the number of spots and energy layers by 40% and 35%, respectively, with minimal cost to plan quality. It also provides a better trade-off between delivery efficiency and quality than standard l_1 or group l_2 regularization.

3 PortPy: An Open-Source Python Package for Planning and Optimization in Radiation Therapy Including Benchmark Data and Algorithms

Gourav Jhanwar[1], Mojtaba Tefagh[2], Vicki Trier Taasti[3], Sadegh Alam[4], Seppo Tuomaala[1], Saad Nadeem[1], Masoud Zarepisheh[1], [1]Memorial Sloan Kettering Cancer Center, New York, NY, [2]Sharif University of Technology, Tehran, Iran, Islamic Republic of; [3]Department of Radiation Oncology (MAASTRO), GROW – School for Oncology and Reproduction, Maastricht University Medical Centre+, Maastricht Limburg, Netherlands; [4]Weill Cornell Medicine, New York, NY, Contact: jhanwarg@mskcc.org

Following the success of our in-house automated treatment planning system (called ECHO) which treated more than 7,000 patient to-date, we decided to develop the first open-source python library for *benchmarking*, *reproducibility*, and *community-driven* development of radiotherapy cancer treatment planning optimization algorithms. PortPy is a python codebase currently including: 1) 100 research-ready benchmark dataset for lung patients with pre-calculated influence matrix from an FDA-approved treatment planning system, 2) benchmark optimization algorithms 3) 2D and 3D visualizations, and 4) benchmark evaluation metrics. The PortPy GitHub organization (https://github.com/PortPy-Project) hosts the codebase. PortPy promotes transparency for treatment planning algorithm developments by providing benchmark code and datasets.

4 Automated Vmat Treatment Planning Using Sequential Convex Programming: Algorithm Development and Clinical Implementation

Pinar Dursun, Linda Hong, Gourav Jhanwar, Qijie Huang, Ying Zhou, Jie Yang, Hai Pham, Laura Cervino, Jean M. Moran, Joseph O. Deasy, Masoud Zarepisheh, Memorial Sloan Kettering Cancer Center, New York, NY, Contact: pinar.dursun@boun.edu.tr

This study develops and clinically implements a fully automated treatment planning system for volumetric modulated arc therapy (VMAT). Two constrained optimization problems are solved sequentially using an algorithm that optimizes machine parameters directly and handles non-convexity using sequential convex programming. Two novel convex surrogate metrics improve plan delivery efficiency and reduce plan complexity. Before clinical implementation, the program was tested retrospectively on 60 patients and compared to manual plans, with automated plans found dosimetrically comparable or superior. The program is currently deployed in a clinic and used in daily clinical routine.

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TB23

CC-North 129B

Smart Urban Mobility and Logistics: Integration and Optimization

Community Committee Choice Session

Session Chair: Sheng Liu, University of Toronto, Toronto,

ON, Canada
Session Chair: Yiling Zhang, University of Minnesota, Minneapolis, MN

1 Strategic Service Games with Customer-Induced Competition

Lavanya Marla[1], Jungeun Shin[2], Sanyukta Deshpande[3], [1]University of Illinois at Urbana-Champaign, Urbana, IL, [2]University of Illinois at Urbana-Champaign Department of Industrial and Enterprise Systems Engineeri, Nottingham, United Kingdom; [3]University of Illinois at Urbana Champaign, Champaign, Contact: lavanyam@illinois.edu

We study decentralized Emergency Medical Services (EMS) in emerging economies, where customers order from multiple providers and choose the one that provides quicker service. In turn, providers strategically define their service regions. We model this as a stylized non-cooperative game with two providers located at each end of a Hoteling line. Providers strategically choose service regions to maximize their utility given the stochasticity and opportunity costs. We analyze provider behavior using renewal theory, to show that the coupling is `limited', resulting in a tractable approximation of the system -- and the existence of an "epsilon"-equilibrium for the original system. We find that customer-utility-maximizing coverages are pareto-improving compared to the provider equilibrium; and are moreover, non-intuitive compared to policymakers' expectations.

2 A Continuum Approximation Approach for Freight-On-Transit System Design Under Spatially Heterogeneous Demand

Shiyu Shen, Yanfeng Ouyang, University of Illinois at Urbana-Champaign, Urbana, IL, Contact: sshen10@illinois.edu

Recent decline in transit ridership and surge in freight demand pose challenges for both sectors. A freight-on-transit (FOT) system is proposed to utilize the available transit vehicle capacities to support freight deliveries. The service region, with spatially heterogeneous freight demand, is divided into disjoint zones each containing a subset of co-modal stations from the transit network. Transit vehicles are used to perform freight line-haul services across zones, while dedicated local vehicles provide intra-zonal and last-mile services. A continuum approximation (CA) approach with an embedded aspatial queuing network model is used to optimize zonal service configurations (including the distributions of zones, co-modal stations, and local fleet sizes). A series of numerical experiments are conducted to demonstrate the applicability of the proposed model.

3 Robust Probabilistic Envelope Constrained Programming for Ultra-Fast Delivery

Xin Wang, Erick Delage, Okan Arslan, Jean-François Cordeau, HEC Montréal, Montréal, QC, Canada. Contact: xin.wang@hec.ca

Ultra-fast delivery is a novel idea for food and grocery delivery service within a matter of minutes. We investigate the arising delivery problem with different service level guarantees, and develop robust probabilistic envelope constrained programming models in which both the travel time distribution and the probability of customer placing order in different time periods are not explicitly known, and the demand depends on the uncertainty and allocation decisions. We then derive equivalent and tractable linear programming models. We compare the performances of period and daily service levels under different protections, and find the profitable ones that yield fast delivery, high demand coverage, and low level of violations. We carry out extensive experiments using a real-world dataset provided by Amazon and Google API, and derive some managerial insights.

4 Packages, Passengers, or Both? The Value of Joint Delivery and Ride-Hailing

Sheng Liu[1], Junyu Cao[2], [1]University of Toronto, Toronto, ON, Canada; [2]The University of Texas at Austin, Austin, TX, Contact: sheng.liu@rotman.utoronto.ca

With the emergence of on-demand platforms, it has become viable for drivers to participate in package delivery and passenger rides operations at the same time. The integration and coordination of the two services, known as co-modality, is considered a promising solution for improving the efficiency of urban logistics and mobility systems. In this work, we propose a simple zoning-based coordination policy and analyze its performance against pure delivery and ride-hailing policies.

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TB24

CC-North 130

Disruptive Technologies and Operations Management

Community Committee Choice Session

Session Chair: Xiangjing Chen, Arizona State University, Tempe, AZ

1 Competitive Pricing in the Presence of Manipulable Information in Online Platforms

Harish Guda, Yuqi Yang, Hongmin Li, Arizona State University, Tempe, AZ

To entice customers to purchase, sellers on online platforms often misrepresent the quality of their goods/services, e.g., by manipulating customer opinions. We analyze an oligopoly where sellers, heterogeneous in their true quality, compete by jointly choosing their prices and the extent of manipulation. We show that when manipulation cost is symmetric across products, higher quality sellers have a greater incentive to manipulate than lower quality sellers, and thereby manipulate by a greater extent. When the manipulation cost is asymmetric, and the marginal manipulation cost is increasing in the quality of sellers, sellers' propensity to manipulate could be either monotone or unimodal in their true quality. In this paper, we describe the dynamics under a wide spectrum of scenarios to explain observations in practice.

2 Data-Driven Delivery Zoning for Equitable Last-Mile Logistics

Han Yu[1], Sheng Liu[2], Stanley Lim[3], John Gunnar Carlsson[1], [1]University of Southern California, Los Angeles, CA, [2]University of Toronto, Toronto, ON, Canada; [3]Michigan State University, East Lansing, MI, Contact: hyu376@usc.edu

Last mile delivery system is in high demand, due to customer expectations for fast deliveries. We propose a novel approach that utilizes the weighted Voronoi diagram to minimize the expected delivery time and sorting time of customer orders and achieve equitable workload distribution among drivers in a stochastic setting. We consider the randomness and general distribution of order locations. Our policy assigns each hub to a specific subregion, and drivers from that hub are responsible for delivering all orders in that region. We combine the sample average algorithm and robust optimization with the weighted Voronoi diagram and also propose a discrete case of the algorithm. We evaluate our algorithm's performance in Thailand and compare it to the current partition approach, demonstrating its potential to improve last-mile delivery systems.

3 Service Recovery via Social Media: The Role of Brand Personality and Competitive Strategy

Pei Xu[1], Lin Lu[2], Sidi Zhao[1], Yen-Yao Wang[1], [1]Auburn University, Auburn, AL, [2]Fairfield University, Fairfield, CT, Contact: pzx0002@auburn.edu

Due to the public nature of the interactions and the ability to foster quicker responses than traditional media, social media has become a powerful channel for both travelers to post their trip-related questions and issues, and airlines to build their brand images. Based on the Signaling theory and Expectations- Confirmation theory, we propose that airline service recovery via Twitter will boost profitability, and such influence is more vital for network airlines than focused airlines and is moderated by brand personality dimensions.

4 Social Media Impersonation and Identity Verification

Zihong Huang, Texas Tech University, Lubbock, TX

In this paper, we study the economics of social media impersonation. Social media impersonation refers to accounts pretending to be someone else by using other people's profile elements such as names, photos, and demographic information. This study is motivated by the observation of social media platforms' efforts to address the social media impersonation problem by introducing the paid identity verification service. we propose questions that should the platform provide the identity verification service, and what's the welfare impact? By incorporating the platform, content creator, and consumers in the signaling game framework, we can examine the platform's optimal decision and the creator's equilibrium behaviors.

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CC-North 131A

Empirical Healthcare Operations

Community Committee Choice Session

Session Chair: Harshita Kajaria-Montag, University of Cambridge, Cambridge, United Kingdom

1 The Role of Peer Familiarity in Shared Service Delivery: An Investigation into Shared Medical Appointments

Nazli Sonmez[1], Kamalini Ramdas[2], Ryan Buell[3], [1]ESMT Berlin, Berlin, Germany; [2]London Business School, London, United Kingdom; [3]Harvard Business School, Boston, Contact: nazli.sonmez@esmt.org

In shared service delivery, a group of customers is served at once. We examine how peer familiarity impacts service outcomes in shared service delivery in the context of shared medical appointments (SMA) - in which patients with similar chronic conditions meet with a doctor at once, and each receives one-on-one care in turn. Using data from the treatment arm of a prior multistage randomized controlled trial at a large hospital in India and an instrumental variable approach, we find that having familiar peers in the group significantly increases patient satisfaction, taking advantage of plausibly exogenous variation in peer familiarity. Our results shed light on an important aspect of how shared medical appointment groups should be formed. The insights obtained could also be valuable when considering delivery innovation in other traditionally one-on-one service settings.

2 The Mediating Effect of Market Competition on Episode-Based Payments

Turgay Ayer[1], Bilal Gokpinar[2], Austin McCandlish[3], [1]Georgia Tech, Atlanta, GA, [2]UCL School of Management, London, United Kingdom; [3]Georgia Institute of Technology, Atlanta, GA, Contact: ayer@isye.gatech.edu

Episode-based payment (EBP) makes health care providers financially liable for meeting cost benchmarks throughout an entire episode of care. We study the effect of an EBP scheme targeting childbirth using a large employer-sponsored claims data set. We find that EBP is associated with a reduction in inpatient spending, driven by lower facility payments. Further, we find EBP only generates savings in competitive hospital markets, and savings are generated by rerouting patients away from high-cost hospitals. We find no evidence of savings in markets with low competition. We also find no evidence providers significantly alter inpatient treatment patterns or use of follow-up. We conclude physicians targeted with EBP focus on reducing use of high-cost hospitals rather than changing treatment patterns, and as such EBP is only effective in competitive hospital markets.

3 Reducing Appointment Delays: The Impact of Standardized EHR Usage on Physician Timeliness

Umit Celik[1], Sandeep Rath[2], Bradley R. Staats[3], Saravanan Kesavan[4], [1]UNC Kenan-Flagler Business School, Chapel Hill, NC, [2]University of North Carolina at Chapel Hill - Kenan Flagler, Chapel Hill, NC, [3]University of North Carolina at Chapel Hill, Chapel Hill, NC, [4]University of North Carolina-Chapel Hill, Chapel Hill, NC, Contact: umit_celik@kenan-flagler.unc.edu

This paper explores the impact of standardized Electronic Health Record (EHR) usage on physician timeliness and appointment delays. Data from physicians' schedules and detailed EHR timestamps are analyzed. Standardizing EHR work before appointments reduces multitasking, while standardization before and during appointments further reduces multitasking. Increased multitasking during appointments leads to subsequent appointment delays, but increased standardization reduces them. These findings inform healthcare operations strategies for reducing delays by standardizing EHR usage, benefiting healthcare administrators, improving physician timeliness, and enhancing patient satisfaction.

4 Workforce Composition as a Key Determinant of Primary Care Outcomes

Harshita Kajaria-Montag[1], Michael Freeman[2], [1]University of Cambridge, Cambridge, United Kingdom; [2]INSEAD, Singapore, Singapore. Contact: hk437@cam.ac.uk

Primary care practices have responded to the workforce crisis by altering the composition of their workforce, specifically, by hiring more part time and locum physicians. But, this is counterproductive as research suggests that providing continuity of care is productivity-enhancing, which is difficult to offer with such a fragmented workforce. Consequently, the trend suggests that continuity of care has been declining over the past decade. This paper examines this question from an operations management perspective by exploring the relative importance of workforce composition related operational factors that may explain variation in rates of COC between practices and over time

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CC-North 131B

Supply Chain Finance and Operations

Community Committee Choice Session

Session Chair: Christopher J. Chen, Indiana University Kelley School of Business, Bloomington, IN

1 The Endemic Population-Trust and Supply Chain Networks

Ziang Wang[1], Volodymyr O. Babich[2], Gilles Hilary[3], Jing Wu[4], [1]The Hong Kong Polytechnic University, Hong Kong, Hong Kong; [2]Georgetown University, Washington, [3]Georgetown University, Washington, DC, [4]Chinese University of Hong Kong, Hong Kong, Hong Kong

We study the effect of endemic population trust on the formation and dissolution of supply chain links. We apply the matching markets theory from Becker (1973) to analyze supply chain partnerships. Our empirical evidence is consistent with the complementarity of the endemic population trust of supply chain partners. Specifically, using a unique combination of supply chain links with socio-demographic and financial variables, we find a negative relationship between the supply chain durability and the trust distance between the two partners, indicating a positive

assortive matching. We also find that outside of the steady state, after the exogenous shocks to supply chains, the average endemic population trust of supply chain partners increases the durability of supply chain links.

2 Resource Reallocation: Empirical Evidence from Drug Shortages in the United States

Iva Rashkova[1], Panos Kouvelis[2], [1]Washington University in St Louis, St Louis, MO, [2]Washington University in St. Louis, St Louis, MO, Contact: irashkova@wustl.edu

We utilize two drug shortages data sources to study the link between new drug approvals and drug shortages. Drug approvals vary by therapeutic class of the drug and approval type - brand name, generic with or without market exclusivity. We find that the timing of a new drug shortage, in either database, is correlated with a subsequent drug approval for the same firm. Interestingly, the time lag between these events is increasing in the attractiveness of the drug approval's type. With the time lag identified based on the drug approval type, we also find a positive correlation between the time-to-recovery for an individual drug-shortage event and the associated drug approval. Our results potentially offer healthcare providers and policymakers insights into industry-wide capacity and resource allocation trends.

3 Effects of Financial Constraints on Supply Chain Financing Choices and Operational Decisions

Anqi Wu[1], Qi Wu[2], Sridhar Seshadri[3], [1]Florida International University, Miami, FL, [2]Case Western Reserve University, Cleveland, OH, [3]UIUC, Champaign, IL, Contact: anwu@fiu.edu

Bank credit is an important source of financing for firms and can have a significant impact on operational decisions. However, limited OM literature empirically investigates this impact and the mechanisms through which this impact manifest. This study bridges this gap by jointly considering multiple financial and operational factors in a supply chain. We overcome a primary empirical challenge, which arises from the embedded simultaneity between financial and operation decisions, by exploiting a policy intervention that imparted an exogenous shock to bank credit accessibility. We find that the improvement of firms' access to bank credit generates heterogenous effects on their financing choices and operational decisions in terms of different firm sizes and time periods.

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CC-North 131C

Platform Operations

Community Committee Choice Session

Session Chair: Dennis Zhang, Washington University in St Louis, ST LOUIS, MO

Session Chair: Bing Bai, Washington University in St. Louis, Saint Louis, MO

1 Inferring Consideration Sets from Heatmap Data

Zahra Ziaei[1], Adam J. Mersereau[2], Seyed Emadi[3], Vidyaranya Gargeya[4], [1]Kenan-Flagler Business School, Chapel Hill, NC, [2]University of North Carolina at Chapel Hill, Chapel Hill, NC, [3]University of North Carolina-Chapel Hill, Chapel Hill, NC, [4]University of NC-Greensboro, Greensboro, NC, Contact: zahra_ziaei@kenan-flagler.unc.edu

Ignoring consideration sets in modeling customer decisions may lead to biased estimation of customer preferences, yet consideration sets are difficult to infer in brick-and-mortar contexts. We show that the challenge of estimating consideration set models in brick-and-mortar contexts can be overcome with an emerging source of data: heatmap data. In contrast with clickstream data, heatmap data show customer traffic only in the aggregate. Despite this limitation, we show that heatmap data enable us to recover many of the benefits of individual-level data, such as eliminating the need for exclusion-restriction assumption and decreasing finite-sample bias. Finally, we install heatmap sensors in a retail store and find that heatmap data can result in improved predictive accuracy and better-estimated revenues in a product placement decision problem.

2 An Empirical Study of Blockchain-driven Transparency in a Consumer Marketplace

Jane Yi Jiang[1], Kenneth Moon[2], Wedad Jasmine Elmaghraby[3], [1]University of Maryland, College Park, MD, [2]University of Pennsylvania, Philadelphia, PA, [3]University of Maryland, College Park, MD, Contact: jyjiang@umd.edu

Blockchain tracing generates credible transparency into products' supply chains, firms and marketplaces are now asking whether sharing such information with consumers can better convey the quality of their goods and increase consumer trust. We collaborate with a leading online platform in China to study such supply chain transparency's effects in a consumer marketplace. Using synthetic control methods, we find that such transparency significantly increases third-party sellers' average monthly revenues by up to 23.4% but disproportionately benefits products that are handling-sensitive or sold in less trusted markets. We structurally model the consumers' Bayesian learning process regarding quality and find that whereas transparency improves the accuracy of the quality signals that consumers receive, how consumers benefit depends on their sophistication.

3 Green E-Commerce: Environmental Impact of Fast Delivery

Chenshan Hu[1], Xiaoyang Long[2], Jiankun Sun[3], Dennis Zhang[4], [1]Washington University in St. Louis, Saint Louis, MO, [2]University of Wisconsin-Madison, Madison, WI, [3]Imperial College London, London, United Kingdom; [4]Washington University in St Louis, ST LOUIS, MO, Contact: chenshan.hu@wustl.edu

In this paper, we empirically investigate how an increase in delivery speed influences consumer purchasing behavior and evaluate how this would further lead to environmental issues. Then, we develop a model to explain our empirical results and accordingly, propose delivery pricing policies to achieve both environmental benefits and decent company revenue.

4 Externalities of Restaurant Density in Online Food Delivery Platforms

Ruomeng Cui, Emory University, Amazon, Decatur, GA

The rapid growth in sales within the food-delivery industry is driven by platforms striving to increase both the quantity and variety of their partnered restaurants. In this paper, we assess the impact of restaurant density on the operational performance of restaurants partnered with food delivery platforms. By integrating empirical findings with theoretical predictions from a queuing model, we ascertain that the role of delivery becomes more dominant than customer expansion and cannibalization as restaurant density increases.

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CC-North 132A

Data-Driven Methods for Supply Chain Management

Community Committee Choice Session

Session Chair: Yining Wang, University of Texas at Dallas, Richardson, TX

1 Data-Driven Population Tracking in Large Service Systems

Morgan Wood[1], Fernando Bernstein[2], N. Bora Keskin[2], Adam J. Mersereau[3], Serhan Ziya[4], [1]University of North Carolina, Chapel Hill, NC, [2]Duke University, Durham, NC, [3]University of North Carolina at Chapel Hill, Chapel Hill, NC, [4]University of North Carolina, Chapel Hill, NC, Contact: smithmor@email.unc.edu

We develop asymptotically optimal policies to track queue lengths under different loss structures in a setting with inaccurate arrival and departure sensor data. By deriving general lower bounds on any policy's expected cumulative loss, we show that tracking the population in real-time is challenging because of the accumulation of tracking errors. We propose a detection policy with provably good performance guarantees that corrects the estimated population count when the system is believed to be nearly empty. Further, we explore the benefits of augmenting the sensor information with periodic queue inspections at a cost. Our model is motivated by queue tracking implemented at a large airport.

2 Assortment Optimization Under the Multivariate MNL Model

Tiancheng Zhao[1], Xin Chen[2], Menglong Li[3], Jiachun Li[4], Yuan Zhou[5], [1]University of Illinois at Urbana–Champaign, Champaign, IL, [2]Georgia Institute of Technology, Atlanta, GA, [3]City University of Hong Kong, Hong Kong, Hong Kong; [4]Tsinghua University, Beijing, China; [5]Tsinghua University, Beijing, China. Contact: tz14@illinois.edu

In this paper, we study an assortment optimization problem in which an assortment consists of products from two categories, and customers are allowed to choose a bundle of at most one product from each category. We allow arbitrary product interaction that determines the utility of each bundle. We show that the problem is NP-hard. Motivated by this, we design a 0.74-approximation algorithm based on an LP relaxation of the problem. This algorithm almost closes the integrality gap of the LP relaxation which is shown to be at most 0.75. Numerical experiments are conducted to demonstrate the quality and efficiency of our proposed algorithm.

3 A Dynamic Learning Policy for Multi-Warehouse Multi-Store Systems with Censored Demands

Sentao Miao[1], Yining Wang[2], [1]McGill University, Montreal, QC, Canada; [2]University of Texas at Dallas, Richardson, TX, Contact: sentao.miao@mcgill.ca

In this paper, we discuss the problem of inventory allocation in a multi-warehouse multi-store system when demand is unknown and we can only observe the censored demand. In particular, two decisions have to be made: replenishment at each store and percentage allocation from warehouses to stores, which depend on each other and make the problem a highly complicated non-convex dynamic programming. We propose a primal-dual learning algorithm based on a robust cutting plane method which decouple these two decisions. Our results show that the proposed algorithm performs near optimal.

4 Unit Commitment without Commitment: A Dynamic Framework for Managing an Integrated Energy System

David Brown[1], James Smith[2], [1]Duke University, Durham, NC, [2]Dartmouth College, Hanover, NH

Renewable energy sources like solar and wind are prone to variability and uncertainty. Although variable and uncertain demand has always been an issue for power systems, the growing reliance on renewable energy increases the need for system operators to manage production systems carefully. In this work, we develop a rigorous, analytical framework based on weakly coupled stochastic dynamic programming to help system operators manage production under uncertainty. We demonstrate our framework using models based on data provided by Duke Energy. Compared to current practice, our approach is computationally efficient and substantially improves operational efficiency, with the efficiency gains increasing in the renewable capacity of the system.

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CC-North 132B

Empirical Examinations of Emerging Topics in Sustainable Operations

Community Committee Choice Session

Session Chair: Natalie Ximin Huang, University of Minnesota, Minneapolis, MN

Session Chair: Wayne Fu, University of Michigan-Dearborn, Dearborn, MI

1 Pooling Carbon Targets

Christian Blanco[1], Oznur Özdemir-Akyildirim[2], Erdinc Akyildirim[2], [1]Ohio State University, Columbus, OH, [2]University of Bradford, Bradford, United Kingdom. Contact: blanco.58@osu.edu

Many corporations now set voluntary direct (Scope 1) and indirect (Scope 2) carbon emissions reduction targets, but low success rates reflect that firms are not very strategic in designing these targets. We examine the design and cost implications of carbon reduction targets.

2 The Role of Waste Management Hierarchy in Sustainable Operations

Dustin Cole[1], Wayne Fu[2], [1]Auburn University, Auburn, AL, [2]University of Michigan-Dearborn, Dearborn, MI, Contact: waynefu@umich.edu

This research aims to understand how waste management hierarchy influences firm environmental performance. Based on the hierarchy, we compare the impact of primary reduction, source reduction, and secondary reduction, waste reduction on firm water usage and carbon emissions. The study results suggest that primary reduction has a stronger impact in general. In addition, a firm's official recognition of corresponding environmental issues leads to an enhanced effect of primary reduction but a diminished effect of secondary reduction, highlighting a potential tradeoff between the two reduction mechanisms.

3 Does Legalizing Marijuana Increase Toxic Waste? Evidence from Manufacturing Facilities in the United States

Suvrat Dhanorkar[1], Suresh Muthulingam[2], In Joon Noh[3], [1]Pennsylvania State University, University Park, PA, [2]The Pennsylvania State University, University Park, PA, [3]Penn State University, University Park, PA, Contact: suresh@psu.edu

We examine whether legalization of marijuana affects the toxic chemical releases at manufacturing facilities. To do so, we leverage a state-level quasi-experimental setting that evolves from the staggered enactment of marijuana legislation by different states in the US. We find that medical marijuana legislation (MML) adversely affects the toxic releases of manufacturing facilities in the state—the average waste released by facilities increased by 5.22% after MML. Further analysis shows that facilities undertake fewer managerial and technical modifications to their operational processes, which clarifies the mechanisms that affect toxic releases. Finally, we find that recreational marijuana legislation (RML), which increases marijuana's access for the general population, leads to further increases in toxic releases—the effect goes beyond the impact of MML.

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TB30

CC-North 132C

Towards Environmental Friendly and Sustainable Energy, Manufacturing, and Service Industries

Flash Session

Session Chair: Priscilla Rodriguez, INSEAD, Fontainebleau, France

1 Reaching a Deep-Decarbonization Energy System Under CO_2 Sequestration Uncertainty

Felipe A. Feijoo, Pontificia Universidad Católica de Valparaíso, Valparaiso, Chile. Contact: felipe.feijoo@pucv.cl

Chile seeks a net zero economy by 2050 considering emission reduction and natural sources of CO2 sequestration. However, this target allows further decarbonization of the energy system, particularly in the transport and residential sectors, which could indeed yield to net-negative systems. To assess tradeoffs of net zero or net negative systems, this research uses the Latin American Global Change Analysis Model, a well-known integrated assessment model, and the H2RES model to evaluate deep decarbonization scenarios reaching a net negative system by 2050. Results indicate that deep decarbonization of the energy system results in higher levels of electrification of final demand sectors, reducing dependence of uncertain bio-sources of negative emissions, which have been highly affected by wild-fires in Chile.

2 An Empirical Investigation of Investment Substitutability and Complementarity Between Flexible and Intermittent Electricity Generation

Seyed Amin Seyed Haeri[1], Ahmet Colak[2], Safak Yucel[3], [1]Clemson University, Clemson, SC, [2]Clemson University, Pendleton, SC, [3]Georgetown University, Washington, DC, Contact: sseyedh@clemson.edu

In this study we evaluate the role of the operational flexibility on capacity investment decisions made in electricity grids. We adopt an empirical approach and evaluate this role using a unique granular panel data set of United States electricity grid spanning across 2002-2019. We specifically evaluate how investment in a particular generation technology can influence future investments in other types of generation technologies. We essentially shed light on the evolving nature of the electricity generation portfolio from an operations management perspective while informing policy makers in designing more effective technology-specific policies that facilitate the transition toward renewable generation.

3 High Spatial Resolution Estimates of Residential Heating Flexibility for Power System Planning

Claire Halloran[1], Filiberto Fele[2], Malcolm McCulloch[1], [1]University of Oxford, Oxford, United Kingdom; [2]University of Seville, Seville, Spain. Contact: claire.halloran@eng.ox.ac.uk

Regional variation in housing stock can lead to spatial differences in heating flexibility potential. We introduce a method to evaluate residential thermal energy storage potential at high spatial resolution with low data and computational requirements for power system planning. We leverage high-resolution spatial data on metered gas and electricity annual consumption and weather reanalysis, a more accessible dataset compared to the information required by standard approaches using physics-based building simulations. Incorporating this spatially detailed building stock flexibility potential can significantly benefit bulk power system planning and operation. For instance, we identify regional opportunities in the UK for long-term heat pump flexibility contracting to reduce storage and generation investment requirements, leading to system-wide savings.

4 Evaluating the Impact of Pre- and Post-pandemic Implementation of Flexible Work Policies on Firms' Operational Resilience

Priscilla Rodriguez[1], So Yeon CHUN[2], [1]INSEAD, Fontainebleau, France; [2]INSEAD, Singapore, France

The global shift towards remote and flexible work arrangements, accelerated by the COVID-19 crisis, has notably heightened the importance of flexible work policies (FWP) within organizational strategies. In this research, we explore the drivers behind the adoption of FWP by examining different firm characteristics both prior to and following the pandemic. Additionally, we evaluate how FWP influences firms' performance outcomes

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CC-North 221A

Program Leadership's Panels II

Panel Session

Session Chair: Elif Akcali, University of Florida, Gainesville, FL

Collaborating with AI in Research

Elif Akcali, University of Florida, Gainesville, FL

Artificial intelligence (AI) is becoming increasingly more proficient in many "human" jobs, including conducting academic research. While AI is expected to change how research is conducted and by whom, AI's greatest potential yet to be explored relates to how it can complement and augment capabilities of human researchers. This panel discussion will highlight how human researchers and AI may collaborate in the fields of operations research and management sciences.

1 Moderator

Xiang Zhong, Univ. of Florida, Gainesville, FL

2 Panelist

Phebe Vayanos, University of Southern California, Los Angeles, CA

3 Panelist

Soroush Saghafian, Harvard University, Cambridge, MA

4 Panelist

Cynthia Rudin, Duke University, Durham, NC, Contact: cynthia@cs.duke.edu

5 Panelist

ChatGPT Chat GPT, ChatGPT, Gainesville, FL

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CC-North 221B

Forecasting, Learning, and Data Analysis

Contributed Session

Session Chair: Hyungjin Kim, Hanyang University, Seoul, Korea, Republic of

1 Incorporating Prior Function Belief into Neural Networks Through Dropout and Negative Correlation Learning

Hyungkwon Lee, Jaesub Yun, Jong-Seok Lee, Sungkyunkwan University, Suwon, Korea, Republic of. Contact: lhk6565@g.skku.edu

The utilization of dropout in neural networks, which is recognized as an ensemble technique, has been linked to Gaussian Process (GP) regression. However, the current dropout method lacks the modeling capabilities of the GP covariance structure found in the original GP model. To address this limitation, we propose a novel dropout training method that incorporates negative correlation learning. Through empirical evaluation, we demonstrate that our approach effectively captures the intended covariance structure of GP within the neural networks model. We believe that our research has important implications for the machine learning field, particularly in enhancing the generalization capability of neural networks.

2 Optimal Regularization of the First Principal Component

Youhong Lee, University of California, Santa Barbara, Santa Barbara, CA, Contact: ylee@pstat.ucsb.edu

In this study, we introduce a novel regularization technique, Direction-Regularized Principal Component Analysis (drPCA), which amalgamates traditional estimators with a structured target, a method widely adopted in high-dimensional data analysis. This method aims to determine the maximum variance direction within the data, while adhering to a pre-specified target direction, thereby offering a solution to the PCA problem. We deploy the high-dimensional, low-sample size framework for an asymptotic analysis of the solution, yielding an optimal tuning parameter that minimizes an asymptotic loss function. As a result, the data rapidly assimilates the estimator corresponding to this optimal tuning parameter.

3 Inexact Bilevel Stochastic Gradient Methods for Constrained and Unconstrained Lower-Level Problems

Griffin D. Kent, Tommaso Giovannelli, Luis Nunes Vicente, Lehigh University, Bethlehem, PA, Contact: gdk220@lehigh.edu

Two-level stochastic optimization formulations have become instrumental in a number of machine learning contexts such as continual learning, neural architecture search, adversarial learning, and hyperparameter tuning. In this paper, we introduce a bilevel stochastic gradient method for bilevel problems with lower level constraints. We also present a comprehensive convergence theory that covers all inexact calculations of the adjoint gradient (also called hypergradient) and addresses both the lower-level unconstrained and constrained cases. To promote the use of bilevel optimization in large-scale learning, we introduce a practical bilevel stochastic gradient method (BSG-1) that does not require second-order derivatives and, in the lower-level unconstrained case, dismisses any system solves and matrix-vector products.

4 Parameter Estimation via Random Search with Surrogate and Simulation Models for Multiple Vectors of Observations

Hyungjin Kim[1], Chuljin Park[2], Heeyoung Kim[3], [1]Hanynag universitiy, Seoul, Korea, Republic of; [2]Hanyang University, Seoul, Korea, Republic of; [3]Korea Advanced Institute of Science and Technology, Daejeon, Korea, Republic of. Contact: jins731@gmail.com

We consider the parameter estimation for multiple vectors of observations when a simulation model is available. To solve the problem, we first introduce a surrogate model and provide explicit forms of the mean and variance of the least square function between the posterior predictive of the surrogate model and a vector of observations. Then, we propose a framework that iteratively finds the parameters corresponding to a vector of observations using random search with surrogate and simulation models. We show that the framework controls the expected number of simulations as a user-specified value. We test the framework in numerical examples and a case study in semiconductor manufacturing.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB33

CC-North 221C

Applications of Integer Programming

Community Committee Choice Session

Session Chair: Ashley Peper, University of Wisconsin - Madison, Madison, WI

1 Selecting And Scheduling Cybersecurity Mitigations With Resource Constraints

Ashley Peper, Jim R. Luedtke, Laura Albert, University of Wisconsin-Madison, Madison, WI, Contact: apeper2@wisc.edu

We study the problem of selecting and planning cybersecurity mitigations. Existing models address the problem of selecting a portfolio of security mitigations subject to a budget constraint in order to maximize coverage of vulnerabilities, where covering a vulnerability multiple times exhibits diminishing returns. A key limitation of such models is that they do not consider the limited resources required to deploy the mitigations over time. We introduce a new integer programming model that simultaneously selects mitigations and schedules their deployment while accounting for limited resources. We perform computational experiments that illustrate the benefit of our new model.

2 Solving a Multiple Tethered Autonomous Underwater Vehicle (T-AUV) Routing Problem Toward Entanglement Free Navigation

Jungyun Bae, Abhishek Patil, Myoungkuk Park, Michigan Technological University, Houghton, MI, Contact: bae@mtu.edu

T-AUVs can perform underwater tasks under reliable communication and power supply, which is the most substantial benefit of their operation. Thus, we focus on developing operational strategies that handle multiple T-AUV operations without having tether entanglements while considering workload balancing between the vehicles. The proposed heuristic consists of two main steps, 1) task allocation and routing and 2) re-routing and scheduling. In the first step, the primal-dual technique is applied for initial task allocation and routing while minimizing the maximum travel cost of the vehicles. During the second step, the heuristic confirms if there exists any possible entanglement. A mixed approach has been proposed for those cases to avoid entanglement with time scheduling and sectionalization methods. The algorithm is verified through repeated simulation runs.

3 Optimal Allocation of Chargers at Recharging Stations to Minimize Time Window Violations in Electric Vehicle Routing Problems with Time Windows and Queuing Times

Vamsi Krishna Kunapareddy[1], Rajan Batta[2], [1]University at Buffalo, Buffalo, NY, [2]University at Buffalo (SUNY), Buffalo, NY, Contact: vkunapar@buffalo.edu

This talk addresses the impact of queuing times at charging stations on the compliance of time windows for Electric Vehicles (EVs) in a Vehicle Routing Problem with Time Windows (VRPTW). An optimization model is proposed to allocate optimal chargers to maximize the number of customers whose time windows are not violated. The model is tested on a set of instances with varying characteristics, and the results demonstrate the importance of considering queuing times in EVRPTW. The proposed model can be used as a decision-making tool for EV fleet managers to ensure timely and efficient delivery.

4 Helicopter Routing Problem for Cargo and People Transportation

Hernan Caceres[1], Juan Pablo Contreras[2], [1]Universidad Catolica del Norte, Antofagasta, Chile; [2]Universidad Católica del Norte, Antofagasta, Chile. Contact: hcaceres@ucn.cl

The routing problem of helicopters for transporting people and cargo poses a significant challenge in aviation logistics. This work addresses the optimization of helicopter routing to efficiently allocate resources and minimize operational costs while meeting constraints such as passenger and cargo demands, flight distances, fuel consumption, airspace restrictions, and operational time windows. We propose a comprehensive mathematical model integrating route planning, resource allocation, and scheduling. The model incorporates both deterministic and stochastic elements, accounting for uncertainties in demand, weather conditions, and other relevant factors. Additionally, various optimization techniques, including metaheuristics and mathematical programming, are explored to solve the complex routing problem effectively.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB34

CC-North 222A

Nonlinear Optimization in Machine Learning

Community Committee Choice Session

Session Chair: Hande Benson, Drexel University, Philadelphia, PA

Session Chair: Cassidy Buhler, Philadelphia, PA

1 Decision-Making for Land Conservation: A Derivative-Free Optimization Framework with Nonlinear Inputs

Cassidy Buhler[1], Hande Benson[2], [1]Drexel University, Philadelphia, PA, [2]Drexel University, Philadelphia, PA, Contact: cb3452@drexel.edu

Protected areas (PAs) are designated spaces where human activities are restricted to preserve critical habitats. Decision-makers are challenged with balancing a trade-off of financial feasibility with ecological benefit when establishing PAs. OR tools like simulation and optimization are used to select PAs, but current decision models are primarily linear. We propose a derivative-free optimization framework paired with a nonlinear component, population viability analysis (PVA). Formulated as a mixed integer nonlinear programming (MINLP) problem, our model allows for linear and nonlinear inputs and can be paired with ecological software. Our numerical results serve as a proof of concept, showing our model yields PAs with similar expected risk to that of preserving every parcel in a habitat, but at a significantly lower cost.

2 Effective Weighted Trust-Region Methods for Unconstrained Optimization

Johannes J. Brust[1], Philip Gill[2], [1]Arizona State University, Tempe, AZ, [2]University of California-San Diego, La Jolla, CA, Contact: jjbrust@asu.edu

Unconstrained optimization is essential for many data driven problems. When only gradients of the objective function are available, methods that estimate the Hessian of second derivatives are effective. We develop a trust-region (TR) method that updates a symmetric factorization of the Hessian approximation, and that only requires the matrix factors. The main computational challenge for trust-region methods is the solution of the TR subproblem, which determines the next search direction. In order to overcome this difficulty, the factored matrix can be used to define subproblems in terms of weighted norms, which significantly reduce the costs of a subproblem. We develop two solvers based on a weighted two and a weighted infinity norm. The methods are effective when tested on a vast set of unconstrained optimization problems from the benchmarking CUTEst collection.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB35

CC-North 222B

Primal-dual Methods for Minimax Problems

Community Committee Choice Session

Session Chair: Serhat Aybat, Penn State University, University Park, PA

Session Chair: Mert Gurbuzbalaban, Rutgers University, Piscataway, NJ

1 Robust Accelerated Primal-Dual Methods for Computing Saddle Points

Xuan Zhang[1], N. Serhat Aybat[2], Mert Gurbuzbalaban[3], [1]The Pennsylvania State University, STATE COLLEGE, PA, [2]Penn State University, University Park, PA, [3]Rutgers University, Piscataway, NJ, Contact: xxz358@psu.edu

We propose a stochastic accelerated primal-dual (SAPD) algorithm for solving strongly-convex-strongly-concave saddle point problems, demonstrating linear convergence to a unique saddle point neighborhood. The neighborhood size depends on the asymptotic variance of iterates. We characterize robustness to gradient noise, optimize SAPD parameters for desired convergence rate-robustness trade-offs, and enable fast convergence with noise robustness. SAPD admits convergence guarantees for the distance metric with a variance term that is optimal up to a logarithmic factor -which can be removed by a restarting strategy. We also discuss how convergence and robustness results extend to the convex-concave setting. Finally, we illustrate our framework on distributionally robust logistic regression.

2 A Stochastic GDA Method with Backtracking for Solving Nonconvex Strongly Concave Minmax Problems

Qiushui Xu[1], Xuan Zhang[2], N. Serhat Aybat[1], Mert Gurbuzbalaban[3], [1]Penn State University, University Park, PA, [2]The Pennsylvania State University, STATE COLLEGE, PA, [3]Rutgers University, Piscataway, NJ, Contact: qjx5019@psu.edu

We propose a stochastic Gradient Descent Ascent method with backtracking (SGDA-B) to solve nonconvex-strongly-concave (NSC) minimax problems min_x max_y sum_{i=1}^N g_i(x_i)+f(x,y)-h(y), where h and g_i for i=1...N are closed convex, f is L-smooth and mu-strongly concave in y. SGDA-B does not require to know L, and using random block-coordinate updates it can compute an eps-stationary point with probability p within O(kappa^2 L eps^{-4} log(1/p)) stochastic oracle calls, where kappa=L/mu. To our knowledge, SGDA-B is the first GDA-type method with backtracking to solve NSC minimax problems. We provide numerical results for SGDA-B on a distributionally robust learning problem.

3 High Probability and Risk-Averse Guarantees for Stochastic Saddle Point Problems

Yassine Laguel[1], Mert Gürbüzbalaban[2], Serhat Aybat[3], [1]Rutgers University, Piscataway, NJ, [2]Rutgers University, Piscataway, NJ, [3]Penn State University, University Park, PA, Contact: laguel.yassine@gmail.com

We investigate the stochastic accelerated primal-dual algorithm for strongly-convex-strongly-concave saddle point problems, common in distributionally robust learning, game theory, and fairness in machine learning. Our algorithm offers optimal complexity in several settings and we provide high probability guarantees for convergence to a neighborhood of the saddle point. We derive analytical formulas for the limit covariance matrix and develop lower bounds to show that our analysis is tight. Our risk-averse convergence analysis characterizes the trade-offs between bias and risk in approximate solutions. We present numerical experiments on zero-sum games and robust learning problems. Collaborators: Mert Gürbüzbalaban and Necdet Serhat Aybat.

4 Recent Advances in Stochastic Primal Dual Algorithms with Applications to Distributionally Robust Learning

Bugra Can[1], Serhat Aybat[2], Mert Gurbuzbalaban[3], [1]Rutgers University, New Brunswick, NJ, [2]Penn State University, University Park, PA, [3]Rutgers University, Piscataway, NJ

We first consider smooth strongly convex strongly concave (SCSC) minimax problems. Such problems arise frequently in machine learning in the context of robust empirical risk minimization (ERM), e.g. distributionally robust ERM (DR-ERM), where partial gradients are estimated using mini-batches of data points. Assuming we have access to an unbiased stochastic first-order oracle we consider the stochastic accelerated primal dual (SAPD) algorithm for SCSC minimax problems as a robust method against gradient noise. We propose efficient bias-reduction strategies for SAPD based on Richardson-Romberg extrapolation and show that our method improves upon SAPD. Second, we present a class of subgradient algorithms with finite-sample complexity guarantees for solving non-smooth non-convex/concave minimax problems that arise in the DR-ERM setting.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB36

CC-North 222C

Global Optimization

Community Committee Choice Session

Session Chair: Sergiy Butenko, 1</sup

1 Convexification of Nonconvex Compositions with Norms

Anatoliy Kuznetsov, Nikolaos Sahinidis, Georgia Institute of Technology, Atlanta, GA, Contact: akuznetsov3@gatech.edu

Nonconvex optimization problems involving compositions of functions with norms present a challenge for global optimization algorithms based on spatial branch-and-bound since they exhibit a high degree of symmetry, and factorable relaxations of reverse convex constraints and compositions of functions with norms are generally weak. In this work, we introduce novel convex envelopes for common functions composed with norms based on the characterization of their generating sets. The theoretical development exploits the fact that the generating set of these functions is a finite collection of many compact convex sets. We implement our envelopes in the global optimization solver BARON and demonstrate their impact using open problems from the literature as a benchmark.

2 On the Convex Hull of Mixed-Integer Nonlinear Submodular Minimization

Shaoning Han, Andres Gomez, University of Southern California, Los Angeles, CA, Contact: shaoning@usc.edu

We study the mixed-integer epigraph of a convex function which is jointly submodular in continuous and indicator variables. This class of mixed-integer sets appears in many applications such as Markov random fields, value-at-risk minimization and outlier detection. In this talk, we give the recipe of building the convex hull of such sets, based on which we are able to unify the existing results in literature. Beyond that, we discuss more implications of the abstract convexification result in mixed-integer quadratic and conic minimization problems.

3 A Hierarchy of Nonconvex Continuous Reformulations for Discrete Optimization
Miltiades Pardalos, Sergiy Butenko, Mykyta Makovenko, Texas A&M University, College Station, TX
We propose a fundamentally new approach to designing hierarchies of continuous formulations for discrete and combinatorial optimization problems by shifting the focus from convexifying a given formulation to establishing equivalent non-convex reformulations of the original problem. The aim is to move towards an "equi-maximal" reformulation in which every local optimum is global, a property which is eventually achieved at the final level of the hierarchy. The improved quality of local maxima is achieved through an increasing cost of objective function evaluation.

4 On Risk Averse Optimization in Discrete Systems
Masoud Eshghali, Pavlo A. Krokhmal, University of Arizona, Tucson, AZ
We discuss risk-averse stochastic optimization in discrete systems, such as networks or graphs. In particular, we consider identification of minimum-risk structures in graphs with random vertex or edge weights. The discrete setting allows us to obtain new insights into the interplay of risk reduction and diversification, the staple strategy in risk management.

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TB37

CC-North 223
Structuring the Ambiguous: New Perspectives on Distributionally Robust Learning
Community Committee Choice Session
Session Chair: Bahar Taskesen, EPFL, Lausanne, Switzerland

1 Distributional Robustness, Causal Transport, and Time Consistency
Rui Gao, University of Texas at Austin, Austin, TX
Distributionally robust optimization is an emerging paradigm for decision-making under model ambiguity. It hedges against model uncertainty by penalizing the deviation from a reference model. In this talk, we will discuss distributional robustness in a dynamic setting, where the deviation is measured by the bi-causal transport distance between stochastic processes. Such a choice accounts for information evolution, making it hedge against a plausible family of data processes. In spite of the non-convexity of the problem, we develop an equivalent robust Bellman recursion that gives a time-consistent representation.

2 Pessimistic Estimates and Optimistic Decisions for Bandits
Mengmeng Li[1], Bahar Taskesen[2], Daniel Kuhn[3], [1]EPFL, St Sulpice, Switzerland; [2]EPFL, Lausanne, Switzerland; [3]Ecole Polytechnique Federale de Lausanne (EPFL), Lausanne, Switzerland. Contact: bahar.taskesen@epfl.ch
We study optimism-pessimism interplay for online bandit problems and propose a general learning principle based on integrating pessimistic estimation with optimistic action selection.
Leveraging recent developments in the offline reduction of online contextual bandits algorithms, we demonstrate that pessimistic evaluations offer valuable out-of-sample disappointment probability bounds, crucial for safety-critical applications, while maintaining the same regret bounds. Our distributional optimism approach, unifies and generalizes existing state-of-the-art (non-)randomized contextual bandit algorithms.
In the finite arm setting, we utilize modern discrete choice theory to suggest an optimistic distribution model, which offers fresh perspectives on existing methods and addresses some challenging problems in the online learning field.

3 Robust Data-Driven Prescriptiveness Optimization
Mehran Poursoltani[1], Erick Delage[2], Angelos Georghiou[3], [1]HEC Montreal, Montreal, QC, Canada; [2]HEC Montréal, Montreal, QC, Canada; [3]University of Cyprus, Nicosia, Cyprus
The emergence of various optimization techniques, which leverage available side information, has motivated the development of a universal measure of performance called the coefficient of prescriptiveness. This coefficient quantifies both the quality of contextual decisions compared to a reference one and the prescriptive power of side information. To identify policies that maximize the former in a data-driven context, we introduce a distributionally robust contextual optimization model where the coefficient of prescriptiveness substitutes for the classical empirical risk minimization objective. We present a bisection algorithm to solve this model and study a contextual shortest path problem to evaluate the robustness of the resulting policies against alternative methods when the out-of-sample dataset is subject to a distribution shift.

4 Distributionally Robust Linear Quadratic Control
Bahar Taskesen[1], Dan Andrei Iancu[2], Cagil Kocyigit[3],

Daniel Kuhn[4], [1]EPFL, Lausanne, Switzerland; [2]Stanford University, Stanford, CA, [3]University of Luxembourg, Luxembourg, Luxembourg; [4]Ecole Polytechnique Federale de Lausanne (EPFL), Lausanne, Switzerland. Contact: cagil.kocyigit@uni.lu

The Linear-Quadratic-Gaussian (LQG) involves controlling a system with linear dynamics and imperfect observations, subject to additive noise, with the goal of minimizing a quadratic state and control cost. We consider a generalization of the LQG problem, where the noise distributions are unknown and belong to Wasserstein ambiguity sets centered at nominal (Gaussian) distributions. The objective is to minimize a worst-case cost across all distributions in the ambiguity set, including non-Gaussian distributions. We prove that a control policy that is affine in the observations is optimal for this problem, as in the classical LQG problem. We propose a numerical solution method that efficiently characterizes this optimal policy by using the Frank-Wolfe algorithm to identify the least favorable distributions, and Kalman filter estimation to compute the optimal policy.

Tuesday, October 17, 10:45 AM - 12:00 PM

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CC-North 224A

Large Scale Optimization with Applications to Machine Learning

Community Committee Choice Session

Session Chair: Haoyue Wang, Massachusetts Institute of Technology, Cambridge, MA

1 Improving the Geometry of (Conic) Linear Optimization Problems for the Primal-dual Hybrid Gradient Method

Zikai Xiong[1], Robert Michael Freund[2], [1]MIT, Cambridge, MA, [2]MIT Sloan School of Management, Cambridge, MA, Contact: zikai@mit.edu

The primal-dual hybrid gradient method (PDHG) (with restarts) has shown significant success in solving huge-scale LP problems. However, current condition measures may take on extreme values and lead to poor performance, which begs the question of whether these condition measures can be improved by transformations of the given instance? In this study we provide a new geometric measure based on the primal-dual level set and show in particular how row and column rescaling can theoretically improve these condition measures. Our theoretical development leads to guidelines for practical implementation of re-scaling based on analytic centers. Moreover, these results could also be extended to conic linear optimization problems. Also, our experiments on LP relaxations of the MIPLIB 2017 dataset demonstrate the impact of rescaling on the actual performance of PDHG.

2 Algorithms for Learning Decision Trees: Optimality and Beyond

Xiang Meng, MIT, Cambridge, MA, Contact: mengx@mit.edu

In this paper, we present a novel branch-and-bound (BnB) based discrete optimization method to obtain optimal decision trees for both regression and classification tasks with continuous features. Our approach splits the search space according to the quantiles of the feature distribution, enabling effective upper and lower bounds evaluation. We provide complexity and error bounds, and leverage our method to design heuristics for building high-quality decision trees. Experiments on benchmark datasets show our optimal tree algorithm achieves up to 10^3 times speedups compared to state-of-the-art methods, and our heuristics improve out-of-sample performance by 5%-80%.

3 On Statistical Properties of Sharpness-Aware Minimization: Provable Guarantees

Kayhan Behdin, Rahul Mazumder, Massachusetts Institute of Technology, Cambridge, MA, Contact: behdink@mit.edu

Sharpness-Aware Minimization (SAM) is a recent optimization framework aiming to improve the deep neural network generalization, through obtaining flatter (i.e. less sharp) solutions. Recent papers have studied the theoretical aspects of the framework and have shown SAM solutions are indeed flat. However, there has been limited theoretical exploration regarding statistical properties of SAM. We directly study the statistical performance of SAM, and present a new theoretical explanation of why SAM generalizes well. To this end, we study two statistical problems, neural networks with a hidden layer and kernel regression, and prove under certain conditions, SAM has smaller prediction error over Gradient Descent (GD). Our results show that SAM is particularly well-suited for non-convex problems.

4 Polycd: A Cyclic Coordinate Descent Method for Convex Optimization on Polytopes

Haoyue Wang, Rahul Mazumder, Massachusetts Institute of Technology, Cambridge, MA, Contact: haoyuew@mit.edu

Coordinate descent (CD) methods are popular for huge-scale optimization problems when the objective is separable across coordinates. In this paper, we propose a new variant of cyclic CD that can handle polyhedral constraints if the polytope does not have too many extreme points. Loosely speaking, our proposed algorithm PolyCD, can be viewed as a hybrid of cyclic CD and the Frank-Wolfe algorithms. We prove that PolyCD has an O(1/k) convergence rate for smooth convex objectives. Furthermore, we propose PolyCDwA, a variant of PolyCD with away steps that has a linear convergence rate when the loss function is smooth and strongly convex. Empirical studies demonstrate that PolyCDwA achieves strong computational performance for large-scale benchmark problems including L1-constrained linear regression, L1-constrained logistic regression and kernel density estimation.

Tuesday, October 17, 10:45 AM - 12:00 PM

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CC-North 224B

TSL Mid-career and Lifetime Award Session

Award Session

Session Chair: Karen Smilowitz, Northwestern University, Evanston, IL

Session Chair: Elise Miller-Hooks, George Mason University, Fairfax, VA

1 TSL Mid-Career Award Winner Presentation

Elise Miller-Hooks, George Mason University, Fairfax, VA

2 TSL Lifetime Award Winner Presentation

Karen Smilowitz, Northwestern University, Evanston, IL

Tuesday, October 17, 10:45 AM - 12:00 PM

TB40

CC-North 225A

Innovative Solutions for Last-mile Delivery

Community Committee Choice Session

Session Chair: Sarah Powell, 1</sup

1 Underground Freight Transportation for Last Mile Delivery

Sarah Powell[1], Ann Melissa Campbell[2], [1]University of Iowa, Iowa City, IA, [2]University of Iowa, Iowa City, IA, Contact: sarah-powell@uiowa.edu

Underground freight transportation (UFT) is an unmanned freight transportation system in which small crates of packages travel through tubes in a network. The use of UFT for last-mile delivery offers many benefits, such as no emissions and reduced traffic congestion. We examine where to build a UFT system along roads in an existing road network. This system will deliver packages to distribution centers that each serve a small area. We present a model to maximize the amount of demand served by UFT while a budget for constructing the network is respected. Strong formulations of this problem can be used to solve realistic instances of the UFT for large cities. We perform a set of experiments using data from New York City and Chicago to weigh the tradeoffs of cost vs. potential impact. Our results show that UFT is a promising alternative for last-mile delivery.

2 Customer Satisfaction and Differentiated Pricing in E-Retail Delivery

Dipayan Banerjee, Alan Erera, Alejandro Toriello, Georgia Institute of Technology, Atlanta, GA, Contact: dipayan.banerjee@gatech.edu

We study a system in which a common delivery fleet serves both same-day delivery (SDD) and next-day delivery (NDD) orders placed by e-retail customers who are sensitive to delivery prices. We develop a continuous approximation model of the system and optimize with respect to two separate objectives. Our model captures the effect that one day's operations have on the next, a novel modeling component not present in SDD-only models; a key technical result is establishing the model's convergence to a steady state. We optimize for customer satisfaction by maximizing the quantity of NDD orders fulfilled one day early given fixed prices. Next, we optimize prices for profit in a two-level scheme with discounts for early-ordering customers. We derive structural insights and efficient algorithms for both objectives. We conduct simulations on a real-world road network for validation.

3 The Driver-Aide Problem in Urban Areas

Mengting Chao[1], Bruce L. Golden[2], Rui Zhang[3], Adriano Masone[4], [1]University of Maryland-College Park, College Park, MD, [2]University of Maryland-College Park, Columbia, MD, [3]University of Colorado Boulder, Boulder, CO, [4]University of Naples, Naples, Italy. Contact: mchao@umd.edu

The exponential growth of package volumes in recent years has presented significant challenges for last-mile delivery, especially in urban areas. Many logistics companies, including FedEx and UPS, have resorted to using a "driver-aide" to assist with deliveries. The aide can be used to assist the driver in two ways. As a "jumper", the aide works with the driver to deliver packages at a given stop. As a "helper", the aide can serve several stops independently, while at the same time the driver serves other stops. Then they meet each other at a later stop. Our goal is to determine both the delivery route and the most effective way to use the aide to minimize the total delivery time. We model this problem as an integer program with an exponential number of variables and an exponential number of constraints, and propose a branch-cut-and-price approach for solving it.

4 Dynamic Routing, Confirmation and Compensation for Combined Urban Transportation of Passengers and Goods

Yilun Wang, Min Xu, The Hong Kong Polytechnic University, Hong Kong, Hong Kong. Contact: yilun.wang@connect.polyu.hk

Transporting goods with passengers on board can increase profits for Mobility-on-demand companies but may negatively affect travel experience of passengers due to detours for making deliveries along the way. To mitigate this, we investigate the potential of offering on-board passenger compensation as incentives in dynamic and stochastic scenarios, where the requests arrive dynamically and the passengers' acceptance of detour is unknown. We design an anticipatory policy based on a new value function approximation with slide memory and makes integrated routing, confirmation, and compensation decisions. Numerical experiments show that compared to the benchmark policies, the anticipatory policy achieves up to 15% more profits.

5 Time Slot Management for Attended Home Services Using Predetermined Routes

Ehsan Aghamohammadzadeh[1], Niels Agatz[2], Luuk Veelenturf[1], [1]Erasmus University Rotterdam, Rotterdam, Netherlands; [2]Erasmus University, Rotterdam, Netherlands

The timely and convenient delivery of attended home services presents a distinct challenge: customers must be present at home to receive their goods or services. In response, companies offer a selection of service time slots, taking into account both marketing strategies and operational logistics. In our study, we explore a scenario where we have accurate information about customer locations. By using this invaluable information, we investigate the effectiveness of utilizing predetermined routes to streamline the decision-making process for assigning optimal time slots.

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TB41

CC-North 225B

Emerging Applications in Transportation and Logistics

Community Committee Choice Session

Session Chair: Julia Y. Yan, University of British Columbia, Vancouver, BC, Canada
Session Chair: Chiwei Yan, University of California-Berkeley, Berkeley, CA

1 A Tale of Two Electric Vehicle Battery Swapping Policies

Wei Qi[1], Mengyi Sha[1], Yuli Zhang[2], [1]Tsinghua University, Beijing, China; [2]Beijing Institute of Technology, Beijing, China. Contact: qiw@tsinghua.edu.cn

Battery swapping is gaining traction in cities. To deal with random service requests and random status of incoming batteries, the literature has assumed a FIFO policy of swapping batteries due to its tractability. We propose models to compare FIFO and HEFO swapping policies. The results demonstrate that HEFO is superior to FIFO in most scenarios, except when all EVs wait for the recharged batteries to reach a target state-of-charge (SOC).

2 A Continuous Approximation Model for Random Stow in Warehouses

John Gunnar Carlsson, University of Southern California, Los Angeles, CA, Contact: jcarlsso@usc.edu

We study the probabilistic behavior of routing optimization problems in which one is given a collection of points and the goal is to find the shortest tour that visits a subset of those points that meets certain criteria. Examples of such problems, which we call "selection routing problems", include the "one-of-a-subset" travelling salesman problem (TSP), and generalized TSP. We derive continuous approximation formulas for several such problems under the assumption that point-to-point distances are Euclidean and all points are independent and identical samples of a probability density on a compact planar region. Numerical simulations demonstrate that our formulas provide pretty accurate estimates of routing costs when a large number of samples are drawn. We also analyze the random stow warehouse model using our results.

3 Robotic Warehousing Operations: A Learn-Then-Optimize Approach to Large-Scale Neighborhood Search

Alexandria Schmid, MIT, Beverly, MA, Contact: aschmid@mit.edu

The rapid deployment of robotics technologies in warehousing requires dedicated optimization algorithms to manage large fleets of autonomous agents. This paper formulates a fleet management problem for parts-to-picker operations to maximize throughput, while managing human workload and congestion in the warehouse. To solve it, we develop a large-scale neighborhood search algorithm with a learn-then-optimize approach to subproblem generation. The algorithm relies on an offline machine learning procedure that attributes objective improvements to subproblem features, and an online optimization routine that generates new subproblems to maximize improvement. In collaboration with a major online retailer, we demonstrate the benefits of our model and algorithm compared to baseline algorithms and heuristics.

4 An Analysis of Batching and Greedy Policies in Dynamic Matching

Myungeun Eom[1], Alejandro Toriello[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Tech ISyE, Atlanta, GA, Contact: myungeun.eom@gatech.edu

Motivated by applications from ride-sharing and freight marketplaces, we study a dynamic non-bipartite matching, where nodes appear following a type-specific independent distribution and wait in the system for a given sojourn time. We analyze the asymptotic properties of two widely used policies, batching and greedy. We show that the batching is asymptotically optimal with respect to the sojourn time □ with an optimality gap of □(1/√□). Similarly, we show that a greedy with a minor modification is asymptotically optimal with a gap of □(1/□). More interestingly, both policies converge exponentially fast to (1-□)-optimality. We prove the convergence by analyzing a single-pair and converting from the single-pair to the general counterpart using a fluid relaxation and randomization. Finally, we present a case study to assess the empirical effectiveness of the policies.

5 Path-Based Formulations for the Design of On-Demand Multimodal Transit Systems with Latent Demand Awareness

Hongzhao Guan[1], Beste Basciftci[2], Pascal Van Hentenryck[3], [1]Georgia Institute of Technology, Atlanta, GA, [2]University of Iowa, Iowa City, IA, [3]ISyE Georgia Tech, Atlanta, GA, Contact: hguan7@gatech.edu

This study investigates capturing the latent demand in on-demand multimodal transit systems, namely the ODMTS Design with Adoptions problem (ODMTS-DA) by proposing a new path-based optimization model, called P-Path. This model addresses the computational difficulties from previous work that utilizes bilevel programs. The key idea of P-Path is to enumerate two specific sets of paths which capture the essence of the choice models associated with the adoption behavior of riders. Then ODMTS-DA can be formulated as a single-level MIP model. P-Path is evaluated on two comprehensive case studies. Results show that P-Path solves the mid-size instances in a few minutes, bringing more than two orders of magnitude improvements compared to previous approach. Moreover, the results show that P-Path can solve large-scale ODMTS-DA instances to optimally in a few hours or in a few days.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB42

CC-North 226A

Network Modeling and Optimization of Railway Systems

Community Committee Choice Session

Session Chair: Jiateng Yin, 1</sup

1 Operating Plan Development Using a Zero-Based Optimal Blocking Model

Gunnar Feldmann, Mehmet Kolcu, Clark Cheng, Norfolk Southern Corporation, Atlanta, GA

The railroad blocking problem is a large-scale network routing problem that groups shipments into blocks to minimize total shipment cost. It considers various factors, such as the shipment type, business rules, network constraints, and the available yard resources. The blocking problems has two objectives, minimizing distance traveled and handling cost. In this presentation, we will describe how the use of a Zero-based Optimal Blocking Model at Norfolk Southern improves the development of operating plans.

2 Optimizing the Routing of Wagons During Disruptions in Single Wagonload Transport

Maurice Krauth, Daniel Haalboom, Henning Preis, Nikola Besinovic, TU Dresden, Dresden, Germany. Contact: maurice.krauth@tu-dresden.de

In highly utilized rail networks disruptions can quickly have great impact. Dealing immediately with disruptions is important to maintain satisfactory operation level. In this research, we model single wagonload networks and optimize the routing of wagons when a disruption occurs. In particular, wagons can be reassigned to different trains and trains could be rerouted, while minimizing routing costs and delay. The model performance is demonstrated in real life German rail network. A simulation is used that stochastically trigger disruptions. Wagon routing is then optimized while considering the current state of the network. The proposed model enables to evaluate the impact of disruptions on networks and supports dispatchers to optimize real-time network operation performance.

3 A Multi-Task Deep Reinforcement Learning Approach for the Real-Time Traffic Management of High-Speed Trains

Jiateng Yin, Wei Wu, Beijing Jiaotong University, Beijing, China. Contact: jtyin@bjtu.edu.cn

Existing approaches for the real-traffic management of high-speed trains focused on a series of scenario-dependent mathematical formulations, which however requires to solve the model under different disruption scenarios. The traditional deep reinforcement learning (DRL) has similar drawbacks that the model has to be trained under each disruption scenarios. In our study, we develop a multi-task DRL approach for the real-time traffic management of high-speed trains. Our approach only constructs and trains one DRL model, which can be used for different disruption scenarios. We also propose a novel MIP formulation to select the optimal tasks for the training of the DRL model. We test our approach on the real-world data of Beijing-Zhangjiakou high-speed railway network.

4 Modeling Railway Network Resiliency and Derailment Consequences Considering Multi-Yard and Mainline Interactions

Jiaxi Zhao[1], Tyler Dick[2], [1]University of Texas at Austin, Austin, TX, [2]University of Texas at Austin, Austin, TX, Contact: jiaxi.zr@utexas.edu

Safely and efficiently processing longer trains has become necessary as railroads seek to optimize network capacity. Given the interaction and feedback between rail yards and mainlines, once a service disruption occurs, the congestion can promptly spread through the network and deteriorate system performance. Therefore, understanding the resiliency of railway operations to derailments cannot be limited solely to the immediate location of an incident. To further investigate the network-scope impact of a derailment, specifically in classification yards, this paper models and analyzes rail network recovery patterns after abnormal operations between multiple classification yards and connecting mainlines using a mixed micro- and macro-level simulation developed with AnyLogic.

5 Vulnerability Envelopes for Railway Transport Networks

Nikola Besinovic[1], Christopher Szymula[2], [1]Technical University of Dresden, Dresden, Germany; [2]Technische Universität Dresden, Dresden, Germany

In railway networks, multiple disruptions occur causing extreme challenges to both freight and passenger operators. In these cases, the operators need to significantly adjust, reroute or even cancel the existing services, as well as plan additionally extra ones. In this talk, we explore a concept of vulnerability envelopes to describe an expected performance for any given number of disruptions. To model it, three interdependent networks are combined including infrastructure, train operations and freight and passenger flows. We present the initial results on a realistic railway network. Based on the vulnerability envelope of the system, the operator can directly understand the expected level of deterioration in the network. This could help them to take appropriate response and recovery strategies to minimize the impacts and restore the system as soon as possible.

6 Risk-Averse Two-Stage Stochastic Programming Approach for Metro Train Rescheduling Under Uncertain Disturbances

Boyi Su, 1</sup

Taking the uncertainty of the disturbance duration into account, this paper focuses on integrated train timetabling and rolling stock rescheduling for a disturbed metro system. The problem is formulated as a two-stage stochastic programming model, in which the first stage optimizes the dispatching of backup rolling stocks at the occurrence time of disturbance, while the second stage reschedules metro trains. To evaluate the benefits and risks of rescheduling decisions, the mean-conditional value-at-risk criterion is introduced. Then, we reformulate the proposed model as an equivalent mixed-integer linear programming, which can be directly solved using CPLEX software. Finally, numerical experiments are conducted to demonstrate the performance of the proposed method.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB43

CC-North 226B

Digital Air Traffic Services: Human Performance Perspective

Community Committee Choice Session

Session Chair: Tatiana Polishchuk, 1</sup

1 The Bridge Between Meta-heuristics and Simulation: Application to ATM

Daniel Delahaye, ENAC, Toulouse, France

The bridge between optimization and simulation is more and more efficient due to the CPU (GPU) computation power increase. The talk starts to give a brief overview of the optimization methods and focus on the objective function evaluation. The benefit produced by connecting optimization and simulation is then presented. Such optimization-simulation approach can be also improved by the mean of machine learning. Applications to air traffic management operations are then presented.

2 Human-Centered AI/ML Decision Support for Pre-Departure Trajectory Option Set Reroutes
Jeremy Coupe, NASA, Moffett Field, CA, Contact: william.j.coupe@nasa.gov
This talk will describe NASA's approach to use AI/ML within a human-centered design to augment air traffic management decision making with decision support tools. For NASA's Machine Learning Airport Surface Model this human-in-the-loop requirement guided many design decisions ranging from user interfaces to the selection of the appropriate prediction models. The result of the design decisions is an Airport Surface Model that combines both human input and Machine Learning models to generate predictions that are aligned with Air Traffic Control expectations of traffic flows.

3 Assessment of Remote Pilot Maneuver Taskload Under Multi-Vehicle Control Schemes
Husni Idris, CA
Multi-vehicle control schemes where a number of remote pilots (m) supervise a number of uncrewed vehicles (N>m) are desired to enable scalability of operations, such as air cargo delivery, in the face of pilot shortage and other constraints. We use queuing models derived from historical track data to assess the increased task load on a remote pilot due to maneuvering demands as the number of supervised vehicles increase. We quantify metrics such as the probability that the inter-maneuver time and inter-communication time is under certain values. We discuss the use of digital communication to mitigate the increased demand on the remote pilot.

4 Digitalization Within Airspace Management: Opportunities and Barriers for Risk Assessment
Billy Josefsson, LFV, Norrköping, Sweden
How can we validate ML / AI support to define efficient, the proper objective understandable methods to identify risks in the coming highly automated ATM / UTM systems.?These systems team up with a human and their task will be to manage the Air-Space from ground to heaven, vehicles performance will vary accordingly but needs to be considered together. The overall challenge from an Air Navigation Service Provider or an UTM Service Provider in the future will be to manage the airspace usage in terms of access, safety, efficiency and follow up assisted with automation. Opportunities and barriers for digitalization within Air Space management will be discussed at the presentation

Tuesday, October 17, 10:45 AM - 12:00 PM

TB44

CC-North 226C
Artificial Intelligence in FinTech
Community Committee Choice Session
Session Chair: Ruiyun Xu, The University of Hong Kong, Hong Kong, Hong Kong

1 Can Earning Calls Tell? A Multimodal Attentive Network for Financial Misstatement Detection
Wei Du[1], Qi Lu[2], Wei Xu[2], [1]Renmin University of China, Beijing, China; [2]Renmin University of China, Beijing, China. Contact: ahduwei@ruc.edu.cn
Deceptive signals extracted from the text (i.e., verbal cues) and audio (i.e., non-verbal vocal cues) in earning calls help detect financial misstatements. However, prior studies either treat the earning calls as a whole or simply superpose the multimodal features. We hereby propose a multimodal attentive network that deeply learns the deceptive signals from the multi-round dialogues in earnings calls by systematically integrating verbal and vocal features. The attention mechanism helps provide interpretative results by capturing abnormal information in detecting misstatements. Experimental results on a real-world dataset from SeekingAlpha and the Securities and Exchange Commission (SEC) demonstrate the outperformance and interpretability of our model compared to baselines.

2 Determinants of the Inequality in Non-Fungible Tokens Markets
Wei Hu, Tongji University, Shanghai, China
Non-fungible token (NFT) is a unique digital identifier recorded on a blockchain to certify ownership and authenticity. Due to high inequality, most of the population has little to no economic mobility, leading to increased transaction costs and criminal activities. In this study, we collect the NFT projects from NiftyGateway and the transaction data from Ethereum. We construct dynamic trader networks with a sliding time window and measure the inequality using the Gini index and the coefficient of power-law distribution. Ethereum underwent an upgrade process known as “the Merge” on September 15, 2022, switching from proof-of-work (PoW) to proof-of-stake (PoS). In this study, we validate that “the Merge” process can exacerbate the inequality of NFT transactions. By employing econometric analysis, we analyzed the economic mechanisms.

3 Towards Ubiquitous Ultraefficient Deep Learning

Yanzhi Wang, MA
We present our recent work CoCoPIE, representing Compression-Compilation Codesign, to overcome this limitation towards the best possible DNN acceleration on edge devices. We propose novel fine-grained structured pruning schemes, including pattern-based pruning, block-based pruning, etc. They can simultaneously achieve high hardware performance (similar to filter/channel pruning) while maintaining zero accuracy loss, with the help of compiler, which is beyond the capability of prior work. Through the CoCoPIE framework, we are able to achieve real-time on-device execution of a number of DNN tasks, including object detection, pose estimation, activity detection, speech recognition, just using an off-the-shelf mobile device, with up to 180X speedup compared with prior work.

4 The Power of Visualization on Making High-Quality Business Analytical Reports: A Multi-Dimensional Analysis

Wenping Zhang, Zhiyuan Liu, Yanan Liu, Zhiting Yan, Zhihong Yi, Renmin University of China, Beijing, China. Contact: wpzhang@ruc.edu.cn

Visualization techniques have been deeply developed and widely used in various domain. Nevertheless, there are many improper utilizations, which is harmful instead of helpful for information transmission. We conducted a study on the usage of visualization in analyst reports with the hope to reveal the proper utilization of visualization techniques, more specifically exploring the problem that what kinds of visualization help to make a successful analyst report. Based on visualization theories, we proposed a model to assess the quality of visualization. Five aspects, namely originality, aesthetics, clarity, standardization and understandability, were defined and measured based on multimodal data anlytical techniques. Our study found that these aspects have significant impacts on the success of analyst reports.

5 Geotagged Echoes: Deciphering the Impact of Location Disclosure Policy on Online User Interactions

Yizhi Liu[1], Qili Wang[2], Xingchen Xu[3], Liangfei Qiu[4], [1]University of Maryland, College Park, MD, [2]University of Florida, Gainesville, FL, [3]University of Washington, Seattle, WA, [4]University of Florida Warrington College of Business Administration, Gainesville, FL

Amidst the debate surrounding the extent of identity disclosure on social media, this study empirically investigates the impact of group identity disclosure on user posting behavior. Leveraging a natural experiment arising from the province-level location disclosure policy implemented on Chinese social media platforms in April 2022, we uncover notable changes in user posting patterns and the dynamics of online discussions. Our exploration of the underlying mechanisms reveals various effects on different user groups and a tendency towards group polarization in discussions. Our study sheds light on the impact of group identity disclosure and its implications for online behavior and discussions, contributing valuable insights to the broader identity disclosure debate.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB45

CC-North 227A

Social Good

Community Committee Choice Session

Session Chair: Elisabeth Paulson, Harvard Business School, Somerville, MA

1 Enhancing Early Childhood Education Outcomes Through Personalized Behavioral Nudges in Resource-Constrained Settings: A Data-Driven Approach

Divya Singhvi[1], Alex Akira Okuno[1], Somya Singhvi[2], [1]New York University, New York, NY, [2]USC Marshall School of Business, Los Angeles, CA

Early Childhood Education (ECE) is one of the most cost-effective investments that countries can make to eradicate poverty, boost prosperity, and ensure the creation of human capital needed for sustainable and diversified growth. However, low- and middle-income countries worldwide struggle to support childhood education. In this study, we collaborate with one of India’s leading non-profits focused on catalyzing ECE. We run a series of large-scale experiments to evaluate the impact of personalized behavioral nudging using WhatsApp messages. Our results demonstrate the significant positive effect that data-driven techniques can have on parents’ engagement on these platforms.

2 Survival Bandits

Arielle Elissa Anderer[1], Hamsa Sridhar Bastani[2], John M. Silberholz[3], [1]Cornell University, Ithaca, NY, [2]Wharton School, Philadelphia, PA, [3]University of Michigan Ross School of Business, Ann Arbor, MI, Contact: aea68@cornell.edu

This project adapts online learning techniques to scenarios with time-to-event data, where there is a delay between choosing an arm and observing feedback that is endogenous to the quality of the arm. We posit a multi-armed bandit algorithm that uses a cox-proportional hazards estimator. We theoretically analyze and prove guarantees on the regret under this algorithm. Lastly, we examine its performance on a dataset of metastatic breast cancer clinical trials, and compare it to that of other adaptive allocation schemes.

3 Robust, Balanced Dynamic Matching and Its Application to Refugee Resettlement

Kirk Bansak[1], Soonbong Lee[2], Vahideh Manshadi[3], Rad Niazadeh[4], Elisabeth Paulson[5], [1]University of California, Berkely, Berkely, CA, [2]Yale university, New Haven, CT, [3]Yale University, New Haven, CT, [4]Chicago Booth School of Business, CHICAGO, IL, [5]Harvard University, Cambridge, MA, Contact: soonbong.lee@yale.edu

Motivated by the refugee resettlement process in the U.S., we study a dynamic allocation problem that involves two types of resources, static (e.g., housing) and dynamic (e.g., processing). The goal is to maximize the matching reward (the employment outcomes) while respecting the capacity constraints for static resources and balancing congestion for the dynamic ones. To address large variations in the composition of refugee pools across the years, we take a robust approach and develop a primal-dual algorithm that minimally relies on data from past years. Despite having high-dimensional dual variables, we show that our algorithm has a sub-linear regret. Further, it outperforms existing ones when tested on data from a major resettlement agency, making it a viable candidate for replacing the current practice upon experimentation.

4 Learning and Planning Under Uncertainty for Wildlife Conservation

Lily Xu, Harvard University, Cambridge, MA

Wildlife poaching fuels the multi-billion dollar illegal wildlife trade and pushes countless species to the brink of extinction. To aid rangers in preventing poaching in protected areas around the world, we have developed PAWS, the Protection Assistant for Wildlife Security. We present technical advances in multi-armed bandits and robust sequential decision-making using reinforcement learning, with research questions that emerged from on-the-ground challenges. We also discuss bridging the gap between research and practice, presenting results from field deployment in Cambodia and large-scale deployment through integration with SMART, the leading software system for protected area management used by over 1,000 wildlife parks worldwide.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB46

CC-North 227B

Panel Discussion: Implementing Experiential Learning for Analytics Across Diverse Academic Settings

Panel Session

Session Chair: Carrie Beam, University of California Davis
Session Chair: Sanjay Saigal, Stanford University, Menlo Park, CA

1 Moderator

Carrie Beam, University of California Davis

2 Panelist

Polly Mitchell-Guthrie, Kinaxis, Scottsdale, AZ

3 Panelist

Janet Moss, Georgia Southern University, Statesboro, GA

4 Panelist

Eric Specking, University of Arkansas College of Engineering, Fayetteville, AR

Tuesday, October 17, 10:45 AM - 12:00 PM

TB47

CC-North 227C

Computation Services in Cyber Physical Systems

Community Committee Choice Session

Session Chair: Yingyan Zeng, Virginia Tech, Blacksburg, VA

1 Investigating Dielectric Spectroscopy and Soft Sensing for Nondestructive Quality Assessment of Engineered Tissues

Yingyan Zeng[1], Shohanuzzaman Shohan[2], Xiaoyu Chen[3], Ran Jin[4], Rohan A. Shirwaiker[5], [1]Virginia Tech, Blacksburg, VA, [2]North Carolina State University, Raleigh, NC, [3]University of Louisville, Louisville, KY, [4]Virginia Tech, Blacksburg, VA, [5]Assistant Professor, Raleigh, NC

This study explores a non-destructive dielectric spectroscopy (DS) soft-sensing approach for inline quality monitoring of tissue engineered medical products (TEMP). The performance of DS was evaluated using gelatin methacrylate (GelMA) constructs containing human adipose-derived stem cells and compared to traditional biochemical assays. A key metric (Δ?) related to cellular metabolic activity was assessed, considering photocrosslinking duration and growth media volume. To minimize cytotoxicity risks, a bilinear basis mixed model (BBMM) was developed as a soft sensor for accurate quality prediction. The BBMM outperformed state-of-the-art vector prediction methods, demonstrating its potential as an inline monitoring tool for scaled-up TEMP production systems.

2 Synthetic Data Generation and Sampling for Online Training of Dnns in Manufacturing Supervised Learning Problems

Prithivrajan Thiyagarajan, Virginia Tech, Blacksburg, VA, Contact: prithivrajant@vt.edu

The Industrial Internet provides passive manufacturing data for data-driven modeling with DNNs. However, data class imbalance, shifting distribution, and multi-modality variables impede DNN performance. To solve this, the SIDES framework proposes a bi-level Hierarchical Contextual Bandits to integrate active DoE data generation and passive data sampling to enhance the DNN's online learning performance. SIDES employs a Multimodality-Aligned Variational Autoencoder to transform predictors into a shared low-dimensional space for effective data generation and sampling. The benefits of SIDES are shown in a printed electronics case study, which improved DNNs' learning performance. We integrate SIDES with Chat GPT to improve the usability.

3 Change Point Estimation, an Evaluation Tool for Computational Detection Algorithms

Vasileios Pavlopoulos, University of Alabama in Huntsville, Huntsville, AL, Contact: vasilis.pavlopoulos7@gmail.com

A rich literature on detection algorithms is trying to capture change points in the distribution of time series data. However, applying those algorithms to the same dataset, we find different estimates, thus creating confusion for practitioners. We propose an estimation methodology as a tool to evaluate different computational algorithms. We test methodologies from change point estimation to evaluate the detected estimates. We provide inferences about the effectiveness of each algorithm and their estimates. The aim is to minimize the randomness associated with the detected estimates. We focus on change points in the covariance matrix of multivariate time series data. Finally, we provide a comparison of detection algorithms.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB48

CC-North 228A

Reliability Modeling and Maintenance Optimization

Community Committee Choice Session

Session Chair: Yili Hong, Virginia Tech, Blacksburg, VA

1 Remaining Useful Life Prediction Based on Forward Intensity

Peihong Xiao, National University of Singapore, Singapore, Singapore. Contact: xiaopeihong@u.nus.edu

This study proposes a new RUL prediction method using a novel tool called forward intensity to overcome the challenge of finding fixed failure thresholds for degradation signals in existing methods. The degradation signals of the product of interest are treated as time-varying covariates for its forward intensity, with regression coefficients estimated using smoothing splines under the reproducing kernel Hilbert space framework. The proposed method enables RUL prediction without a fixed failure threshold, providing satisfactory prediction accuracy and interpretable covariate effects. Prediction intervals for the RUL are also developed. Three real examples demonstrate the effectiveness of the proposed method, outperforming existing methods in terms of prediction accuracy.

2 Robust Condition-Based Production and Maintenance Planning for Degradation Management

Qiuzhuang Sun, National University of Singapore, Singapore, Singapore. Contact: q_strong@163.com

We study the robust production and maintenance control for a production system subject to degradation. Different from the existing literature that posits aparametric stochastic degradation process, we suppose the degradation increment during a decision epoch lies in an uncertainty set. We derive closed-form solutions for production planning that facilitate the real-time implementation of our model on IoT-enabled production systems.

3 Optimal Sensor Placement for Linear Inverse Problems with Nonnegativity Constraints

Xinchao Liu[1], Dzung Phan[2], Youngdeok Hwang[3], Levente Klein[2], Xiao Liu[1], Kyongmin Yeo[2], [1]University of Arkansas, Fayetteville, AR, [2]IBM Research, Yorktown Heights, NY, [3]Baruch College, City University of New York, New York, NY

To optimally deploy sensors for atmospheric inverse modeling based on Gaussian plume model, closed-form designs (e.g., A or D-optimal) do not exist due to the nonnegativity constraint of emission rates. A bi-level optimization framework is proposed with a stochastic outer objective (i.e., estimation loss) and a constrained inverse model with regularization at the inner level. We solve this bi-level problem by implicit gradients considering the inner KKT system. Finally, two first-order iterative algorithms are investigated and compared using two numerical examples. The scalability of the SGD-based approach is demonstrated.

4 Vehicle Battery Life Modeling with Two Failing Stages and Partially Observed Covariates

Qingyu Yang[1], Yili Hong[2], [1]Wayne State University, Detroit, MI, [2]Virginia Tech, Blacksburg, VA

Recent years have seen a significant increase in the development of vehicle batteries. This paper investigates the impact of the length of time a vehicle spends on a dealership lot or in a manufacturing facility on the durability of its battery. The unique conditions under which a vehicle battery operates in idle mode in these environments can result in different degradation and failure modes compared to when the vehicle is in use. To address this, the paper presents a new two-stage reliability model for vehicle battery modeling that considers partially observed covariates. The methodology is validated through a real-world case study, providing practical evidence for its effectiveness in understanding and predicting battery durability.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB49

CC-North 228B

Recent Advances in Collaborative Data Analytics and Its Applications

Community Committee Choice Session

Session Chair: Seokhyun Chung, University of Michigan, Ann Arbor, MI

Session Chair: Xubo Yue, University of Michigan, Ann Arbor, Ann Arbor, MI

1 Addressing Data Heterogeneity in Collaborative Fault Diagnosis via Clustered Federated Learning

Manan Mehta, Chenhui Shao, University of Illinois Urbana-Champaign, Champaign, IL, Contact: mananm2@illinois.edu

Federated learning (FL) has received significant attention for collaborative training of deep learning models across devices while preserving privacy. Industrial big data in applications like healthcare, robotics, and smart manufacturing is inherently non-IID and heterogeneous, which deteriorates the quality of the learned FL model. To address this, we present a clustered FL framework called Federated Learning via Agglomerative Client Clustering (FLACC). FLACC greedily agglomerates clients or groups of clients after each server round. FLACC allows clients with similar underlying distributions to benefit by training together and restricts negative information transfer between dissimilar clients. We demonstrate its efficacy through extensive experiments on three benchmark FL datasets and a real-world case study for industrial mixed fault classification.

2 Causal Representation Learning with Structured and Unstructured Data: Neural Bayesian Machine

Yan Xue, Hao Yan, Yongming Liu, Arizona State University, Tempe, AZ, Contact: yxue37@asu.edu

A novel causal representation learning integrating Neural Networks for unstructured data representation learning and Bayesian causation structural learning is proposed to handle structured and unstructured data simultaneously. The proposed method addresses the discovery of high-level causal factors from low-level unstructured data. The proposed model also achieves continuous gradient optimization and outperforms benchmark methods/models for handling heterogeneous structured and unstructured data. The effectiveness of the proposed model is demonstrated and verified with numerical toy problems and with two real-world problems, i.e., melanoma diagnosis and material failure with random microstructure.

3 Process Defects Knowledge Modeling in Laser Powder Bed Fusion Additive Manufacturing: An Ontological Framework

Nazmul Hasan[1], Md Habibor Rahman[1], Andrew Wessman[2], Timothy Smith[3], Mohammed Shafae[4], [1]University of Arizona, Tucson, AZ, [2]University of Arizona, Tucson, AZ, [3]NASA Glenn Research Center, Cleveland, OH, [4]University of Arizona, Tucson, AZ

A lack of a structured approach to representing knowledge of defects in the laser powder bed fusion (LPBF) process hinders its industrial adoption for metal additive manufacturing (AM). This study addresses this issue by proposing an ontological framework that systematically structures and represents knowledge of LPBF defects. The implementation of the proposed LPBF defect ontology is demonstrated in web ontology language using the Protégé software. The framework captures the intricate network of relationships among defects and causal factors, providing a sustainable and reusable knowledge base for tutoring researchers, assisting in defect root cause identification, and guiding practitioners in defect-controlled process planning.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB50

CC-North 229A

Impact of Variability and Extremes of Weather in Energy Systems

Community Committee Choice Session

Session Chair: Aleksander Grochowicz, 1</sup

Session Chair: Jacqueline Dowling, California Institute of Technology, Pasadena, CA

1 Improving System Reliability in Wind- and Solar-Dominated Electricity Systems via Capacity Investment

Natasha Reich, California Institute of Technology, CA

In this study, we examined wind- and solar-dominated electric power systems using a capacity expansion model to analyze cost-effective investments to improve system reliability. We used over 40 years of U.S. weather data to evaluate the performance (i.e. ability to meet demand) of systems planned with a single year of data when operated on the full dataset. Then, additional investments in each technology were made and the system's performance was re-evaluated to determine the impact of the investment on system reliability. Our findings suggest that wind power is a more cost-effective investment than solar power, indicating that expanding wind power capacity over solar power capacity could increase the adequacy of an energy system at a lower cost.

2 Multi-Scale and Multi-Resource Analysis of Increased Adoption of Renewable Energy Sources

Elnaz Kabir[1], Vivek Srikrishnan[2], Vivienne Liu[2], Scott Steinschneider[2], Lindsay Anderson[2], [1]Texas A&M, College Station, TX, [2]Cornell University, Ithaca, NY

The variability and intermittency of renewable energy sources pose several challenges for power systems operations, including energy curtailment and price volatility. In power systems with considerable renewable sources, co-variability in renewable energy supply and electricity load can intensify these outcomes. In this study, we examine the impacts of renewable co-variability across multiple spatial and temporal scales on the New York State (NYS) power system, which is undergoing a major transition toward increased renewable generation. Our results demonstrate that renewable energy resources can vary considerably, where the variability is substantially greater in shorter time scales. For the case of NYS, this results in a 9% variation in annual average electricity prices and up to a 56% variation in the frequency of price spikes.

3 Identifying Weather Stress Events from Power System Optimisation Outputs

Koen van Greevenbroek[1], Aleksander Grochowicz[2], Hannah Bloomfield[3], [1]UiT The Arctic University of Norway, Tromsø, Norway; [2]University of Oslo, Oslo, Norway; [3]University of Bristol, Bristol, United Kingdom. Contact: koen.v.greevenbroek@uit.no

The shift toward renewable generation increases the impact of weather and climate on the energy sector and can introduce new risks if not accounted for properly. However, the characteristics of large compound events leading to potential lost load are still poorly understood. In this work, we apply a high-resolution optimization model for a decarbonized European electricity system to the question. Dual variables of this model are used to identify difficult weather periods, understood as periods that drive system design and total cost. We then characterize the meteorological conditions during these periods. This interdisciplinary approach combining meteorology and energy systems modeling enhances our understanding of weather resilience.

4 Firming Electricity Systems Reliant on Wind and Solar Generation

Ken Caldeira, Carnegie Institution for Science, Stanford, CA

Wind and solar electricity generation is variable in time, as is electricity demand. Matching electricity generation with electricity demand depends on the deployment of technologies or approaches that can supply electricity at times when demand exceeds generation by wind or solar. These firming technologies could involve dispatchable generation or dispatchable energy storage devices. Load management can also contribute. There are many technologies that could potentially play this firming role. However, uncertainties in future costs precludes determination of which technologies might comprise future least-cost electricity systems. However, a large number of such technologies could potentially play a firming role at acceptable cost levels. Rather than looking for least-cost solutions, it may suffice to find low-cost solutions.

5 How the Combination of Space Heating Electrification and Climate Change Could Impact Seasonal Peaking and Reliability of the Texas Power Grid

Henry Ssembatya, North Carolina State University,

Raleigh, NC
Texas typically experiences peak electricity demand in the summer. Around 60% of households rely on electricity for space heating, but as decarbonization efforts surge, more households could switch from using natural gas to electricity, thus significantly increasing winter electricity demand. Simultaneously, climate change will increase summer temperatures and the potential for heat waves. Uncertainty regarding the timing and magnitude of these simultaneous changes raises questions about how they will jointly affect seasonal generation requirements and the firm capacity needed. In this study, we investigate long-term patterns in electricity demand driven both by space heating electrification and climate change using an open-source nodal power system model. The results will help system planners to better plan for adequate supply capacity.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB51

CC-North 229B

Wild Fire Mitigation and Forest Harvest Planning

Contributed Session

Session Chair: Fatemeh Rezaei, Mississippi State University, Starkville, MS

1 Restoration of Forest Linear Disturbances from Oil-And-Gas Exploration: How Can Network Models Help?

Denys Yemshanov[1], Mackenzie Simpson[1], Ning Liu[1], Aaron Petty[2], Frank H. Koch[3], Cynthia Chand[2], George Duffy[2], Vita Hoyles[2], Chris Mallon[2], [1]Natural Resources Canada, Sault Ste. Marie, ON, Canada; [2]Alberta Environment and Parks, Edmonton, AB, Canada; [3]USDA Forest Service Southern Research Station, Research Triangle Park, NC, Contact: denys.yemshanov@nrcan-rncan.gc.ca

We propose a two-tier network optimization model for restoration of linear forest disturbances in areas of oil-and-gas extraction. The model delineates a contiguous set of coarse-scale regions for restoration and then uses this solution to warm start a fine-scale forest patch-level network optimization model that allocates restoration activities to maximizing the access of wildlife species to undisturbed habitat, maintain human access to unrestored sites and keep restoration in meaningful clusters. We applied the approach to develop forest restoration scenarios in the Red Rock caribou range in the northwestern Alberta, Canada.

2 Application of Machine-learning Models for Wildfire Prediction in South Korea

Chanjung Lee[1], Yohan Lee[2], [1]Seoul National University, Seoul, Korea, Republic of; [2]Seoul National University, Seoul, Korea, Republic of. Contact: gtano@snu.ac.kr

This study aims to develop a model that predicts domestic forest fire occurrences during fire outbreaks using machine learning techniques. For the modeling methods, logistic regression analysis and ensemble techniques, such as gradient boost and random forest, were used while the oversampling technique was utilized to address the imbalance problem of the forest fire data. The model developed in this study predicted 239 out of 333 forest fire occurrences during the nationwide forest fire period in 2020 with a prediction accuracy of approximately 0.71. We found that forest fire occurrences are not just influenced by climate factors, such as temperature, humidity, and precipitation, but also by farmland density and stem volume per hectare as human-associated factors in the minimum level of administrative regions of the Repulic of Korea.

3 A Stochastic Model for Forest Harvest Planning Problem

Fatemeh Rezaei[1], Bruno Kanieski da Silva[1], Jesse D. Henderson[2], Mohammad Marufuzzaman[1], Shaun Tanger[3], [1]Mississippi State University, Starkville, MS, [2]USDA Forest Service, Southern Research Station, Research Triangle Park, Durham, NC, [3]University of Arkansas at Monticello, Monticello, AR, Contact: fr277@msstate.edu

The forest harvest planning problem consists of the maximization of landowners' goals within a complex combination of biological, economic, and social variables. In the US South, the uncertainties related to tornados and hurricane occurrences have a major impact on forest planning and economic profitability. In this paper, we develop a stochastic multi-stage model to investigate the optimal harvest planning policy.

Keywords: Harvest planning, Uncertainty, Climate events

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CC-North 230

Carbon-centric Power System Operation and Transaction

Community Committee Choice Session

Session Chair: Yunhe Hou, The University of Hong Kong, Hong Kong, Hong Kong

Session Chair: Yue Chen, The Chinese University of Hong Kong, Sha Tin

1 An Energy Market with Carbon Emission Allocation Enabling Real-Time Energy Storage Participation

Rui Xie, Yue Chen, The Chinese University of Hong Kong, Hong Kong, China. Contact: yuechen@mae.cuhk.edu.hk

This paper proposes an energy market with a carbon emission allocation mechanism. The emission is allocated among generators, electric demands, and energy storage based on Aumann-Shapley prices. A novel multi-parametric linear programming-based algorithm is developed to calculate the allocations more accurately. Furthermore, to fully cultivate the potential of ES in reducing carbon emissions, a real-time ES bidding method is established based on Lyapunov optimization. Case studies demonstrate the effectiveness and advantages of the proposed method compared to some existing approaches, e.g., the carbon emission flow method.

2 Commercial Building Hvac Demand Response for Low-Carbon Power Systems: Theoretical Energy Efficiency Analysis and Data-Driven Flexibility Estimation

Shunbo Lei, Weimin Wu, The Chinese University of Hong Kong, Shenzhen, Shenzhen, China

Demand response from commercial building heating, ventilation, and air conditioning (HVAC) systems, which sometimes is treated as a virtual battery, possesses a significant potential to accommodate the uncertainty and variation of renewable energy, thereby expediting the transition to low-carbon power grids. This talk introduces our investigation into the impact of HVAC demand shifting on building energy efficiency. Based on a general thermodynamics model, we analyze the influence of both thermodynamics and control strategies on HVAC energy efficiency, and propose a method for efficiency improvement. We also propose a data-driven method to quantify the demand flexibility of HVAC systems. By combining it with the theoretical energy efficiency analysis and adjusting control signals, we aim to enhance HVACs' energy efficiency in providing services to power grids.

3 Robust Dispatch with Demand Response Under Decision-Dependent Uncertainty

Yifan Su, Tsinghua University, Beijing, China. Contact: suyf19@mails.tsinghua.edu.cn

Demand response is recognized as a promising solution to reducing operation costs and alleviating system risks by encouraging end-users to participate in system regulation. In practice, demand response will inevitably introduce uncertainty to decision-making due to volatile weather and complicated social behaviors. The decisions, conversely, may affect the uncertainty itself on parameters or information structures. This kind of uncertainty is the decision-dependent uncertainty (DDU), which has not been explored in demand response. We propose a novel two-stage robust economic dispatch model with demand response under DDU, where the uncertainty set of demand response varies with respect to its set-point determined by the decision. To solve this problem, we propose an improved column and constraint generation (C&CG) algorithm with a scenario mapping embedded.

4 A Submodularity-Based Interpreting Scheme for Generalized Forward Scenario Selection: A Case of Wind Power Generation

Qinfei Long[1,2], Yunhe Hou[3], [1]The University of Hong Kong, Hong Kong, China; [2]HKU Shenzhen Institute of Research and Innovation, Shenzhen, China; [3]The University of Hong Kong, Hong Kong, Hong Kong

The generalized forward scenario selection is important in scenario-based technologies, such as stochastic programming. However, as a combinatorial optimization, forward scenario selection typically lacks an approximation guarantee for the solution, and the selected number cannot be scientifically predetermined. This study reports a new approach to interpret generalized forward scenario selection. First, the process submodularity ratio (PSR) is proposed to measure the process submodular degree. Then a PSR-based approximation guarantee is theoretically derived to quantitively assess the performance of the selection process. Finally, the tail cost is established via power-law exponent, which can dynamically estimate the selection cost and indicate when the selection should be stopped. Its performance is verified by a wind power generation case.

5 Zoning Ordinances: Implications for Rural Utility-Scale Pv Deployment and Power System Decarbonization

Papa Yaw Owusu-Obeng, Michael Craig, University of Michigan, Pinckney, MI

Power system planning models overlook the influence of zoning ordinances on utility-scale PV investment. We present advances in two fronts: 1) we estimate the extent to which zoning ordinances influence the capacity value and competitiveness of large-scale utility-scale PV projects. 2) we determine whether renewable energy portfolio standards can drive the deployment of utility-scale PV investment amidst zoning ordinances.

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Environmental and Sustainability Issues across Different Product Life-Cycle Stages

Community Committee Choice Session

Session Chair: Arda Yenipazarli, Georgia Southern University, Statesboro, GA

1 From Transparency to Transformation: Causal Effects of CDP's Supply Chain Program

Jury Gualandris[1], William Diebel[2], Robert Klassen[1], [1]Ivey Business School at Western University, London, ON, Canada; [2]Ivey Business School, London, ON, Canada

This study investigates the causal effect of supply chain transparency driving sustainable change. Using data from CDP's supply chain program, coarsened exact matching, and panel data analysis, we examine how increased transparency enables to identify and report on environmental supply chain issues more effectively. This research underscores the importance of embracing transparency as vital tool in the pursuit of more sustainable supply chains.

2 Environmental Strategies for Building Competitive Advantage: When Does It Pay to Be "Green"?

Arda Yenipazarli, Georgia Southern University, Statesboro, GA, Contact: ayenipazarli@georgiasouthern.edu

In this paper, we focus on competing firms' incentives to pursue product-oriented differentiation-based environmental strategies associated with high technological risk, delayed payoffs (if successful) and substantial research and development (R&D) investments in lieu of lower-risk, short-term and low-cost process-oriented environmental strategies, and vice versa. Drawing on a two-period game-theoretic model, we characterize how the presence of strategic rivals who potentially pursue an environmental strategy in dynamic markets, competition intensity, product development capabilities, technology trajectories and customer concerns govern the environmental strategy priorities and choices of firms, and identify under what supply and market conditions these strategic choices provide competitive advantage and thereby result in win-win outcomes.

3 Inventory Disclosure with Product Returns

Tolga Aydinliyim, Ceren Gultekin, Baruch College, CUNY, New York, NY, Contact: tolga.aydinliyim@baruch.cuny.edu

We study whether selective-inventory-disclosure, which can mitigate the adverse profit implications of consumers' strategic purchase deferrals, remains effective when product returns are allowed. Using a price- and refund-setting newsvendor framework with availability-dependent demand, we show consistent-inventory-disclosure to be optimal. Furthermore, equilibrium refund relative to consistent-inventory-masking can be higher or lower.

4 Sustainable Bioleaching of Lithium-Ion Batteries for Critical Materials Recovery

Majid Alipanah[1], Hongyue Jin[1], Qiang Zhou[1], Caitlin Barboza[2], David Gazzo[3], Vicki Thompson[2], Yoshiko Fujita[2], Jiangping Liu[4], Andre Anderko[4], David Reed[2], [1]University of Arizona, Tucson, AZ, [2]Idaho National Lab, Idaho Falls, ID, [3]University of Notre Dame, Notre Dame, IN, [4]OLI Systems, Parsippany, NJ, Contact: hjin@arizona.edu

Recycling spent lithium-ion batteries could alleviate supply risks for critical metals such as lithium, cobalt, and nickel, and be less harmful to the environment compared to new production. This study aimed to optimize a recycling technology called bioleaching for maximum economic competitiveness through design of experiments assisted by thermodynamic modeling. The optimal condition was identified as 2.5% pulp density in 75 mM gluconic acid biolixiviant at 55°C for 30 h which could recover 57%-84% of nickel, 71%-86% of cobalt, and 100% of lithium and manganese, yielding a 17%-26% net profit margin. The recommended pulp density and acid concentrations, together with the observed metal solubilization, were supported by thermodynamic modeling predictions.

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CC-North 231B

Optimization Modeling Software I

Community Committee Choice Session

Session Chair: Susanne Heipcke, FICO, Birmingham, United Kingdom

Session Chair: Robert Fourer, AMPL Optimization Inc., Evanston, IL

1 New Modeling and Programming Features in Xpress Mosel 6

Susanne Heipcke, FICO, Birmingham, United Kingdom

This talk presents examples of recent new features of FICO Xpress Mosel. On the mathematical modeling side, these include support for the new global solver of Xpress, handling of multiple objectives and extension of Irreducible Infeasible Sets (IIS) to nonlinear constraints. Many new programming features, in particular new forms of data input from different text formats including JSON, rely on the concept of union types, a container holding an object of one of a predefined set of types. Support for reflection, that is, inspection of the currently executing program itself, particularly helps for the implementation of testing systems. New mechanisms for library compatibility and depreciation markup ease the maintenance of large-scale projects over longer periods of time.

2 Model Building with Gurobipy-Pandas

Robert Luce, Gurobi Optimization, Berlin, Germany. Contact: luce@gurobi.com

Gurobipy-pandas is a Python project that allows you to connect pandas with gurobipy. It enables you to easily and efficiently build mathematical optimization models from data stored in DataFrames and Series, and to read solutions back directly as pandas objects. We will walk through the basic API and discuss best practice model building patterns.

3 Modeling for Optimisation over Trained Graph Neural Networks

Shiqiang Zhang, Juan Campos, Calvin Tsay, Ruth Misener, Imperial College London, London, United Kingdom

Our open-source software OMLT (Optimization and Machine Learning Toolkit, https://github.com/cog-imperial/OMLT) translates machine learning models into Pyomo formulations and thereby enables optimization over already-trained models. This presentation discusses extending the OMLT framework to incorporate graph neural networks and discusses effective modelling for these optimization problems.

4 MAPL: A New Modeling Program Language for Optimization Problems

Cheng Yang, Alibaba

Modeling complex systems has always been a challenging task in science and engineering. A new modeling language called MAPL (MindOpt Algebraic Modeling Language) has been developed to address this challenge. MAPL provides a concise syntax similar to mathematical expressions and supports vectorized numerical computing syntax, making it easier to model complex systems more efficiently without sacrificing accuracy. MAPL also supports multiple solvers, including the self-developed MindOpt solver, capable of handling large-scale optimization problems and providing quick solutions to large problems. In addition, the integration of MAPL with AI technology leverages Alibaba's large language model to assist developers in the modeling process.

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CC-North 231C

Mechanism of Matching Demand for Sharing Economy

Contributed Session

Session Chair: Peash Saha, Queen's University, Kingston, ON, Canada

1 Modeling a Hybrid On-Demand Meal Delivery System in a Link-Node-Based Network Setting with Dynamic Choice Behaviors

Rui Ma, Zohre Noormohamadzade, University of Alabama in Hunstville, Huntsville, AL, Contact: rui.ma@uah.edu

This paper presents an optimization framework with dynamic user equilibrium describing the choice behaviors of the delivery drivers. The framework can be utilized to reveal how to maximize operators profit or the overall social benefit in such an on-demand meal delivery system. The network model is based on a link-node network representation that considers road network topology, time-varying demand and dispatched drivers, restaurant strategies and a matching mechanism to connect waiting drivers with pending orders. In this model, restaurants have two strategies to serve their demands by either using their own vehicles in house or delegating tasks to a third party platform. Various competing strategies that restaurants can adopt in response to different network setup, demand profiles and background traffic scenarios are analyzed under the proposed framework.

2 The Impacts of Ride-Hailing on Car Ownership Under Individual Choice Endogeneity

Yuliu Su[1], Ying Xu[2], Shih-Fen Cheng[3], Costas Courcoubetis[4], [1]Siemens, Beijing, China; [2]Singapore University of Technology and Design, Singapore, Singapore; [3]Singapore Management University, Singapore, Singapore; [4]The Chinese University of Hong Kong, Shenzhen, Shenzhen, China. Contact: xu_ying@sutd.edu.sg

With the emergency of ride-hailing platforms, individuals with travel needs face a new tradeoff: either purchase a car and provide ride-hailing service or use the ride-hailing service. We aim to quantitatively evaluate the impact of ride-hailing on individuals' car demand and usage. We adopt an equilibrium choice model to study a heterogeneous population's choices on car ownership and transportation modes. We evaluate how driving costs and platform pricing schemes affect car ownership, platform profits, and environmental impacts.

3 Demand Seasonality Driving the Value of Information Sharing

Vladimir Kovtun[1], Avi Giloni[1], Clifford Hurvich[2], Noam Shamir[3], [1]Sy Syms School of Business, New York, NY, [2]Stern School of Business, New York, NY, [3]Coller School of Management, Tel Aviv, Israel. Contact: vladimir.kovtun@yu.edu

We explore the impact of demand seasonality on the value of information sharing between retailer and supplier in supply chains. By using spectral analysis to view several types of demand-generating ARMA models we uncover several key results. Information sharing is found to be valuable when retailer demand is "seasonal enough" unless the retailer's leadtime is a multiple of the seasonal period. This is true for simple ARMA models such as AR(1) and AR(2), as well as several Seasonal ARIMA models commonly used to study seasonal data. In studying an extremely-seasonal SARIMA model we note that seasonality causes the supplier's demand to be equal to the sum of a negligible shock and retailer demand occurring some time in the past. That is, current demand observed by the retailer drives future demand observed by the supplier thereby making this information valuable to the supplier.

4 Popular Matching Under Boston School-Choice Mechanism and Its Applications

Peash Saha, Salimur Choudhury, Kai Salomaa, Queen's University, Kingston, ON, Canada. Contact: p.saha@queensu.ca

Boston mechanism is a long-established model for two-sided matching problems with strict preferences on one side and rough priorities on the other. The model focuses on the welfare of the agents with the preferences. We analyze the popularity of the matching produced using the Boston mechanism and provide a characterization of the popular matching and the maximum cardinality popular matching in the model. A popular matching is the one preferred by the maximum number of agents among all matchings. Our proposed polynomial time algorithm finds a popular matching if there is any in such a setting. There exist many corresponding applications of popular matching under the Boston mechanism such as volunteer and food rescue tasks matching.

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Energy-aware Business Practices

Contributed Session

Session Chair: Kumar Saurav, IBM Research Labs, Bangalore, India

1 Navigating the Bitcoin Boom: Assessing the Impact of Mining on Power Generation Expansion

Fargol Nematkhah[1], Andrew Lu Liu[2], Yihsu Chen[1], [1]University of California, Santa Cruz, Santa Cruz, CA, [2]Purdue University, West Lafayette, IN, Contact: fnematkh@ucsc.edu

Texas has welcomed an influx of Bitcoin miners seeking affordable energy resources. However, the presence of miners has raised debates about their impact on the carbon footprint of the power grid and new-generation investments. In this work, we study the impact of Bitcoin mining on generation expansion in ERCOT as a two-stage stochastic cost minimization problem which we further analyze using a progressive hedging approach to tackle the large problem size.

2 Computing Equilibrium Automotive Technology Decisions Under Regulation

Johnathan Vicente[1], Jeremy J. Michalek[1,2], Kate S. Whitefoot[1,2,3], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Carnegie Mellon University, Pittsburgh, PA, [3]Carnegie Mellon University, Pittsburgh, PA

Computational equilibrium models of the automotive industry are used to inform vehicle technology strategies and policies by understanding the impact of particular regulations on automaker costs and technology use. However, the use of these models in practice has been hindered by (1) high computational time and (2) unknown properties governing when the model will successfully solve for valid equilibria. By exploiting properties of automakers' profit-maximization problem and deploying a multi-stage solution approach, this work identifies improvements that accelerate solutions and guarantee valid equilibrium solutions given sufficient time.

3 The Impact of Corporate Responses to Environmental Shareholder Proposals on Financial Performance

Marilyn Lucas, Thomas Noordewier, University of Vermont, Burlington, VT

Shareholder-sponsored proposals that petition publicly held companies to adopt environmental initiatives have become commonplace in recent years. The way in which firms respond to such proposals plays a key role in explaining the diversity of observed relationships between corporate environmental behavior and corporate financial performance. This study, which focuses on withdrawn proposals, builds upon the resource-based view (RBV) and stakeholder management theory. We merge information from multiple sources to assemble a comprehensive data set, and empirically investigate this relationship, highlighting the contingent role of the firm's R&D and advertising activities.

4 Carbon-Aware Data Center Management: Towards Sustainable and Efficient Operations

Kumar Saurav[1], Ayush Jain[2], [1]IBM Research Labs, Bangalore, India; [2]IBM Research Labs, Delhi, India. Contact: kr.saurav.010@in.ibm.com

With the proliferation of data centers worldwide, their environmental impact has become a pressing concern. As a result, carbon-aware operation for a group of data centers has emerged as a strategic approach to minimize emissions and improve efficiency across multiple facilities. This abstract presents a carbon-aware operation for a group of data centers to reduce their carbon emission by 10% without any significant increase in operational costs by exploring strategies such as geo-shifting of loads, renewable energy integration, etc. By adopting carbon-aware practices at the group level, data centers can achieve significant reductions in carbon emissions, enhance energy efficiency, and contribute to a more sustainable digital infrastructure.

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CC-North 232B

Quantum Computing and Optimization III

Community Committee Choice Session

Session Chair: Rodolfo Alexander Quintero Ospina, 1</sup

Session Chair: Brandon Augustino, Lehigh University, Landing, NJ

1 A Quantum Framework for Topological Data Analysis

Bernardo Ameneyro Rodriguez[1], Vasileios Maroulas[1], George Siopsis[2], Rebekah Herrman[3], [1]University of Tennessee, Knoxville, TN, [2]University of Tennessee, Knoxville, TN, [3]University of Tennessee, Knoxville, TN, Contact: bameneyr@vols.utk.edu

TDA methods capture the shape of data, which can be useful for classification problems. First they extract topological features from the data via persistent homology, tracking them across different scales or resolutions. The topological features are then displayed in persistence diagrams that show the birth and death of each feature. These diagrams are a great way to summarize data before performing machine learning algorithms. But to do this one must compute distances between persistence diagrams, such as the Wasserstein distance. To estimate these one needs to minimize a cost function over all possible ways to match points from two persistence diagrams. We present a quantum algorithm for persistent homology, as well as a QAOA approach for estimating the distance between persistence diagrams.

2 Quantum Semidefinite Programming with the Hadamard Test and Approximate Amplitude Constraints

Iria Wang, Harvard Griffin Graduate School of Arts and Sciences, Cambridge, MA, Contact: iriawang@g.harvard.edu

While semidefinite programs (SDPs) yield favorable scaling behavior in exchange for a quantifiable loss of accuracy, classical SDPs remain intractable for high-dimensional problems. Our proposed solution is a variational algorithm for Quantum SDPs using the Hadamard Test and Approximate Amplitude Constraints (HTAAC-QSDP), which approximates SDPs with up to 2^n variables using n+1 qubits, O(1) quantum measurements, and O(poly(n)) classical approximations. The Hadamard test enables optimization by estimating an expectation value on an ancilla qubit, and with O(poly(n)) Pauli string amplitude constraints, allows approximate enforcement of the SDP contraints. We extend its original implementation (Goemans-Williamson algorithm for MaxCut) to other instances of Karp's 21 problems and demonstrate specific bounds for solution quality and unitary complexity.

3 Polyhedral Structure of Penalty Constants in Quadratic Unconstrained Binary Optimization and Applications to Quantum Computing

Rodolfo Quintero Ospina, Lehigh University, Bethlehem, PA

Quadratic Unconstrained Binary Optimization (QUBO) problems have resurged, offering a unified framework for solving combinatorial optimization problems (COPT). Quantum computing algorithms like QAOA, VQE, and quantum annealing effectively address QUBO models. We present a polyhedral characterization of penalty constants in penalization-based reformulations of linear and quadratic integer programs as QUBO problems. Our approach recovers prior techniques and establishes a bijective correspondence between optimal solutions of QUBO constructions and the original problem. Moreover, for inequality-constrained combinatorial optimization problems, we characterize QUBO formulations that eliminate binary slack variables, albeit with challenging computation of penalty constants. Computational experiments exemplify the efficacy of these ideas.

4 Quantum State Estimation from a Dynamical System Perspective

Muqing Zheng, Xiu Yang, Lehigh University, Bethlehem, PA

The presence of noise significantly limits the complexity and capabilities of model quantum devices, while nature prevents us from accurately recording the actual evolutions in real devices. In this research, we propose a data-driven approach to viewing quantum circuits from a dynamical system perspective, enabling the application of the classical tool, Kalman smoother. By using time-series measurement data, we iteratively infer the state evolution process without introducing additional quantum noise. Promising results are obtained through experiments on backend noise simulators and real quantum backends.

5 Semidefinite Programming Using Thermal Pure Quantum States

Oscar Watts, Quantinuum, London, United Kingdom. Contact: Oscar.Watts@quantinuum.com

We propose a modification of the quantized MMW algorithm introduced by Brandao and Svore, replacing the Gibbs sampler with thermal pure quantum (TPQ) states. Our approach relies on Quantum Signal Processing and extending Jaynes Principle to TPQ states. While our methodology incurs an additional problem-dependent error, which reduces as the problem size grows, it avoids the explicit preparation of (purified) Gibbs states and shows a similar quantum speedup saturating the theoretical Õ(sqrt(N)+sqrt(m)) lower bound. We numerically verify the algorithm for the Hamiltonian learning problem for sizes of up to N=2^10 variables.

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CC-North 232C

Optimization in Healthcare Treatment and Resource Allocation

Contributed Session

Session Chair: Eunbi Kim, Korea University., Seoul, Korea, Republic of

1 Intelligent CT-Scanner Parameter Selection Using AI-Powered Recommender System

Neda Sayahi, Wayne State University, Detroit, MI

In this study, a Machine Learning-based recommender system for CT-scanner parameter selection is proposed for recommending optimal scan parameters. As predicting scan feasibility using machine learning methods is at the heart of the proposed recommender system, the accuracy of four ML methods in predicting scan feasibility is compared. The results indicate that multi-layer perceptron predicted scan feasibility with higher accuracy and outperformed the other methods. Furthermore, a game theoretic approach was utilized to explain the predictions provided by the model.

2 Joint Scheduling of Automated External Defibrillators and First Responders with Coordination in Out-of-hospital Cardiac Arrests

Kexin Cao, Xinglu Liu, Mingchuan Yang, Wai Kin (Victor) Chan, Tsinghua University, Shenzhen, China. Contact: kexincao5@gmail.com

A one-minute delay in the treatment of out-of-hospital cardiac arrest (OHCA) reduces a patient's chance of survival by 10%, making the treatment extremely time-sensitive. However, timely real-time access to automated external defibrillators (AED) remains a challenge. This research focuses on the joint scheduling problem of AEDs and first responders for AED delivery. To guarantee a very short time limit as well as the accuracy and robustness of decisions, our research also considers the coordination between multiple-type first responders and some other detailed factors. A mixed integer programming model is constructed for this problem and is solved by Gurobi. The experimental results reveal that a significant decrease in response time is achieved through our optimization and the improvement in coordination consideration is effectively verified.

3 Spatiotemporal Analysis of Volunteer First Responders Effectiveness

Michael Khalemsky[1], Yuval Hadas[2], Janna Ataiants[3], Stephen Lankenau[3], Anna Khalemsky[1], Alexis Roth[3], Gabriela Marcu[4], David G. Schwartz[5], [1]Hadassah Academic College, Jerusalem, Israel; [2]Bar-Ilan University, Ramat Gan, Israel; [3]Drexel University, Philadelphia, PA, [4]University of Michigan, Ann Arbor, MI, [5]Bar-Ilan University, Ramat Gan, Israel

Rapid first aid is vital for reducing mortality and improving long-term prognosis during medical emergencies. One approach to achieving faster response times is through smartphone-based Volunteer First Responder (VFR) networks.

VFR effectiveness is measured by factors such as arrival time, relevant intervention, and medical outcomes. Geographic coverage is a commonly used measure of emergency medical service effectiveness. This study presents a novel analytical technique for analyzing VFR network effectiveness in terms of geographic coverage using real-world data from a field study. The analysis considers the unpredictable location and availability of VFRs during an emergency event, aiding decision-making for recruitment and retention efforts and improving collaboration with EMS. Findings can enhance VFR network administrators' efforts to save lives.

4 EMS Location-Allocation Problem Under Uncertainties

Wei Wang[1], Shuaian Wang[1], Lu Zhen[2], Xiaobo Qu[3], [1]The Hong Kong Polytechnic University, Hong Kong, Hong Kong; [2]Shanghai University, Shanghai, China; [3]Tsinghua University, Beijing, China

Emergencies pose great threats to health, life, and property. Immediate response and treatment are crucial in mitigating these threats. This research optimizes the locations of ambulance stations, deployment of ambulances, and dispatch of vehicles under demand and traffic uncertainty to improve the response speed. The research problem is formulated as a dynamic scenario-based two-stage stochastic programming model with the goal of minimizing total costs while responding to as much demand as possible. Two solution methods, i.e., sample average approximation and a two-phase Benders decomposition solution scheme, are proposed to solve the problem. Numerical experiments using real-world emergency data are conducted to validate the performance of the solution methods and derive constructive managerial insights for the EMS system.

5 Enhancing the Emergency Rescue System: An Analysis of Incorporating Drone Ambulances

Eunbi Kim[1], Joonyup Eun[2], Taesu Cheong[1], [1]Korea University, Seoul, Korea, Republic of; [2]Korea Univeristy, Seoul, Korea, Republic of

Performing immediate cardio-pulmonary resuscitation within 4 minutes of cardiac arrest is crucial to achieve a survival rate of 50% or above. However, paramedics' median arrival time is 7 minutes in Korea, which exceeds patients' "golden time". According to this issue, we come up with an idea to use human-crewed drone ambulances that can transport paramedics to patients rapidly. This study aims to determine the optimal location of a human-crewed drone ambulance station to minimize the average dispatch time during cardiac arrest emergencies. We expect that this study provides a way to improve the patients' survival rate by enabling paramedics to respond promptly (within 4 minutes) to cardiac arrest cases.

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CC-West 101A

Methodological Advancements in Multiobjective Optimization I

Community Committee Choice Session

Session Chair: Margaret M. Wiecek, Clemson University, Clemson, SC

1 Pareto Leap: An Algorithm for Biobjective Mixed-Integer Optimization

Philip de Castro, Clemson University, Clemson, SC, Contact: pdecast@clemson.edu

We present an algorithm for solving biobjective mixed-integer optimization problems which exploits the structure of the nonconvex outcome set. The algorithm "leaps" between subsets of the outcome set, correctly identifying those that contribute to the global Pareto set. The leaps are performed using tabu constraints (also known as "no-good" constraints) and convex approximations of the nonconvex region dominated by the subsets. We discuss theoretical results, detail the algorithm, and apply it to test instances for demonstrations of the results.

2 Decision-Space Decomposition for Multiobjective Programs

Emma Soriano, Clemson University

We present a decomposition theorem for computing the efficient set of multiobjective programs (MOPs). The entire efficient set can be computed as the intersection of efficient sets of lower-dimensional subproblems. The approach is inspired by the parametric decomposition theorem for MOPs of Cuenca Mira and Miguel Garcia (2017), and by the block-coordinate descent for single objective programs. Preliminary results allowing for a decomposition implementation are included.

3 Identifying Alternative Stops for First and Last Mile Urban Travel Planning

Thomas Horstmannshoff[1], Michael Redmond[2], [1]Otto-von-Guericke-Universität Magdeburg, Magdeburg, Germany; [2]University of Iowa, Iowa City, IA

As we move into an increasingly connected world for urban travel planning, we need to expand our concept of itinerary planning to meet the multimodal and diverse needs of today's traveler. Our approach provides travelers with a set of optimal nearby stops that presents a number of traveler preferences in an easily comprehensible and quickly calculable manner. We display first and last mile stops that fall on a Pareto front based on multiple criteria such as travel time, number of transfers, and frequency of service. This tool combines both stop and route based information, and we incorporate free-floating scooters to investigate the impact on decision making with multiple transportation modes. This tool can greatly help in offering diverse itineraries for travelers based on their preferences.

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Diversity, Equity, and Inclusion Research in Information Systems and Operations Management

Community Committee Choice Session

Session Chair: Lanfei Shi, Virginia University, VA

Session Chair: Lu Kong, University of South Florida, Tampa, FL

1 Hiding Behind Complexity: Supply Chain, Oversight, Race, and the Opioid Crisis

Jorge Mejia, Indiana University, Bloomington, IN

The opioid crisis has ravaged the United States taking 69,000 lives in 2020, with prescription opioids accounting for 98% of opioid abuse. Though nationally, this epidemic is often considered a White public health crisis, overdose deaths have doubled among people of color from 2017-2019. We find evidence that the scope of the blame goes beyond individual actors to include the very structure of supply chains, where complex supply chains fueled the crisis by dispensing significantly more opioids. We show evidence that supply chain complexity allowed mass quantities of opioids to escape detection by the Drug Enforcement Administration (DEA).

2 Online Education's Impact on Teaching Evaluations: The Role of Instructors' Gender and Race in a Digital Learning Era

Lu Kong[1], Kejia Hu[2], Lanfei Shi[3], [1]University of South Florida, Tampa, FL, [2]Vanderbilt University, Nashville, TN, [3]University of Virginia, Charlottesville, VA, Contact: kongl@usf.edu

The growing prevalence of online education necessitates a deeper understanding of potential biases in teaching evaluations within the context of diversity, equity, and inclusion (DEI). Using the teaching evaluation dataset from a public website, we assess the impact of DEI initiatives on online education. Our findings reveal significant disparities in evaluations, with non-white male instructors experiencing a 27.03% decline in ratings after transitioning to online classes. Our study contributes to the understanding of online education's effectiveness and highlights the need for more equitable evaluation methods that consider the unique challenges and opportunities of online learning. By providing valuable insights to educators and university leadership, we emphasize the importance of fostering an inclusive environment for instructors and students alike.

3 Equitable Data-Driven Assignments of Workers to Tasks

Cagla Keceli, Daniel Adelman, University of Chicago, Booth School of Business, Chicago, IL, Contact: ckeceli@uchicago.edu

Managers may be cautious of using individuals' innate characteristics when allocating workers to tasks to prevent discrimination. We develop a practical algorithm to predict task completion times, which obscures workers' (innate) performance information and only uses the task familiarity of individual workers, i.e., the "equitable" policy. We compare the emerging steady-state predictions against the policy that doesn't obscure worker-specific performance, i.e., the "full-information" policy. We study the ramifications of using the equitable policy.

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CC-West 101C

Dynamic Resource Allocation in Public Sector Settings

Community Committee Choice Session

Session Chair: Hamid Reza Zarei, Northeastern University, Somerville, MA

1 Sublinear Time Algorithm for Online Weighted Bipartite Matching

Zhaozhuo Xu, Rice University, TX

Online bipartite matching is a critical problem in online algorithms, where two sets of vertices need to be matched for optimal edge weight sum. In recommendation systems and search engines, these weights depend on the inner product of deep user and item representations. Traditional online matching involves linearly scanning and computing weights for all items, resulting in a time complexity of nd. However, real-world scenarios like online e-commerce platforms often have an extremely large number of items (n). Hence, enhancing weight computation efficiency becomes crucial. Our research introduces randomized data structures enabling sublinear time computation of weights while maintaining the competitive ratio of the matching algorithm. This work establishes a theoretical foundation for approximate weight computation, addressing its practical significance.

2 A Data-Driven Approach for Matching While Learning with Two-Sided Arrivals

Hamid Reza Zarei[1], Ozlem Ergun[2], [1]Northeastern University, Somerville, MA, [2]Northeastern University, Newton, MA, Contact: zarei.h@northeastern.edu

In this study, we design a service platform that matches dynamically arriving workers to jobs inspired by the experience of matching workers to long-term care facilities during the COVID-19 outbreak in Massachusetts. Workers and jobs arrive randomly over time with different characteristics. The outcome of a match is not known before matching and by using data from outcomes of previous matches, the platform finds the probability of success for a match. By matching workers to jobs, the platform aims to maximize the total probability of success considering future expected outcomes subject to job availability. We examined the performance of the service platform using real-world data that we obtained from the COVID-19 matching framework in MA.

3 Quantification of Social Metrics for Solid Waste Management Optimization

Jenny Gutierrez-Lopez[1], Ronald G. McGarvey[2], James Noble[1], Christine Costello[3], Damon Hall[4], [1]University of Missouri, Columbia, MO, [2]IESEG School of Management, Lille, France; [3]The Pennsylvania University, University Park, PA, [4]University of Missouri, Columbia, MO, Contact: jg9z9@umsystem.edu

This study presents a methodology for quantifying a social metric for integrated solid waste management (SWM) using Life Cycle Assessment - based optimization. SWM workers are exposed to a high demand for manual material handling activities during their work-shift, which is observed to contribute to high employee turnover. The social metrics proposed capture: 1) a worker's physical exposure to the job, considering activities such as lifting, carrying, placing, emptying, and sitting, 2) turnover of employees including loss of productivity, hiring and replacement costs, and quit rate. These metrics are used as a multi-criterion decision-making framework for SWM, extending the traditional economic and environmental objective functions. Results illustrate the trade-offs among these conflicting criteria and provide insights of diverse waste management strategies.

4 Dynamic Matching for Cloud Manufacturing Platforms Based on Model-Based Deep Reinforcement Learning

Pengyu Yan[1,2], Liu Yang[2], Sentao Miao[3], Kaize Yu[2], [1]Yangtze Delta Region Institute (Huzhou), University of Electronic Science and Technology of China, Huzhou, China; [2]School of Management and Economics, University of Electronic Science and Technology of China, Chengdu, China; [3]Desautels Faculty of Management, McGill University, Montreal, QC, Canada

Cloud manufacturing platform is a service-oriented platform connecting the supply and demand sides of manufacturing resources and services. However, matching the two sides can be challenging due to the incomplete information and uncertain environment. This study focuses on how to dynamically match the sequentially arriving manufacturing orders with available production services while learning the unknown information, aiming to maximize the long-term revenue of the platform. Such a matching-while-learning problem is formulated as a Markov decision process and solved by a model-based deep reinforcement learning algorithm(MDRL). The MDRL alleviates the issue of low-sample efficiency by allowing the agent to interact with a learned environment model. The numerical experiments validate that the MDRL can obtain a better and more interpretable matching policy.

5 On a Combinatorial Algorithm for the Correct Parity Matching Problem

Hitoshi Murakami, Yutaro Yamaguchi, Osaka University, Osaka, Japan. Contact: hitoshi.murakami@ist.osaka-u.ac.jp

The Exact Matching problem is a constrained variant of the matching problem, in which we are required to find a perfect matching that contains a specified number of specified edges. There exists a randomized polynomial-time algorithm for this problem, and it is open whether it can be derandomized. El Maalouly et al. (2022) proposed a deterministic polynomial-time algorithm for an easier variant, called the Correct Parity Matching problem, using a linear algebraic technique. In this research, we try to design a more direct, combinatorial, deterministic polynomial-time algorithm for this problem.

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CC-West 102A

Scheduling Applications

Community Committee Choice Session

Session Chair: Rodrigo A. Carrasco, Pontificia Universidad Catolica de Chile, Santiago, Chile

1 Improving Exoplanet Observations Through Mathematical Optimization

Constanza Lorca[1], Rodrigo A. Carrasco[2], [1]University of Virginia, Charlottesville, VA, [2]Pontificia Universidad Catolica de Chile, Santiago, Chile. Contact: wrk2pp@virginia.edu

Several approaches have been used to tackle the observation scheduling problem in astronomy observatories. However, many observatories still schedule observations manually or using greedy algorithms, making it difficult to predict the impact certain decisions will have in the future. When making daily decisions analyzing multiple exoplanet candidates, the task of choosing the ones to observe manually in a limited timeframe can be time-consuming, providing suboptimal results. This work proposes a combinatorial optimization model, derived from the Vehicle Routing Problem (VRP), adjusted to the exoplanet transits observations scheduling problem. We provide an approach maximizing observational efficiency, aligning the resulting schedule with the observatory's objectives and prioritizing observation constraints in the discovery of exoplanets.

2 An Approximation Algorithm for Resource-Constrained Project Scheduling Applied to Strategic Planning in Undergroundmining

Rodrigo A. Carrasco[1], Diego Fuentes[2], Eduardo Moreno[2], [1]Pontificia Universidad Catolica de Chile, Santiago, Chile; [2]Universidad Adolfo Ibanez, Santiago, Chile

The resource-constrained project scheduling problem (RCPSP) is central to many planning applications; hence, it has been thoroughly studied in many different settings. This work focuses on the underground mining strategic planning problem, which can be formulated as an RCPSP instance. We present a new approximation algorithm for computing solutions in this setting, computing approximation bounds for specific settings and showing that this approach can solve very large instances to a high degree of accuracy.

3 Scheduling Limited Initiation Cues (SLIC): A Novel Combinatorial Scheduling Formulation for Adaptive Machine Learning and Cybersecurity Applications

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Inspired by adaptive machine learning theory and cybersecurity games, we develop a combinatorial framework to optimize on resources of a given system. We introduce a novel scheduling problem where each of a set of parallel machines has a specific set of jobs that must be executed on that one machine in a specific order. We must select a limited set of global start times. Upon completing a job, a machine must wait to the next global start time to begin its next job. We wish to maximize the total work completed before a given global deadline. This problem comes from a stochastic-programming version of a probabilistic game that models moving-target defense in cybersecurity. This game also has an interpretation in adaptive machine learning. We motivate and define the scheduling problem and give the hardness results, algorithms for special cases, and initial approximations.

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CC-West 102B

Advances in Planning and Managing Services

Community Committee Choice Session

Session Chair: Felix Papier, Essec Business School, Cergy Pontoise Cedex, France

1 Asymmetries of Service: Interdependence and Synchronicity

Andrew Daw[1], Galit Bracha Yom-Tov[2], [1]University of Southern California, Marshall School of Business, Los Angeles, CA, [2]Technion - Israel Institute of Technology, Haifa, Israel

We propose and analyze a Hawkes cluster model of service interactions that captures two (a)symmetries between the customer and agent: co-production vs self-production, synchrony vs asynchrony. We analyze the stochastic process through a novel decomposition in terms of objects from probabilistic combinatorics. This model reveals connection to the behavioral operations literature, such as non-monotonic system performance from monotonic agent-load slowdown, which we prove will exist under customer-agent asynchrony. Given this existence, we can prescribe an optimal concurrency, or level of multi-tasking, for the service agents. However, the efficiency of such operational improvements is limited by symmetry in interdependence: the more co-productive the service, the less opportunity there is to improve.

2 Socially Responsible Operations for Medical Devices

Zumbul Atan[1], Yeqing Zhou[2], Ayten Beyza Emre[2], [1]Eindhoven University of Technology-Industrial Engineering &Innovation Sciences, Eindhoven, Netherlands; [2]Eindhoven University of Technology, Eindhoven, Netherlands. Contact: z.atan@tue.nl

Underserved communities lack essential medical devices. We propose a business model, where a manufacturer refurbishes and rents medical devices to these communities. The devices are originally owned by hospitals. Given that the medical devices have limited lifetimes, we develop a decision support tool to determine the optimal timing of taking the machines from original hospitals and renting them to underserved communities. This business model leads to higher profit and increases the accessibility of healthcare.

3 The Operational Data Analytic (ODA) for Service Speed Design

Qi Annabelle Feng[1], Zhibin Jiang[2], J. George Shanthikumar[3], Yang Yang[4], [1]Purdue University, West Lafayette, IN, [2]Shanghai Jiao Tong University, Shanghai, China; [3]Purdue University, WEST LAFAYETTE, IN, [4]Purdue University, West Lafayette, IN

We develop the operational data analytics (ODA) framework for the classical service design problem of G/G/c/k systems. Validating the data-integrated decision model against the long-run average service reward leads to a uniformly optimal service rate for any given sample size. We further derive the ODA-predicted reward function based on the data-integration model, which gives a consistent estimate of the underlying reward function. We demonstrate that the ODA framework can lead to an efficient design of service rate and service capacity, which is insensitive to model specification.

4 Scheduling Customer-Preference-Based Field Appointments Under Uncertainty

Yanlu Zhao[1], Felix Papier[2], [1]Duham University Business School, Durham, United Kingdom; [2]Essec Business School, Cergy, France. Contact: felix.papier@gmx.de

Motivated by sales force operations of a B2B services company in Belgium, we develop a data-intensive model for scheduling field appointments at the customer sites. The appointments are made by an outbound call center and subject to uncertain customer approval. The objective of the model is to maximize the number of sales appointments by minimizing the the agent's travel and idle times. We formulate the model as MDP, derive analytic properties of the problem, and develop time-efficient scheduling policies that dynamically decide which clients to call and which time slots to propose. We use a real data set to perform numerical experiments to test the policies, and we find that the policies are an effective way to achieve a trade-off among field force effectiveness, efficiency, and reactivity that best fits the company's strategy.

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CC-West 102C

Topics on Social Media Engagement

Contributed Session

Session Chair: Frances Wang, Cornell University, Ithaca, NY

1 Effect of Deception in Influence Maximization and Polarization on Social Networks: A Sheaf Laplacian Approach

MEHMET EMIN AKTAS, Georgia State University, Atlanta, GA, Contact: maktas@gsu.edu

This study investigates the effects of deception on information diffusion, specifically focusing on influence maximization and polarization in social networks. We start with modeling deception among users within social networks. Building upon the sheaf Laplacian diffusion model derived from algebraic topology, we examine opinion dynamics in the presence of deception. Moreover, we redefine the Laplacian centrality to quantify the influence of deception in influence maximization. We further model polarization in networks and investigate the impact of deception on polarization. Our findings suggest that deceptive individuals wield more influence than honest users within social networks. Furthermore, we demonstrate that deception amplifies polarization in networks, with influential individuals playing a significant role in deepening the polarization.

2 What are the Motivations of Finfluencers? Evidence from Tiktok

Alexander Kupfer, University of Innsbruck, Innsbruck, Austria

Policymakers and researchers have recently become aware of the importance of financial literacy in empowering individuals to make informed decisions about their money. In this context, social media influencers who “cover” financial aspects in their social media posts (so-called finfluencers) have recently become very popular. Although recent studies suggest that those born between the late 1990s and early 2010s (i.e., the so-called Generation Z) follow their advice, little is known about finfluencers’ motives and the actual content of their posts. This study focuses on finfluencers on TikTok and examines their profile pages for indicators of financial motives, such as affiliate links or links to their own premium subscription services.

3 Is an Emoji Worth a Thousand Engagements? Empirical Evidence from a Peer-to-Peer Digital Payment Platform

Ying Gu[1], Panteleimon Loupos[2], [1]Univesity of Washington, Seattle, WA, [2]University of California, Davis, Davis, CA

Emojis are becoming an ever-increasing tool in every marketer’s toolbox, but does this strategy lead to a favorable customer engagement outcome? This work examines the effect of emoji usage on customer engagement in peer-to-peer platforms where network effects are also present. We leverage a large panel dataset from Venmo and use a dynamic linear-in-means model to causally identify the effect of emoji usage and its peer effects on customer engagement. To achieve identification of the dynamic network peer effects, we exploit the introduction of the emoji auto-complete keyboard feature. We find that both individual emoji usage and its contextual peer effects are positively associated with customer engagement. Our findings offer substantive guidelines to marketing practitioners who wish to use emoji-driven marketing tactics to engage with their audience.

4 Free or Paid: Profit Maximizing Pay-Per-Click Advertising

Frances Wang, Christopher Anderson, Cornell University, Ithaca, NY

Using a switchback experiment, we investigate the impact of PPC advertising on consumer channel choice and firm profitability. A group of 26 hotels are cycled on and off Google’s hotel platform. Through the use of a matched control group, we are able to measure the incremental demand created through display on Google. We model consumer channel choice (direct versus third-party) as a function of display on Google (both organic and PPC advertising) in an effort to develop profit-maximizing advertising policies.

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CC-West 103A

Technology and Not-for-Profit Organizations

Community Committee Choice Session

Session Chair: Harish Guda, Arizona State University, Tempe, AZ

1 Combating Excessive Overtime in Global Supply Chains

Chuanya Jiao[1], Anyan Qi[2], Jiayu Chen[3], [1]University of Science and Technology of China, Hefei, China; [2]The University of Texas at Dallas, Richardson, TX, [3]University of Calgary, Calgary, AB, Canada. Contact: cyjiao@ustc.edu.cn

Workers in developing economies may be forced by suppliers to work excessive overtime, resulting in severe mental and physical issues for the workers and possible significant damage to the brand of multinational enterprises (MNEs) if exposed in public. In this paper, we develop a game-theoretic model of a dyadic supply chain to analyze a manufacturer’s strategies to combat these excessive overtime issues of a supplier, including a *stick* strategy of auditing the supplier’s practice and a *carrot* supplier-development strategy of cross-training the supplier’s workers to increase their versatility. We show that, (i) cross-training may be either complement or substitute to the auditing; (ii) cross-training may backfire and increase the degree of excessive overtime; (iii) cross-training may Pareto improve the manufacturer’s and the supplier’s profits.

2 When Doing Good May Backfire: Smallholder-Farmer Selection into Yield-Improvement Programs

Utku Serhatli[1], Guillaume Roels[2], [1]Nova School of Business and Economics, Fontainebleau, France; [2]INSEAD, Fontainebleau, France

In agricultural-intensive economies, manufacturers often help smallholder farmers improve their yields through training and yield-improvement programs. However, and perhaps paradoxically, some farmers feel that these programs can lower their profit, in part due to a decrease in commodity prices. Using a Cournot model, we show that a) these programs can push prices down, which may indeed decrease the profits of some farmers, b) the objectives of minimizing market prices and protecting farmer well-being might be conflicting, and c) certifying more efficient farmers may perform well in terms of both individual and aggregate farmer well-being.

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CC-West 103B

Big Data Applications in Global Operations and Management

Community Committee Choice Session

Session Chair: Xiaojin Liu, Virginia Commonwealth University, Richmond, VA

Session Chair: Pankaj Kumar, Virginia Polytechnic Institute and State University, Blacksburg, VA

1 Automatic Analysis and Adaptive Learning for Continuous Chemical Manufacturing

Yanjun Qian, Virginia Commonwealth University, Richmond, VA

In continuous chemical manufacturing, the slug-flow process plays a vital role in crystallization synthesis and provides better process control and reproducibility. However, it is challenging to maintain the uniformity of the crystal size when scaling-up slugs. Thanks to the advances in in-line imaging technologies, we can develop analyzing methods to improve flow control for better crystallization quality. Incorporating image processing and statistical learning tools, we propose an in-line monitoring and modeling framework for the slug-flow process. This will lead to a controller to scale up the process without sacrificing slug and crystal size uniformity.

2 Detecting Earnings Management from Earnings Calls

Xinran Wang[1], Lee Spitzley[2], [1]Colorado State University, Fort Collins, CO, [2]State University of New York at Albany, Albany, NY, Contact: xinran.wang@colostate.edu

Companies frequently adopt earnings management (e.g., changing accounting estimates and policies) to manipulate financial reports, and earnings management is misleading and deceptive in nature. Current approaches to identifying earnings management rely on the availability of financial reports and are limited in their timeliness. To address this limitation, we propose to detect earnings management in a timelier manner by analyzing executives' behaviors during earnings calls. Using a unique dataset of earnings calls held by S&P 500 companies provided by Alpha Street, we study the relationships between earnings management and executives' verbal and vocal behaviors and examine the moderating role of preparation. We also build predictive models with executives' behavioral cues to detect earnings management.

3 Semiparametric Bayesian Joint Models for Proportion Outcomes and Informative Observation Times: A Scalable Approach for Electronic Health Records

Ya Su[1], Dipankar Bandyopadhyay[1], Sanvesh Srivastava[2], [1]Virginia Commonwealth University, Richmond, VA, [2]University of Iowa, Iowa City, IA, Contact: suyaf@vcu.edu

Electronic health records (EHR) data when thevisiting process is informative gains much attention recently. This paper considers a Bayesian joint modelingapprooach for proportion outcomes via a semiparametric mixed effectmodel and informative observation times via a counting process with asemiparametric intensity function with frailty. The EHR data couldinclude a large number of patients and this together with theintrinsic high dimension of the parameter space poses a challengingtask for any MCMC sampler to function well. We adopt a divide andconquer approach with a simple adjustment on the likelihood in eachsubset followed by an easy combination step to approximate theposterior samples based on the original posterior. Simulation and realdata analysis reveal the efficiency the algorithm achieves whilemaintaining accuracy.

4 Take It or Not? Impact of Investments from Tech Giants on It-Startups' Future Funding

Linmei Huang, Baruch College, City University of New York, New York, NY, Contact: linmei.huang@baruch.cuny.edu

While tech giants have become important external equity financing sources, it remains unclear whether IT-startups should take investments from tech giants. In this study we empirically examine how taking investments from tech giants influences future funding of IT-startups. Our results indicate that taking investments from tech giants significantly reduces the amount of funding IT-startups could obtain in the following rounds. Additionally, we find that social ties between IT-startups' regions and locations with substantial capital will attenuate such negative impact of taking investments from tech giants. We further explore the mechanisms. Results suggest that when tech giants make investments in IT-startups, they predominate the new technologies by applying for more patents in the relevant fields and crowd out new investors.

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CC-West 104A

Disaster Management: Social, Economic and Urban Analytics

Community Committee Choice Session

Session Chair: Hootan Kamran, [1]</sup

1 Resiliency of Energy and Power Grids with Multi-Modal Interdependencies on Other Critical Infrastructures

Massoud Amin, Lindsay Lien Amin, Energy Policy & Security Associates, Minneapolis, MN

This presentation covers energy and power infrastructure resiliency and its interconnectedness with other critical infrastructures. The reliability, security, and efficiency of power and energy infrastructures are critical for crucial economic and social functions. We will present recent advances in distributed sensing, modeling, and control, with case studies, and address short to long-term technologies, training, policies, and protocols needed to protect power systems. Key themes include a systems-based approach to resilience and the use of big data and data science to tackle the challenges of interconnected critical infrastructures.

2 Estimating Tropical Cyclone Induced Power Outages in Future Climate Scenarios

Zaira Pagan Cajigas[1], Seth Guikema[1], Brent Boehlert[2], Charles Fant[2], [1]University of Michigan, Ann Arbor, MI, [2]Industrial Economics Inc, Cambridge, MA, Contact: zpagan@umich.edu

The occurrence of natural disasters, such as tropical cyclones, frequently disrupts the energy system, leading to power outages. Climate change projections indicate hazards will become more frequent and severe, prolonging the duration of outages. Our research uses a power outage statistical model to examine how tropical cyclones affect power outages in the Atlantic and Gulf Coasts regions at the census tract level, considering future climate projections from seven distinct climate models. This study provides a basis for understanding future climate scenarios' impact on the frequency and duration of outages. Our findings can inform the development of strategies to mitigate the risks associated with climate change and ensure the resilience of the energy system.

3 Modeling Policy Interventions to Reduce Losses for Low Income Households from Hurricanes

Cen Guo[1], Dahui Liu[1], Linda Karen Nozick[1], Meghan Millea[2], Jamie Kruse[2], Caroline Williams[3], Rachel Davidson[3], Joseph Trainor[3], [1]Cornell University, Ithaca, NY, [2]East Carolina University, Greenville, NC, [3]University of Delaware, Newark, DE, Contact: dl742@cornell.edu

Regional hurricane losses are escalating with significant impacts on the economy alongside ever-increasing burdens to homeowners. We applied a multi-year computational framework to examine how insurance subsidies, retrofit grants, and buyouts can elevate the recovery prospects of low-income homeowners. We introduce policy interventions as means- and risk-adjusted to improve efficacy and equity. As a result, when insurance subsidies, retrofit grants, and buyouts are integrated and low-income homeowners are supported, insurance prices fall, GDP recovers more quickly and completely, and household recovery is more consistent across income groups.

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CC-West 104B

Machine Learning Assisted Biomarker Discovery in Medical Research

Community Committee Choice Session

Session Chair: Jay Shah, Tempe

1 An Improved Saliency Map that Shows Trustworthiness for Localizing Abnormalities in Medical Imaging

Nolan Skelly, Air Force Institute of Technology, Dayton, OH

Saliency maps are a widely used methodology to make deep learning models more interpretable by providing post-hoc explanations through identification of the most pertinent areas of an input medical image. These techniques have been assessed on the basis of 1) localization utility, 2) sensitivity to model weight randomization, 3) repeatability, and 4) reproducibility. No tested saliency map technique has been able to pass all of the criteria. The neural networks used to predict and read medical information require a reliable solution to provide medical practitioners intelligible results. Using the information of two large publicly available radiology datasets, we look to quantify and posit a solution to this problem, so that the usage of saliency maps in the high-risk domain of medical imaging will require less scrutiny and can hold a more trustworthy base.

2 ExpertRNA: A New Framework for RNA Secondary Structure Prediction

Menghan Liu, Arizona State University, Tempe, AZ, Contact: mliu126@asu.edu

Ribonucleic acid (RNA) is a fundamental biological molecule that is essential to all living organisms, and we want to study RNA folding problem for RNA function discovery. RNA folding problem is, given the sequence of nucleotides, a probable list of base pairs are returned, referred to as the secondary structure prediction. There are many existing algorithms solving RNA folding problem and the two main categories are minimum free energy algorithms and data-driven algorithms. In this work, we introduce the new ExpertRNA algorithm that provides a modular framework that can easily incorporate an arbitrary number of rewards (free energy or non- parametric/data driven) and secondary structure prediction algorithms. We argue that this capability of ExpertRNA has the potential to balance out different strengths and weaknesses of state-of-the-art folding tools.

3 Using Ai to Predict Treatment Response in Leukemia Patients

Kevin Leder, University of Minnesota - Industrial and Systems Engineering, MINNEAPOLIS, MN

Multiple Myeloma is a blood cancer with a median survival time of 6 years. The disease is characterized by recurrent episodes of remission and relapse under treatment. Failure to predict treatment response leads to wasted time and resources, and often adverse side effects of failed treatments. In this work, we aim to predict treatment response in advance by linking baseline observations and treatment history to treatment response using a Hierarchical Bayesian framework that combines a mechanistic model of tumor growth with statistical learning methods. Preliminary work has shown that the method works in simple simulated situations. If successful in real clinical scenarios, this approach may help clinicians choose more effective treatments, prolonging the lives of patients and easing their disease course.

4 Accurate Prediction of Post-Traumatic Headache Persistence Using One Week of Headache Diary Data

Gina Dumkrieger, Todd Schwedt, Catherine Chong, Mayo Clinic, Phoenix, AZ

Currently, there is no accurate way of predicting which patients will recover quickly from post-traumatic headache (PTH) and which patients will continue to have PTH months or years after mild traumatic brain injury (mTBI). Here we utilized daily headache diary data over 7 days to predict headache resolution after 3 months. Individuals with acute PTH due to mTBI completed a daily headache e-diary beginning 1-59 days post mTBI. Features generated from diary data were used to create a prediction model. Recovery status after three months was predicted with 78% leave-one-out cross validation accuracy using the features generated from the first 7 days of diary data. This model achieved 73% accuracy on an unseen sample. Despite simple models and simple features high accuracy is achieved. This approach could be used to set patient expectations and guide decisions on interventions.

5 Predicting Rna Sequence-structure Likelihood Via Structure-aware Deep Learning

You Zhou, Arizona State University, Tempe, AZ, Contact: yzhou253@asu.edu

Machine learning method was used to evaluate RNA sequence, secondary structure pair. However, several challenges arise: Firstly, whether the features from existing machine learning model can thoroughly encode the sequence-structure pairs is uncertain. Secondly, the design of the features could rely on subjective choice. Thirdly, the RNA level feature could not encode all base pairing information. We propose a deep learning approach including two models to evaluate sequence-structure pair. The first one is NU-ResNet which uses ResNet18 as the primary architecture. This model solves the challenges by explicitly encoding the sequence-structure pair into a 3D matrix. The second one is NUMO-ResNet, which extends NU-ResNet with added information from the characterizations of the 2D shape of the folding, motifs. We also developed an automatic way to extract motifs.

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Theory and Applications of Active Learning

Community Committee Choice Session

Session Chair: Ashif Iquebal, Arizona State University, Tempe, AZ

1 Active Learning for Classification with Imperfect Labels

Pouya Ahadi, Kamran Paynabar, ISyE Georgia Tech, Atlanta, GA, Contact: pouya.ahadi@gatech.edu

In an active learning problem, query samples will be annotated using some oracles. In most cases, these labels include noise due to the noisy oracles. Moreover, uncertain samples are more likely to receive imperfect labels from those labelers. Learning with highly imperfect labeled data points will result in an inaccurate classifier. We propose a novel method for active learning problems to construct a robust classification model by minimizing the noise level. Our approach includes an assignment model to optimally assign query points to labelers in order to minimize the highest possible noise in a cycle. Moreover, we propose a new sampling approach for finding the best query points in order to mitigate the effect of label noise on the classifier's performance.

2 Consistent Exploration-Exploitation Trade-Off in Active Learning Regression with Dirichlet Process Prior

Upala Junaida Islam, Ashif Iquebal, Arizona State University, Tempe, AZ, Contact: uislam@asu.edu

Approaches of active learning usually focus on either exploration or exploitation in the design space. Methods considering exploration-exploitation simultaneously employ fixed or ad-hoc measures to control the trade-off that may not be optimal. We develop a Bayesian hierarchical approach with Dirichlet process prior to dynamically balance the trade-off as more data are queried. We subsequently formulate an approximate Bayesian computation approach based on the linear dependence of data samples in the feature space to sample from the posterior distribution of the trade-off parameter obtained from the model. Our approach performs better or at least as well as either pure exploration or pure exploitation. Using theoretical results, we prove that our methodology achieves posterior consistency as well.

3 Dispersion-Enhanced Sequential Batch Sampling for Adaptive Contour Estimation

Yiming Che, Binghamton University, Vestal, NY

The issue of near duplicates poses tremendous quandary for sequential learning. Near duplicates severely diminish the computational efficiency as they barely contribute extra information towards update of the surrogate. To address this issue, we impose a dispersion criterion on concurrent selection of sampling points, which essentially forces a sparse distribution of critical points in each batch, and demonstrate the effectiveness of this approach in adaptive contour estimation. Specifically, we adopt Gaussian process surrogate to emulate the simulator, acquire variance reduction of the critical region from new sampling points as a dispersion criterion, and combine it with the modified expected improvement (EI) function for critical batch selection.

4 A Faster Upper Confidence Bound for Point-Based Value Iteration to Approximate Finite-Horizon Pomdps

Siqiong Zhou[1], Ashif Iquebal[1], Esma S. Gel[2], [1]Arizona State University, Tempe, AZ, [2]University of Nebraska-Lincoln, Lincoln, NE, Contact: siqiong.zhou@asu.edu

We present the algorithm Approximating with Upper Confidence Bound(AUCB), an active learning approach for approximating upper bounds in point-based value iteration for solving finite-horizon Partially Observable Markov Decision Processes (POMDPs). AUCB utilizes the upper confidence bound of a Gaussian Process Regression (GPR) fit to efficiently approximate value function upper bounds. AUCB enables estimation for any point in the belief space, providing an effective solution for large-scale problems. Experimental evaluation demonstrates the effectiveness of AUCB in improving the performance of solving finite-horizon POMDPs over state-of-the-art algorithms. Specifically, AUCB achieves 2.5 times more iterations and a 30% improvement in the value function gap between upper and lower bounds within a limited time of 3000 seconds for large-scale examples.

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CC-West 105B

Information Systems Research in the Era of New Technologies

Community Committee Choice Session

Session Chair: Sameer Borwankar, Purdue University, West Lafayette, IN

1 The Impact of Political Polarization on Restaurant Reviews: Evidence from Yelp.Com

Rajan Mishra[1], Wreetabrata Kar[2], Sugato Chakravarty[1], [1]PURDUE UNIVERSITY, WEST LAFAYETTE, IN, [2]Krannert School of Management, Purdue University, West Lafayette, IN, Contact: mishra92@purdue.edu

By examining a large sample of Yelp restaurant reviews during the 2016 national election cycle, this study examines the influence of party ideology on the tone of restaurant reviews, focusing on Yelp as a leading online platform for user-generated reviews. The findings of our study reveal compelling insights into the relationship between political polarization and restaurant reviews. Following a national election, when a region undergoes a political shift from Democratic (BLUE) to Republican (RED) affiliation, we observe significant changes in the characteristics of restaurant reviews: 1) These reviews tend to be shorter in length. 2) A decrease in the number of compliments provided indicates a shift towards more critical evaluations. 3) A higher proportion of "simpler" words, suggesting a shift towards less sophisticated language usage.

2 Collaboration Network Dynamics in Technology Standardization Platforms

Rushikumar Pandya, Purdue University

Technology standardization platforms have emerged as unique innovation communities to design interoperability standards. Domain experts strategically collaborate with others to develop standards that benefit complex technology ecosystems. This study explores social network ties formation, i.e., collaboration patterns within open standards development organization (SDO) for internet technology. Large-scale co-authorship data shows active SDO participants adopt exploration vs. exploitation strategy choices for partner selection. Participants' firm affiliation, influence within the network structure, and domain expertise significantly impact their strategy selection. The study contributes to understanding SDO network dynamics and offers insights into tie formation strategies adopted by the participants.

3 Book Bans in American Libraries: Impact of Politics on Inclusive Content Consumption

Naveen Basavaraj[1], Uttara Ananthakrishnan[2], Sabari Rajan Karmegam[3], Ananya Sen[1], Michael D. Smith[1], [1]Carnegie Mellon University, Pittsburgh, PA, [2]University of Washington, Seattle, WA, [3]George Mason University, Gaithersburg, MD, Contact: nthotada@andrew.cmu.edu

Banning of books has become increasingly prevalent and politically polarizing in the United States. While the primary goal of these bans is to restrict access to books, conversations about the bans have garnered attention on a wider scale. This increased attention to bans can influence consumers' choices to either consume or boycott banned books, depending on their political and moral concerns around the ban. In this study, we use a novel, large-scale dataset of US library book circulations and evaluate the impact of book bans on the consumption of banned books. Using a staggered difference-in-differences design, we find that the circulations of banned books increase by 12% on average compared to comparable non-banned titles in the period after the ban. We also find that banning a book in a state leads to increased circulation in states that do not observe any bans. We show that the increase in consumption is driven by books from lesser-known authors suggesting that new and unknown authors stand to gain from the increasing consumer support. Additionally, our results demonstrate that books with higher visibility on social media following the ban see an increase in consumption, suggesting a link between social media and political consumerism. We also find that book bans have a tangible political impact through campaign donations - Democratic Party candidates attract significantly more donations following the ban events.

4 Elections and Hate Speech on Twitter

Indulekha Guha, 1</sup

This paper studies the impact of presidential and gubernatorial election timing on the level of toxicity present on social media platforms such as Twitter. We empirically determine the extent to which the toxicity of Twitter content changes during election times as compared to non-election times. We randomly sample Twitter users and collect all tweets made by this sample around election time. We use a difference-in-differences identification leveraging election and non-election years. We further focus on toxic content that is motivated by political polarization and examine various bias-motivation categories that come up in this content as well as the variation in intensity of toxicity between national and local election times.

5 Using Consumer Wearable Sensor Data to Understand Covid-19 Experience

Shiyang Sima, Alok R. Chaturvedi, Hossein Ghasemkhani, Purdue University, West Lafayette, IN, Contact: ssima@purdue.edu

The emergence of the novel SARS-CoV-2 virus has resulted in a significant disease burden on both individuals and society at large. The virus has caused substantial mortality and disability, while also impacting productivity and incurring substantial healthcare, societal, and economic costs. Notably, certain social groups have been disproportionately affected, experiencing higher disease rates and inferior outcomes, despite being underserved. This paper leverages routinely collected passive sensor data from wearable devices to understand the COVID-19 experience. Furthermore, we attempt to use change point detection to infer the symptom onset date. Lastly, we contrast the changes in daily health measurements using the diagnosis dates and estimated symptom onset dates.

6 Information Warranties - A Game Theoretic Approach to Addressing Fake News

Michael Lewis, University of Houston, Houston, TX

Social media platforms and smart phones, while reducing barriers to generate news content, can facilitate the spread of false information and erode prospects for collective sensemaking. Previous approaches to combatting fake news are subject to claims of biased application or fail to change the incentives for fake news producers. In this paper, we study the effects of information warranties on the production and distribution of verifiable news content. We model these processes as Stackelberg games, with the news producer as the game's leader and the consumer as the follower. The implications of news veracity, warranty adjudication, and news verification costs are discussed, and the resulting equilibria presented. We find that the key drivers of outcomes are the benefit-to-loss ratio of the consumer that propagates information and the nature of the verification costs.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB71

CC-West 105C

Competitive Strategies

Community Committee Choice Session

Session Chair: Xia Zhao, University of Georgia, Athens, GA

1 Quality Control of Transaction Platform for Trading Experience Goods

Xinlin Tang, Florida State University, Tallahassee, FL

The success of transaction platforms depends on effective quality control on both complementors (sellers) and complements (products). Due to the large volume of complements traded on the platform, the current quality control is distributed between the platform owner and customers: the platform owner controls the quality of complementors, but leaves that of complements to the customers. Technology advances make it possible for the platform owners to control the quality of the complements. We assess the effectiveness of this new quality control mechanism on promoting product change and the market response using the recent move of ctrip.com to assign quality grade to package tours sold on the platform. This study enriches our knowledge on a novel mechanism of quality control and demonstrates the benefits of shared control on a transaction platform trading experience goods.

2 Keep Your Friends Close and Your Enemies Closer? the Role of Competitive Intelligence

Mariana Andrade-Rojas, University of Georgia, Athens, GA

This study uses a network multiplexity perspective to explore the effects of two complex networks: competition and collaboration networks. While collaboration and competition networks are two important sources of strategic information, in the current information age, firms do not only rely on information from partners and competitors, but also on information obtained via information technology. Two IT-enabled capabilities that allow the firm to obtain information are competitive intelligence and enterprise social media. In this study, we develop a conceptual model to investigate whether IT-enabled competitive intelligence and enterprise social media influence how firms benefit from the information they obtain from collaboration and competition networks.

3 Antecedents and Consequences of Digital Resource Redeployment in Mergers and Acquisitions in the Healthcare Industry

Chengxin Cao, Baruch College, NY

Despite the surging hospital consolidations, the effects of how health information technology (HIT) contributes to the value creation of hospital M&A remain mixed. Against this backdrop, this paper examines (1) how digital resources of the acquirer and target affect the likelihood of hospital consolidation, and (2) the role of digital resource redeployment from the target to the acquirer in the performance of the acquiring hospitals after M&A. Using a sample of over 3,000 US hospital systems and 5,000 hospitals, our empirical analysis suggests that M&A served as a means for acquiring hospitals to obtain new resources and capabilities from targets, i.e., digital resource redeployment occurred from target to acquiring hospitals. Furthermore, the digital resources gained from target hospitals helped improve the care quality of the acquiring hospitals.

4 Can Information Sharing Reduce Diagnostic Bias? Evidence from a Health Information Exchange

Minghong Yuan[1], Indranil R. Bardhan[2], Wen Wen[1], [1]University of Texas at Austin, Austin, TX, [2]The University of Texas at Austin, Bee Cave, TX

Prior literature has documented evidence of bias in physician diagnosis, which negatively impacts some minority groups. Such implicit bias can contribute to disparities in healthcare delivery, patient perceptions of care, and health outcomes. By leveraging a quasi-experimental approach, our study offers a new perspective on the identification and measurement of racial bias against racial minority patients in physician diagnoses. We find health information sharing may help to reduce the level of such bias. We also find the effect is stronger among physicians with low prior case experience with racial minority patients. Our study suggests significant potential of using Health Information Exchange (HIE) systems to address disparities in the treatment and care of ethnic minority groups, thereby promoting health equity.

5 An Empirical Investigation of the Bidirectional Effects Between Online Reviews and Offline Business Performance

Xue Guo[1], Kexin Zhao[2], Sam Lee[3], [1]University of North Carolina-Charlotte, Charlotte, NC, [2]University of North Carolina-Charlotte, Charlotte, NC, [3]Texas State University, San Marcos, TX, Contact: xue.guo@uncc.edu

Our study focuses on the dual role of consumers in both creating and consuming online reviews simultaneously and explores the bidirectional interaction between consumers' online-offline behaviors. Specifically, we employ the panel vector autoregression (PVAR) methodology to explore the dynamic relationship among multiple time series variables. We find significant bidirectional effects between online reviews and offline visits in the short term but not long term. We also find the above bidirectional effect varies for different restaurants' characteristics (i.e., younger vs. older restaurants and chain vs. independent restaurants). Our study provides rich theoretical contributions and practical implications for platforms and business owners.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB72

CC-West 106A

Electronic Commerce and Consumer Behavior

Community Committee Choice Session

Session Chair: Han-Fen Hu, University of Nevada, Las Vegas, Las Vegas, NV

1 Factors Affecting Polarization in Online Communities: Insights from Five Online Platforms

Le Kuai[1], Rajiv Sabherwal[2], [1]University of Arkansas, Fayetteville, AR, [2]University of Arkansas - Sam M. Walton College of Business, Fayetteville, AR, Contact: LKuai@walton.uark.edu

Online communities enable individuals to offer their opinions, but can also create echo chambers and group polarization. This study uses sentiment analysis to examine how group polarization in online communities is influenced over time by the nature of focal topics and the addition and deletion of related posts. It is based on data downloaded every six hours from 9-2021 to 2-2022 from 40 online communities on five platforms across U.S. and China. The results suggest that more active discussions, non-IT-related online communities, and intense topics like work, money, or religion involve greater group polarization, but relaxed topics like leisure or home do not. The time of day when a discussion takes place affects polarization. Overall, this study provides insights into the factors that could intensify or alleviate group polarization in discussions on online communities.

2 Anonymous vs. Timely Transactions: Impact of Real Name Regulation in Crypto-Asset Investment Market

Jaeho Myeong[1], Miyeon Jung[2], JaeHyeon Ahn[1], [1]Korea Advanced Institute of Science and Technology, Seoul, Korea, Republic of; [2]University of Nevada, Las Vegas, Las Vegas, NV, Contact: mwogh96@kaist.ac.kr

Our research investigates how failure to comply with government regulations at the national level affects the performance of international cryptocurrency exchanges and the behavior of global investors. By employing synthetic control methods and unique on-chain data, we examine how digital assets move between international exchanges by individual investors. Our analysis reveals that non-compliant exchanges experienced substantial declines in asset reserves. When regulatory grace periods were implemented, investors shifted their assets from foreign exchanges to domestic ones. During enforcement periods, investors moved their assets to unregulated domestic exchanges to reduce their risk. Additionally, our findings offer useful insights for market participants regarding the risk-averse actions of global customers in the context of international business.

3 Does Black Music Also Matter? the Effect of the George Floyd Incident on Hip-Hop Music Streaming in the United States

Yifei Wang[1], Gorkem Turgut Ozer[1], Anandasivam Gopal[2], [1]University of New Hampshire, Durham, NH, [2]Nanyang Technological University, Singapore, Singapore. Contact: ywang269@umd.edu

This study explores the role of music, particularly hip-hop, in promoting awareness and discourse related to race-based social justice following the death of George Floyd. Using Spotify's streaming data, we found a significant increase in hip-hop consumption, particularly in less racially diverse cities, and consumption shifts towards black artists across all genres. These findings suggest that hip-hop may act as a means of participating in discussions related to Floyd's death, and music made by black artists can serve as a source of information and sense-making in the context of anti-black police violence and racial inequality in the United States.

4 ASIC, Hodl, Sats: New Language, Common Ground, and the Diffusion of Innovation

Jesse-Burton Nicholson[1], Sharon A. Alvarez[2], Arielle Badger Newman[3], Narayan Ramasubbu[4], [1]University of Pittsburgh, Pittsburgh, PA, [2]University of Pittsburgh,

Pittsburgh, PA, [3]Syracuse University, Syracuse, NY, [4]University of Pittsburgh, Pittsburgh, PA, Contact: jesseburton@pitt.edu

For new-to-the-world innovations to diffuse, new language—the creation of new words, the co-opting of existing words into a new context, new meanings being ascribed to existing words, and/or the combination of existing words in a new way—must be created in order to make meaning and to build a common ground of shared beliefs, knowledge, language, and values. In this paper, we explore how the creation of new language reduces the uncertainty surrounding an innovation by allowing tensions associated with the unknown or unanticipated aspects of the innovation to be lessened or resolved. We follow a computational grounded theory approach and develop a theoretical model that illustrates this process. We find that new language is often essential to the creation of meaning and understanding that enables a new-to-the-world innovation to diffuse.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB73

CC-West 106B

Quantitative Methods in Finance and Risk Management

Community Committee Choice Session

Session Chair: Dohyun Ahn, The Chinese University of Hong Kong

1 Efficient Tail Risk Estimation Under Distributional Uncertainty

Dohyun Ahn, Lewen Zheng, The Chinese University of Hong Kong, Shatin, Hong Kong. Contact: lwzheng@se.cuhk.edu.hk

We study the problem of efficiently estimating tail risk when the distribution of risk factors is unknown. While tail risk estimation has been a central problem in finance, most existing studies either develop efficient tail risk quantification methods assuming the data-generating model is fully known or address the issue of distributional uncertainty without providing efficient estimation techniques. Our research aims to bridge this gap. Specifically, we devise a novel simulation method that approximately minimizes errors in both determining the uncertainty set for risk factor distributions and estimating the worst-case bound for tail risk given the uncertainty set. We prove the efficacy of our approach both theoretically and numerically.

2 Generalized Importance Sampling for Nested Simulation

Amber Qingyuan Chen[1], Ben Mingbin Feng[2], [1]Cornell University, Ithaca, NY, [2]University of Waterloo, Waterloo, ON, Canada. Contact: ben.feng@uwaterloo.ca

Importance sampling (IS) is a classical variance reduction technique as one often seeks variance-minimizing optimal sampling distribution. IS has success in many applications such as engineering, operations research, and finance. In some applications such as enterprise risk management and input uncertainty quantification, complex simulation designs such as nested simulation arises naturally: The outer-level simulation generates a set of risk factors, i.e., the scenarios, which are used as inputs for inner-level simulations. In this study, we propose, analyze, and test a generalized importance sampling technique for nested simulation. Our generalized IS approach reuses one set of inner simulation outputs across different outer scenarios. Numerical experiments show that our proposal is orders of magnitudes more efficient than the standard procedure.

3 Resampling Stochastic Gradient Descent Cheaply

Zitong Wang, Henry Lam, Columbia University, New York, NY

Stochastic gradient descent has been widely used in model training and stochastic optimization. Inference on the obtained solutions from SGD has only been recently studied, yet is important due to the growing need for uncertainty quantification. We investigate two easily implementable resampling-based methods to construct confidence intervals for SGD solutions. One uses multiple, but few, SGDs in parallel via resampling with replacement from the data, and another operates this in an online fashion. Our methods can be regarded as enhancements of established bootstrap schemes to substantially reduce the computation effort in terms of resampling requirements, while at the same time bypasses the intricate mixing conditions in existing batching-type methods. We achieve these via a recent cheap bootstrap idea and Berry-Esseen-type bound for SGD.

4 Systemic Risk Adjustments for Term Structures

Zachary Feinstein[1], Andreas Sojmark[2], [1]Stevens Institute of Technology, Hoboken, NJ, [2]London School of Economics and Political Science, London, United Kingdom

In this talk, we introduce a dynamic Gai-Kapadia interbank network to study the yield curve of bank debt under a network valuation adjustment. Such a dynamic system requires a forward-backward approach in which the future probability of default is required to determine the present value of debt. In this way, the systemic model presented provides the network valuation adjustment to the term structure for free without additional steps required. Time permitting, we present this problem in two parts: (1) a single maturity setting that closely matches the traditional interbank network literature and (2) a multiple maturity setting to consider the full term structure.

5 Accelerating Risk-Sensitive Reinforcement Learning via Forecasting

Ju-Hyun Kim, Seungki Min, Korea Advanced Institute of Science and Technology, Daejeon, Korea, Republic of. Contact: vgb8111@kaist.ac.kr

We consider a decision maker (DM) who wants to enhance robustness of his policy by adopting conditional value-at-risk (CVaR) as an objective. Some reinforcement learning algorithms offer a means to find the CVaR-optimal policy. However, they often suffer from slow convergence since they only utilize the worst q-fraction of the outcomes. We accelerate the convergence using convex representation and time decomposition of the CVaR objective. Our main idea is to introduce a "forecaster" that actively predicts the probability that a current sample path belongs to the worst q-fraction. We utilize this forecast sequence, which is a martingale, to reduce the variance in learning. We demonstrate its effectiveness via theoretical analyses and numerical experiments.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB74

CC-West 106C

Pricing in Combinatorial Auctions

Community Committee Choice Session

Session Chair: Benjamin Lubin, Boston University, Boston, MA

Session Chair: Robert Day, University of Connecticut, Bergen, Norway

1 Combinatorial Auctions for Truckload Transportation

Mohsen Emadikhiav[1], Robert Day[2], [1]Florida Atlantic University, Boca Raton, FL, [2]University of Connecticut, Storrs, CT, Contact: memadikhiav@fau.edu

We present a combinatorial auction/exchange market for a truckload transportation system where carriers can use a compact bid language to express their preferences to participate in the market. We present a dual-pricing mechanism that finds (epsilon-)competitive equilibrium prices and evaluate market outcomes under consideration of different practical constraints.

2 Machine Learning-Powered Combinatorial Clock Auction

Ermis Nikiforos Soumalias[1], Jakob Weissteiner[1], Jakob Heiss[2], Sven Seuken[3], [1]University of Zurich, Zurich, Switzerland; [2]ETH Zurich, Zurich, Switzerland; [3]University of Zurich, Zuerich, Switzerland

In this work, we introduce a machine learning-powered combinatorial clock auction. Our main technical contribution is a novel method for training ML models on demand query observations and a theoretically motivated and efficient ML method for determining the next price vector. We evaluate our new auction design compared to the well-known combinatorial clock auction (CCA). Compared to the clock phase of the CCA, our approach achieves up to 9% points higher efficiency and significantly higher clearing potential.

3 Single Price Path Vickrey Auctions

Sébastien Lahaie[1], Benjamin Lubin[2], [1]Google Research, New York, NY, [2]Boston University, Boston, MA

Iterative auctions typically converge to market clearing (i.e., competitive equilibrium) prices, where demand balances supply. However, to induce truthful bidding during the auction process, it is understood that VCG payments need to be charged upon auction completion. The naive approach to achieve this is to either re-run the auction as many times as there are bidders, or run auctions in parallel using multiple price paths. In this work, we present an auction that computes VCG payments using just a single price path, where the pricing structure (e.g., linear, anonymous) remains flexible.

4 Walrasian and Price-Match Equilibria via Primal Cuts in Combinatorial Auctions

Robert Day[1], Benjamin Lubin[2], [1]University of Connecticut, Storrs, CT, [2]Boston University, Boston, MA, Contact: robert.day@uconn.edu

In a combinatorial auction, there is often no vector of prices for the items being auctioned that constitutes a Walrasian equilibrium, in which all bidders prefer their allocated bundle and excess supply items are priced at zero. We use valid inequalities (cuts) of the binary integer program for winner determination as "artificial items" that can be interpreted intuitively and priced to generate an artificial Walrasian Equilibrium. We show that the lack of an integer programming gap is not a sufficient stopping criterion for cut generation to arrive at a "price-match equilibrium" and provide examples where this refinement differs from Walrasian equilibrium.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB75

Session.Location:CC-West 208A

Emerging Topics for Electric Vehicles

Contributed Session

Session Chair: Hyeong Suk Na, University of Missouri, Columbia, MO

1 The Impact of Electric Vehicle Sharing on Automaker's Electric Vehicle Charging Infrastructure

Tania Saha[1], Prasenjit Mandal[2], [1]SP Jain Institute of Management & Research (SPJIMR), Mumbai, India; [2]NEOMA Business School Reims Campus, Reims, France. Contact: tania.saha@spjimr.org

Carbon emissions cause global temperature to rise, contributing to climate change. The adoption of electric vehicles (EVs) is an effective way of reducing carbon emissions. Building EV charging stations can elevate EV adoption among customers but is capital-intensive for a manufacturer. In recent years, the sharing economy is getting more and more popular. Instead of having exclusive ownership, the consumer-to-consumer (C2C) sharing service enables the accessibility of products to consumers. In this study, we understand the impact of C2C sharing service on a manufacturer's strategic decision in developing EV charging infrastructure.

2 A Linear Program Model for the Electric Vehicle Routing Problem: A Case Study in a Swiss Network of Supermarkets

Reinaldo Crispiniano Garcia[1], Bruno Souza Nunes[2], André Gonçalves Corrêa Pereira[3], [1]University of Brasilia (UnB) - Director ORLaB (www.orlab.com.br), Brasília - DF, Brazil; [2]University of Brasilia (UnB), Brasília - DF, Brazil; [3]University of Brasilia (UnB), Brasília - DF, Brazil. Contact: rcgar@yahoo.com

The use of electric vehicles by companies is a reality in the world since there is an incentive to replace the vehicles powered by fossil fuels to mitigate carbon dioxide emissions. However, the electric vehicles are a challenge for the logistic systems because its related vehicle routing problem depends not only on the distance travel and the vehicle load capacity but also on the battery life. This work implements a model taking into account the electric vehicles distance travel and their load capacity besides their battery life, the working hours and the stores demand, among other factors. The implemented model minimizes then the distance travel by the electric vehicles being applied to a network of a Swiss supermarket stores.

3 Sustainability and Accessibility of Electric Vehicles in Disaster Management

Olusola Ogungbeje[1], Joon-Yeoul OH[2], [1]Texas A & M University-Kingsville, Kingsville, TX, [2]Texas A&M University-Kingsville, Kingsville, TX, Contact: olusolaogungbeje@gmail.com

The rapid proliferation of electric vehicles market in the United State is revolutionizing the transportation sector. There is little evidence of the sustainability, and accessibility of the electric vehicle charging stations during an evacuation from disasters. This research is to investigate the sustainability and accessibility of electric vehicle during natural disasters and propose the way of the increasing the sustainability and accessibility in the South Texas area. The results of this study help the stakeholders to design electric vehicles systems in terms of a social infrastructure.

4 Electric Vehicle Charging Behavior Optimization in Congested Network Environments

Nastaran Tork[1], Alireza Khani[2], [1]University of Minnesota, Minneapolis, MN, [2]University of Minnesota, MInneapolis, MN, Contact: tork0100@umn.edu

The rapid expansion of electric vehicles (EV) makes their role more prominent in transportation networks. The majority of the existing literature overlooked the interconnection between charging and route choice behavior of EV drivers. The objective of this study is to devise charging pricing mechanisms to influence the rational decision-making of individual EV drivers. This strategy is intended to simultaneously alleviate traffic congestion and prevent the overloading of power distribution across the network.

5 Stochastic Evacuation Route Planning for Electric Vehicles

Hyeong Suk Na[1], Sang Jin Kweon[2], [1]University of Missouri, Columbia, MO, [2]Ulsan National Institute of Science and Technology (UNIST), Ulsan, Korea, Republic of. Contact: hyeongsuk.na@missouri.edu

The increasing demand for fuel-efficient and low-emission vehicles has driven significant expansion of the global electric vehicle (EV) market. However, EVs still face drawbacks such as long charging times and restricted operational ranges. Furthermore, the growing adoption of EVs for evacuations has highlighted the need for robust charging infrastructure to effectively manage long-distance EV evacuations. To address these challenges, this study focuses on the stochastic evacuation route planning for EVs, considering the limited availability of EV charging facilities during evacuations. Accordingly, we propose a resilient evacuation plan that strategically allocates mobile EV charging stations along evacuation routes. A case study on a hurricane evacuation in Florida is presented to validate the applicability and the practicability of our proposed model.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB76

Session.Location:CC-West 208B

Assortment Planning with Multiple Warehouses

Contributed Session

Session Chair: Hongyuan Lin, National University of Singapore, Singapore, Singapore

2 Shall We Only Store Popular Products? Warehouse Assortment Selection for E-Companies

Xiaobo Li[1], Hongyuan Lin[2], Fang Liu[3], [1]National University of Singapore, Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore; [3]University of Chinese Academy of Sciences, Beijing, China. Contact: lin_hongyuan@u.nus.edu

We study the single-warehouse assortment selection problem, with the aim to minimize order fulfillment cost under cardinality constraints, considering spillover fulfillment and order-splitting costs. Despite the problem's inherent complexity, we formulate Mixed Integer Linear Programs (MILPs) and put forward a feasible Marginal Choice Indexing (MCI) policy that primarily stores popular products. The MCI policy proves optimal under conditions common in both classic and many multi-purchase discrete choice models. Through extensive analysis of a real-world dataset, the MCI policy is demonstrated to be near-optimal and robust, significantly enhancing the fill rate, thereby asserting its practical value.

1 Assortment Planning of Pharmaceutical E-Commerce Platform Considering Drug Substitution and Complementarity

Yingying Wang, Huazhong University of Science and Technology, Wuhan, China. Contact: yingying_wang@hust.edu.cn

Assortment planning across multiple warehouses is a challenge for pharmaceutical e-commerce platforms. A fixed assortment plan may lead to inventory crises for enterprises. This study focused on optimizing assortment planning in pharmaceutical e-commerce platforms under demand uncertainty. Taking into account the substitutability, we also consider the complementarity of drugs, which means drugs need to be used in combination. We use transaction data from pharmaceutical e-commerce platform to estimate parameters and apply the sample average approximation method to approximate the model. Our study shows that the platform should focus on assortment depth when demand for a particular product increases significantly. The platform can increase profits by broadening categories when demand is stable.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB77

Session.Location:CC-West Lecture Hall

Applications of Deep Learning for Predictive Modeling

Contributed Session

Session Chair: Sorouralsadat Fatemi, University of Illinois, Chicago, IL

1 Individualized Location Prediction Using Autoencoders and Long-Short Term Memory Networks

Gerald Onwujekwe[1], Manfred Zibo Men[2], Joseph Eyo Duke[3], [1]Washington University in St. Louis, St. Louis, MO, [2]Washington University in St. Louis, St. Louis, MO, [3]University of Calabar, Calabar, Nigeria

Predicting an individual's future location is a challenging task that has significant implications for a variety of real-world applications. In this paper, we present a novel location prediction algorithm based on an autoencoder using Convolutional Neural Network and Long-Short Term Neural Network. Our approach aims to predict an individual's future location rather than a generalized prediction for everyone's next location. The experiments were conducted using the GeoLife dataset. The autoencoder model effectively learned the underlying features of the input data, while the LSTM model showcased great ability to learn from the input features, achieving a validation loss of 0.0643 (mean squared error). These results demonstrate the potential of the proposed approach for individualized location prediction in real-life scenarios.

2 Clustering Morphological Properties of Cells Using Neural Network-Basedimage Segmentation Models

Hyemin Lim[1], Geonhee Jang[1], Wonkeun Jo[1], Yeongjun Koh[1], Dongil Kim[2], [1]Chungnam National University, Daejeon, Korea, Republic of; [2]Ewha Womans University, Daejeon, Korea, Republic of. Contact: lim960516@o.cnu.ac.kr

Image-based cell profiling is a method that extracts features from cell images to quantify cell information. With recent advancements in CNN-based research, recognition of small objects such as microscope images has become feasible. In this paper, we propose a method for clustering cells using a combination of neural network-based segmentation and clustering models by utilizing a pretrained model on the LiveCell dataset. Experimental results demonstrated that the proposed method showed superior performance compared to existing clustering models.

3 Graph Koopman Operator for Traffic Forecasting

Weiheng Zhong, Hadi Meidani, University of Illinois Urbana Champaign, Champaign, IL, Contact: weiheng4@illinois.edu

Traffic forecasting is a crucial part of traffic management. While graph neural networks (GNNs) have been successful in predicting traffic, their complex model architectures make them impractical for use in large networks due to high computing and memory costs. To overcome this barrier, we propose a novel linear model, named Graph Koopman Operator, which encodes the graph topology into the Koopman Operator to capture graph-based dynamics. Using real-world traffic data from the entire California highway network with over 37,000 nodes, we demonstrate that this proposed simple linear method, compared to all the existing nonlinear GNN forecast models, surprisingly can achieve higher prediction accuracy and is more efficient by around two orders of magnitude.

4 Graph Neural Network for Estimating Bond Returns

Dan Zhou[1], Ajim Uddin[1], Xinyuan Tao[1], Dantong Yu[1], Jiang Lei[2], [1]New Jersey Institute of Technology, Newark, NJ, [2]Tsinghua University, Beijing, China. Contact: dz239@njit.edu

Networks are ubiquitous in financial systems. Holding similar portfolios forms implicit network connections between assets. This paper turns the institutional bond holding (eMAXX) into this type of network and develops an advanced Temporal Bipartite Graph Neural Network (TBGNN) model to capture valuable information from connections for corporate bond pricing. Our bond networks and associated model have two advantages: demonstrate the networks of common bond holdings explain excessive returns and predict the future bond returns. Results show that our model can explain about 90% of the in-sample return variation, with at least 70% improvement compared to benchmarks. Overall, our finding strongly suggests that incorporating network economically and highly statistically improves future bond return prediction and such impacts are above and beyond pricing factors.

5 Stock Market Movement Prediction Utilizing LLMs

Sorouralsadat Fatemi[1], Yuheng Hu[2], [1]University of Illinois-Chicago, Chicago, IL, [2]University of Illinois-Chicago, Chicago, IL, Contact: sfatem6@uic.edu

In recent times, significant advancements have been observed in the performance of large language models (LLMs) across diverse tasks in natural language processing (NLP). Nonetheless, their potential in the financial sector, particularly in the prediction of stock market trends, has yet to be thoroughly investigated. This study undertakes a comprehensive examination of the abilities of LLMs such as ChatGPT in the context of predicting changes in stock movements using a multimodal approach, incorporating both stock-related news and technical indicators. Our experimentation encompasses zero-shot and few-shot inference, employing advanced models such as gpt-3.5, as well as smaller, instruction-based LLMs like Flan-T5. Our results indicate that LLMs demonstrate comparable performance when compared to the state-of-the-art models.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB78

Session.Location:CC-West 211A

Practioner Job Search Panel

Panel Session

Session Chair: Thomas Fink, INFORMS, Catonsville, MD

1 Moderator

Mark Velednitsky, Afresh Technologies, Bothell, WA

The purpose of this session is to bring visibility to the students and postdocs looking for non-academic positions. Panelists from business and industry will share their experiences. This panel discusses their experiences in the interview process along with the do’s & don’ts associated with the job search.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB79

Session.Location:CC-West 211B

First Order Methods, Machine Learning, and Beyond

Community Committee Choice Session

Session Chair: Bart Paul Gerard Van Parys, Massachusetts Institute of Technology, Cambridge, MA

Session Chair: Shuvomoy Das Gupta, MIT, Cambridge, MA

1 BnB-PEP: A Unified Methodology for Constructing Provably Fastest Optimization Methods

Shuvomoy Das Gupta, MIT, Cambridge, MA, Contact: sdgupta@mit.edu

As the data revolution continues to unfold, the pressing demand for provably fastest first-order methods has become increasingly apparent, given their key role in large-scale optimization and machine learning. To address this issue, we present BnB-PEP, the first unified methodology for constructing provably fastest first-order methods for both convex and nonconvex optimization. BnB-PEP poses the problem of constructing the fastest method as a nonconvex but practically tractable quadratically constrained quadratic optimization problem and solves it to certifiable global optimality using a customized branch-and-bound algorithm. We apply BnB-PEP to various practically relevant setups, yielding methods that surpass previous state-of-the-art results. Finally, we demonstrate how BnB-PEP can be used to systematically generate analytical convergence proofs.

2 Computer-Assisted Design of Accelerated Composite Optimization Methods: OptISTA

Ernest Ryu[1], Shuvomoy Das Gupta[2], Uijeong Jang[3], [1]Seoul National University, Department of Mathematical Sciences, Seoul, Korea, Republic of; [2]MIT, Cambridge, MA, [3]Seoul National University, Seoul, Korea, Republic of. Contact: ernestryu@snu.ac.kr

In this work, we present a novel double-function stepsize-optimization PEP methodology that poses the optimization over fixed-step first-order methods for composite optimization as a finite-dimensional nonconvex QCQP, which can be practically solved through spatial branch-and-bound algorithms. We utilize this methodology to design the exact optimal method OptISTA for the composite optimization setup, which outperforms the state-of-the-art accelerated composite optimization method FISTA (Beck, Teboulle 2009) by a factor of 2. We then establish the exact optimality of OptISTA with a novel lower-bound construction based on the extension of semi-interpolated zero-chain construction. By establishing exact optimality, our work concludes the search for the fastest first-order methods for the proximal, projected-gradient, and proximal-gradient setups.

3 A First-Order Approach to the Product Replacement Problem with Cross-Item Effects in Retail

Manuel Moran-Pelaez[1], Georgia Perakis[2], Tamar Cohen-Hillel[3], [1]MIT Operations Research Center, Cambridge, MA, [2]Sloan School of Management, MIT, Cambridge, MA, [3]UBC Sauder School of Business, Vancouver, BC, Canada. Contact: mmoranp@mit.edu

Assortment optimization is an important problem in the retail sector with the retailer deciding on which products to display in the stores. In this work we deviate from the usual first-choice model approaches where customers purchase their preferred available option. We model demand by capturing substitution (cannibalization) and complementarity cross-item effects. Although the original problem is NP-hard, we develop efficient and near-optimal first-order methods to compute assortments. We show the scalability and optimality of our approach in synthetic experiments. Our methods compute solutions within a 2% optimality gap for thousands of items in minutes. We also show a 6-8% revenue improvement of these methods in a real setting.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB80

Session.Location:CC-West 212A

KINFORMS Special Issue

Community Committee Choice Session

Session Chair: Chang Won Lee, Hanyang University, Seoul

1 Understanding the Concept of Proactive Quality Management and Its Impact on Firm Value

Yejee Kim, Hosun Rhim, Korea University Business School, Seoul, Korea, Republic of. Contact: gkrdus8279@naver.com

Most customers do not complain the inconvenience of a product or service, but rather decide to stop using it. To address this issue, we define the concept of proactive quality management and classify it into three types; guarantee program, preventive quality management, and forecasting-

based quality management. We conduct the event study method to examine the impact of proactive quality management on firm value.

2 Creating Sustainable Metaverse Business Models in Korea Healthcare Industry: Strategic Map Perspectives

Chang Won Lee[1], Kwangjum Kim[2], Jae Byung Chae[3], Ji Eun Kim[4], [1]Hanyang University Business School, Seoul, Korea, Republic of; [2]The Catholic University of Korea, Seoul, Korea, Republic of; [3]SK Telecom Metaverse Co, Seoul, Korea, Republic of; [4]Korea Health Industry Development Institute (KHIDI), Seoul, Korea, Republic of. Contact: leecw@hanyang.ac.kr

Metaverse is an emerging issue in the recent era. This study is to explore some cases and applications in the metaverse. Korean cases in the healthcare industry are discovered and presented in 4 different types of metaverse models. This study will provide important insights for decision-makers and policy-makers to create and implement sustainable metaverse business models and ecosystems.

3 Is Supply Chain (SC) Resilience a Critical Factor for Every Business?: Mitigation for the Sustainable Supply Chain Including SC Vulnerability

Da-sol Lee[1], Minjeong Oh[2], Sungyong Choi[3], [1]Hanyang University, Seoul, Korea, Republic of; [2]Yonsei University, Wonju, Korea, Republic of; [3]Hanyang University Business School, Seoul, Korea, Republic of. Contact: dslee1006@hanyang.ac.kr

This study aims to identify the critical factors that enhance the supply chain (SC) resilience in organizations, by taking into account their vulnerabilities, and provide empirical evidence to support the improvement of SC resilience, performance, and sustainability. The study examines the impact of key SC resilience competencies on the SC resilience phase and extends it to investigate the effects on sustainability. The study finds that the factors contributing to SC resilience vary depending on the SC vulnerability of each company. The study's findings can assist organizations in developing SC resilience strategies, and provide empirical results to support the enhancement of resilience and performance, ultimately contributing to the improvement of the entire supply chain's resilience.

4 Optimal Inventory Policy for Upstream when Downstream Follows (S,S) Policy

Byung Kwon Lee, Jeongwook Lim, Kun Soo Park, Seoul National University, Seoul, Korea, Republic of. Contact: kunsoo@snu.ac.kr

We consider a decentralized supply chain with one upstream firm and one downstream firm. The downstream firm faces customer demand with a fixed ordering costs, and it uses (s,S) policy to make its order to the upstream firm. The upstream firm in this decentralized supply chain does not know the downstream firm's inventory level, and it only knows the distribution of customer demand. By actively analyzing the downstream's order features, we propose a novel approach to optimize the upstream firm's optimal inventory policy.

5 Building Numeracy by Playing with Toys

James J. Cochran, The University of Alabama, Tuscaloosa, AL

Numeracy is an important and elusive component of literacy. We show how to use Legos pieces and operations research to quickly develop students' skills in modelling, demonstrate the real-world relevance of algebra and geometry, and demonstrate connections between these two sometimes intimidating areas of mathematics. By doing so, we demonstrate how to rapidly improve our students' numeracy and make them see that they are *very* capable of working with abstract mathematical concepts (and so also expand our students' literacy).

Tuesday, October 17, 10:45 AM - 12:00 PM

TB81

Session.Location:CC-West 212B

Cloud Computing and Deep Learning

Contributed Session

Session Chair: Mohammadreza Samadi, Google, Mountain View, CA

1 Automated Benchmarking for High-Performance Computing Workloads in Life Sciences

Rostislav I. Markov[1], Matthew Noyce[2], [1]Amazon Web Services, Inc., New York, NY, [2]Amazon Web Services, Inc., Nashville, TN, Contact: rmarkov@amazon.com

Running high-performance computing workloads such as genomics workflows requires large pools of compute instances that process data at a petabyte scale. Benchmarking helps evaluate workflow performance and discover faster and cheaper ways of running them. In practice, performance evaluations happen irregularly because of the associated heavy lifting. Using action research, we build a prototype based on cloud computing services of Amazon Web Services to help life-science research teams automate such evaluations. Our automated benchmarking solution measures performance on timing and pricing dimensions and provides: 1) more accurate enterprise resource planning by performing historical analytics, 2) lower cost to the business by comparing performance on different resource types, and 3) cost transparency to the business by quantifying periodical chargeback.

2 Supervised and Unsupervised Deep Learning for Workload Classification

Bing Hu[1], Andrew N. Mason[2], Karl Kempf[2], [1]Intel Corp., Chandler, AZ, [2]Intel Corporation, Chandler, AZ, Contact: bing.y.hu@gmail.com

A recuring decision in any data center involves optimally matching the computational requirements of an arbitrary workload with the computational capabilities of the available servers and their specific provisioning. As a first step in this decision process to utilize the full potential of a software/hardware system and obtain scalable performance improvements, a set of meaningful and accurate workload classifiers is essential. This paper proposes supervised and unsupervised deep learning workload analysis tools to capture complex workload dynamics. Our experiments show that these tools can precisely classify workloads by using latent feature representations from deep learning models.

3 Adaptive Federated Learning with Auto-Tuned Clients

J. Lyle Kim[1], Mohammad Taha Toghani[2], Cesar A. A. Uribe[3], Anastasios Kyrillidis[3], [1]Rice University, Houston, TX, [2]Rice University, HOUSTON, TX, [3]Rice University, Houston, TX

Federated learning (FL) is a distributed machine learning framework where the global model of a central server is trained via multiple collaborative steps by clients, without sharing their own data. While being a flexible framework where the distribution of local data, client participation rate, and computing power of each client can greatly vary, such flexibility gives rise to plethora of challenges, especially in terms of the hyperparameter tuning of the optimization routines used by the server and the clients. We propose a simple step size rule, that not only enables each client to use its own step size, but also adapts to the local smoothness of the function each client is optimizing. We provide both theoretical and empirical results where the benefit of the client adaptivity is shown in various FL scenarios.

4 Parameter Optimizer for Cloud Resource Forecasting

Albert Shyn Kwan Tan[1], Mohammadreza Samadi[1], Prashanth Mohan[2], Juan Li[3], [1]Google, Mountain View, CA, [2]Google, Sydney, Australia; [3]Google, New York, NY

Cloud services typically need to support Service Level Objectives (SLO) of less than 1% of downtime despite the variability in the demand and unplanned events. In Cloud resource planning, meeting the availability SLO is a hard constraint. However, different demand structures (e.g. ordering frequency, degree of fungibility across workloads, etc.) require different capacity levels to meet the availability SLO given the volatility of the demand. In this work, we present a statistical backtest simulation framework where we simulate capacity paths based on backtests under different demand structure assumptions, and compare them to actual demand to obtain efficiency and availability metrics. With that, the efficiency-availability tradeoff can be fully evaluated for decision makers.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB82

Session.Location:CC-West 212C

Machine Learning Methods in Healthcare - 2

Contributed Session

Session Chair: Oscar Rincon Guevara, 1</sup

1 Recognition of Super-Agers and Cognitive Decliners with fMRI and sMRI - Classification Study on ADNI

Parvin Mohammadiarvejeh, Mohammad Fili, Guiping Hu, Auriel Willette, Iowa State University, Ames, IA

The decline in multiple cognitive domains is considered the normal part of the aging process. However, older individuals show variation in the cognitive trajectories' patterns in their lifetime. Furthermore, adults aged 80 years or older, called "Super-Ager", showed cognitive functions at least as good as middle-aged adults. In this study on the ADNI database, we developed classification models to distinguish Super-Agers from normal Cognitive Decliners using Structural brain Magnetic Imaging Resonance (sMRI) and Functional Magnetic Imaging Resonance (fMRI) features. Understanding the differences in neurobiological features provides the knowledge to resist cognitive decline in healthy people and mitigate Alzheimer's disease.

2 The Effect of COVID-19 on COPD Patient's Readmission and Its Predictors

Behrad Barghi, Nasibeh Azadeh-Fard, Rochester Institute of Technology, Rochester, NY, Contact: bb3412@rit.edu

Chronic obstructive pulmonary disease (COPD) is a progressive lung disease among the top three causes of death in the US. Identifying risk factors for COPD patients' readmission and reducing it has become even more critical since the start of the COVID-19 pandemic. In this study, we use a nationwide dataset and machine learning techniques to develop a novel readmission prediction model, and the Bayesian optimization method is used to find the most optimal hyperparameters in each model.

3 Deep Learning Classification in Presence of Uncertain Predictors for Medical Decision Making

Maryam Kheirandish Borujeni, Shengfan Zhang, University of Arkansas, Fayetteville, AR, Contact: mkheiran@uark.edu

Deep learning classification models are becoming increasingly applicable in healthcare but are also significantly challenging due to the inherent uncertainties in clinical and laboratory test data. These errors are usually presented as sensitivity and specificity measures and do not follow a normal but some discrete distribution. We demonstrate the impact of these uncertainties on predictions and develop a framework to handle and quantify these uncertainties in medical decision-making problems.

4 Identifying Early Mpox Symptoms in Clinical Notes Using Natural Language Classification

Oscar Rincon Guevara, Mukesh Hamal, Lara Bull-Otterson, Centers for Disease Control and Prevention, Atlanta, GA

Natural language processing models trained on clinical notes can support extraction of critical features associated with emerging conditions of public health importance. In this study, a pretrained transformer model was applied to clinical notes within American Board of Family Medicine PRIME Registry data (April 2022 to January 2023) to identify potential early symptoms of monkeypox virus infection (i.e., occurring before rash onset or diagnosis) among patients with sexually transmitted disease-related outpatient visits. The transformer model identified differential symptoms between patients with and without mpox diagnoses; a random forest classifier was used to identify symptoms having the strongest association within each subgroup. These findings could support early diagnosis of mpox to aid prevention and treatment efforts.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB83

Session.Location:CC-West 213A

Stochastic Models on Part Failures

Contributed Session

Session Chair: Xiao Chen, University of New Hampshire, Dunham, NH

1 Servicizing Models with Product Remanufacturing Regarding Uncertain Collection Quality

Qidong He[1], Nengmin Wang[2], [1]Southwest Jiaotong University, Chengdu, China; [2]Xi'an Jiaotong University, Xi'an, China. Contact: heqd@outlook.com

Servicizing business models have been widely adopted by manufacturers to provide maintainable service especially when products are not fully functional. But the uncertain quality of collected cores reduces the economic benefit of remanufacturing process. To investigate the influence of quality uncertainty on servicizing, first, we propose new collection functions with customers heterogeneously prioritizing maintainable service in a two-period model, in which the manufacturer choose to provide servicizing, purchasing, or leasing business. Second, the collection rates and profits of manufacturers choosing different business models are compared under quality uncertainty and remanufacturing of wasted products. We find out the best business model choice under different quality scenario and impact of uncertain quality on servicizing efficiency.

2 Enhancing Semiconductor Equipment Failure Detection Using Correlation Analysis and Data Augmentation

Minjae Baek, Seoung Bum Kim, Korea University, Seoul, Korea, Republic of. Contact: minjae7306@korea.ac.kr

Traditional control charts and machine learning methods have been used to detect equipment failures in semiconductor processes. However, detecting failures and identifying their root causes can be challenging because of the complexity of the process and structural characteristics of the equipment. Moreover, the anomaly sections for each part can be imbalanced, which can hinder classification performance. In this study, we propose a method to detect failures using the correlation of variables and data augmentation. We demonstrate the effectiveness and applicability of the proposed method using real-world multivariate time series data obtained from ashing process equipment.

3 Manufacturing Rescheduling After Crisis or Disaster-Caused Supply Chain Disruption

Hongguang Bo[1], Xiao Alison Chen[2], Qian Luo[3], Wenpeng Wang[4], [1]Dalian University of Technology, Dalian, China; [2]University of New Hampshire, Durham, NH, [3]Xi'an Jiaotong-Liverpool University, Suzhou, China; [4]Dalian University of Technology, Dalian, China. Contact: alison.

chen@unh.edu

In this paper, we address the rescheduling challenges faced by a repair shop following major supply disruptions. These disruptions cause delays in production and order delivery, necessitating the rescheduling of unfinished parts. Our study considers the holding costs associated with finished and unfinished parts, as well as setup costs when switching between part types. We formulate the rescheduling problem as an integer program, aiming to minimize total tardiness, setup cost, and holding cost. Then, we propose a two-stage genetic algorithm that incorporates an estimation of distribution algorithm for enhanced search. We evaluate the algorithm using data from a heavy machinery maintenance provider. Results show that our approach outperforms the initial schedule and other benchmark algorithms without sacrificing computational time.

Tuesday, October 17, 10:45 AM - 12:00 PM

TB84

Session.Location:CC-West 213B

Models for Supply Chain Resilience and Disruption

Contributed Session

Session Chair: Ashesh Kumar Sinha, Kansas State University, Manhattan, KS

1 Cognitive Digital Twins for Supply Chain Resilience Enhancement

Mahmoud Ashraf[1,2], Islam Ali[1,2], Amr B. Eltawil[1,2], [1]Egypt-Japan University of Science and Technology, Alexandria, Egypt; [2]Alexandria University, Alexandria, Egypt. Contact: mahmoud.ashraf@ejust.edu.eg

Given the adverse impact of local and global crises on global supply chains, building resiliency is vital to mitigate such adverse impacts. Therefore, a cognitive digital supply chain twin is developed to enhance supply chain resilience through improved decision-making support, driven by the growing digital transformation efforts. The cognitive digital twin adopts a set of machine learning-based modules, enabling disruption detection, disrupted component identification, disruption duration prediction, and time-to-recovery prediction. Additionally, a disruption extrapolation module is developed to predict the future supply chain performance trajectory under a disruptive event and test recovery actions. Obtained information from the cognitive digital twin helps decision-makers make appropriate decisions based on real-time disruption detection data.

2 A Coverage Procurement Approach Does Not Pay: Empirical Evidence of the Cost of Flexibility

Angela Acocella, Tilbrug University, Tilburg, Netherlands. Contact: a.j.acocella@tilburguniversity.edu

Market uncertainty can drive procurement decisions that favor flexibility and delayed decision-making to mitigate financial risk. However, we empirically demonstrate that doing so can lead to higher costs and lower supplier performance. In the full truckload transportation services industry, buying firms (shippers) establish non-binding contracts with trucking companies (carriers) that function as options to avoid price escalations and volatility in a spot market. We build a set of empirical models of shippers' and carriers' strategic and operational behaviors to test the effects of shippers' choices to establish contracts but ultimately not exercise them. Despite firms' intentions to reduce costs and mitigate risks, we find that the strategy has tangible costs. We add to the by exploring a context in which these tactics are unfavorable and quantify the costs.

3 Exploring the Interplay of Agile Methodologies, Resilience, and ESG in Supply Chains: A Bibliometric Review and Qualitative Analysis

Angelica Alebrant Mendes, Susan Meireles Christiano Dantas, Federal University of ABC, Santo André, Brazil. Contact: angelica.alebrant@ufabc.edu.br

The importance of agile methodologies and resilience has increased due to competitiveness and the risk of value chain disruption. ESG frameworks in investment decision-making are gaining momentum, but implementation across industries is limited, and its relationship with functions such as supply chain, and logistics is understudied. The impact of ESG and agility on supply chain resilience is still being explored, resulting in a lack of extensive research. A bibliometric review and qualitative analysis of 58 articles from 2013 to 2022 revealed a 32.98% growth in scientific production on the topic. The study emphasizes the interdependence between resilience and agility, focusing on financial and operational performance in the supply chain regarding ESG. Identified gaps in the literature provide insights for future research.

4 Option Contract in the Air Cargo Industry Under Limited Capacity and Multiple Forwarders

Jiyong Kim[1], Byeongkwon Lee[1], Kunsoo Park[1], Kwanghun Chung[2], [1]Seoul National University, Seoul, Korea, Republic of; [2]Hongik University, Seoul, Korea, Republic of

The outbreak of COVID-19 has imposed restrictions on international travel, which has posed significant challenges for airlines managing their operations. In this context, the air cargo industry has played a crucial role in sustaining the airlines. Furthermore, as global logistics continue to expand, cargo industry is expected to grow steadily in the future. Consequently, our research aims to analyze the overbooking decisions of a carrier, as well as the reservation decision of forwarders, who are the key stakeholders within the air cargo industry. To achieve this, we employ option contracts and the stackelberg game model. Diverging from prior literature, which assumes a single carrier and forwarder or a carrier with unlimited capacity, our analysis focuses on the scenario involving multiple forwarders and a carrier with limited capacity.

5 Data Driven Decomposition Approach for Drone Battery Swapping in Last Mile Logistics

Ashesh Kumar Sinha, Kansas State University, Manhattan, KS, Contact: ashesh.sinha24@gmail.com

Supply chain disruptions have been a challenging issue worldwide, leading to losses of over several million dollars. The need for a resilient supply chain has led to the rise of technology-driven logistics, especially using e-commerce. In recent years, drones have become a low-cost, efficient, and less polluting alternative to land transportation for delivering packages in last-mile logistics, even in rural and hard-to-reach areas. One of the substantial operational challenges in using drones in the supply chain network is the limited flight coverage since they have limited flight range. The research goal of this proposal is to improve resiliency in the last-mile logistics of drones through a novel data-driven battery swapping/charging model that utilizes realistic charge and discharge cycles.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC01

CC-North 120A

Mining Nonlinear Dynamics in Operational Data for Process Improvement

Tutorial Session

Session Chair: Hari Balasubramanian, University of Massachusetts, Amherst, Amherst, MA

1 Nonlinear Dynamics Modeling and Control of Operational Data for Process Improvements

Hui Yang, Pennsylvania State University, University Park, PA

Whenever multifarious entities cooperate, compete, or interfere in manufacturing or service operations, there will be the rise of nonlinear and nonstationary dynamics. As complex systems evolve in time, operational dynamics deal with change. Whether the system settles down to the steady state, undergoes incipient changes, or deviates into more complicated variations, it is dynamics that help analyze system behaviors. Effective monitoring, modeling and control of nonlinear dynamics will increase system quality and integrity, thereby leading to significant economic and societal impacts. For example, manufacturing processes will make products with better quality and higher throughput. Gaining a deeper understanding of nonlinear dynamics of complex diseases will help improve the delivery of healthcare services, reduce the healthcare cost, and improve the health of our society. However, nonlinear dynamics pose significant challenges for operations engineering. Particularly, nonlinear dynamical systems defy understanding based on the traditional reductionist's approach, in which one attempts to understand a system's behavior by combining all constituent parts that have been analyzed separately. In order to cope with system complexity and increase information visibility, modern industries are investing in advanced sensing modalities such as sensor networks and internet-of-things technology. Real-time sensing gives rise to rich datasets pertinent to operational dynamics. Realizing the full potential of such operational data for process improvements requires fundamentally new methodologies to harness and exploit complexity. Nonetheless, there is a critical gap in the knowledge base that pertains to integrating nonlinear dynamics research with operations engineering. The theory of nonlinear dynamics has been primarily studied in mathematics and physics. There is an urgent need to harness and exploit nonlinear dynamics for creating new products (or services) with exceptional features such as adaptation, customization, responsiveness, and quality in unprecedented scales.This tutorial presents a review of nonlinear dynamics methods and tools for real-time system informatics, monitoring and control. Specifically, we will discuss the characterization and modeling of recurrence dynamics, network dynamics, and self-organizing dynamics hidden in operational data for process improvements. Further, we contextualize the theory of nonlinear dynamics with real-world case studies and discuss future opportunities to improve the design, monitoring, and control of manufacturing and service operations. We posit this work will help catalyze more in-depth investigations and multi-disciplinary research efforts in the intersection of nonlinear dynamics and data mining for operational excellence.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC04

CC-North 121A

Theory and Practice of Revenue Management in Service Systems by Jeunghyun and Xu

Community Committee Choice Session

Session Chair: Xu Sun, University of Florida, Gainesville, FL
Session Chair: Jeunghyun Kim, Korea University, Seoul, Korea, Republic of

1 Multichannel Advertising: Budget Allocation in the Presence of Spillover and Carryover Effects

Huijun Chen[1], Ying-Ju Chen[2], SUNGHYUK PARK[3], Dongwook Shin[4], [1]HKUST, Hong Kong, Hong Kong; [2]The Hong Kong University of Science and Technology, Kowloon, Hong Kong; [3]KAIST College of Business, Dongdaemun-Gu, Korea, Republic of; [4]HKUST Business School, Clear Water Bay, Hong Kong. Contact: hchenby@connect.ust.hk

This paper investigates how the presence of the spillover and carryover effects in the multi-channel ad campaign affects the budget allocation decisions of a marketing agency. The dynamic customer response to the advertisement is modeled by a hidden state Markov process. We first characterize the state in-attentive budget allocation problem, where the decision maker solves a static optimization iteratively. Second, we study the state attentive budget allocation problem and find the optimal budget remains most of the time close to an optimal steady state. Finally, we show that when channels are very different, the gap between them is not negligible.

2 Consistent Assortment Optimization Under Uncertainty

Carlos Henrique Cardonha[1], Aritanan Gruber[2], [1]University of Connecticut, Storrs, CT, [2]Federal University of ABC, Santo André, Brazil

This work investigates a dynamic version of the Assortment Optimization Problem (AOP) under the Multinomial Logit (MNL) choice model, where the firm relies on exogenous observations from multiple sources (competitors) to identify an optimal assortment. More precisely, we assume that all customers follow an MNL choice model, but the utility components of the parameters are unknown to the firm. Instead, the firm knows the assortments offered by its competitors. Additionally, the firm can derive the factor indicating how much the utility of the products differs from the utilities used by its competitors. We present preliminary structural, algorithmic, and complexity results for constrained and unconstrained versions of the problem and address some extensions and further applications of the model.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC05

CC-North 121B

New Models in Digital Platforms

Community Committee Choice Session

Session Chair: Rim Hariss, McGill University, Montreal, QC, Canada
Session Chair: Setareh Farajollahzadeh, University of Toronto, Toronto, ON, Canada

1 Responsible Revenue Sharing Models in Streaming Platforms

Rim Hariss[1], Shreyas Sekar[2], [1]McGill University, Montreal, QC, Canada; [2]University of Toronto, Toronto, ON, Canada. Contact: rim.hariss@mcgill.ca

Recently, there has been a growing concern that the adopted policies by online platform can exacerbate the biases present in the data and lead to outcomes that favour specific groups of popular users. This can affect the long-term health of the marketplace by endangering users' trust in the platform and lead to lopsided growth.This work tackles the problem of designing data-driven policies for online platforms that lead to diverse/fair outcomes. We focus on one lever used by the platform: pricing/revenue sharing. We adopt a two-pronged approach: 1) Use publicly available data from platforms such as Spotify to quantify how current policies lead to undesirable outcomes that only benefit some users; 2) Design policies for revenue sharing that benefit a broad spectrum of users operating on the platform.

2 An Operational Perspective on Microfinancing in Developing Countries

Opher Baron, Elaheh Rashidinejad, Gonzalo Romero, Rotman School of Management, University of Toronto, Toronto, ON, Canada. Contact: e.rashidinejad@rotman.utoronto.ca

We compare two microfinancing structures in developing countries where an entrepreneur with zero initial budget borrows a loan to operate a business. The entrepreneur faces a Newsvendor problem with financing and effort framework. We characterize conditions under which a community bank, which can apply social pressure on the entrepreneur to pay all of its debt back, improves individual and social welfare in comparison with a social bank, which has no such mechanism. We study the banks under profit maximization or zero profit objectives. Our theoretical model provides

practical guidelines on how to improve the design of microfinancing structures to maximize social impact and help alleviate poverty in a financially sustainable fashion.

3 Sequential vs. Simultaneous Product Release

Setareh Farajollahzadeh[1], Ningyuan Chen[2], Ming Hu[3], Hojat Abdollahnejad[2], [1]McGill University, Montreal, QC, Canada; [2]University of Toronto, Toronto, ON, Canada; [3]University of Toronto, Minneapolis, MN, Contact: setarefarajollahzade@gmail.com

We study the release strategy of media content where the content creators, such as authors or producers of series, are uncertain about the level of consumer interest in their products. They must decide whether to release all the content at once or release it in sequential episodes. With each episode release, a buzz is generated in the market, which attracts consumers to the product but fades away in the following period. During each period, consumers may learn about the content's attractiveness through direct experience (private learning), reading other users' reviews (social learning), or reading expert opinions (public learning). We determine the optimal pricing and release strategy for the seller under different learning settings.

4 Offline-Online Retail Collaboration via Pickup Partnership

Zahra Jalali[1], Maxime Cohen[2], Necati Ertekin[3], [1]McGill University, Vancouver, BC, Canada; [2]McGill University, Montreal, QC, Canada; [3]University of Minnesota, Minneapolis, MN

We study an popular retail practice called pickup partnership that allows online retailers to offer an in-store pickup service by partnering with a physical store. In practice, online retailers use two policies for such partnerships: (i) paying a fixed fee for each pickup order to the offline partner, or (ii) offering a coupon with each pickup order to customers to be redeemed at the offline partner's store. Our goal is to examine each policy and identify the best approach for online retailers. We develop a stylized model that captures the key features of a pickup partnership. We find that the coupon policy allows the online retailer to gain greater market coverage compared to the fixed fee policy, but it does not always increase the online retailer's profit. We characterize when an online retailer should establish a pickup partnership using the fixed fee versus the coupon policies.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC06

CC-North 121C

Multi-Armed Bandits and Their Applications

Community Committee Choice Session

Session Chair: Arpit Agarwal, Columbia University, New York, NY

1 Batched Algorithms for the Dueling Bandits Problem

Rohan Ghuge[1], Arpit Agarwal[2], Viswanath Nagarajan[1], [1]University of Michigan, Ann Arbor, MI, [2]Columbia University, New York, NY

In this work, we study the K-armed dueling bandits problem, which has applications in a wide-variety of domains like search ranking, recommendation systems and sports ranking where eliciting qualitative feedback is easy while real-valued feedback is not easily interpretable; thus, it has been a popular topic of research in the machine learning community. Previous works have only focused on the sequential setting where the policy adapts after every comparison. However, in many applications, it is preferable to perform comparisons in a limited number of parallel batches. We introduce and study the batched dueling bandits problem under two standard settings: (i) existence of a Condorcet winner, and (ii) strong stochastic transitivity and stochastic triangle inequality. For both, we obtain algorithms with a smooth trade-off between the number of batches and regret.

2 Improving Efficacy and Data Utility of Generalized Linear Contextual Bandits via Doubly Robust Method

Wonyoung Kim[1], Kyungbok Lee[2], Myunghee Cho Paik[2], [1]Columbia University, New York, NY, [2]Seoul National University, Seoul, Korea, Republic of

We propose a novel algorithm for generalized linear contextual bandits (GLBs) with an $\tilde{O}(\sqrt{\kappa^{-1} \phi^{-1} T})$ regret over T rounds where ϕ is the minimum eigenvalue of the covariance of contexts and κ is a lower bound of the variance of rewards. In several identified cases of $\phi^{-1}=O(d)$, where d is the dimension of contexts, our result is the first regret bound for GLBs achieving the order $\sqrt{d}$ without discarding the observed rewards. Our algorithm achieves the bound by incorporating contexts from all arms in our double doubly-robust (DDR) estimator. We also provide an $O(\kappa^{-1} \phi^{-1} \log (NT) \log T)$ regret bound for N arms under a probabilistic margin condition. We conduct empirical studies using synthetic data and real examples, demonstrating the effectiveness of our algorithm.

3 Diversified Recommendations for Agents with Adaptive Preferences

Arpit Agarwal, Wiliam Brown, Columbia University, New York, NY

When an Agent visits a platform recommending a menu of content to select from, their choice of item depends not only on immutable preferences, but also on their prior engagements with the platform. The Recommender's objective is to encourage content consumption which optimizes some reward, such as ad revenue. We formalize this problem as an adversarial bandit task. At each step, the Recommender presents a menu of k (out of n) items to the Agent, who selects one item in the menu according to their unknown preference model, which maps their history of past items to relative selection probabilities. The Recommender then observes the Agent's selected item and receives bandit feedback of the item's reward. Our main result is to show that low regret algorithms are possible if the Recommender ensures that the total distribution of chosen items has sufficiently high entropy.

4 Langevin Thompson Sampling with Logarithmic Batches

Siddharth Mitra, Yale University, New Haven, CT

Thompson sampling is widely used for sequential decision making due to its ease of use and strong performance. Two core challenges faced by Thompson sampling, however, are that it requires the posterior distributions to have closed form solutions, and that it is classically studied for fully sequential decision making, which is unable to factor in any delay in obtaining reward. In this talk, we will jointly address these problems with the aim of further strengthening Thompson sampling. We will then discuss this improved Thompson sampling algorithm for stochastic multi-armed bandits and reinforcement learning.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC07

CC-North 122A

Game Theoretic Models of Supply Chain

Community Committee Choice Session

Session Chair: Aadhaar Chaturvedi, University of Auckland, AUCKLAND, New Zealand

1 Supply Chain Model Under Common Agency

Aadhaar Chaturvedi, University of Auckland, AUCKLAND, New Zealand

We look at a supply chain model under common agency setting and show how it applies towards investigating impact of upstream yield correlation on a buyer's profit.

2 Supplier Allocation in Collaborative Product Development with Internal Competition

Timofey Shalpegin[1], Svenja C. Sommer[2], Christian van Delft[3], [1]Univeristy of Auckland, Auckland, New Zealand; [2]HEC Paris, Jouy-En-Josas, France; [3]Groupe HEC, Jouy Enjosas, France

This study examines how internal competition affects supplier collaboration and firm profits in a development process where a firm deploys multiple competing internal teams to explore alternative approaches for a single product. We propose a tournament model with two suppliers, who differ in expertise and development costs, and identify cost savings resulting from the similarity between different development efforts. Our analysis suggests that increasing supplier competition by increasing the number of teams per supplier can increase supplier efforts. The optimal allocation of internal teams to potential suppliers depends on their expertise and cost-effectiveness. Allocating more teams to the stronger supplier generally undermines their incentives to exert high levels of effort.

3 A Game-Theoretic Analysis of Pollution Tax, Partial Privatization/Nationalization, and Greening Technologies in a Mixed Oligopoly

Subhamoy Ganguly[1], Vinay Ramani[2], [1]University of Auckland, Auckland, New Zealand; [2]Indian Institute of Technology Kanpur, Kanpur, India. Contact: s.ganguly@auckland.ac.nz

We consider a mixed oligopoly where a (partially) privatized firm competes with one or more private firms. The production process of the firms causes some environmental damage through pollution. Firms have options to make investments (e.g., green technologies) that will reduce pollution. The partially privatized and the private firms differ not only in the cost of production and the greening technology, but also in their objectives. While the private firm maximizes profit, the partially privatized firm maximizes a weighted average of profit and consumer welfare. Using game-theoretic models, we investigate how government can use pollution tax and the degree of privatization/nationalization to maximize social welfare and control environmental damage caused by industrial production.

4 Promotion Incentives for Customer Retention: Field Experiment with a Subscription Meal Kit Service

Aysun Mutlu, Sanjith Gopalakrishnan, Mehmet Gumus,

Saibal Ray, McGill University, Montreal, QC, Canada. Contact: aysun.mutlu@mail.mcgill.ca

Customer retention is a challenging problem in retail management. Companies employ a variety of incentives to retain or re-acquire customers. However, their effectiveness needs to be better understood. Via field experiments carried out with a subscription meal kit service, we estimate the impacts of various incentives on customer retention and lifetime value. Furthermore, analyzing these incentives facilitated the exploration of personalized promotions and promotion timing optimization as strategies to enhance customer retention. The research findings provide valuable insights for retail businesses aiming to improve customer retention by implementing personalized promotions and optimizing promotion timing based on the effects of incentives.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC08

CC-North 122B

Advances in Revenue Management and Pricing

Community Committee Choice Session

Session Chair: Rene A. Caldentey, The University of Chicago, Chicago, IL

1 Fluid Approximations of Network Revenue Management Under General Demand Model

WEIYUAN Li[1], Huseyin Topaloglu[1], Paat Rusmevichientong[2], [1]Cornell Tech, New York, NY, [2]USC Marshall School of Business, Los Angeles, CA, Contact: wl425@cornell.edu

In revenue management literature, a popular demand model divides the selling horizon into time periods where at most one customer arrival is allowed per period. This discretized demand model is equivalent to a Poisson process approximation, but has a drawback: if the mean number of customer arrivals is high, then the variability of arrivals must be low. This limits the ability to handle both large demand volume and variability. This talk explores a generalized revenue management model that overcomes this limitation. The aim is to determine the fluid approximation under a general demand model.

2 Near Optimal Pricing for Nor1 eStandby Upgrades

Farbod Ekbatani[1], Andrew Vakhutinsky[2], Natalia Kosilova[3], [1]Chicago Booth School of Business, Chicago, IL, [2]Oracle Labs, Burlington, MA, [3]NULL, State College, PA, Contact: fekbatan@chicagobooth.edu

The eStandby upgrade is one of the prominent offering from Nor1. With this product, hotels have the ability to enhance a customer's experience by providing the option to upgrade from a standard room to a premium one at a reduced price. This approach brings advantages to hotels on two fronts: firstly, it serves as a revenue-generating tool, and secondly, it assists in redirecting bookings from overbooked standard rooms to available premium accommodations. In this presentation, we introduce a simple pricing strategy that is nearly optimal, interpretable, and easily implementable.

3 Bundling and Pricing Decisions for Ancillary Products

Tong Xie, Rene A. Caldentey, The University of Chicago, Chicago, IL

We study ancillary revenue management in the presence of consumer risk aversion. We characterize the firm's optimal pricing and bundling decisions in settings where there is a lag between the time of purchase and the time of consumption of the products or services. We consider both myopic and strategic purchasing behavior from the part of consumers.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC09

CC-North 122C

APS Market Showcase

Award Session

Session Chair: Christina Lee Yu, Cornell University, Ithaca, NY

Session Chair: Andrew Daw, University of Southern California, Marshall School of Business, Los Angeles, CA

Tuesday, October 17, 12:45 PM - 2:00 PM

TC10

CC-North 123

Algorithm Design for Causal Inference

Community Committee Choice Session

Session Chair: Christopher Harshaw, UC Berkeley, Berkeley, CA

1 Clip-OGD: An Experimental Design for Adaptive Neyman Allocation in Sequential Experiments

Jessica Dai, UC Berkeley, Berkeley, CA, Contact: jessicadai@berkeley.edu

Though adaptive sequential designs have become increasingly popular for causal inference, the extent to which adaptive designs can improve precision is not well understood. In this work, we study Adaptive Neyman Allocation (ANA) in a design-based potential outcomes framework. The goal is to construct an adaptive design that is nearly as efficient as the optimal but infeasible non-adaptive Neyman design. Motivated by online learning, we propose Neyman Regret, a performance measure of adaptive designs for ANA. We present Clip-OGD, an adaptive design which achieves $\tilde{O}(T^{1/2})$ Neyman Regret, recovering the optimal Neyman variance in large samples. Finally, we construct a conservative variance estimator to develop asymptotically valid confidence intervals. We also conduct simulations using data from a microeconomic study. Joint work with Chris Harshaw and Paula Gradu.

2 New Problems and Future Directions at the Interface of Nonconvex Optimization and Causal Inference

Bryon Aragam[1], Kevin Bello[2], [1]Chicago Booth, Chicago, IL, [2]Carnegie Mellon University, Pittsburgh, PA

Interpretability and causality are key desiderata in modern machine learning systems. Graphical models, and more specifically DAGs (aka Bayesian networks), are an established tool for representing interpretable causal models. Unfortunately, estimating the structure of DAGs from data is a notoriously difficult combinatorial problem, and existing approaches rely on various local heuristics. Recently, we proposed NOTEARS, a fundamentally different strategy that re-formulates the problem as a smooth but nonconvex optimization problem that avoids combinatorial constraints entirely. Although deceptively simple, many open questions---some elementary---remain regarding the properties of this class of problems. After reviewing this framework and recent progress in understanding its properties, we will discuss some future directions and open problems.

3 Fast Computation of Exact Confidence Intervals for Randomized Experiments with Binary Outcomes

Patrick Lopatto, Brown University, Providence, RI

Given a randomized experiment with binary outcomes, exact confidence intervals for the average causal effect of the treatment can be computed through a series of permutation tests. This approach requires minimal assumptions and is valid for all sample sizes, as it does not rely on large-sample approximations such as the central limit theorem. We show that these confidence intervals can be found in O(n log n) permutation tests in the case of balanced designs, where the treatment and control groups have equal sizes, and $O(n^2)$ permutation tests in the general case. Our results improve on prior work of Li and Ding (2016) and Rigdon and Hudgens (2015), and facilitate exact inference as a viable option for randomized experiments far larger than those accessible by previous methods. This is joint work with P. M. Aronow and Haoge Chang.

4 Off-Policy Evaluation Beyond Overlap: Partial Identification Through Smoothness

Samir Khan, Stanford University, CA

Off-policy evaluation (OPE) is the task of estimating the value of a target policy using data collected under a logging policy. OPE methods often assume overlap, enabling solutions based on reweighting or imputation. In this work, we approach OPE without overlap by partially identifying the off-policy value under weak assumptions on the expected outcome, such as Lipschitz smoothness. Under such assumptions, we formulate linear programs whose values bound the contributions of the no-overlap region. We show that these linear programs can be solved efficiently and that their solutions converge to the sharp partial identification bounds. We also show that the rate of convergence is optimal, up to log factors. We deploy our methods on two semi-synthetic examples, and obtain informative and valid bounds that are tighter than those possible without smoothness assumptions.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC11

CC-North 124A

Learning and Scheduling in Stochastic Systems

Community Committee Choice Session

Session Chair: Fiona Slothaak, Eindhoven University of Technology, Eindhoven, Netherlands

1 Learning While Scheduling in Multi-Server Systems with Unknown Statistics: Maxweight with Discounted Ucb

Zixian Yang[1], R. Srikant[2], Lei Ying[3], [1]The University of Michigan, Ann Arbor, Ann Arbor, MI, [2]University of Illinois, Urbana, IL, [3]The University of Michigan, Ann Arbor, Ann Arbor, MI, Contact: zixian@umich.edu

We consider a multi-server system with multiple servers and multiple types of jobs, where different job types require different amounts of processing time at different servers. The goal is to schedule jobs on servers without knowing the statistics of the processing times. To fully utilize the processing power of the servers, it is known that one has to at least learn the service rates of different job types on different servers. We propose a new algorithm, which combines the MaxWeight scheduling policy with discounted upper confidence bound (UCB), to simultaneously learn the statistics and schedule jobs to servers. We obtain performance bounds for our algorithm that hold for both stationary and nonstationary service rates. Simulations confirm that the delay performance of our algorithm is several orders of magnitude better than previously proposed algorithms.

2 Integrated Learning and Decision Making for Cumulative Shock Degradation

Collin Drent[1], Melvin Drent[1], Joachim Jacob Arts[2], Stella Kapodistria[1], [1]Eindhoven University of Technology, Eindhoven, Netherlands; [2]University of Luxembourg, Luxembourg City, Luxembourg. Contact: c.drent@tue.nl

We study maintenance optimization for a system whose condition deteriorates according to a compound Poisson degradation with a fairly general compounding distribution, where the parameters of both the Poisson process and the compounding distribution are unknown. We propose a Bayesian framework to learn these unknown parameters independently from each other and embed this into a Markov decision process, so that learning and decision making are integrated. We establish the optimality of a control limit policy that depends on the entire historical deterioration path of the individual system. We demonstrate the effectiveness in practice with a case study on interventional x-ray machines.

3 Optimal Stopping Policies when Assessing Students' Mastery

Sandjai Bhulai, Androniki Sapountzi, Jaap Storm, Martijn Meter, Vrije Universiteit Amsterdam, Amsterdam, Netherlands. Contact: s.bhulai@vu.nl

Assessing learning outcomes and determining mastery of a skill from a sequence of responses is a significant challenge. The difficulty lies in a reliable diagnosis with minimal student responses while offering an adaptive length assessment personalized for the learner online. This paper introduces a three-component solution to this challenge. Firstly, a Markov reward model is proposed in which the value function represents the student's mastery level. Secondly, a combination of reinforcement learning and machine learning techniques is utilized to evaluate the value function. Lastly, stopping policies based on the value function are introduced to balance accuracy and efficiency in mastery assessment. These policies are user-friendly and intuitive, even for teachers. The effectiveness is demonstrated using both synthetic and historical student response data.

4 Regret Analysis for Routing Policies in Matching Queues with Uncertain Payoffs

Sanne van Kempen, Eindhoven University of Technology, Eindhoven, Netherlands. Contact: s.f.m.v.kempen@tue.nl

We consider queueing in call centers, where customers classified by problem subject need to be matched to agents with suitable expertise. We model this as a multi-class multi-server queueing system with a fixed matching topology in the form of a bipartite graph. To capture the uncertainty in customer classification and heterogeneity of customers and servers, we introduce customer-server dependent random rewards associated to each allocated service. We aim to learn an optimal routing policy in a system where the rewards are sampled from unknown probability distributions. Such a routing policy is constrained by the stability conditions of the queueing system. We introduce a model that combines decision making with queueing dynamics and formulate the regret of a routing policy. By exploiting the structure of this problem, we are able to extend known results on regret bounds.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC12

CC-North 124B

Bayesian Optimization

Community Committee Choice Session

Session Chair: Raul Astudillo, California Institute of Technology

1 Knowledge Gradient Policy for Multi-Objective Bayesian Optimization with Decoupled Evaluations

Jack Buckingham[1], Sebastian Rojas Gonzalez[2], Juergen Branke[3], [1]Warwick University, Coventry, United Kingdom; [2]Data Science Institute, Leuven, Belgium; [3]Warwick University, Coventry, United Kingdom

Multi-objective Bayesian optimization aims to approximate the set of Pareto-optimal solutions with different trade-offs between a set of expensive objectives, while collecting as few samples as possible. In some cases, it is possible to evaluate the objectives separately. This presents an opportunity to learn the Pareto front more effectively by evaluating the objectives in a decoupled fashion, especially if they have different latencies. We propose a scalarization based knowledge gradient acquisition function which accounts for the different evaluation costs of the objectives. We prove consistency of the algorithm and show empirically that it significantly outperforms a benchmark algorithm which always evaluates all the objectives.

2 Class Bo: Bayesian Optimization for Heterogeneous Functions

Mohit Malu[1], Giulia Pedrielli[2], Gautam Dasarathy[1], Andreas Spanias[1], [1]Arizona State University, Tempe, AZ, [2]Arizona State University, Tempe, AZ, Contact: mmalu@asu.edu

In standard Bayesian Optimization method with Gaussian Process prior, we typically assume the function to be optimized is stationary (homogeneous) over the domain, but in many real-world applications we often deal with heterogeneous functions that can be divided into locally stationary functions over the partitions of input space. In this work, we propose a novel tree-based optimization technique dubbed as Class-BO (Class Bayesian Optimization), with information sharing across the non-contiguous partitions that belong to the same homogeneous class. This method uses a novel acquisition function dependent on the partitions of the input space. We also show the superior performance of Class-BO via extensive empirical evaluations.

3 Latent Space Preference Exploration for Bayesian Optimization with Many Outcomes

Yujia Zhang[1], Jelena Markovic-Voronov[2], Jerry Z. Lin[2], Ryan-Rhys Griffiths[2], Qing Feng[2], Peter Frazier[3], Eytan Bakshy[4], [1]Cornell University, Ithaca, NY, [2]Meta, Menlo Park, CA, [3]Cornell / Uber, Ithaca, NY, [4]Meta, New York, NY

Bayesian Optimization (BO) is a sample-efficient black-box optimization method when direct queries of the objective are possible. In many real-world problems, however, information about the objective is only available through a human decision maker who voices binary preferences over vector-valued outcomes from expensive experiments. Bayesian optimization with preference exploration (BOPE) partially addresses this challenge by modeling both the outcome and preference functions. However, it struggles computationally and statistically with high dimensional outcomes. To overcome this limitation, we introduce preference exploration over a latent subspace to jointly model the outcomes and user's preference. Our approach enables faster computation, efficient preference learning, and improved optimization performance.

4 Optimizing Value-at-Risk and Conditional Value-at-Risk of Black-Box Functions

Quoc Phong Nguyen, Massachusetts Institute of Technology, Boston, MA, Contact: qphongmp@gmail.com

Value-at-risk (VaR) and conditional VaR (CVaR) are established measures to assess risks in critical real-world applications with random environmental variables. In this talk, we present two Bayesian optimization (BO) algorithms with theoretical performance guarantee to maximize VaR and CVaR of a black-box function which are based on the well-established principle of optimism in the face of uncertainty. The BO of VaR is constructed by proving the existence of values of environmental random variables (to be selected to achieve no regret) such that the confidence bound of VaR lies within that of the black-box function evaluated at such values. Then, we utilize a connection between CVaR and VaR to derive a variant of our BO algorithm for the optimization of CVaR.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC13

CC-North 125A

Decision Analysis in Pandemic Management

Panel Session

Session Chair: Richard S. John, University of Southern California, Los Angeles, CA

1 Decision Analysis in Pandemic Management

Richard S. John, University of Southern California, Los Angeles, CA

The panel will discuss how difficult decisions made during the COVID-19 pandemic regarding testing, masking, closing and reopening businesses, allocating ventilators, and prioritizing vaccines would have been improved with more DA involvement. With its focus on quantifying uncertainties, value trade-offs, and risk attitudes, how can DA be a more useful tool for decision makers during the next pandemic?

2 Panelist

Robin Dillon-Merrill, Georgetown University, Washington

3 Panelist

Ralph L. Keeney, Duke University, San Francisco, CA

4 Panelist

Mark S. Roberts, University of Pittsburgh, Pittsburgh, PA

5 Panelist

Jun Zhuang, University at Buffalo, Buffalo, NY

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TC14

CC-North 125B

New Business Models for Socially Responsible Operations

Community Committee Choice Session

Session Chair: Luyi Gui, The Paul Merage School of Business, UC Irvine, Irvine, CA

Session Chair: Xiaoyang Long, University of Wisconsin-Madison, Madison, WI

Session Chair: Yixin Lu, George Washington University, Washington, DC

1 Managing Returns: Economic and Environmental Impact

Yulan Amanda Wang[1], Xin Wang[2], Kanglin Chen[3], [1]The Hong Kong Polytechnic University, Kowloon, Hong Kong; [2]The Hong Kong University of Science and Technology, Kowloon, Hong Kong; [3]Southern University of Science and Technology, Shenzhen, China. Contact: yulan.wang@polyu.edu.hk

In this study, we discuss some innovative return management means adopted by the platforms and study their economic and environmental impacts.

2 Spatial Competition of High-Performance Charging Stations

Philipp Kienscherf[1], Yixin Lu[2], Long He[2], Wolfgang Ketter[1], [1]University of Cologne, Cologne, Germany; [2]George Washington University, Washington, DC

Many countries have launched ambitious policy initiatives to foster adoption of electric vehicles (EV). In this paper, we study the competition of high-performance EV charging stations in a network, where the profitability of each charging station depends on its ability to extract monopolistic or oligopolistic rents via pricing. We model the interaction between operators of charging stations and consumers as a networked Stackelberg game. We then apply our modeling framework to analyze the recently proposed national EV charging network in Germany. Our study provides timely insights into the competitive landscapes of real-world EV charging networks.

3 Self-Targeting in Social Assistance Programs: How to Harness Data's Power?

Yuanzheng Ma[1], Guodong Lyu[2], Chung Piaw Teo[3], Huan Zheng[4], [1]Shanghai Jiao Tong University, Shanghai, China; [2]The Hong Kong University of Science and Technology, Hong Kong, China; [3]National University of Singapore Business School, Singapore, Singapore; [4]Shanghai Jiao Tong University, Shanghai, China. Contact: joan_myz@sjtu.edu.cn

Proxy-Means-Test (PMT) is often used in Social Assistance Programs (SAPs) to predict the consumption levels of individuals using big data. Self-Targeting is another approach developed to identify beneficiaries because the people living in poverty will more likely come forward to claim the benefit. Can we predict the shift in the sub-population coming forward based on the big data collected for PMT and use it to develop a more accurate targeting method? A simple model characterizing the effect in emerging self-enrolling SAPs using the Bayesian approach is proposed. Real data from Sierra Leone was used to evaluate the efficacy of the proposed method.

4 The Impact of Ride-Sharing Transportation on Patient No-Shows: Evidence from a Quasi-Experiment

Saif Benjaafar[1], Jason Chan[1], Nathaniel Witte[2], Shihong Xiao[3], [1]University of Minnesota, Minneapolis, MN, [2]University of Minnesota, Rochester, MN, [3]Fudan University, Shanghai, China. Contact: shihongxiao@fudan.edu.cn

We investigate the extent to which access to healthcare services can be improved through programs providing free ride-sharing transportation to medical appointments for patients. Specifically, we examine the impact of such a program on no-show rates using a quasi-experiment that contrasts treated patients with control patients. We find that the program is effective on average, but its effectiveness tends to dwindle over time, except that its effect sustains only for patients with low clinic attending frequency. Moreover, we find that among treated patients, primary care appointments enjoy a larger no-show reduction with the ride-sharing service than other types of appointments. Also, we find that the ride-sharing service reduces patients' visits to emergency departments, which implies that ride-sharing services can generate substantial impact on patient health.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC15

CC-North 126A

Supply Chain Risk and Obsolescence Management

Community Committee Choice Session

Session Chair: Hugh Medal, University of Tennessee, Knoxville, TN

1 Understanding the Key Factors Associated with Obsolescence Risk in Critical Supply Chains

Michael Sherwin, Duquesne University, Pittsburgh, PA

All supply chains are impacted by diminishing manufacturing sources and material shortages (DMSMS). However, critical supply chains are uniquely susceptible to DMSMS risks. In particular, the obsolescence of products and suppliers poses a substantial risk to the continuinity of supply. In addition to ordinary risks that affect the longevity of a company, irregular procurement cycles, qualification barriers, and strict requirements pose additional risks in the supply chain network of manufacturers. This research is focused on gaining valuable information for strategic and tactical decision-making by identifying key factors that assure continuity of supply. As such, we pose and test hypotheses pertaining to key variables that may affect the continuity of supply within critical supply chains and present results with the purpose of improving decision-making.

2 A Reliability Approach for Prediction and Management of Part Obsolescence

Christina Mastrangelo, University of Washington, Seattle, WA

Accurate prediction of part obsolescence is critical to maintaining system health, especially for the long-lived systems that typically exist in aerospace and naval domains. These environments are often characterized by decreasing product life (dynamic probability distribution parameters), incomplete data (highly censored), and relatively few predictor variables (but large sample size). This work describes a Weibull-based conditional probability method for the prediction of part-level obsolescence risk. Practical implementation solutions are discussed with respect to oversampling for small datasets, uncertainty estimation, and operational rationale/assumptions.

3 Optimizing the Selection of Resolutions to Part Obsolescence over a Time Horizon

Chad Uhles[1], Hugh Medal[2], [1]University of Tennessee, Knoxville, TN, [2]University of Tennessee, Knoxville, TN, Contact: cuhles@vols.utk.edu

Diminishing manufacturing sources and material shortages (DMSMS) is a significant issue in many industries such as aerospace, defense, and nuclear power. Problems caused by DMSMS can arise when crucial systems are extended well beyond their initially anticipated lifetimes and parts become obsolete. To combat this issue, it is important to develop a plan to buy, replace, and refresh parts over time to sustain the system. Indeed, a well-crafted sustainment plan can yield significant cost savings. In this work, we develop a mixed-integer programming model for selecting resolutions of DMSMS issues over time. Possible resolutions include, but are not limited to, part substitutions, lifetime buys, or a full refresh of the current part or system design. We demonstrate our model on a hypothetical system that is subject to obsolescence.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC16

CC-North 126B

Equity-promoting Optimization: Theory and Applications

Community Committee Choice Session

Session Chair: Karmel Shehadeh, 1</sup

1 Reducing Disparities in Transportation Distance in a Stochastic Facility Location Problem

Karmel S. Shehadeh, Lehigh University, Bethlehem, PA, Contact: karmelshehadeh@gmail.com

Uneven distributions of service-providing facilities across different regions lead to disparity in accessibility and transportation distance to essential services. To mitigate such disparities, we propose equity-promoting stochastic programming (SP) and distributionally robust optimization (DRO) models for the stochastic fixed charge facility location problem. Our results show, for the first time, how different methods of modeling equity under uncertainty can result in different location decisions with varying impacts on equity. Notably, the proposed equity-promoting DRO models lead to a more diverse distribution of facilities and better mitigate disparities in transportation distance than their SP counterparts and equity-neutral models

2 Equity-Promoting Integer Programming Approaches for Medical Resident Rotation Scheduling

Shutian Li[1], Karmel S. Shehadeh[1], Beth Hochman[2], Jacob Krimbill[2], Alexander P. Kossar[2], [1]Lehigh University, Bethlehem, PA, [2]Columbia University Medical Center, New York, NY, Contact: shl919@lehigh.edu

Newly graduated physicians from medical schools often join certified residency programs to fulfill specialty board certification requirements. Residents rotate through various clinical settings during their residency to gain the necessary training. Manually constructing the annual rotation schedule is challenging and laborious. Moreover, manual methods often produce inequitable schedules. To address these challenges, we propose new equity-promoting integer programming approaches for rotation scheduling. Numerical experiments based on a case study from a residency program illustrate the potential of the proposed approaches in automating the resident-to-rotation scheduling process and improving equity among residents and their satisfaction.

3 A Unified Framework for Analyzing and Optimizing a Class of Convex Inequity Measures

Man Yiu Tsang, Karmel S. Shehadeh, Lehigh University, Bethlehem, PA

We present a unified framework for analyzing a new parameterized class of convex inequity measures suitable for optimization contexts. We provide theoretical analyses and derive a dual representation of these measures. Importantly, this dual representation renders a unified mathematical expression and an alternative geometric characterization for convex inequity measures. Moreover, we present generic solution approaches for equity-promoting optimization problems with a convex inequity measure objective or constraint. Finally, we provide stability results on the choice of convex inequity measures in the objective of optimization models. Our numerical results show the computational efficiency of our approaches over existing approaches.

4 Fairness Regulation and Market Collusion

Zongsen Yang[1], Xiao Lei[2], Pin GAO[3], [1]Chinese University of Hong Kong, Shenzhen, Shenzhen, China; [2]University of Hong Kong, Hong Kong, Hong Kong; [3]The Chinese University of Hong Kong, Shen Zhen, Shenzhen, China. Contact: zongsenyang@link.cuhk.edu.cn

The regulation of price discrimination due to fairness concerns has drawn significant attention recently. While previous literature has focused on price fairness in a monopoly setting, its impact under a competitive market is not clear. We consider the impact of price fairness regulation under a duopoly market and examine its interplay with price collusion, another important topic in market regulation. Our findings suggest that strict fairness regulation can facilitate collusion, leading to reduced consumer surplus. To remedy this drawback, we propose the use of randomized regulation, which can effectively deter price collusion while maintaining the benefits of fair pricing. Our study highlights the need for a nuanced approach to price fairness regulation and provides important insights for policymakers and market regulators.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC17

CC-North 127A

Discrimination and System Design in Admissions and Career Advancement

Community Committee Choice Session

Session Chair: Jordan D. Tong, University of Wisconsin Madison, Madison, WI

Session Chair: Xiaoyang Long, University of Wisconsin-Madison, Madison, WI

1 Application Mistakes and Informations Frictions in College Admissions

Ignacio Rios[1], Tomas Larroucau[2], Anais Fabre[3], Christopher Neilson[4], [1]The University of Texas at Dallas, Richardson, TX, [2]Arizona State University, Tempe, AZ, [3]Toulouse School of Economics, Toulouse, France; [4]Yale University, New Haven, CT, Contact: ignacio.rios.u@gmail.com

We study application mistakes in a centralized college admissions system. We use data from Chile and exploit institutional features to identify four types of mistakes: admissibility, over-confidence, under-confidence, and ordering. We identify that biases in students beliefs about their admission chances and information frictions explain a large fraction of these mistakes. We use these insights to design and implement a large-scale information policy to reduce application mistakes. We find that showing personalized information about admission probabilities significantly reduces the risk of not being assigned to the centralized system and the incidence of application mistakes. Our results suggest that information frictions play a significant role in affecting the performance of centralized college admissions systems.

2 Dropping Standardized Testing for Admissions Trades off Information and Access

Faidra Monachou, Harvard University, Cambridge, MA

We study the role of information and access in capacity-constrained selection problems with fairness concerns. Using theory and UT Austin data, we develop a framework with testable implications that formalizes the trade-off between the informativeness of a feature and its exclusionary nature when members of different social groups have unequal access to this feature. Our framework finds a natural application to policy debates on dropping standardized testing in college admissions. Our primary takeaway is that dropping a feature may exacerbate disparities by decreasing the amount of information available for each applicant, especially those from non-traditional backgrounds. However, in the presence of barriers, we show that the interaction between the informational environment and the effect of access barriers on the applicant pool size becomes highly complex.

3 Gender Bias in Job Assignment: Evidence from Retail Frontline Managers

Ruoran Chen[1], Susan F. Lu[2], Lauren Xiaoyuan Lu[3], Simin Huang[4], [1]Southwest Jiaotong University, Chengdu, China; [2]Purdue University, West Lafayette, IN, [3]Dartmouth College, Hanover, NH, [4]Tsinghua University, Beijing, China. Contact: lauren.x.lu@tuck.dartmouth.edu

While anecdotes suggest that workplace gender disparities widely exist, the current literature has not provided sufficient causal evidence due to two deficiencies. First, because most gender studies rely on surveys and laboratory experiments, causal evidence of gender disparities in the field is rare; Second, because most empirical gender studies focus on individual workers or C-suite executives, research on low-level managers using real-world personnel data is also rare. In this study, we aim to address these deficiencies by empirically studying the effect of gender on the job assignment of frontline managers in a large sportswear retail chain using personnel, sales, and operational data. Our estimation strategy is a two-step panel estimation framework, which separately identifies manager and store fixed effects by exploring manager switches across stores.

4 Funnels and Favoritism: How Recruiting Structures Shape Diversity and Quality

Jordan Tong, Xiaoyang Long, University of Wisconsin-Madison, Madison, WI, Contact: jordan.tong@wisc.edu

Behavioral research has uncovered several biases that evaluators display when judging quality. How do these biases impact the diversity and quality of hires? We examine this question using a stylized model of recruiting structures, i.e., the funnel shape from the candidate pool to the final hire(s), and the hiring committee composition. We show that the impact of judgment biases depends critically on the recruiting structure. Whereas a basic model of taste-based discrimination leads to intuitive dynamics, incorporating other established biases like outgroup homogeneity and judgment noise can lead to surprising results. We deliver insights into what combinations of judgment biases and recruiting structures most (dis)advantage minorities, and how organizations can change their recruiting structure to improve both quality and diversity.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC18

CC-North 127B

Applied Models and Empirics in Healthcare

Community Committee Choice Session

Session Chair: Joel Goh, NUS Business School, Singapore, Singapore

1 Wheels on the Bus: Impact of Vaccine Rollouts on Demand for Public Transportation

Huaiyang Zhong[1], Tinglong Dai[2], Guihua Wang[3], [1]Virginia Tech, Blacksburg, VA, [2]Johns Hopkins University, Baltimore, MD, [3]The University of Texas at Dallas, RICHARDSON, TX, Contact: hzhong@vt.edu

The COVID-19 pandemic caused a decline in public transit ridership, impacting vulnerable riders without alternative transportation. This study examines the relationship between COVID-19 vaccination progress and public transportation demand, focusing on vulnerable populations. To estimate the impact, we use a unique instrumental variable by merging US vaccination and county-level mobility data. Results show that higher vaccination rates lead to increased demand for public transport, particularly in uninsured and non-college-educated communities. These findings highlight the need for targeted efforts to increase vaccination coverage and restore public transit infrastructure for an equitable recovery.

2 Should Doctors and Patients Decide Together? An Analytical Framework for Shared Decision-Making

Feray Tuncalp[1], Rouba Ibrahim[1], Song-Hee Kim[2], Jordan D. Tong[3], [1]University College London, London, United Kingdom; [2]Seoul National University, Gwanak-gu, Korea, Republic of; [3]University of Wisconsin Madison, Madison, WI, Contact: f.tuncalp@ucl.ac.uk

In recent years, shared decision-making (SDM), where doctors and patients jointly decide on appropriate treatment options, has drawn a lot of attention in the healthcare domain. Despite the documented benefits and limitations of SDM, there are no clear guidelines that identify when to involve patients in treatment decisions, and when to rely solely on the doctor's medical expertise. To provide insights into when to do SDM, we study the decision-making process between two treatments using a stylized model where we account for both patients' and doctors' bounded rationality in decision-making, as well as doctors' insufficient metacognition about these errors. Contrary to the common medical belief which advocates using SDM for all conditions, we find that there is no one-size-fits-all policy for the healthcare decision-making process.

3 Dynamic Physician Staffing During a Pandemic:
Yvonne Huijun Zhu[1], Joel Goh[2], [1]National University of Singapore, Singapore, Singapore; [2]NUS Business School, Singapore, Singapore
We study a dynamic model of healthcare service provider staffing in the context of an infectious disease pandemic. In the model, physicians are split into two teams, a "hot" team that serves patients who have the infectious disease, and a "clean" team that serves regular patients. A unique feature of the model is that service providers can themselves be infected with the disease, which takes them out of service for a period of recovery. Through the model, we analyze the structure of dynamic optimal policies for staffing these two teams.

4 Adaptive Design of Clinical Trials
Zhengli Wang[1], Stefanos Zenios[2], [1]University of Hong Kong, Hong Kong, Hong Kong; [2]Stanford University, Stanford, CA
: Adaptive design of clinical trials hold great promise for reducing the cost of clinical trials. In this paper, we propose a tractable Bayesian framework where the clinical trial designer can either choose among different experiments with different information, or to terminate the trial. There are rewards associated with making the correct decision and penalties from incorrect ones. We present solutions to the resulting asymptotic stochastic control problem.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC19

CC-North 127C
Conversation with the Editors
Panel Session

1 Healthcare Research Journal Editors Panel
Jonathan Eugene Helm, Indiana University, Bloomington, IN, Contact: helmj@iu.edu
Different from previous years, this session will not only discuss journal departments that publish healthcare papers but will also include a focus on publishing papers that are directly targeted for impact on practice.
Session Chair: Jonathan Eugene Helm, Indiana University, Bloomington, IN

2 Panelist
Carri Chan, Columbia Business School, New York, NY

3 Panelist
Greg Zaric, Ivey Business School, London, ON, Canada

4 Panelist
Paul Brooks, Virginia Commonwealth University, Richmond, VA

Tuesday, October 17, 12:45 PM - 2:00 PM

TC20

CC-North 128A
Healthcare Operations Management
Community Committee Choice Session
Session Chair: Shuming Wang, University of Chinese Academy of Sciences, Beijing, China
Session Chair: Linggang Qi, Hong Kong
Session Chair: Zhan Pang, Purdue University, West Lafayette, IN

1 On Reducing Medically Unnecessary Cesarean Deliveries: The Design of Payment Models for Maternity Care
Emily Z. Fainman[1], Beste Kucukyazici[2], TING WU[3], [1]Texas State University, San Marcos, TX, [2]Queen's University, Kingston, ON, Canada; [3]Nanjing University, Nanjing, China. Contact: c_z88@txstate.edu
This data-driven study focuses on the design of financial incentives to reduce unnecessary C-sections, resulting in enhanced birth quality with alleviated economic burden for healthcare systems. We first use semi-supervised learning methods to classify pregnancy women into low- and high-risk groups. Then we validate the optimal delivery methods for two risk groups through post-delivery variables in the dataset. We propose easily implementable and robust pay-for-performance models, resulting in risk sharing between payer and physicians, and coordination among any group of physicians.

2 Improving Health Outcomes with Less Cost? Provision of Mobile Clinic in Developing Economics
Fang Liu[1], Pengfei Guo[2], Yulan Amanda Wang[3], Yuejuan Xi[1], [1]University of Chinese Academy of Sciences, Beijing, China; [2]City University of Hong Kong, Hong Kong, Hong Kong; [3]The Hong Kong Polytechnic University, Hung Hom, Hong Kong. Contact: yuejuanxi@ucas.ac.cn

Consider a public healthcare system consisting of a hospital, a mobile clinic (MC), and a population of potential patients. The government is concerned about the system's healthcare spending and the population's health outcomes. It needs to decide whether and how to provide the MC service to maximize the social welfare that consists of two terms: the system's long-run average healthcare cost and the population's average quality-adjusted life year (QALY). We model the population's natural disease progression and derive both the average healthcare cost and the average QALY for a given MC delivery cycle. We show that the MC service is provided only when the setup cost is below a certain threshold under both disease types. Once the MC service is provided, we show that if the disease is fast-progressive, the MC service is provided either every or every other period.

3 Managing Incentives for Medical Care Services Under Competition and Imperfect Quality Information

Linggang Qi[1], Zhan Pang[2], [1]City University of Hong Kong, Hong Hong, China; [2]Purdue University, West Lafayette, IN, Contact: lingganqi2-c@my.cityu.edu.hk

Our paper investigates how to design performance-based incentives in a healthcare market with imperfect quality information. We adopt a three-stage game to model the system: the payer first designs a payment contract, hospitals then decide their quality levels and last patients choose hospitals. We first characterize hospitals' quality decisions under a given bonus contract, and also characterize the optimal contracting decision in a class of bonus contracts. We find that the fee-for-service reimbursement should be set as small as possible to reduce payments to the hospitals and improving quality information can lower bonus reimbursement. Moreover, the system under the optimal bonus contract can reach the social optimum under some certain conditions. Our results also show that competition intensity and performance-based incentives are substitutes to each other.

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TC21

CC-North 128B

Data-Driven Decision Making in Healthcare I

Community Committee Choice Session

Session Chair: Agni Orfanoudaki, Oxford University, Oxford, United Kingdom

1 Automated Data Extraction for Clinical Databases Using Natural Language Processing

Dimitris Bertsimas[1], Robert Habib[2], George Margaritis[1], Agni Orfanoudaki[3], Periklis Savvas Petridis[4], David Shahian[5], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Society of Thoracic Surgeons, Chicago, IL, [3]Oxford University, Oxford, United Kingdom; [4]Massachussetts Institute of Technology, Cambridge, MA, [5]Massachusetts General Hospital, Boston, MA, Contact: geomar@mit.edu

Across the U.S., 97% of adult cardiac surgery programs transfer their patient data to the STS National Database for quality improvement and risk assessment. However, this involves substantial manual human effort, as most patient records are unstructured text reports. Utilizing recent advances in Natural Language Processing, we propose a flexible, end-to-end ML pipeline that automates this data-extraction process. Preliminary results from Massachusetts General Hospital and Brigham and Women's Hospital are promising, demonstrating high accuracy in predicted outcomes. The benefits of this approach include reduced operational costs, improved data consistency and quality, and a unified framework for medical predictions from diverse patient data.

2 Integrated Planning and Control of Drone Networks for Emergency Medical Response

Jamal Chu[1], Sheng Liu[1], Wei Qi[2], Timothy Chan[1], [1]University of Toronto, Toronto, ON, Canada; [2]Tsinghua University, Beijing, China. Contact: jamal.chu@mail.utoronto.ca

Drones have been proposed as a supplemental response to medical emergencies such as cardiac arrest and anaphylactic shock through the delivery of time-critical supplies. Recent work has focused on separate drone base placement and heuristic dispatch policies via two-stage models, which may lead to performance loss compared to an integrated model. We first propose a new dispatch policy and prove that it is optimal under the assumption that drones have non-overlapping coverage zones. We then propose a novel stochastic integer program to jointly optimize base placements and dispatch policies for both p-median and max coverage objectives. We show that our integrated placement-dispatch model can have substantial improvements over a two-stage model on out-of-sample data.

3 Interpretable Framework for Optimal Sepsis Treatment Under Limited Resources

Lien H. Le[1], Angela Lin[2], Dessislava Pachamanova[3], Georgia Perakis[2], Omar Skali Lami[4], [1]Newton-Wellesley Hospital, Newton, MA, [2]Massachusetts Institute of

Technology, Cambridge, MA, [3]Babson College, Wellesley, MA, [4]MIT / McKinsey & Company, Cambridge, MA, Contact: aglin@mit.edu

Sepsis is a life-threatening response to infection responsible for 250K deaths per year and the largest portion of hospitalization costs in the US. Deciding which treatments to give sepsis patients in intensive care units (ICU) with limited resources is challenging, as sepsis is broad and heterogeneous, and timely treatment is critical to patient outcomes. In this work, we propose a clinical decision-making framework for treating sepsis patients: we learn a concise Markov Decision Process (MDP) model from observed data, propose novel value iteration algorithms for finding optimal policies, and formulate a tractable optimization problem for allocating scarce resources. Upon testing our framework on an ICU dataset, we see a 14% increase in number of patients successfully discharged, 8% decrease in number of deaths, and over two-fold decrease in length of ICU stay.

4 Improving Stability in Decision Tree Models

Vassilis Digalakis[1], Dimitris Bertsimas[2], [1]MIT/HEC Paris, Cambridge, MA, [2]MIT, Cambridge, MA

Owing to their inherently interpretable structure, decision trees are commonly used in applications where interpretability is essential. Recent work has focused on improving aspects of decision trees, including their predictive power and robustness; however, their instability has been addressed to a lesser extent. We take a step towards the stabilization of decision tree models through the lens of real-world healthcare applications. We introduce a distance metric for decision trees and use it to determine a tree's level of stability. We propose a methodology to train stable decision trees and investigate the existence of trade-offs between stability, predictive power, and interpretability. We show that, on average across six healthcare applications, a 4.6% decrease in predictive power can improve the model's stability by as much as 38%.

5 Efficient Estimation for the Transportability Index Using Neural Networks

Jiwei Zhao, University of Wisconsin, Madison, WI

We consider estimating some quantity of interest on the target population, via efficiently leveraging information from a different but relevant source. In the literature, such transportation is possible after imposing assumptions on source and target. This type of assumption is, unfortunately, made partially on unobserved data and hence unverifiable empirically. To assess the impact of its violation, we adopt a sensitivity analysis framework indexed by a sensitivity parameter. We propose a new measure, transportability index, that quantifies the sensitivity to change in quantity of interest with respect to a small perturbation to the underlying assumption. Estimating the transportability index involves two nuisances, both of which are conditional expectations. We validate and demonstrate our proposal via experiments on synthetic and real-world datasets.

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TC22

CC-North 129A

Optimization Models in Medical Decision Making with Uncertainty

Community Committee Choice Session

Session Chair: Kimia Ghobadi, Johns Hopkins University, Baltimore, MD

1 A Geometric Approach to Beam Angle Optimization in Radiation Therapy

Danielle Ripsman, University of Waterloo, Waterloo, ON, Canada

Beam angle optimization (BAO) is a difficult component of planning radiation therapy treatments. Despite the wealth of proposed methodologies for selecting beam-angles in the literature, in practice, clinicians often opt for a fixed number of equidistant beams, or manual iterative planning. This is due in part, to the requirement for a secondary fluence map optimization (FMO) to validate any BAO selections and the resource-intense calculations needed to calculate the parameters for such a model at each iteration. In this talk, the BAO problem is modeled using a geometrical abstraction, allowing it to be considered in a single-stage column generation-driven set-covering framework. This novel abstraction allows for a reduction in the reliance of BAO modeling on sophisticated dose calculators, as well as eliminating the need for time-consuming BAO-FMO iteration.

2 Achieving Financial Sustainability in Chilean Healthcare: A Stackelberg Model Approach

Diego A. Martínez, Luis Lillo, Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile. Contact: luis.lillo@pucv.cl

According to the World Bank´s universal healthcare index, Chile is among the best-ranked countries in Latin America. However, Chile´s health system is fragmented and unfair, affecting vulnerable urban and rural populations. Social and political actors are debating the future of the Chilean health system with a long-term focus on equity and financial sustainability. Considering the stochastic longitudinal dynamics inherent in two-tiered healthcare systems, we propose a Stackelberg model to support this debate. We discuss the model insights and provide actionable information to re-design the current pay model (volume- vs. value-based).

3 Inventory System Optimizing Under Endogenous and Exogenous Uncertainty

Jing Liu[1], Cassandra Thiel[2], Kimia Ghobadi[3], [1]Johns Hopkins University, Baltimore, MD, [2]NYU Langone Health, New York, NY, [3]Johns Hopkins University, Baltimore, MD, Contact: jliu254@jhu.edu

Medical supply inventories have been under stress in recent years with a combination of unstable markets, global supply chain challenges, and increased demand, e.g., during the pandemic. In this talk, we propose a robust inventory optimization model that considers exogenous demand uncertainty and endogenous shipping lead time uncertainty that are captured through a set of order-dependent uncertainty subsets. We demonstrate the efficacy of our methods using data from New York University Healthcare System and showed our robust model achieves more resilient inventory over the nominal model and lower costs than a state-of-the-art model under uncertain settings.

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TC23

CC-North 129B

Sustainable Transportation: Modeling and Reality

Community Committee Choice Session

Session Chair: Yudai Honma, The University of Tokyo, Meguro-Ku, Japan

1 Location Analysis of In-Motion Wireless Power Transfer System for Trips in Urban-Scale Region by Electric Vehicle

Yudai Honma[1], Daisuke Hasegawa[2], Katsuhiro Hata[1], Takashi Oguchi[1], [1]The University of Tokyo, Meguro-Ku, Japan; [2]The University of Tokyo, Bunkyo-Ku, Japan. Contact: yudai@iis.u-tokyo.ac.jp

The popularization of electric vehicles (EVs) is limited by their driving range and long charging times. To address this, in-motion wireless power transfer systems (WPTSs) are currently attracting attention as a new power supply system. This study aims to propose a new mixed integer programming (MIP) model to determine the optimal locations of WPTSs in urban-scale area. Specifically, we calculate the amount and locations of WPTS necessary and sufficient to achieve substantially zero consumption of energy in urban areas. We also present an numerical example by real data of a typical medium-sized city in Japan.

2 Strategic Planning for EV Charging Networks by Integrating Demand and Supply Dynamics Through Continuous-Time Models

Xuesong Zhou[1], Xiangyong Luo[2], Michael Kuby[1], [1]Arizona State University, Tempe, AZ, [2]Arizona State University, Tempe, AZ, Contact: xzhou74@asu.edu

By using continuous-time models, it considers the demand and supply dynamics, taking into account the long-term perspective required for effective resource planning. The study recognizes the emergence of EVs as a sustainable and cost-effective option, emphasizing the importance of considering innovation diffusion and predicted adoption curves.

3 An Inverse Shortest Paths Problem Model for Evaluating Urban Facilities Using Visit Data

Hiroyuki Hasada[1,2], Yudai Honma[1], Takashi Oguchi[1], [1]The University of Tokyo, Meguro-Ku, Japan; [2]The Institute of Behavioral Sciences, Shinjuku-ku, Japan. Contact: hasada-hiroyuki649@g.ecc.u-tokyo.ac.jp

Despite few visitors, some inaccessible public facilities are nonetheless attractive. We propose an evaluation method that estimates the utility value and consumer surplus of each facility based on visitor's travel costs, rather than visitor numbers. We implement a linear integer programming model to maximize the surplus of the visited facility among those of other facilities. This model also classifies visitors into segments sharing the same estimated utility value, forming a novel inverse shortest paths problem model. We apply this method to Japan's "Michi-no-Eki" roadside stations, utilizing ETC2.0 vehicle probe data. The evaluation identifies valuable, remote stations used by truck drivers. Our method contributes to the accurate evaluation and optimal placement of facilities beneficial to logistics operators.

4 Modelling and Piloting Emerging Transportation Technologies

Shuyao Hong, Arizona State University, Tempe, AZ, Contact: shuyao.hong@asu.edu

Emerging transportation technologies have the potential to lead us to a safer, more sustainable and equitable transportation system. However, they also present uncertainty and risk to the society. Piloting and modelling are two important tools to understand the impact of emerging technologies as they evolve rapidly: the widespread testing of autonomous vehicles, the acceleration of vehicle electrification, the commercialization of AI-based traffic control technologies, the proliferation of connected vehicle data, just to name a few. This presentation will discuss some of these efforts that's happening locally here in Phoenix, Arizona.

5 The Fundamentals of Optimum Coordination Control of Traffic Signals

Takashi Oguchi, The University of Tokyo, Tokyo, Japan. Contact: takog@iis.u-tokyo.ac.jp

How to optimize traffic signals along with a route with series of adjacent intersecions? Because the existence of counter directional traffic flow, providing a green wave for both directions for the simplest case with a link with two adjacent intersections is determined by several parameters. They are the displacement of two adjacent intersections, vehicle running speed, traffic signal cycle time duration, green time duration, and traffic demands for both directions. The theory introduction is followed by the discussion for increase of number of intersections on the same route. Finally the effects of area wide or road network on the traffic signal coordination are also outlined.

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TC24

CC-North 130

Emerging topics on OM/Marketing Interface

Community Committee Choice Session

Session Chair: Rachel Rong Chen, University of California-Davis, Davis, CA

Session Chair: Xuying Zhao, Texas A&M University, College Station, TX

1 Vertical Competition with Common Attributes

Xiaojuan Puyang[1], Jane Gu[2], Juan Li[3], Rachel Rong Chen[4], [1]Sichuan Normal University, ChengDu, China; [2]University of Connecticut, Stors, CT, [3]Nanjing University, Nanjing, China; [4]University of California-Davis, Davis, CA, Contact: rachen@ucdavis.edu

Vertically differentiated products in a competitive market often share common attributes (e.g., location value, infrastructure, or technologies) provided by third-parties. In this study, we characterize how common attributes affect high- and low-quality firms in their offerings of individual attributes and pricing, and consequently affect market competition and social welfare. First, we disentangle three distinctive effects of common attributes on vertical competition, and identify a "bottom-up" influence through which common attributes affect the firms. Second, we contrast how common attributes affect vertical competition in different product markets. Finally, we examine a retail platform's commission policy when its infrastructure constitutes common attributes for vertically differentiated vendors.

2 How Does the Best Seller Recommendation Shape the Ecosystem of an Online Marketplace?

Yi Xu[1], Farzad Fathi[1], Bo Zhou[2], [1]University of Maryland, College Park, MD, [2]University of Maryland, College Park, College Park, MD, Contact: yxu1@umd.edu

This paper studies the impact of the best seller recommendation, a widely used popularity-based system, on consumers, sellers, and the online marketplace. We show that the best seller recommendation intensifies competition among sellers, resulting in a lower equilibrium price and potentially decreased profits for sellers and the marketplace. Our results highlight the importance of accounting for the strategic response of the sellers before an online marketplace implements the best seller recommendation system.

3 Behavior-Based Pricing Under Informed Privacy Consent

Yunhyoung Kim[1], Tony H. Cui[2], Yi Zhu[2], [1]Carlson School of Management, University of Minnesota, Twin Cities, Minneapolis, MN, [2]University of Minnesota, Minneapolis, MN, Contact: kim01073@umn.edu

The implementation of recent privacy protection regulations requires firms to obtain privacy consent from consumers before collecting their information. Informed privacy consent has significant implications for behavior-based pricing, with which firms practice third-degree price discrimination based on consumers' purchase history. Consumers' ex ante endogenous privacy decisions are affected by two components: cost of risk from privacy breaches and avoidance to unfavorable discriminative price in the following period. We find that consumers give privacy consent only if there is a monetary incentive for opting in, and that consumers' sophisticated privacy decisions lead to higher profits for firms even with the cost of compensation. It is found that this also holds when there is an additional utility from opting in (e.g. personalization, ease of ordering, etc.).

4 Opaque Product in a Decentralized Supply Chain

Xuying Zhao[1], Lifei Sheng[2], Ashutosh Prasad[3], [1]Texas A&M University, College Station, TX, [2]University of Houston Clear Lake, Houston, TX, [3]University of California-Riverside, Riverside, CA, Contact: xzhao@mays.tamu.edu

We study whether or not a retailer should offer an opaque product to consumers, considering the interaction between the manufacturer and the retailer in a decentralized supply chain. We show that a retailer is less likely to offer an opaque product in a decentralized supply chain than in a centralized supply chain. We find that the ratio of the product's profit potential to the consumers' strength of product preference is a critical factor in whether the retailer should offer an opaque product. The retailer should sell an opaque product if and only if the ratio is not too low or too high. Furthermore, we explore how the retailer can further improve the profit when selling an opaque product. We find that the retailer should preemptively communicate the product inclusion probability before wholesale prices are decided.

5 Buy Now, Pay Later: Independent Versus Integrated Consumer Installment Plans

Buqing Ma[1], Bo Zhou[2], Ying-Ju Chen[3], [1]University of Science and Technology of China, HeFei, China; [2]University of Maryland, College Park, College Park, MD, [3]The Hong Kong University of Science and Technology, Kowloon, Hong Kong

This paper investigates the impact of the installment model on the firms' profits and consumer surplus when the product and the installment plan are offered by one firm (i.e., integrated model) or two independent firms (i.e., disintegrated model). By building a two-dynamic period, we find several insights. First, the installment plan induces the seller to increase the price, which prevents consumers from buying the product. Put differently, the adoption of installment plans can lead to lower market coverage and leave out consumers who may, ironically, need the service more. Second, the disintegrated model leads to a higher interest rate but a lower retail price than the integrated model. Third, the installment plan can benefit consumers regardless of the installment plan structure, and the disintegrated model can lead to a higher consumer surplus than the integrated model.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC25

CC-North 131A

Analytics for Social Good

Community Committee Choice Session

Session Chair: Pengyi Shi, Purdue University, West Lafayette, IN

1 Estimating Prevalence of Opioid Use Disorder at County Level Using Public Available Data: A Bayesian Hierarchical Modeling Approach

Zixuan Feng[1], Qiushi Chen[1], Le Bao[2], Paul Griffin[1], [1]The Pennsylvania State University, University Park, PA, [2]The Pennsylvania State University, University Park, PA, Contact: zixuan.feng@psu.edu

Understanding the prevalence of opioid use disorder (OUD) is crucial for shaping health policies and resource allocation strategies to address the opioid crisis. While there exist OUD prevalence estimates at national and state levels, county-level estimates are lacking for most states. To fill this gap, we developed a Bayesian hierarchical model that only relied on publicly available sources such as county-level socioeconomic, healthcare, criminal justice, and opioid-related outcome metrics to estimate OUD prevalence. Using Massachusetts' data, our model showed good performance with an average absolute percentage error of 8.8% from the leave-one-out cross-validation. We further applied our method to generate OUD prevalence estimates in other states and demonstrated its generalizability.

2 Combining Machine Leaning And Queueing Theory For Data-driven Incarceration-diversion Program Management

Bingxuan Li[1], Antonio Castellanos[2], Pengyi Shi[1], Amy R. Ward[2], [1]Purdue University, West Lafayette, IN, [2]The University of Chicago Booth School of Business, Chicago, IL, Contact: li3393@purdue.edu

Incarceration-diversion programs are proven effective in reducing recidivism. Accurately predicting the number of program participants with varying characteristics is vital since this prediction guides program size determination and staffing needs. However, due to the diverse outcomes and lengths-of-stay in these programs, this task is complex. Collaborating with an Illinois government agency, we develop a framework that integrates machine learning and queueing model simulation, yielding accurate forecasts for program census and offering insights into program dynamics and decision impact in counterfactual scenarios. Additionally, we introduce a user-friendly beta version of a web app for visualization and demonstrate two use cases: altering program admission criteria and introducing similar initiatives in new counties.

3 Pooling Physical and Virtual Services with Application to Telehealth

Omer Berk Olmez, Alex Mills, Baruch College, City University of New York, New York, NY

Healthcare services can be offered both in-person and virtually by the same providers. We study a clinic's decision of whether to pool the resources of both channels or to have dedicated resources for each channel, where patients decide which channel to join (or whether to balk) while observing the expected waiting time for both channels and the distance to the in-person facility. Contrary to the consensus in the classical pooling literature, our findings indicate that patients' expected waiting times and net utilities do not necessarily improve with pooling. We highlight that pooling the two channels yields benefits for the providers only when the net profit generated from the virtual channel is substantially similar to that of the physical channel.

4 Machine Learning Based Health Status Prediction and Development of Food-Health Vulnerability Index for Us Counties

Surya Ramachandiran, Tasnia Biswas, Harshita Ayala, Soundar Kumara, Pennsylvania State University, State College, PA, Contact: harshitaa45@gmail.com

Food insecurity is a growing public health concern in the United States. In this study, we investigate the relationship between health risks and food insecurity-related factors across 2953 US counties. We propose a machine learning-based US county-level health risk prediction model using food vulnerability and socio-economic data. A robust food-health vulnerability index based on integrating six health outcomes, such as life expectancy and % of adults with various chronic diseases like diabetes and obesity, is developed. Further, we achieve both global and local interpretability in the trained model using SHAP. The results indicate that the three most highly responsible factors affecting the proposed robust health index are % food insecure, % enrolled in free lunch, and median household income. Thus the government should enable targeted interventions in these areas.

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TC26

CC-North 131B

Supply Chain Finance and Risk Management

Community Committee Choice Session

Session Chair: Qi Zhang, [1</sup]

Session Chair: gangshu Cai, [1</sup]

1 Gold or Cash? Analyzing the Operational and Financial Value of Tokens on the Tokenized Commodity Market

Yunzhe Qiu, Dongwei Xie, Peking University, Beijing, China

With the development of blockchain technology, tokenomics have gradually emerged by virtue of tokens' operational value as cryptocurrency and financial value as investments. We model the firm's dynamic inventory on a tokenized commodity market in the presence of a token trading platform. The firm counteracts the risk of stochastic demand for goods, and price fluctuations through the transformation of commodity and token stocks. We discuss the operational and financial value of tokens in a stationary model with i.i.d. prices and a dynamic model with a stochastic evolution token market, separately. We find that the tokens' operational and financial values depend on the characteristics of the token, commodity, and market, e.g., user base, demand pattern, and platform productivity.

2 Financing a Capital-constrained Supply Chain: Equity or Debt

Xiuli He[1], Suresh P. Sethi[2], Xun Xu[3], Nina Yan[4], [1]UNC Charlotte, Charlotte, NC, [2]The University of Texas at Dallas, Richardson, TX, [3]California State University, Dominguez Hills, Carson, CA, [4]Central University of Finance and Economics, Beijing, China

Many small or medium retailers often have limited access to capital to fund their operations. Here, we consider a supply chain consisting of a capital-constrained retailer (she) and a manufacturer (he) and examine the effect of equity and debt financing schemes on their operational decisions. Using a game theoretical approach, for the risk-neutral scenario, we take expected profit maximization as the participants' objective to examine the equilibria of their operational and financing decisions.

3 Carrot and Stick: When to Offer Trade Credits and Encroach on the Downstream Market

Qiaohai Hu[1], Wenhui Zhao[2], Hao Wang[3], [1]colorado school of mines, Golden, CO, [2]Shanghai Jiao Tong University, Shanghai, China; [3]Shanghai Jiaotong University, Shanghai, China. Contact: JOICE.HU@GMAIL.COM

This paper explores the relationship between an upstream supplier's decision to encroach on its downstream market and its decision to offer trade credits to its downstream retailer under market uncertainty. Different from the existing literature, we allow the parties to adopt revenue management strategy when their total supply exceeds the level of of a Cournot equilibrium.

4 Calibrated Recommendations with Sponsored Items

Shaojie Tang[1], Jing Yuan[2], Shuzhang Cai[3], Yao Wang[4], [1]University of Texas-Dallas, Richardson, TX, [2]University of North Texas, Denton, TX, [3]The University of Texas at Dallas, Richardson, TX, [4]Xi'an Jiaotong University, Xi'an, China

Calibrated Recommendation Systems (CRS) surpass traditional models by factoring in user preferences along with diversity, fairness, and novelty. These systems deliver personalized and inclusive suggestions. Businesses increasingly utilize sponsored slots in these systems to engage customers. However, existing CRS studies often overlook the influence of sponsored content. Our work addresses this by examining CRS within sponsored contexts, treating it as a combinatorial optimization challenge. The objective is to generate a recommendation list that optimizes utility and integrates sponsored items. We introduce constant-factor approximation algorithms for this purpose.

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TC27

CC-North 131C

Incentive and Information in Service Operations

Community Committee Choice Session

Session Chair: Shouqiang Wang, The University of Texas at Dallas, Richardson, TX

Session Chair: Qiong Chen, Southwestern University of Finance and Economics, Chengdu

1 Impact of Emerging Technology on Online Healthcare Platforms

Zhi Cao[1], Meng Li[2], Qiang Li[3], [1]University of Electronic Science and Technology of China, Sugar Land, TX, [2]University of Houston, Houston, TX, [3]Wilfrid Laurier University, WATERLOO, ON, Canada. Contact: zcao@std.uestc.edu.cn

Our study applies the difference-in-differences methodology with CEM to identify the causal relationship between the adaptation of real-time video-based communication technology and the volume of follow-up online consultations for physicians. The results show that the adoption of this technology significantly increases physicians' follow-up online consultations by approximately 36.8%.

2 Enhancing Resilience in Services During the Post-Covid Era: An Analysis of the Restaurant Industry

Hongli Ye[1], Aleda Roth[2], [1]Clemson University, clemson, SC, [2]Clemson University, Seneca, SC, Contact: hongliy@clemson.edu

Our research focuses on building resilience in the high customer contact services in the Post-COVID Era. We develop new measurements for assessing pandemic service resilience strategies applied to dine-in restaurants. Then we apply these unique measurements to test the service resilience strategies, as there are no valid and reliable measurements for service operation resilience strategies. Using experiments, we assess the underline service resilience strategy mechanisms that motivate customers' return to in-restaurant dining and underlying mechanisms. We show that certain customers value these restaurants, while others may be indifferent.

3 Strategic Role of Service Quality Monitoring

Shouqiang Wang[1], Aleda Roth[2], Qiong Chen[3], [1]The University of Texas at Dallas, Richardson, TX, [2]Clemson University, Seneca, SC, [3]Southwestern University of Finance and Economics, Chengdu, China. Contact: chenqiong@swufe.edu.cn

This paper examines a firm that delegates service delivery to a service provider, such as a contractor or an employee. We examine the strategic role played by the firm's commitment to a service quality monitoring program. The quality monitoring program audits users' opinions of the quality of service provided by a service provider. Our analytical results demonstrate the conditions under which commitment becomes more valuable, and a third-party quality monitoring program should be employed.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC28

CC-North 132A

Supply Chains, Operations, and ESG Outcomes

Community Committee Choice Session

Session Chair: Niyazi Taneri, Cambridge Judge Business School, Cambridge, United Kingdom

1 Can Tax-Subsidies for Charitable Donations Foster Accessibility to Fresh Goods?

Armagan Ozbilge[1], Saif Benjaafar[2], Elkafi Hassini[3], Mahmut Parlar[3], [1]Dalhousie University, Halifax, NS, Canada; [2]University of Minnesota, Minneapolis, MN, [3]McMaster University, Hamilton, ON, Canada. Contact: ozbilgea@dal.ca

Leveraging government tax incentives to prompt corporate charitable giving has gained considerable popularity over the last decade. This paper sheds light on the broader consequences of the U.S. government's enhanced tax deduction policy for charitable food donations. We incorporate the enhanced tax deduction into a food retailer's after-tax profit function in a two-period model. She makes a purchase prior to the selling season and (possibly) donates at the end of period 1. We develop the retailer's optimal policy and characterize conditions under which she donates some, all, or none of her unsold inventory. Our study reveals that contrary to conventional wisdom, charitable donations have a non-monotone relationship with both quality and tax-subsidy. Hence, when implemented inadequately, tax-subsidies may undermine societal objectives and squander public funds.

2 Improving Labor Outcomes: The Role of Operations and Supply Chains

Niyazi Taneri[1], Wei Kiat Lim[2], Hsiao-Hui Lee[3], Sameer Hasija[4], [1]Cambridge Judge Business School, Cambridge, United Kingdom; [2]National University of Singapore, Singapore, Singapore; [3]National Chengchi University, Taipei, Taiwan; [4]Insead, Singapore, Singapore. Contact: n.taneri@jbs.cam.ac.uk

We develop and test hypotheses that can help firms make operational decisions to prevent the incidence of labor controversies. Our analysis of a panel of 9,484 observations reveals two core results and a mitigation strategy: (i) higher sales volatility increases a firm's involvement in labor controversies, (ii) supplier controversies spill over to the focal firm, (iii) supplier spillovers are moderated by inventory buffer. Our results are robust to various model specifications and accounting for potential endogeneity with instrumental variables external to the focal firm's decision-making. Together, these results suggest that the operations and supply chain functions of the firm need to be at the heart of efforts to improve labor outcomes.

3 Plastic Recycling in Agriculture Industry

Yinping Mu[1], Wenli Xiao[2], Feifei Shan[3], Qiong Chen[4], [1]University of Electronic Science and Technology of China, Chengdu, China; [2]University of San Diego, San Diego, CA, [3]University of Science and Technology of China, Hefei, China; [4]Southwest University of Finance and Economics, China

In thisstudy, we compare three prevailing forms of agricultural film recycling:Penalty Scheme, Reward Scheme and Service Scheme. Our results suggest thesocial planner should set a sufficiently high penalty if the manufacturer isresponsible for collection and a moderate penalty if the farmer is responsiblefor collection.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC29

CC-North 132B

Incentives and Mechanism Design with Social Considerations

Community Committee Choice Session

Session Chair: Iva Rashkova, Washington University in St Louis, St Louis, MO

1 Trust-And-Evaluate: A Dynamic Non-Monetary Mechanism for Internal Capital Allocation

Shivam Gupta[1], Saurabh Bansal[2], Milind Dawande[3], Ganesh Janakiraman[4], [1]University of Nebraska Lincoln, Lincoln, NE, [2]Penn State University, University Park, PA, [3]The University of Texas at Dallas, Richardson, TX, [4]University of Texas-Dallas, Richardson, TX, Contact: sgupta7@unl.edu

To stay competitive, firms regularly invest in innovation by supporting internal capital projects (funded and executed in-house) that explore new products and operational improvements. Each year managers from different functional units submit proposals for such projects. Managers, due to their domain knowledge and expertise, are naturally better informed about the costs and benefits of their projects, and can use this information strategically to secure funding. An example of such behavior is the under-reporting of the cost estimate of a project and subsequently requesting additional funding during the execution phase. Such strategic behavior not only affects the firm's ability to fund the best projects but is also costly. We propose a dynamic non-monetary mechanism that is both provably near-optimal and guarantees truthful reporting from managers.

2 Optimal Investment of Farming Mechanization

Ying Zhang[1], Jayashankar M. Swaminathan[2], [1]Santa Clara University, Santa Clara, CA, [2]University of North Carolina Chapel Hill, Chapel Hill, NC

Adopting mechanization in farming is a fundamental and sustainable approach to increase agricultural productivity. In this paper, we study the seeds and farm mechanization procurement of a farmer for a single crop in a cropping season under land and budget constraint, where a farmer's budget is dependent on her land size. We explore the optimal procurement policy in the monopoly model and Cournot competition model. Our results show that the optimal total expenditure follows a tiered threshold-type policy. We further explore the impact of government subsidies on the mechanization level, farmers' welfare and social welfare.

3 Information Disclosure for Perishables: Profit and Food Waste Implications

Fan Zhou[1], Ekaterina Astashkina[2], Ravi Anupindi[3], [1]Ross School of Business, University of Michigan, Ann Arbor, MI, [2]Ross School of Business, University of Michigan, Ann Arbor, [3]University of Michigan, Ann Arbor, MI, Contact: fanzhou@umich.edu

The freshness of produce often varies and may be unobservable to consumers, particularly in online grocery retail settings. This study aims to investigate how the visibility of produce freshness impacts profitability and waste generation.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC30

CC-North 132C

Job Market Candidate Showcase

Community Committee Choice Session

Session Chair: Yuanyuan Ding, University of Minnesota, Minneapolis, MN

1 Essays on Social Sustainability in Operations Management

Soh Hyun Chu, The Ohio State University, Columbus, OH, Contact: chu.589@osu.edu

My dissertation is driven by an overarching problem: Socially Sustainable Operations are important, yet organizations have potentially conflicting priorities or operational motives. In the first essay, I explore the impact of different Social Sustainability issues on a firm's financial performance over three decades. I compare the severity of the impact of social misconducts whether they arose in focal firms or supply chains. In the second essay, I explore one dimension of Social Sustainability, worker safety. This essay explores whether safety and completion time in warehouse operations trade off differently under alternative performance evaluations or training conditions. In the third essay, I explore whether firms' Social and Environmental Sustainability efforts tradeoff as well as create potential synergies on their operational performance.

2 Managing Operational Design within Innovative Retail Contexts

Yuanyuan Ding, University of Minnesota, Minneapolis, MN

My research centers on behavioral operations within the context of retailing, with a focus on utilizing behavior insights to help retailers improve their operational design decisions. I examine two design decisions that have emerged in recent years: (i) introduction of open-box products to the assortment, and (ii) a new subscription-based online retailing service. For both contexts, I develop theories to inform the appropriate design decisions and then test them using empirical evidence from experiments. In the first context, I explore how to design the display of open-box products along with corresponding new products. In the second context, I focus on the design of two features (i.e., collection transparency and customer involvement) within a subscription-based service. The presentation today will mainly focus on the second project.

3 The Whiplash Effect: Congestion Dissipation and Mitigation in a Circulatory Transportation System

Ming Hu[1], Chaoyu Zhang[2], [1]University of Toronto, Minneapolis, MN, [2]University of Toronto, Toronto, ON, Canada. Contact: cyu.zhang@rotman.utoronto.ca

We build an analytical fluid model to investigate how disruptions at one port can affect the disrupted port and its counterpart in another country. Our analysis reveals two main effects of port disruption: the inbound backlog and the outbound backlog. We provide an analytical expression for the recovery time of two ports and track the evolution of backlogs of goods and ships. In addition, we identify a whiplash effect that occurs in the outbound backlog level at two ports, resembling the commonly known "bullwhip effect". Furthermore, we extend our analysis to a network of ports and show that the key findings still hold in the multi-port system. Finally, we apply machine learning techniques to predict the time vessels spend in the Shanghai port and show that our proposed model reduces prediction errors compared to the benchmark, indicating the application potential of our model.

4 Inventory Productivity and Stock Returns in Manufacturing Networks

Deepak Agrawal[1], Nikolay Osadchiy[2], [1]Emory University, Atlanta, GA, [2]Emory University, Atlanta, GA

We provide a novel, supply network-based perspective on inventory productivity. Using data from 2003 to 2019, we find that inventory productivity is lower for firms located upstream in the supply network, and higher for high degree and more central firms. Firms with high inventory productivity show high equity valuations and abnormal returns, with both valuations and abnormal returns amplified for upstream, low degree, and peripheral firms. Moreover, the difference in valuations and abnormal returns between best and worst performing firms is greater upstream, suggesting that financial markets offer outsized rewards for improving inventory productivity to upstream firms. We show that the information about firm's upstreamness and centrality in the supply network is a valuable predictor of its inventory productivity and financial performance.

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TC31

CC-North 221A

Freestyle OR Supreme

Community Committee Choice Session

Session Chair: Carrie Beam, UC Davis, Walnut Creek, CA

1 Freestyle OR Supreme

Carrie Beam, UC Davis, Walnut Creek, CA

Calling all students, early-career professionals and anybody else who wants to build a resume! Freestyle O.R. Supreme Expo is our fast-moving live game show, in which teams frame a real-life problem and present a solution in real time. This is a great opportunity to participate in the conference without having to write a paper or make a poster. An industry "client" will present a 10 - 15 minute overview of a real-world problem to solve. Your team will have a 30 minute break out session to craft your 3 - 5 minute O.R. presentation with recommendations for methodology for an implementable solution. The client will listen to each team and give feedback on their presentations, and will select a winner from the presentations. Fame and glory can be yours.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC32

CC-North 221B

Amazon Last Mile Warehouse Operations

Community Committee Choice Session

Session Chair: Chinmoy Mohapatra, Amazon, Bellevue, WA

1 Optimized Resource Task Planning for Warehouse Operations

Chinmoy Mohapatra[1], Rohit Malshe[1], Gah-Yi Ban[2], Mahdieh Allahviranloo[3], [1]Amazon, Bellevue, WA, [2]Imperial College Business School, London, United Kingdom; [3]The City College of New York, New York, NY, Contact: cmohapat@amazon.com

We develop a joint optimization and machine-learning based model to determine the optimal assignment and prioritization of pick activities in a warehouse to available associates. The objective is to minimize the overall completion time of all tasks while also satisfying several time-based operational constraints. We present novel formulations for the problem and show performance improvements with respect to heuristic approaches.

2 Optimizing Rack Types in Delivery Stations

Gah-Yi Ban[1], Kyoung Yoon Kim[2], Rohit Malshe[2], Sourabh Puri[2], Liron Yedidsion[3], [1]Imperial College Business School, London, United Kingdom; [2]Amazon, Bellevue, WA, [3]Amazon, Redmond, WA, Contact: kyounkim@amazon.com

In Amazon Logistics, delivery stations contain two types of racks to handle processing of non-oversized and oversized packages in a 50:50 ratio. We consider optimizing this ratio and introducing fungible racks to delivery stations. We propose stochastic optimization models to address these problems and show that they can be solved using data-driven mixed-integer linear programs. We carry out a real-data case study and find that (i) having a 50:50 ratio of standard racks is not at all optimal, (ii) introducing fungible racks by a small amount (just 2-4% of the total capacity) can allow the station to serve peak demand even with a low tolerance for spillover, and (iii) optimizing the rack volumes of OV, NOV, and fungible racks can increase the station's capacity by 13 to 19% during off-peak and 14 to 24% during peak, which translates to an annual saving potential of $0.7B-1B.

3 Volume Allocation Using the Layout of Warehouses

Sourabh Puri[1], Kyoung Yoon Kim[2], [1]Amazon, Bellevue, WA, [2]Amazon.com, Bothell, WA, Contact: purisour@amazon.com

We consider the problem of volume (packages and bags) allocation for Amazon Last Mile Warehouses, aka delivery stations. Currently, when the operation allocates the packages and bags to delivery station floor, the process relies on manually generated static configurations that are not agnostic of demand, cube, layout of the station, and on-road capacity fluctuations. This leads to inefficiencies in the pick and stage operations, congestion of aisles, and safety incidents. The paper addresses the inefficiency of the current planner and proposes a dynamic allocation scheme using dynamic programming and MILP that utilizes the station layouts and optimally allocates incoming packages to the floor. Finally, we share the results for walk time savings, aisle cube variation, and other metrics from the two planners, leading to over $60M combined annualized savings for Amazon.

4 Applications of 2D Renewal Theory to Last Mile Operations

Abhilasha Katariya[1], Natarajan Gautam[2], Rohit Malshe[3], [1]Amazon, Issaquah, WA, [2]Syracuse University, Syracuse, NY, [3]Amazon, Bellevue, WA

Given forecasted demand and capacities across different dimensions like time and space, last mile planning systems need to predict operational metrics like rates and throughputs. These are then input to downstream planning systems to plan and optimize use of available resources. To this end, we applied a combination of 2D renewal theory, machine learning and optimization to improve Amazon's planning processes. This has reduced costs and improved on-time delivery metrics.

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TC33

CC-North 221C

Bilevel Optimization

Community Committee Choice Session

Session Chair: Federico Battista, Bethlehem, PA

1 Data-Driven Bilevel Optimization of Integrated Planning and Scheduling Problems with Mixed-Integer Nonlinear Lower-Level Formulations

Hasan Nikkhah[1], Vasileios M. Charitopoulos[2], Styliani Avraamidou[3], Burcu Beykal[1], [1]University of Connecticut, Storrs, CT, [2]University College London, London, United Kingdom; [3]University of Wisconsin-Madison, Madison, WI

Planning and scheduling are critical components in supply chain management. The interconnected relationship between the two can be mathematically realized through bilevel programming, but this poses algorithmic challenges such as NP-hardness. This work proposes using data-driven optimization, specifically the DOMINO framework, to overcome these difficulties. The framework is tested on an MINLP scheduling model for a multiproduct continuous manufacturing process formulated as a traveling salesman problem, and the results show that the production targets are achieved for the entire planning period with scheduling levels solved to global optimality.

2 Parametric Inequalities in Mixed Integer Linear Optimization

Ted K. Ralphs, Lehigh University, Bethlehem, PA, Contact: ted@lehigh.edu

Parametric inequalities are valid inequalities that are parameterized such that they remain valid when (some of) the problem data are perturbed. The so-called Benders cuts that arise in Benders decomposition can be viewed as a kind of parametric inequality, but the notion arises in a number of other contexts and such inequalities are useful/necessary in a range of methodological applications, such as in warm-starting, the solution of bilevel/multilevel optimization problem, multiobjective optimization, etc. In this talk, we present a brief overview of the theoretical underpinnings and discuss a general approach to generating such inequalities.

3 Exploiting Dual Functions in Mixed Integer Bilevel Linear Programs

Federico Battista, Ted K. Ralphs, Lehigh University, Bethlehem, PA, Contact: feb223@lehigh.edu

Mixed integer bilevel linear problems (MIBLPs) involve the optimization of the strategy of a leader (upper level) and the subsequent reaction of a follower (lower level). One of the time-consuming steps in MIBLPs algorithms is the resolution of numerous (yet related) mixed integer linear problems (MILPs) as a subroutine to check the feasibility of a solution and/or to generate cuts, e.g. in a branch-and-cut framework. Instead of optimizing these MILPs each time from scratch, in this talk we discuss how building iteratively refined dual functions of such MILPs value functions can both improve the solution process at each subproblem and provide information to extract violated cuts. Preliminary results are presented using open-source solver MibS.

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TC34

CC-North 222A

Advances in Nonlinear Stochastic Optimization II

Community Committee Choice Session

Session Chair: Alberto Solomon Berahas, University of Michigan, Ann Arbor, MI

Session Chair: Raghu Bollapragada, The University of Texas at Austin, Austin, TX

1 Adaptive Sampling Mechanisms for Stochastic Constrained Optimization

Raghu Bollapragada, The University of Texas at Austin,

Austin, TX
In this talk, we discuss adaptive sampling mechanisms for solving stochastic constrained optimization problems.

2 On the Optimization Landscape of Low-Rank Matrix Recovery: When Do Global Solutions Correspond to Ground Truth?
Salar Fattahi, Jianhao Ma, University of Michigan, Ann Arbor, MI, Contact: fattahi@umich.edu
Low-rank matrix recovery is typically solved via a nonconvex method called Burer-Monteiro factorization (BM). If the rank of the ground truth is known, BM is free of sub-optimal local solutions, and its true solutions coincide with the global solutions--that is, the true solutions are identifiable. When the rank of the ground truth is unknown, it must be over-estimated, giving rise to an over-parameterized BM. In the noiseless regime, it is recently shown that over-estimation of the rank leads to progressively fewer sub-optimal local solutions while preserving the identifiability of the true solutions. In this work, we show that with noisy measurements, the global solutions of the over-parameterized BM no longer correspond to the true solutions, essentially transmuting over-parameterization from blessing to curse.

3 An Adaptive Sampling Augmented Lagrangian Method for Stochastic Optimization with Deterministic Constraints
Cem Karamanli[1], Raghu Bollapragada[1], Brendan Keith[2], Boyan Lazarov[3], Socratis Petrides[3], Jingyi Wang[3], [1]The University of Texas at Austin, Austin, TX, [2]Brown University, Providence, RI, [3]Lawrence Livermore National Laboratory, Livermore, CA, Contact: cem.karamanli@utexas.edu
We provide an efficient solution algorithm based on the augmented Lagrangian framework for optimization problems with a stochastic objective function and deterministic constraints. Our main contribution is combining the augmented Lagrangian framework with adaptive sampling. To improve efficiency, we consider inexact solutions for the augmented Lagrangian subproblems. We show sublinear convergence for convex objectives and linear convergence for strongly convex objectives with affine equality constraints. We also present the worst-case sample complexity of the resulting algorithm, under different assumptions. Finally, we test the performance of our adaptive sampling augmented Lagrangian framework in machine learning optimization and engineering design problems, including topology optimization of a heat sink with environmental uncertainty.

4 An Interior Point Algorithm for Solving Nonlinear Optimization Problems with Noise
Shima Dezfulian, Andreas Waechter, Northwestern University, Evanston, IL, Contact: shimadezfulian2023@u.northwestern.edu
We propose and analyze a modification of the interior point algorithm for solving bound-constrained nonlinear optimization problems in which the objective and gradient evaluations are affected by non-diminishing and bounded noise. These modifications include a relaxation of the Armijo line search, a novel stop test for the barrier problem, and a new barrier parameter update. Given a fixed barrier parameter, we establish global convergence to a neighborhood of stationary points. We further show the local convergence of the iterates to a neighborhood of stationary points. This neighborhood, defined in the space of decision variables, is narrower for decision variables whose optimal value is at the boundary of the feasible region. This result suggests that noise does not impact the identification of active constraints and is confirmed by our numerical experiments.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC35

CC-North 222B

Recent Developments on Bilevel and Semi-Infinite Programs

Community Committee Choice Session

Session Chair: Qihang Lin, University of Iowa, Iowa City, IA

1 Primal-Dual Hybrid Gradient Methods for Smooth Semi-Infinite Programming with Applications in Machine Learning with Fairness Constraints
Yao Yao[1], Qihang Lin[1], Tianbao Yang[2], [1]University of Iowa, Iowa City, IA, [2]Texas A&M University, College Station, TX, Contact: yao-yao-2@uiowa.edu
We consider a convex smooth semi-infinite problem where the constraint functions continuously depend on parameters from a convex compact domain. We propose a primal-dual method where, in each iteration, decision variables, Lagrangian multiplier and constraint parameters are updated by a gradient step using hybrid gradients. We analyze its iteration complexity for finding an �-optimal solution with and without strong convexity and when the gradient oracles are deterministic and stochastic. Compared

to existing approaches, our methods do not require sampling constraints, have a lower iteration complexity and less computational cost per-iteration. We also present the applications of our methods in fairness-aware machine learning with multiple outputs, including multi-class learning, multi-label learning and multi-task learning.

2 Efficient Bilevel Optimization and Application in Continual Learning

Kaiyi Ji, University at Buffalo, Buffalo, NY

Bilevel optimization (BO) has received increasing attention in modern machine learning (ML), and has become a theoretical foundation for designing efficient computational tools for various ML areas such as meta-learning, autoML, fair ML, continual learning, and etc. In the first part of this talk, I will briefly introduce several recent BO applications in hyperparameter optimization and rehearsal based continual learning. In the second part, I will propose a novel stochastic bilevel optimization algorithm named stocBiO, which features a sample-efficient hypergradient estimation via Hessian-vector computations and automatic differentiation. I will then present the convergence analysis for stocBiO and discuss its application in coreset selection for rehearsal based continual learning by proposing a new bilevel problem formulation.

3 A Fully First-Order Algorithm for Stochastic Bilevel Optimization

Jeongyeol Kwon, University of Wisconsin-Madison, Madison, WI, Contact: jeongyeol.kwon@wisc.edu

We consider Bilevel Programming (BP) when only the first-order stochastic gradient oracles are available. Existing optimization methods either tend to require possibly expensive calculations regarding Hessians of lower-level objectives, or lack rigorous finite-time guarantees. We first study the landscape of BP through the lens of penalty-methods. Then, we propose a Fully First-order Stochastic Approximation (F2SA) method, and study its non-asymptotic convergence properties. For unconstrained BPs with strongly-convex lower-level objectives, we show that F2SA converges to an ⍰-stationary solution of the original BP in poly(1/⍰) iterations with each iteration using O(1) samples. We also discuss how our results can be extended to more general settings when the lower-level problem consists of non-convex objectives and convex constraints.

4 Bome! Bilevel Optimization Made Easy: A Simple First-Order Approach

Bo Liu, University of Texas at Austin, Austin, TX, Contact: bliu@cs.utexas.edu

Bilevel optimization (BO) is useful for solving many important machine learning problems. Conventional BO methods need to differentiate through the low-level optimization process with implicit differentiation, which requires expensive calculations related to the Hessian matrix. There has been a recent quest for first-order methods for BO, but the methods proposed to date tend to be complicated and impractical for large-scale applications. In this work, we propose a simple first-order BO algorithm that depends only on first-order gradient information, requires no implicit differentiation, and is practical and efficient for large-scale non-convex functions in deep learning. We provide a non-asymptotic convergence analysis of the proposed method to stationary points for non-convex objectives and present empirical results that show its superior performance.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC36

CC-North 222C

Recent Advances in Mixed-integer Nonlinear Programming

Community Committee Choice Session

Session Chair: Shaoning Han, University of Southern California, Los Angeles, CA

1 Constrained Optimization with Indicator Variables

Soroosh Shafieezadeh Abadeh[1], Fatma Kilinc-Karzan[2], [1]Cornell University, Ithaca, NY, [2]Carnegie Mellon University, Pittsburgh, PA

Optimization problems involving minimization of a convex function over constraints modeling restrictions on the support of the decision variables emerge in various machine learning applications. These problems are often modeled with indicator variables for identifying the support of the continuous variables. In this paper we investigate compact extended formulations for such problems through perspective reformulation techniques. In contrast to the majority of previous work that relies on support function arguments and disjunctive programming techniques to provide convex hull results, we propose a constructive approach that exploits a hidden conic structure induced by perspective functions. We illustrate the efficacy of our results on sparse nonnegative logistic regression problems.

2 Shortest Paths in Graphs of Convex Sets

Tobia Marcucci, MIT, Cambridge, MA, Contact:

tobiam@mit.edu
Given a graph, the shortest-path problem requires finding a sequence of edges of minimum cost connecting a source vertex to a target vertex. In this talk we introduce a generalization of this classical problem in which the position of each vertex in the graph is a continuous decision variable, constrained to lie in a corresponding convex set, and the cost of an edge is a convex function of the positions of its endpoints. Problems of this form arise naturally in motion planning of autonomous vehicles, robot navigation, and even optimal control of hybrid dynamical systems. The price for such a wide applicability is the complexity of this problem, which is easily seen to be NP-hard. We discuss this novel problem along with different solution approaches, including a strong mixed-integer convex formulation based on perspective functions.

3 On Lagrangian Cuts For Stochastic Integer Programs

Haoyun Deng, Weijun Xie, Georgia Institute of Technology, Atlanta, GA
Stochastic integer programs (SIPs) are optimization problems that involve making decisions over stages under uncertainty realized by a set of scenarios. Recently, by dualizing the nonanticipativity constraints, Lagrangian cuts have been successfully applied to solve SIPs. To understand the strength of Lagrangian cuts, we first prove that the Lagrangian cuts are sufficient to describe the convex hull of the local recourse problems. Next, to compute the Lagrangian cuts, the existing method, however, is subgradient-based and often unstable and rather slow. We propose closed-form Lagrangian cuts and an efficient routine to strengthen them to achieve “partial Pareto optimal.” We numerically demonstrate the performances of the proposed approach.

4 Regression Problems with Outliers: Strong Conic Formulations

Andres Gomez, University of Southern California, Los Angeles, CA
We study regression problems with outliers. Such problems can be naturally modeled as mixed-integer quadratic optimization problems, where binary variables control which observations are flagged as outliers and discarded, and continuous variables correspond to the regression coefficients. The problems studied corresponds to the least trimmed squares in statistics, which has been studied in depth but is widely regarded as intractable, with few exact methods proposed. Indeed, the natural mixed-integer quadratic formulation relies on big-M constraints, and performs poorly in practice. We close this gap in the literature by proposing strong conic formulations, which avoid big-M constraints altogether.

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TC37

CC-North 223

Theory and Applications of Distributionally Robust Optimization

Community Committee Choice Session

Session Chair: Nan Jiang, Georgia Tech, Atlanta, GA
Session Chair: Weijun Xie, Georgia Institute of Technology, Atlanta, GA

1 A Decomposition Algorithm for Distributionally Robust Two-Stage Convex Quadratic Programs

Nazlican Arslan, David Morton, Northwestern University, Evanston, IL
Distributionally robust optimization is a framework to model stochastic optimization problems in which the distribution of the random variables is uncertain. The uncertain distribution is assumed to come from an ambiguity set that contains plausible distributions. The goal is to find decisions that can hedge against the worst distribution in the ambiguity set. This study focuses on a two-stage stochastic program with convex quadratic recourse under distributional ambiguity. We assume uncertainty only in the right-hand side vector. We consider data-driven distributional ambiguity sets based on the Wasserstein distance and an optimal quadratic transport distance. For the latter, we derive decomposition algorithms, and present computational results for a capacity expansion problem.

2 Robust Optimization with Moment-dispersion Ambiguity

Li Chen[1], Melvyn Sim[1], Chenyi Fu[2], Fan SI[3], Peng Xiong[4], [1]National University of Singapore, Singapore, Singapore; [2]Natinonal University of Singapore, tianjin, China; [3]National university of Singapore, Singapore, Singapore; [4]National University of Singapore Business School, Fairfax, Contact: chen_l@u.nus.edu
We introduce the moment-dispersion ambiguity set enabling independent characterization of a random variable’s central location, dispersion, and support. We propose the dispersion characteristic set as the input format for representing dispersion ambiguity in algebraic modeling tools. We also introduce the independence propensity hyper-parameter

to foster joint ambiguity set creation for multiple random variables, enhancing our model's real-world applicability and facilitating varying independence characterization without needing a correlation matrix. We develop safe tractable approximations for assessing risks linked with affine and convex piecewise affine cost functions over moment-dispersion ambiguity sets, accommodating varying risk tolerances. We show two numerical case studies involving appointment scheduling and portfolio optimization.

3 Data-Driven Stochastic Dual Dynamic Programming: Performance Guarantees and Regularization Schemes

Hyuk Park[1], Zhuangzhuang Jia[2], Grani Adiwena Hanasusanto[3], [1]University of Illinois Urbana-Champaign, Urbana, IL, [2]University of Illinois Urbana-Champaign, Champaign, IL, [3]University of Illinois Urbana-Champaign, Austin, TX, Contact: hyukp2@illinois.edu

We present a data-driven approach for multistage stochastic linear programming with Markovian random parameters, using an extended stochastic dual dynamic programming (SDDP) algorithm. Our method uses historical trajectories and evaluates cost-to-go functions empirically using kernel regression. This eliminates the need for scenario trees which can be computationally expensive. However, if the training data is sparse, the SDDP algorithm may suffer from poor out-of-sample performance. To address this, we use distributionally robust optimization, which replaces empirical expectation with worst-case expectation over an ambiguity set. We derive theoretical out-of-sample performance guarantees and demonstrate polynomial sample complexity on the number of time stages. Our numerical experiments show the superiority of our approach over existing schemes.

4 Value of Stochastic Solution with Right-Hand Side Uncertainty

Haoming Shen[1], Ruiwei Jiang[2], [1]University of Arkansas, Fayetteville, AR, [2]University of Michigan, Ann Arbor, MI

We revisit the value of stochastic solution (VSS) in the context of distributional ambiguity. When the uncertainty arises from the right-hand side of a two-stage stochastic program, we consider upper and lower bounds of VSS using distributionally robust and optimistic optimization. We discuss the computation of these bounds and demonstrate them through numerical examples.

5 Hedging Against Black Swans in Renewable Energy Markets via Distributionally Robust Optimization

Liviu Aolaritei, Boubacar Bangoura, Nicolas Lanzetti, Saverio Bolognani, Florian Dörfler, ETH Zurich, Zurich, Switzerland. Contact: aliviu@ethz.ch

A black swan is an event that (i) is an extreme outlier, (ii) has a catastrophic effect, and (iii) is impossibly difficult to predict. While such events are unavoidable in financial and energy markets, it remains widely unclear how to make robust decisions in their presence. In this work we argue that in many cases black swans can be efficiently captured by Optimal Transport ambiguity sets with properly designed transportation costs. Consequently, the decision-making amounts to an Optimal Transport-Based Distributionally Robust Optimization, which we show to have a finite dimensional convex reformulation. We validate this reasoning in renewable energy markets, on real data from a wind farm in Finland.

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TC38

CC-North 224A

Structured and Tame Optimization

Community Committee Choice Session

Session Chair: Lexiao Lai, Columbia University, New York, NY

1 The Complexity of First-Order Optimization Methods from a Metric Perspective

Tonghua Tian, Cornell University, Ithaca, NY

A central tool for understanding first-order optimization algorithms is the Kurdyka-Lojasiewicz inequality. Standard approaches to such methods rely crucially on this inequality to leverage sufficient decrease conditions involving gradients or subgradients. However, the KL property fundamentally concerns not subgradients but rather "slope", a purely metric notion. By highlighting this view, and avoiding any use of subgradients, we present a simple and concise complexity analysis for first-order optimization algorithms on metric spaces. This subgradient-free perspective also frames a short and focused proof of the KL property for nonsmooth semi-algebraic functions.

2 Survey Descent and It's Initialization

X.Y. Han, Cornell University, Ithaca, NY

The recent work of Han and Lewis (2023) proposed a Survey Descent method for blackbox, nonsmooth optimization --- proving its local, linear convergence when the unseen objective is max-of-smooth given the right initialization. In this talk, I will review the Survey Descent method and discuss a potential heuristic for its initialization.

3 A Unified Complexity Metric for Nonconvex Matrix Completion and Matrix Sensing in the Rank-One Case

Haixiang Zhang[1], Baturalp Yalcin[2], Javad Lavaei[2], Somayeh Sojoudi[3], [1]UC Berkeley, Berkeley, CA, [2]University of California, Berkeley, Berkeley, CA, [3]University of California, Berkeley, El Cerrito, CA, Contact: haixiang_zhang@berkeley.edu

We develop a new complexity metric for an important class of low-rank matrix optimization problems, where the metric aims to quantify the complexity of th nonconvex optimization landscape and the success of local search methods. The existing literature has focused on two complexity measures, namely the RIP constant and the sampling rate in terms of the incoherence. The proposed complexity metric has the potential to unify these two notions and applies to a much larger class of problems. We illustrate the usefulness of the new complexity metric from three aspects, and we establish theoretical results to provid conditions on the existence of spurious solutions in terms of the proposed complexity metric.

4 Global Stability of First-Order Methods for Coercive Tame Functions

Cedric Josz, Lexiao Lai, Columbia University, New York, NY, Contact: lexiao.lai@columbia.edu

We consider first-order methods with constant step size for minimizing locally Lipschitz coercive functions that are tame in an o-minimal structure on the real field. We prove that if the method is approximated by subgradient trajectories, then the iterates eventually remain in a neighborhood of a connected component of the set of critical points. Under suitable method-dependent regularity assumptions, this result applies to the subgradient method with momentum, the stochastic subgradient method with random reshuffling and momentum, and the random-permutations cyclic coordinate descent method.

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TC39

CC-North 224B

Topics in Facility Logistics

Community Committee Choice Session

Session Chair: Jennifer A. Pazour, Rensselaer Polytechnic Institute, Troy, NY

1 Warehouse Order-Picking Operations with Human-Drone Coordination

Juan Pablo Morande, Daniel F. Silva, Alice E. Smith, Auburn University, Auburn, AL, Contact: jpm0112@auburn.edu

The focus of this exploratory work is the implementation of drones for order-picking inside warehouses. Specifically, we explore how drones can be used to reduce the time required to collect a set of orders and return them to a specific point in the warehouse. We consider a human worker and a set of drones, either of which can pick orders, working in coordination, with drones dropping items at either their base or handing them off to the human picker. We model the system as a mixed-integer linear program, run computational experiments, and evaluate the results to assess the effectiveness of this application.

2 Zone-Based Approach to Dynamic Facility Layout with Embedded Input/Output Points

Sadan Kulturel-Konak, Penn State Berks, Reading, PA, Contact: sadan@psu.edu

Solving the unequal area Dynamic Facility Layout Problem (DFLP) using a zone-based structure will be presented. The unequal area DFLP is modeled and solved using a zone-based structure, referred to as ZDFLP, where the dimensions of the departments and material handling system input/output (I/O) points are decision variables. A two-phase matheuristic, which directly operates on Problem ZDFLP without requiring an encoding scheme of the problem, is proposed to solve the ZDFLP with promising results.

3 Expected Value and Variance of Picking Travel Distance Under Three Routing Policies

Carlos Morel Figueroa, Hector J. Carlo, Noel Artiles-León, University of Puerto Rico Mayagüez Campus, Mayagüez, Puerto Rico

Order picking from storage bins is one of the functional areas of an E-Commerce Distribution Center. In this area, workers retrieve their assigned order lines (products) using a picking cart according to a routing policy. This work derives the expected travel distance and variance to retrieve a random order with a fixed number of lines under three routing policies (Return, S-Shaped, and Mid-Point). A Monte Carlo simulation is used to validate the resulting formulas. Due to the multivariate nature of the problem, the resulting equations are not closed-form.

4 Modelling and Solving Grid-Based Dynamic Facility Layout Problems with Unequally Shaped Facilities and Obstacles Using a Genetic Algorithm

Felix Rauscher, Karlsruhe Institute of Technology, Karlsruhe, Germany. Contact: felix.rauscher@kit.edu

Achieving high levels of flexibility and adaptability in modern production systems requires optimizing facility layout across various time periods, considering transportation and rearrangement costs. One approach is the application of the dynamic facility layout problem (DFLP). This study explores a method to solve the grid-based DFLP, which involves objects (e.g., facilities) and obstacles with arbitrary (grid-based) shapes connected by feasible transportation paths. The implementation of a genetic algorithm is demonstrated as a viable solution approach. Additionally, the investigation explores significant influencing factors and identifies best strategies for attaining improved solution outcomes.

5 Multi-Load Handling Devices in Multi-Deep Storage Systems: An Investigation of Their Impact on Throughput

Timo Lehmann[1], Martin Bamesberger[2], Johanna Pothmann[2], David Schwär[2], Jakob Hußmann[2], [1]Karlsruhe Insitute of Technology, Karlsruhe, Germany; [2]Karlsruhe Insitute of Technology, Karlsruhe, Germany. Contact: timo.lehmann@kit.edu

Multi-deep storage systems as well as storage systems with multi-load handling devices are widespread in the industry. Multi-Load handling devices can transport several unit loads at the same time and allow several storages and retrievals of these unit loads in the same command cycle. Thus, the throughput of storage systems can be improved compared to single load handling devices. We investigate different operating strategies for such multi-deep systems with multi-load handling devices and compare the different strategies with each other and with strategies for single load handling devices. We present analytic models for each strategy, validate them with discrete event simulation and evaluate the impact of multi-load handling devices.

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TC40

CC-North 225A

Learning in Transportation Network Modeling: Session II

Community Committee Choice Session

Session Chair: Zhichen Liu, University of Michigan, ANN ARBOR, MI

Session Chair: Minghui Wu, University of Michigan, Ann Arbor, MI

1 Dynamic Traffic Assignment with Physics-Informed Deep Learning

Shakiba Naderian, Ohay Angah, Yiran Zhang, Xuegang Ban, University of Washington, Seattle, WA, Contact: naderian@uw.edu

Dynamic traffic assignment (DTA) is a challenging problem in transportation science, having distinct mathematical components that often require significant computational time. Recent DTA advances are featured by applying learning methods, like neural networks (NN), to ease this computational burden. Our study uses a physics-informed deep learning (PIDL) framework to approximate traffic dynamics in DTA. Using Ma et al.'s DTA model as the physical component, our PIDL framework incorporates two neural networks. The first one calibrates DTA parameters based on real-world scenarios, while the second one estimates DTA variables that are difficult to be solved mathematically. Our PIDL approach bridges the gap between mathematical complexity and practical application in DTA, giving insights for improving the use of DTA models in transportation planning and management.

2 Leveraging Connected and Automated Vehicles for Participatory Traffic Control

Minghui Wu[1], Ben Wang[2], Yafeng Yin[1], Jerome P. Lynch[3], [1]University of Michigan, Ann Arbor, MI, [2]Univerisity of Michigan, Industrial and Operations Engineering Department, Ann Arbor, MI, [3]Duke University, Durham, NC, Contact: minghuiw@umich.edu

In the future, traditional physical controllers like traffic signals may be complemented by connected and autonomous vehicles (CAVs) as mobile actuators. This research aims to establish the theoretical foundation for this novel participatory traffic control scheme. In this approach, CAVs exert indirect influence over the day-to-day traffic dynamics of other vehicles, aiming to redistribute traffic demand across various time periods and transportation facilities. To address this challenge, we model the problem within the major-minor mean field control (M3FC) framework and leverage reinforcement learning algorithms to compute the optimal control policy. Our model offers broad applicability, accommodating various commute choices such as departure time and route choices, and is adaptable to different levels of CAV penetration rate.

3 Optimal Information Perturbation for Traffic Congestion Mitigation: Gaussian Process Regression and Optimization

Lili Du, Stephen Spana, University of Florida, Gainesville, FL

Information perturbation is an information provision strategy that strategically alters the traffic information sent to drivers, aiming to mitigate network congestion caused by selfish routing decisions. Previous works have integrated information perturbation into coordinated routing mechanisms and proved the system performance improvement but did not give direct guidance on optimal perturbation levels, considering the competing effects of system performance improvement and user optimality loss. This work aims to uncover this optimal perturbation under general network conditions. The relationships used in the optimization models are obtained through Gaussian process regression, which is trained using the output of computer experiments. We demonstrate the merit of our methodology through a sensitivity analysis using the Sioux Falls network as a test case.

4 Stabilization of Nash Equilibrium for Mixed Traffic

Richard Lee[1], Jeffrey Scruggs[1], Yafeng Yin[2], [1]University of Michigan, Ann Arbor, MI, [2]University of Michigan, Ann Arbor, MI, Contact: leerich@umich.edu

The transition from human driven vehicles (HDVs) to connected-autonomous vehicles (CAVs) raises the question of how mixed traffic interactions will affect overall network performance. This research frames this problem in the context of a population game, where each origin-destination pair constitutes a population. We assume that the evolutionary dynamics are governed by the Impartial Pairwise Protocol with the travel time as the payoff. Due to distinct headways between HDVs and CAVs, the link travel time is dependent on the population proportion of each link. System-theoretic passivity methods are then used to propose a controller that guarantees global asymptotic stability of the system to Nash equilibrium.

5 On the Relocation Game of Ride-Hailing Platforms with Non-Atomic Drivers

Yi-Neng Wang[1], Xi Lin[2], Fang He[1], Zhengtian Xu[3], Zuo-Jun Max Shen[4], [1]Tsinghua University, Beijing, China; [2]Tsinghua University, beijing, China; [3]The George Washington University, Washington, [4]University of California Berkeley, Berkeley, CA, Contact: yn-wang19@mails.tsinghua.edu.cn

Vacant drivers spontaneously relocate to mitigate the supply-demand imbalance embedded in ride-hailing services. We aim at addressing two fundamental questions. (i) To what extent can drivers' spontaneous relocation resolve the supply-demand imbalance? (ii) How does a ride-hailing platform subsidize drivers to cope with the platform-optimum goals? We propose a leader-follower game theoretical framework, where the platform as the leader designs relocation subsidies and idle drivers as followers form a multistage driver equilibrium. After proving the existence of the equilibrium, we depict the non-empty subsidy strategy for the platform. We derive the analytical conditions so that the platform does not need to subsidize drivers to achieve platform goals. For other cases, we prove that the gaps compared with platform goals are bounded by constant discounts.

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CC-North 225B

Network Design : New Techniques and Approaches

Community Committee Choice Session

Session Chair: Pushpendra Singh, Dartmouth College, Hanover, NH

Session Chair: Vikrant Vaze, Dartmouth College, Hanover, NH

1 A Reinforcement Learning (Rl) Approach to Mixed Integer Non Convex Network Design Problems

Pushpendra Singh, Vikrant Vaze, Dartmouth College, Hanover, NH, Contact: pushpendra.singh.th@dartmouth.edu

Numerous transportation applications such as shared micromobility systems, & bus transit systems, all involve discrete choice network design. Network design captures various salient features of planning such as strategic, tactical, & operational decision making that arise in transportation systems. We define a new class of mixed integer non-convex programs (MINCP) problems, which are practically important across many fields and their mathematical similarity motivates this joint study. We provide compact & general formulation for this class of problems & design an algorithm based on RL to solve this problem. We use a model based on attention layers & implement REINFORCE to train our model with baseline greedy rollout. Our algorithm provides better results & runtime, than the existing state of art methods, such as adaptive discretization, to solve these problems.

2 Community/Committee's Choice Submission

Lilly Yang, Vikrant Vaze, Laurens G. Debo, Dartmouth College, Hanover, NH, Contact: lilly.yang.th@dartmouth.edu

Food waste in landfills is an avoidable source of methane emissions responsible for global warming. While composting offers a greener alternative increasingly mandated by governments, cost & ability to compost in one's backyard varies unevenly & inequitably across households. Customer dropoffs & curbside pickups enable a centralized composting alternative with lower processing cost due to economies of scale. But it incurs additional transportation cost & raises the question how to minimize total systemwide costs. Mathematically, this amounts to multivehicle pickup routing with a distributed disposal option. We use continuum approximation for a stylized circular city to underscore peculiar discontinuous tradeoff curves unique to this problem. Our real-world computational case study results in the most populous county in Vermont quantify the total cost savings.

3 Service Region Design and Fleet Sizing for First and Last Mile On-Demand Services

Yineng Sun[1], Vikrant Vaze[2], [1]Dartmouth College, West Lebanon, NH, [2]Dartmouth College, Hanover, NH, Contact: phoebe.sun.th@dartmouth.edu

Over a million US households in primarily rural counties lack access to private cars and must rely on public transit. Yet, 87% of the 200 least productive bus networks are in rural counties. Effective first-last-mile connections via on-demand ridesharing can enhance access, but design of such a system must account for the sparsely distributed demand hotspots and geographically dispersed origins and destinations. To address these distinctive challenges, we propose a two-stage model with service region design and fleet sizing in the first stage and on-demand dynamic pickup and drop-off estimation in the second. We develop a spatial decomposition approach informed by an exact second-stage routing formulation and a vehicle dispatch simulation. On real-world case studies, our service region design approach shows strong practical insights and outperforms benchmarks.

4 A Hybrid Genetic Algorithm for the Minmax Multiple Traveling Salesman Problem with a Dynamic Programming-Based Solution Refinement

Sasan Mahmoudinazlou, Changhyun Kwon, University of South Florida, Tampa, FL, Contact: sasanm@usf.edu

This paper proposes a hybrid genetic algorithm for solving the Multiple Traveling Salesman Problem (mTSP), aiming to minimize the longest tour using a divide-and-conquer approach. The genetic algorithm utilizes a TSP sequence as the representation of each individual, and a dynamic programming algorithm, Split, is employed in order to evaluate the individual and find the optimal mTSP solution for the given sequence. A crossover operator has been designed that combines similar tours from two parents and offers great diversity for the population. The offspring are also improved by a self-adaptive random local search and a thorough neighborhood search. Our algorithms outperform all existing algorithms on average when tested against multiple benchmark sets found in the literature. Additionally, we improve the best solutions for several instances on each benchmark set.

5 Urban Design of an Automated Parcel Locker Network Using Simulation-Optimization Hybrid Models in Pamplona, Spain

Javier Faulin[1], Adrian Serrano[1], Luis Cadarso[2], [1]Public University of Navarre, Pamplona, Spain; [2]Rey Juan Carlos University, Fuenlabrada, Spain. Contact: javier.faulin@unavarra.es

Over the past few years, final delivery of goods in urban regions has encountered various issues including restricted delivery windows, a rise in demand for quick delivery services, and customers who fail to show up to receive their packages. To tackle these difficulties, the implementation of automated parcel locker (APL) systems has surfaced as a hopeful solution. Our study delves into the utilization trends of APLs in Pamplona (Spain) and suggests a simulation-optimization hybrid model to create an efficient APL network design in the same city. Agent-based modeling is utilized to project the future demand for APLs, factoring in socio-economic factors such as population size and e-commerce growth rates. Further, a dynamic optimization model is employed to determine the ideal APL locations, while minimizing operational and service expenses.

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TC42

CC-North 226A

Integrated approaches in urban rail systems

Community Committee Choice Session

Session Chair: Jiateng Yin, 1</sup

1 Lagrangian Relaxation Based Speed Trajectory Optimization for Multiple Trains Under Virtual Coupling with Operational State Transition

Songwei Zhu, Beijing Jiaotong University, Beijing, China

The virtual coupling train operation is a promising way to increase the transport capacity of high speed railway systems. When the virtual coupling signaling is adopted, trains can be coupled and decoupled in the running process, making the train operation under virtual coupling different from that under the fixed block or moving block signaling system. Thus, the traditional speed trajectory optimization method for ordinary operation is unsuited for the train operation under virtual coupling. In this paper, a mixed integer nonlinear programming model is proposed to formulate the operation of trains under virtual coupling, where the states of virtual coupling, i.e., the moving block running state, the coupling state, the coupled running state and the decoupling state, are indicated explicitly by binary variables. By adopting a piecewise-linear method, the nonlinear model is transformed into a mixed integer linear programming model, which can then be solved by commercial solvers. To enhance the computational efficiency, a Lagrangian relaxation method is proposed to relax the constraints of safety distance. Based on the data of Beijing-Shanghai high-speed railway, numerical experiments are conducted to demonstrate the effectiveness of the proposed methodology in coupling and decoupling scenarios. The results indicate that the proposed model can be used to optimize the speed trajectory for multiple trains under virtual coupling, and the objective function value of Lagrangian relaxation method is reduced by 19.12% compared with solving by CPLEX directly in the coupling scenario of two trains. Moreover, the Lagrangian relaxation method obtains a solution better than that of the direct method after the first iteration, proving higher computational efficiency of the Lagrangian method.

2 Integrated Modeling for Optimal Travel Mode Choice and Train Schedule Design

Yiyao Zhang, Beijing Jiaotong University, beiJing, China. Contact: 21120274@bjtu.edu.cn

This paper introduces an innovative integrated modeling framework that addresses the simultaneous optimization of travel mode choice and train schedule design. To capture this dynamic behavior, we propose a multimodal route selection and assignment model that incorporates the choice between bus and subway modes. Concurrently, we integrate a rail transit train schedule optimization model to enhance service quality, utilizing an iterative learning framework that accounts for dynamic interactions between supply and demand. By considering the multimodal aspect, it captures the realistic decision-making process of travelers who choose between different modes based on their preferences and travel conditions. Additionally, the inclusion of the train schedule optimization model further improves service quality.

3 Rail Grinder Routing and Scheduling Problem

Zabih Ghelichi, Paul Kuhn, BNSF Railway, Fort Worth, TX

Freight railroad track components, such as curves and tangents, are subject to a range of load types that cause the development of different wear patterns. Railroads employ grinding method to restore the track profile and remove cracks and other irregularities from these worn track segments. Grinding frequency of a track segment is determined by the gross-ton-miles that segment accumulates, and it varies from component to component. Given the track component-wise thresholds, grinding could be an intermittent and costly while necessary operation. In this regard, this project introduces an optimization model to address the problem of routing and scheduling grinder machines in railroad operations. The main goal is to minimize the overall costs of grinding operations while maintaining the network health at a specific level.

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TC43

CC-North 226B

AAS Distinguished Speaker

Community Committee Choice Session

Session Chair: Nuno Ribeiro, 1</sup

Tuesday, October 17, 12:45 PM - 2:00 PM

TC44

CC-North 226C

AI Applications and the Digital Economy

Community Committee Choice Session

Session Chair: Xinxue Qu, University of Notre Dame, Granger, IN

1 An Economic Analysis of Apple’S Att Policy: Advertising Revenue and App Price

Zhen Yan, Jianqing Chen, Srinivasan Raghunathan, University of Texas at Dallas, Richardson, TX, Contact: zhen.yan@utdallas.edu

Apple’s App Tracking Transparency (ATT) policy mandates developers to obtain tracking permission from users. Given the trend of users opting out, it is predicted that advertising revenues may experience a downturn. This paper investigates the impact of the ATT policy on app pricing strategies. Our model reveals that when advertising revenue per user is comparatively low, developers are likely to reduce app prices, which encourages more users to purchase the app and decreases the developer’s reliance on advertising revenue.

2 Security Patch Management Based on Multi-Agent Reinforcement Learning

Qian Jia[1], Syam Menon[2], Zhengrui Jiang[3], [1]Nanjing University, Nanjing, China; [2]University of Texas at Dallas, Richardson, TX, [3]Nanjing University, Nanjing, China. Contact: qianjia@smail.nju.edu.cn

Security patch management is a critical process in ensuring the security of information systems, as it protects them from attacks that exploit vulnerabilities. However, it is a complex and challenging task that involves multiple stages, such as patch development, testing, release, and deployment, and requires decisions from both software vendors and enterprise system users. This study proposes a joint optimization framework for security patch management based on multi-agent reinforcement learning. Unlike previous research, which focused solely on either software vendors or enterprise system users, our framework provides an integrated solution that optimizes decision-making for both parties. Our study highlights the potential of multi-agent reinforcement learning for optimizing security patch management process in information systems.

3 Marketplace Or Logistics Provider: Extended Mfs Programs In Online Retailing

Geng Sun, University of Texas Rio Grande Valley, Edinburg, TX

We study the emerging phenomenon that online platforms expand their membership-based free shipping programs to merchants running their own e-commerce websites instead of listing on the marketplaces. We find that the external MFS revenue may compensate for the internal commission loss, making the platforms better off overall.

4 Lending in the Shadows: Shadow Bank Financial Fragility and Mortgage Credit

Yu Shan, Syracuse University, Syracuse, NY, Contact: yshan03@syr.edu

This paper examines the impact and dynamics of the financial fragility of shadow bank mortgage lenders. The overall financial fragility of the shadow bank sector has been consistently increasing in recent years, reaching its highest value of the past decade in 2021. Financially fragile shadow banks take advantage of favorable regulatory spillover shocks to build their market share in the riskier segment of the market and lower their underwriting standards more than other shadow banks. Meanwhile, fragile shadow banks' credit supply is less elastic in response to demand shocks. Our results underline the importance of more regulatory attention to the fragility and destabilizing effects of shadow bank lenders.

5 Inventory Control Involving Opaque Selling

Yuan Qu, Rutgers Business School, Newwark, NJ, Contact: ryanqu94@gmail.com

We proposed a stylized model to help a firm practice opaque selling optimally. Rather than set up a given replenishment policy in the background, we attempt to offer the best real-time decisions for both replenishment and rationing. As expected, themes like contraction mapping, submodularity, diagonal dominance, concavity, and mild monotonicity would all loom large in this study. Fitting the rationing aspect is a potentially new property of balance-inducing monotonicity. Key to the current joint rationing-replenishment control is the simultaneous preservation of all kinds of value-function properties, which has been verified. An immediate consequence is that rationing should still follow the balance-inducing principle even when the replenishment decision is jointly made.

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TC45

CC-North 227A

Data, Learning, and Decision-Making

Community Committee Choice Session

Session Chair: Mohsen Bayati, Stanford University, Stanford, CA

1 Epidemic Prediction and Control, Learning from Network Data

Yeganeh Alimohammadi[1], Christian Borgs[2], Amin Saberi[1], [1]Stanford University, Stanford, CA, [2]UC Berkeley, Berkeley, CA, Contact: yeganeh@stanford.edu

People's interaction networks play a critical role in the dynamics of epidemics. However, acquiring comprehensive data regarding these interactions can be expensive and often impossible, limiting our ability to predict outbreak likelihood and size effectively. What information about people's social networks do we need to predict and prevent future outbreaks? In this talk, I will show how leveraging local information from a few samples of the population can estimate the time evolution of epidemics. I will give theoretical guarantees on the estimator's accuracy under general assumptions.

2 High-Dimensional Learning for Multi-Sourced Data

Wanning Chen[1], Chenglong Ye[2], [1]University of Washington, Bellevue, WA, [2]University of Kentucky, Lexington, KY

We propose a matrix transfer learning algorithm that facilitates the learning of a main dataset with the help from multiple auxiliary datasets, when the data can be cast as partial noisy observations of a main matrix and multiple auxiliary matrices that are low-rank. We provide theoretical guarantees on this algorithm and show superior empirical performance comparing with benchmark algorithms.

3 A Model for Experimentation Under Interference

Mohamad Sadegh Shirani Faradonbeh[1], Mohsen Bayati[2], [1]Stanford Graduate School of Business, Stanford, CA, [2]Stanford University, Stanford, CA, Contact: sshirani@stanford.edu

The estimation of causal effects in the presence of network interference is a fundamental challenge in scientific disciplines. Classical approaches are susceptible to bias due to the intricate interaction among individuals. This work introduces a new model to capture complex network interference effects and presents a novel toolbox that facilitates the analysis of network data. This research contributes to advancing our understanding of causal inference in networked settings and provides valuable tools for investigating the impacts of interventions in real-world scenarios.

4 Geometry-Aware Algorithms for Linear Bandits: Balancing Performance and Theoretical Guarantees

Yuwei Luo, Mohsen Bayati, Stanford University, Stanford, CA

This paper addresses the discrepancy between the promising empirical performance of algorithms such as Thompson sampling and Greedy, relative to their pessimistic theoretical regret bounds. We propose a new data-driven technique that tracks the uncertainty ellipsoid's geometry to establish an instance-dependent frequentist regret bound for a broad class of algorithms. This enables us to identify and ``course-correct" instances where the base algorithms perform poorly. The corrected algorithms achieve the minimax optimal regret while retaining the desirable properties of the base algorithms.

5 On Aligning Prediction Models with Clinical Experiential Learning: A Prostate Cancer Case Study

Jacqueline J. Vallon[1], William Overman[1], Wanqiao Xu[1], Neil Panjwani[2], Xi Ling[1], Sush Vij[1], Hilary P. Bagshaw[1], Sandy Srinivas[1], John Leppert[1,3], Erqi Pollom[1,3], Lei Xing[1], Mark K. Buyyounouski[1], Mohsen Bayati[1], [1]Stanford University, Stanford, CA, [2]University of Washington, Seattle, WA, [3]Palo Alto Veterans Affairs Hospital, Palo Alto, CA, Contact: jjvallon@stanford.edu

To increase estimation accuracy, advanced machine learning (ML) models trade off variance by injecting bias. However, in a healthcare setting, this artificial bias can lead to predictions that are inconsistent with the experiential learning of clinicians, limiting the models' use in clinical practice. In this project, we study this challenge by applying modern ML models to prostate cancer outcome predictions using the National Cancer Data Base. We hypothesize that integrating clinical expertise into the training of the ML models will reduce the inconsistencies without compromising model accuracy.

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TC46

CC-North 227B

Analytics in Classrooms

Contributed Session

Session Chair: Kenneth E. Murphy, University of California Irvine, Irvine, CA

1 Case: Using Text Analysis to Investigate Fraud

Matthew D. Dean, Christine Petrovits, Jamie Diaz, William & Mary, Williamsburg, VA

We describe a case study that introduces business students to text analysis in the context of identifying fraud. After reviewing the fraud triangle, students use Python and/or Alteryx to analyze over 1,400 emails attempting to find the culprits. The case has been used in both MBA and MAcc classes. We collected student survey data over multiple offerings and provide some analysis and insights into the students' perceptions of the case and its ability to help them apply the tools of text analysis.

2 Using Generative AI to Build Realistic Classroom Case Studies

Cody Baldwin, University of Wisconsin-Madison, Madison, WI, Contact: cody.baldwin@wisc.edu

As educators, we strive to create learning opportunities that mimic challenges faced in industry. We want our students to be prepared. However, students sometimes feel that academia and industry are out of alignment. While being taught, they might say, "when will I ever use this in my career?" As an example, while performing data analysis on an assignment, students may feel the data is cleaner and more complete than data they would encounter in the "real world", which could be messy and poorly documented.

These experiences can be frustrating for students. To address these concerns, educators can use generative AI to create more realistic assignments. For instance, generative AI can be used to create synthetic datasets, which are modeled after real datasets, or to create video avatars that represent different business stakeholders who can provide business context for students.

3 Developing an Undergraduate Program in Navy Engineering Analytics

Cameron MacKenzie, Iowa State University, Ames, IA, Contact: camacken@iastate.edu

Thanks to funding from the Office of Naval Research, Iowa State University (ISU) is launching a Navy Engineering Analytics Program (NEAP) for undergraduate students. The objective of NEAP is to develop an innovative education and training program that teaches analytical skills to solve Navy and defense problems. The goal of NEAP is to provide undergraduate engineering students with the necessary analytical skills so that they can enter into exciting professions in the Navy and the broader defense community. NEAP is currently composed of four courses: (i) crisis decision making and risk management, (ii) design and evaluation of human-computer interaction, (iii) problem solving using R, and (iv) a project-based course in which students work on defense-sponsored projects. NEAP has awarded 20 students with scholarships for 2023.

4 Implementing an Analytics and Operations Research Project in a Second-Year Engineering Science Design Course

Kevin Jia, University of Auckland, Auckland, New Zealand. Contact: k.jia@auckland.ac.nz

The second-year Engineering Science design course at the University of Auckland includes a six-week analytics and operations research project, where students formulate and solve a moderately large vehicle routing problem. In groups, they are expected to apply their statistics and visualisation skills to estimate problem data; optimisation for problem formulation; and simulation to estimate the solution quality. Professional skills demanded by industry, such as report writing, teamwork, ethics and systems thinking, are further developed. The lessons learnt after five years of course development, including two years of online delivery, will be discussed, and potential ideas for further course and curriculum development explored.

5 Equity in an Online Management Science Course

Kenneth E. Murphy, University of California Irvine, Irvine, CA, Contact: murphyke@uci.edu

This talk hypothesizes that student outcomes in an online management science course are related to the quality of prerequisite coursework. We present empirical results with respect to student preparation and technology readiness and develop a model of the relationship between these variables and course performance. The results inform instructors with respect to actions that they may take to address student equity.

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TC47

CC-North 227C

Modern Design and Analysis of Computer Experiments: Methodologies and Their Applications

Community Committee Choice Session

Session Chair: Cheoljoon Jeong, University of Michigan, Ann Arbor, MI

1 Robust Simulation Optimization with Stratified and Adaptive Sampling

Pranav Jain[1], Sara Shashaani[1], Eunshin Byon[2], [1]North Carolina State University, Raleigh, NC, [2]University of Michigan, Ann Arbor, MI, Contact: pjain23@ncsu.edu

Stratification has been widely used as a variance reduction technique when estimating a simulation output, whereby the input variates are generated following a stratified sampling rule from previously determined strata. This study shows that stratification could make an adaptive sampling class of simulation optimization solvers more robust. While stratified sampling improves the algorithm’s performance, its robustness is sensitive to the stratification structure.

2 Computer Model Parameter Calibration via Bayesian Optimization

Cheoljoon Jeong[1], Eunshin Byon[2], [1]University of Michigan, Ann Arbor, MI, [2]University of Michigan, Ann Arbor, MI, Contact: cjeong@umich.edu

Parameter calibration seeks to estimate unobservable parameters in a computer model by aligning field observations with computer model outputs. This study employs Bayesian Optimization (BO), which offers a sequential design technique for computer experiments that is sample-efficient. We note that in many applications, not all parameters have an impact on the model output and the relative importance of each parameter can vary. Existing calibration studies naively calibrate all parameters or choose a subset of parameters based on domain knowledge and/or through a pre-screening procedure. This study proposes a new sequential approach for identifying important parameters based on the most up-to-date information We demonstrate the effectiveness of our method through numerical studies and a real-life building energy simulation case study.

3 Confidence Intervals for Monitoring Simulated System Performance

David J. Eckman[1], Matthew Plumlee[2], Barry L. Nelson[2], [1]Texas A&M University, College Station, TX, [2]Northwestern University, Evanston, IL, Contact: eckman@tamu.edu

Many grey-box simulation models give rise to performance measures possessing known functional properties, such as monotonicity, Lipschitz continuity, or convexity. We introduce a framework that accommodates and exploits such forms of functional information to infer the performance of a simulated system when in an observed state. In particular, we use mathematical programming to construct upper and lower bounds on the unknown performance measure. Asymptotically, these lower and upper bounds achieve a desired level of confidence uniformly over system states and are consistent pointwise. These ideas are illustrated in numerical experiments.

4 Nonparametric Multivariate Importance Sampling in Stochastic Simulation

Chenfei Li[1], Eunshin Byon[2], [1]University of Michigan, Ann Arbor, MI, [2]University of Michigan, Ann Arbor, MI, Contact: lchenfei@umich.edu

We propose a new multivariate importance sampling method in stochastic simulation. Importance sampling has the potential to significantly reduce the estimation variance when its instrumental density is well-designed. A nonparametric technique has been shown to provide benefits in the literature for capturing the significance of input variables and interaction effects between inputs. However, when the input dimension is higher than three, it easily faces the curse of dimensionality. This study presents an adaptive method to identify crucial input variables and devises a nonparametric instrumental density using those selected variables.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC48

CC-North 228A

Sequential Learning & Optimization Under Uncertainty

Community Committee Choice Session

Session Chair: Imtiaz Ahmed, West Virginia University, Morgantown, WV

1 Targeted Variance Reduction: Robust Optimization of Expensive Black-box Simulators with Noise Parameters

John J. Miller[1], Simon Mak[2], [1]Duke University, Durham, NC, [2]Duke University, Durham, NC, Contact: john.joshua.miller@duke.edu

The problem of optimizing an expensive black-box function arises in many complex scientific and engineering problems. This function often has not only a set of controllable inputs that the user can optimize, but also a set of random inputs that are uncontrollable in practice. Random inputs may arise from uncontrollable noise factors or from unknown simulation parameters that must be inferred from data. We propose a new Bayesian optimization method that accounts for the presence of random input factors. Leveraging a carefully-constructed Gaussian process model, we derive a closed-form acquisition function that balances exploration, exploitation and solution precision over the random inputs for adaptive sampling of the black-box objective. We demonstrate the effectiveness of our approach for designing automobile braking materials.

2 Conformal Sequential Change-Point Detection Through Renewal Theory

Haoyun Wang, Yao Xie, Georgia Institute of Technology, Atlanta, GA, Contact: hwang800@gatech.edu

With the emergence of high-dimensional data where the generating mechanism is unclear, assuming a parametric form of the data distribution becomes sometimes unrealistic. We consider the problem of online monitoring of a process using conformity score, which allows more model robustness than the traditional parametric approach. Classic analysis through renewal theory can be generalized to such non-parametric case and we derive upper bounds on the expected detection delay while controlling average run length. We compare the proposed method with traditional change-point detection methods and show its effectiveness through numerical experiments.

3 Dynamic and Sequential Optimization for Systematic Decision-Making

Siqin Yang[1], Hao Yan[1], James Kong[2], [1]Arizona State University, Tempe, AZ, [2]Virginia Polytechnic Institute and State University, Blacksburg, VA, Contact: syang240@asu.edu

In many applications, modeling the system uncertainty and optimizing the system performance in a sequential setting is a crucial task. For example, in additive manufacturing systems, finding the design process parameters for each layer is challenging. However, one distinct challenge is that many intermediate results in the sequential setting may not be fully observable. For example, it may not be feasible to measure the quality variables in each layer in additive manufacturing. This presentation will concentrate on sequential decision-making, employing Dynamic and Sequential Optimization with unknown intermediate variables online. By integrating optimal interventions into our graph models, we propose a method for making dynamic decisions applicable to various scenarios.

4 Collaborative Optimal Design: Showcasing the Power of Collaboration

Raed Al Kontar, University of Michigan, Ann Arbor, MI, Contact: alkontar@umich.edu

I present a framework for optimal collaborative design where multiple entities, such as scientists, digital twins, machines, or companies, collaborate to fast-track their optimal design process while preserving their intellectual property. I then showcase the power of collaboration for accelerated material discovery and design of process parameters in additive manufacturing.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC49

CC-North 228B

Optimal Design of Experiments through Mathematical Programming Lens

Community Committee Choice Session

Session Chair: Alan Vazquez, University of Arkansas, Fayetteville, AR

1 Designing Optimal Experiments for Ordinal Responses

Rong Pan, Arizona State University, Tempe, AZ

In this talk, we argue that there is a necessity to propose practical methods for optimal design construction for mixtures when the response is ordinal. The primary reason is that ordinal responses are prevalent in industrial chemical applications. Aside from facilitating the mapping of psychological or sensory responses to numerical measurements, such as in sensory studies, ordinal scales could also serve as measurement surrogates for quantifying a dynamic system's progression through phases. We will discuss some search algorithms for finding optimal designs and some practicable approaches for dealing with common issues in design construction.

2 On the Asymptotics of Graph Cut Objectives for Network A/B Testing Design

Qiong Zhang, Clemson University, Clemson, SC, Contact: qiongz@clemson.edu

A/B testing is an effective approach to assess potential impacts of two treatments. For IT sectors, the test units of A/B testing are often connected in a social network. The responses of A/B testing can be related to the network connection of test units. In this talk, I will discuss the relationship between design criterion of network A/B testing and graph cut objectives. We develop asymptotic distributions of graph cut objectives to enable rerandomization algorithms for the design of network A/B testing.

3 An Integer Programming Algorithm for Constructing Maximin Distance Designs from Good Lattice Point Sets

Alan R. Vazquez, University of Arkansas, Fayetteville, AR, Contact: alanv@uark.edu

Computer experiments build computationally cheap statistical models to study complex computer models. These experiments are commonly conducted using maximin distance Latin hypercube designs (LHDs), generated using heuristic algorithms or algebraic methods. However, the performance of these algorithms deteriorates as the number of factors increases and the algebraic methods only work for specific numbers of tests. To overcome these limitations, we introduce an integer programming algorithm to construct flexible maximin distance LHDs. Our algorithm leverages the optimization techniques implemented in commercial solvers and the attractive algebraic structures given by good lattice point sets and the Williams' transformation. Using numerical experiments, we show that our algorithm outperforms benchmark algorithms and methods for constructing large LHDs.

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TC50

CC-North 229A

Climate Resilience and Equity in Energy Systems

Community Committee Choice Session

Session Chair: Sofia Taylor, University of Wisconsin-Madison, Madison, WI
Session Chair: Line Roald, University of Wisconsin - Madison, Los Alamos, NM

1 Transmission Expansion Planning with Reliability Fairness Constraints

Rodrigo Moreno[1], Claudio Silva[1], Angela Flores[2,3], [1]University of Chile, Santiago, Chile; [2]TU Berlin, berlin, Germany; [3]Universidad de Chile, Santiago, Chile. Contact: rmorenovieyra@ing.uchile.cl

This presentation emphasizes the significance of reliability in electrical power systems and the need for fairness in its distribution. It proposes a methodology to address this issue by incorporating the distribution of reliability across the network in system operation and expansion planning optimization models. The models include linear constraints based on the Gini coefficient and a probabilistic/stochastic approach to model system failure scenarios. By modifying load-shedding plans and other operational and investment decisions, the models aim to improve reliability fairness. The results demonstrate that equitable reliability distributions can be achieved at marginal cost increases.

2 Climate Change Impacts on Future Residential Electricity Consumption and Energy Burden: A Case Study in Phoenix, Arizona

Andrew Jones[1], Destenie S. Nock[2], Constantine Samaras[1], Yueming Qiu[3], Bo Xing[4], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Carnegie Mellon University, Pittsburgh, PA, [3]University of Maryland College Park, College Park, MD, [4]Salt River Project, Phoenix, AZ, Contact: ajjones@andrew.cmu.edu

Air conditioning (AC) is vital for climate adaptation but can increase energy costs. We analyze temperature response functions across income, race/ethnicity, and age using smart-meter data and then project consumption from 2020 to 2070. Under RCP 8.5, we find the median household may see a 27.7% increase (16.7% to 38.0%) in summertime electricity consumption compared to 2017-2018. Additionally, we find (i) elderly and low-income households have higher percentage changes by nearly 5 points than their counterparts, (ii) AC efficiency upgrades can reduce cooling consumption for vulnerable groups by up to 70%, and (iii) upgrades can reduce energy burden by 1%-2% points still remaining unaffordable for low-income groups. This indicates that AC efficiency and cost structure changes are needed to allow households to adapt to a warming climate.

3 Community/Committee's Choice Submission

Jean-Paul Watson, 1</sup

4 Managing Wildfire Risk and Promoting Equity Through Optimal Configuration of Networked Microgrids

Sofia Taylor, University of Wisconsin-Madison, Madison, WI

As climate change increases the potential for wildfires, ignitions from electric power lines are a growing concern. To mitigate this risk, many electric utilities preemptively de-energize power lines to prevent electric faults, which could result in wide-scale power outages. Advanced technology, such as networked microgrids, can reduce the size of the resulting outages. However, even microgrids might not be sufficient to supply power to everyone, thus forcing questions about how to prioritize the provision of power among customers. We present an optimization problem that configures networked microgrids to manage wildfire risk while maximizing the power served to customers. Our formulation considers the ability of customers to cope with power outages and discourages the disconnection of particularly vulnerable customer groups.

5 Electric Vehicles Limit Equitable Access to Essential Services During Blackouts

Yamil Essus, Benjamin Rachunok, North Carolina State University, Raleigh, NC, Contact: yaessus@ncsu.edu

Mass adoption of electric vehicles will tie together mobility and electric power availability and exacerbate existing inequality in access to essential services. In this work we show that the intensity of this inequality is driven by geography, household electricity use and the types of vehicles accessible to each household. This happens because people living in areas with worse access to essential services are in turn depleting their EV batteries faster to access the same level of services. Our results provide insights for policymakers to help identify and mitigate the risk of losing access to essential services during prolonged power outages.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC51

CC-North 229B

Vehicle Routing Optimization for Sustainable Intelligent Transportation Systems

Community Committee Choice Session

Session Chair: Tanveer Bhuiyan, UTSA

1 Locating and Allocating Chargers for Fixed-Route Freight Delivery

Amir Davatgari[1], Taner Cokyasar[2,3], Anirudh Subramanyam[4,2], Jeffrey Larson[5], Abolfazl K. Mohammadian[6], [1]University of Illinois Chicago, Chicago, IL, [2]Argonne National Laboratory, Lemont, IL, [3]TrOpt R&D, Adana, Turkey; [4]The Pennsylvania State University, University Park, PA, [5]Argonne National Laboratory, Argonne, IL, [6]University of Illinois Chicago, Chicago, IL, Contact: tcokyasar@anl.gov

As the target deadline for global net-zero economy is approaching, electrification is gaining more importance. In this study, we develop a mixed integer program, a clustering heuristic, and a genetic algorithm to solve the electric charger location and allocation problem of the e-commerce delivery industry. A thorough sensitivity analysis found charger costs to be the key parameter impacting the system cost including facility, charger, value of time, and energy. An 80% decrease in charger costs lead to 25% system cost reduction. While longer electric vehicle ranges decrease the system cost, the drop is up to a saturation point beyond which the system cost stabilizes.

2 Optimal Routing of a Mixed-Fleet of Aerial Drones for Medical Supplies: A Case Study of Blood Delivery Logistics

Tanveer Bhuiyan, The University of Texas at San Antonio, San Antonio, TX, Contact: tanveer.bhuiyan@utsa.edu

This research studies the cost and energy-efficient routing of a mixed fleet of aerial drones for medical supply logistics. The aim is to efficiently route the drone fleet while delivering time-sensitive packages within a specified time window. A novel mixed-integer programming model with several valid inequalities is presented to model the routing problem. A problem-specific heuristic algorithm is proposed for efficiently solving the problem for large problem instances. Numerical results based on actual drone flight test data and blood delivery data are presented to provide key insights into the cost and energy efficiency of aerial drone delivery under different operating conditions and business needs.

3 Community/Committee's Choice Submission

Feng Qiu, Argonne National Laboratory, Lemont, IL

4 Constrained One-to-Many K-Shortest Path with Replenishment

Amir Davatgari[1], Motahare Mohammadi[1], Taner Cokyasar[2], Abolfazl (Kouros) Mohammadian[1], [1]University of Illinois Chicago, Chicago, IL, [2]Argonne National Laboratory, Lemont, IL, Contact: adavat2@uic.edu

We have developed a method to solve the Constrained K-shortest Path (CKSP) problem with replenishment. This method determines K-shortest paths from a specified origin to all destinations while adhering to maximum travel distance constraints. Unlike existing literature, our method considers the replenishment aspect, allowing distance coverage along the paths to be renewed. In contrast to previous studies that solve the CKSP problem without constraints, sort paths by cost, and select the first K feasible paths, our method simultaneously considers constraints during shortest path computation, significantly accelerating the identification of K shortest paths. This method is applicable to the vehicle routing problem, where resource availability and replenishment are crucial factors in route planning and optimization.

5 Design of Drone-Based Last-Mile Delivery Network with Battery Swapping Stations

Wenquan Dong[1], Tanveer Bhuiyan[2], [1]Texas State University, San Marcos, TX, [2]The University of Texas at San Antonio, San Antonio, TX

This study proposes a drone delivery network design that employs Automated Battery Swapping Machines (ABSMs). The design aims to minimize long-term delivery costs, which include ABSM investment, drone ownership, battery expenses, and delivery time costs. It also determines the optimal location of ABSMs and the number of batteries required to serve a specific customer base. Each ABSM can be modeled as a semi-open queuing network and we have applied machine learning to create a closed-form formulation that represents the relationship between the waiting time of drones at an ABSM and the number of batteries, battery chargers, and charging time. The problem is modeled as a mixed-integer nonlinear program. We proposed an efficient algorithm to manage computational burdens. Numerical experiments have been conducted to provide valuable management insights.

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TC52

CC-North 230

Learning-Enabled Resilience for a Decarbonized Power Grid

Community Committee Choice Session

Session Chair: Yichen Zhang, ARGONNE NATIONAL LABORATORY, NAPERVILLE, IL

1 On Improving Resiliency of Networked Microgrids Using Federated Reinforcement Learning

Sayak Mukherjee, Pacific Northwest National Laboratory, WA

This talk will present a novel federated reinforcement learning (Fed-RL) methodology to enhance the cyber resiliency of networked microgrids. We formulate a resilient reinforcement learning (RL) training setup which (a) generates episodic trajectories injecting adversarial actions, and (b) trains the RL agents (or controllers) to alleviate the impact of the injected adversaries. To circumvent data-sharing issues and concerns for proprietary privacy we propose a novel Fed-RL algorithm to train the RL agents - a multi-agent vertically federated variation of actor-critic algorithms, namely federated soft actor-critic (FedSAC). We created a customized GridLAB-D/HELICS co-simulation platform compatible with the OpenAI Gym interface and validated using modified IEEE 123-bus benchmark test systems consisting of three coupled microgrids.

2 Physics-Informed Machine Learning for Enhancing Robustness and Verification of Neural Networks

Wenting Li, Deepjyoti Deka, Los Alamos National Laboratory, Los Alamos, NM, Contact: wenting@lanl.gov

Renewables are increasingly integrated into power grids to cater to the global energy demand. However, variable renewables, like solar and wind power, are random and intermittent, adversely perturbing the data with high uncertainty. Such perturbed data degrade the performance of machine learning for monitoring and controlling power grids. More challenges are the limited labeled data and measured nodes. We robustify neural networks against these challenges with physics-informed learning. We propose a physics-preserved graph neural network architecture for the fault location problem, and develop a robust training algorithm with physical constraints, and then provide a verification algorithm through physics-informed bound propagation. The numerical results demonstrate superior performance of our approaches over the baseline methods in various scenarios.

3 Enhancing Grid Resilience Using Policy-Based Optimal Control

Xiangyu Zhang, National Renewable Energy Laboratory, Golden, CO, Contact: xiangyu.zhang@nrel.gov

As extreme events become more frequent and larger in scale, it is increasingly important to enhance grid resilience to withstand their impact. Advanced control techniques can play a crucial role in achieving this goal. Policy-based optimal control is a promising approach that provides fast real-time response and end-to-end uncertainty management. In this presentation, we introduce two learning techniques, one model-free and one model-based, to obtain near-optimal control policies. Using a critical load restoration (CLR) problem in a distribution system as an example, we demonstrate the effectiveness of policy-based methods for grid resilience enhancement.

4 Distribution Service Restoration With Distributionally Robust Soft Actor-Critic Algorithm

Mohammad Esmaeil Khodayar[1], Seyed Saeed Fazlhashemi[1], Mahdi Khodayar[2], [1]Southern Methodist University, Dallas, TX, [2]University of Tulsa, Tulsa, OK

In this work, the service restoration of the distribution network is formulated as a multi-agent Markov decision process (MAMDP). In the proposed MAMDP, agents are repair crews in the distribution network which are responsible for repairing the faulted locations. The optimal policy for the formed MAMDP is determined using the distributionally robust multi-agent soft actor-critic (DR-MASAC) algorithm. The proposed MAMDP model and algorithm are tested on an IEEE 37-bus system. The performance of the DR-MASAC is compared with multi-agent soft actor-critic (MASAC), and multi-agent deep deterministic policy gradient (MADDPG) algorithms. It is shown that DR-MASAC is superior for improving the mean value and standard deviation of the expected reward and episode length in the training and testing phases.

5 Robust Power System Stability Assessment against Adversarial Machine Learning-based Cyberattacks via Online Purification

Tianqiao Zhao, Brookhaven National Laboratory, Upton, NY

Data-driven approaches for stability assessment (SA) have received significant research interest. However, machine learning models are recognized to be vulnerable to adversarial disturbances, where slight perturbations to power system measurements could lead to unacceptable errors. We have developed a lightweight mitigation strategy to enhance the ML-based assessment model against adversarial disturbances online. This strategy involves a supervised learning-based module for primary SA and a self-supervised learning-based module. These modules are trained jointly with different objective functions and implemented in sequence for SA applications, allowing them to adaptively tackle adversarial disturbances. The comparative results clearly illustrate the competitive and robust accuracy achieved against various online adversarial scenarios.

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TC53

CC-North 231A

Optimization for Agricultural Operations and Sustainable Development

Community Committee Choice Session

Session Chair: Neng Fan, University of Arizona, Tucson, AZ

Session Chair: mahdi Mahdavimanshadi, 1</sup

1 Multistage Stochastic Optimization for Irrigation Scheduling and Planting Planning Under Drought Scenarios in Semiarid Areas

Mahdi Mahdavimanshadi, University of Arizona, Tucson, AZ, Contact: mahdimahdavi@arizona.edu

Extreme weather such as drought has posed a significant risk to the agricultural economy of the semi-arid region of the Southwestern US. To address the problem of drought in planting planning and water irrigation scheduling of guayule, a perennial woody shrub native to this region, we develop a multistage stochastic large-scale mixed-integer programming approach that considers various aspects, including deficit level for water irrigation, multi-method irrigation scheduling, shortage for unsatisfied demand, machinery cost for planting crops and crop rotation under drought scenarios in Arizona, aimed at maximizing expected farmers' NPV over a planning horizon. Due to Arizona's potential for drought scenarios, the amount of precipitation and water availability are stochastic parameters.

2 Multistage Stochastic Optimization for EV Charging Stations Considering Urban Design

Weiliang Deng, The University of Arizona, Tucson, AZ, Contact: wldeng@arizona.edu

This research proposed a comprehensive long-term planning framework for urban areas, taking the charging demand and user satisfaction into account, from the perspective of social planners. Several types of designs for charging stations, both for general and disabled individuals, are evaluated against potential charging stations. The projected number of electric vehicles (EVs) are transformed into number of charging ports. A multi-stage stochastic model for location and capacity optimization of electric vehicle charging station (EVCS) was proposed to minimize the total cost with the highest matching score. Then this model is applied to the urban area of Tucson, Arizona. An exact algorithm is designed to improve the calculation efficiency. The impacts of the distance between EVCSs and the EV charging demand rate on the planning results are also evaluated.

3 Design of a Supply Chain Network for Chemicals from Biomass Using Green Electrochemistry

Motahareh Kashanian[1], Sarah M. Ryan[2], [1]Iowa State University, Ames, IA, [2]Iowa State University, Ames, IA, Contact: motinaa@iastate.edu

Electrochemistry has emerged as a promising technology for converting biomass into specialty chemicals in distributed facilities that exploit renewable energy resources. We develop a mixed-integer linear programming model to investigate the tradeoff between cost and greenhouse gas emissions for alternative supply chain configurations. The optimal locations and capacities of manufacturing facilities balance transportation of raw materials and green energy availability against varying degrees of economies of scale for the processing steps. We explore the economic and environmental benefits of electrochemistry based on a techno-economic analysis and a U.S. case study.

4 Well-To-Tank Life Cycle Assessment of Various Energy Canes as Biomass Crops

Joaquin Haces Garcia[1], Hua Li[2], Jorge A. da Silva[3], Jamie Foster[4], Mahendra Bhandari[5], [1]Texas A&M University - Kingsville, Kingsville, TX, [2]Texas A&M University-Kingsville, Kingsville, TX, [3]Texas A&M AgriLife Research & Extension Center, Weslaco, TX, [4]Texas A&M AgriLife Research – Beeville Station, Beeville, TX, [5]Texas A&M University - Kingsville, Corpus Christi, TX, Contact: joaquin.haces-garcia@students.tamuk.edu

Energy cane is primarily harvested as a biomass crop for bioenergy. Although the growth of energy canes does not require high-input conditions, different genotypes of energy canes will produce different percentages of fibers and other chemicals in the crops, which will affect the production of biofuels. This study analyzes and compares the environmental impacts of different genotypes of energy canes using a well-to-tank Life Cycle Assessment approach, which compares the results from the end of production to utilization. Specific variables to measure environmental impacts are tested, such as global warming power, acidification, and ozone layer depletion, which will help to identify the best genotype to minimize environmental impacts.

5 A Study of Barriers and Challenges Associated with Agriculture E-Commerce in Afghanistan

Khwaja Bahman Qaderi[1], Noorullah Rafiqee[1], Milad Musadiq[2], [1]Central South University, Changsha, China; [2]Lovely Professional University, Punjab, India

This study examines the scope of e-commerce in Afghanistan's agriculture enterprises, how they harness the potential of internet users, and what obstacles they face in implementing e-commerce in their businesses. The study distributed a 39-question questionnaire to agribusinesses in five different zones of Afghanistan. After extracting the responses 280 were included in the analysis step to perform a non-parametric sign test. E-commerce in Afghanistan faces four major political, economic, Internet, and technological obstacles and no company in the country has implemented e-commerce. This study contributes to knowing the challenges and barriers that agriculture e-commerce faces in Afghanistan to find effective solutions to use the capacity of internet users in the country and increase the sales rate of agricultural products through the Internet.

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TC54

CC-North 231B

Optimization Modeling Software II

Community Committee Choice Session

Session Chair: Susanne Heipcke, 1</sup

Session Chair: Robert Fourer, 1</sup

1 Advances in Model-Based Optimization with Ampl

Filipe Brandão, AMPL Optimization Inc., Mountain View, CA

The ideal of model-based optimization is to describe your problem the way you think about it, and then let the computer do the work of getting a solution. Recent enhancements aim to bring the AMPL modeling language and system closer to this ideal. Using a variety of modeling language extensions, common formulations are described more naturally, with the AMPL translator, the AMPL-solver interface, or the solver itself doing most of the needed transformations. Extensions described in this presentation include quadratic expressions, logical operators and constraints, simple near-linear and nonlinear functions, and combinations of these together with linear terms. All are supported by a new C++ AMPL-solver interface library that can be adapted to handle the multiple detection and transformation strategies required by large-scale solvers.

2 Jump: Recent Improvements to a Modeling Language for Mathematical Optimization

Oscar Dowson, JuMP

JuMP is an algebraic modeling language for mathematical optimization. JuMP makes it easy to formulate and solve a range of problem classes, including linear programs, mixed-integer programs, conic programs, semidefinite programs, and constrained nonlinear programs.

In this talk we briefly discuss recent changes to JuMP, including our 1.0 release, support for multi-objective optimization, improved documentation, and our on-going work to improve support for nonlinear programs.

3 Convenient Business Impact Demonstration of Operations Research Applications with Xpress Insight

Alexander Biele, FICO, Xpress Optimization, Germany

Many Operations Research (OR) applications suffer from not being able to quickly show the business impact. This reduces the number of deployed OR applications and their general acceptance in production environments. Most of the development time is spent on developing optimization models, tuning their parameters, and finessing textual output into slides for an appealing presentation. Demonstrating business impact of different scenarios displayed in attractive user interfaces in an automated way is out of reach. We will demonstrate how to reduce the development time, from model implementation, scenario analysis and closing the feedback loop with business users with FICO Xpress Insight with Python examples.

4 Optimization Modeling Software from Lindo Systems

Linus E. Schrage, LINDO Systems, Inc., Chicago, IL

We describe the latest enhancements to: 1) LINDO API, the solver engine, 2) What's*Best*!, the Excel add-in optimizer, and 3) LINGO, the algebraic modeling language. Some of the new features are: LINDO API: substantial improvements to the Global solver, especially linearization, and support for more external solvers. What's*Best*!: Smart support for more Excel functions, especially in large spreadsheets, plus, a new Black Box solver supporting all Excel functions. LINGO: Enhanced editor allowing split windows, auto-completion, and improved performance on large files/models.. We also discuss the extensive Models Library available to help users get started solving a variety of model types such as cutting stock, scheduling, financial models, and more.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC55

CC-North 231C

Innovations in Sharing Economy

Contributed Session

Session Chair: Anuj Kapoor, Indian Institute of

Management Ahmedabad, Ahmedabad, India

1 Platform Leakage: Incentive Conflicts in Two-Sided Markets

Yingkang Xie[1], Huaiyu Zhu[2], [1]Washington University in St. Louis, St. Louis, MO, [2]Lalamove, Beijing, China. Contact: yingkang.xie@gmail.com

Leakage happens when buyers and sellers coordinate outside the platform to avoid paying fees. Using GPS data in cargo delivery, we identify offline transactions that are typically hard to track in on-demand service platform. We exploit a quasi-experiment that gradually introduced driver commissions, thereby generating variation in participants' incentives for leakage. A 15% commission increased leakage by nearly 4 percentage points, doubling the offline transactions we detected. We leverage this variation to estimate price sensitivities and transaction costs. The likelihood of leakage increases as the quoted price of the delivery increases, as the drivers' potential savings in the commission exceed the offline hassle costs. Customers typically receive half of the commission savings from drivers. We discuss ways to mitigate leakage by better aligning incentives.

2 Unraveling the Sanctions Regime: Exploring the Achilles Heel of Mnc'S Strategies

Mehdi Rasouli Ghahroudi[1], P.V. (Sundar) Balakrishnan[2], Yasuo Hoshino[3], [1]University of Washington, Bothell, WA, [2]University of Washington, Bothell, WA, [3]University of Tsukuba, Tsukuba, Japan

We investigate how sanctions impact strategic choices of MNCs in sanctioned markets. The study utilizes longitudinal data on Japanese MNCs operating in four sanctioned countries and employs various regression techniques. Integrating multiple theories, our findings suggest that market-seeking subsidiaries opt for divestment or shrinking, while resource-seeking subsidiaries prefer stability. It also considers the role of expatriate managers and employees in decision-making under sanctions. Moreover, the presence of subsidiary dynamic capabilities enhances their ability to withstand the turbulent environment until the lifting of sanctions. Our research enhances understanding of MNCs' strategic decision-making, providing valuable insights for practitioners.

3 Value of Notifications and Information Obfuscation Experimental Evidence from a Hyper Local News Platform

Anuj Kapoor, IIMA, Ahmedabad, India. Contact: anujk@iima.ac.in

Platforms deploy information notifications that influence consumer behavior. As an information design strategy, either the firm can be transparent and convey the true value of the notification to the user or can obfuscate the notifications (especially for low-value news items). We design and implement field experiments on a hyperlocal news platform that sends notifications for low-value as well as high-value (localized) news information to the users. Across two experiments, we randomize 8479 users in four Asian districts into the two types of notification cohorts for about 2458 unique news items. Within the obfuscated group, we vary the obfuscation of the type of notifications i.e. either low-value information or high-value information, or both. We find that obfuscation increases time spent on the app by 13.51 %, holding fixed all other attributes of the notification.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC56

CC-North 232A

Solutions to Build Climate Resiliency

Contributed Session

Session Chair: Lamis Amer, University of Miami, MIAMI, FL

1 Optimal Energy Management of Networked Energy Hubs in Coastal Cities to Improve Power System Resiliency During Natural Disasters

Md. Monirul Islam, Delia Rosales, Texas A&M University-Kingsville, Kingsville, TX, Contact: md.monirul.islam@tamuk.edu

Smart power system is a crucial building block of a smart city. The key challenges faced by smart power systems are to achieve cost-effectiveness, zero carbon emission, and resiliency. The challenges become further intensified for the coastal cities due to the requirement of achieving additional capabilities to combat extreme natural events while meeting the higher energy demand for the industrial belt around the cities and managing different energy-intensive processes unlike from the islands. Optimally designing and controlling the energy hub network can be a promising solution to address the challenges and enhance the robustness of the power system during natural disasters. A mathematical model is developed for optimal energy management strategies of the network to improve the preparedness and resiliency of the system before approaching disasters.

2 Driving the Residential Heating Transition - Policy Assessment Considering Parametric Uncertainty and Near-Optimal Solutions

Linda Brodnicke, Paolo Gabrielli, Albane Sérès, Giovanni Sansavini, ETH Zurich, Zurich, Switzerland. Contact: lbrodnicke@ethz.ch

Residential heating electrification via heat pumps will be key to achieving climate targets and moving away from fossil-based heating supply. Our study assesses the impact of policies, namely a carbon tax and a heat pump rebate, on residential heating electrification. To do so, we determine the cost-optimal design and operation of residential multi-energy systems for different policy levels and emissions targets. The analysis accounts for i) parametric uncertainty and ii) uncertainty related to human decision-making by i) performing sensitivity analysis and ii) assessing the near-optimal feasible solution space. Results suggest that introducing policies increases the robustness of the transition to highly electrified low-carbon heating.

3 Future-Proofing Septic Systems to Sea-Level Rise: An Optimization Approach for Adaptation Planning

Lamis Amer[1], Murat Erkoc[2], [1]University of Miami, MIAMI, FL, [2]University of Miami, Coral Gables, FL, Contact: lxa659@miami.edu

This study examines the adaptation of septic systems to sea-level rise risks. A mixed-integer linear programming model is developed with the objectives of minimizing total adaptation costs and maximizing the resilience of wastewater disposal and treatment systems. The proposed adaptation strategies include connecting to existing sewer network, constructing new clusters of micro sewer networks, and building mound systems. The proposed model is applied to actual data obtained from Miami-Dade County to provide optimal decisions regarding the adaptation of septic systems and the expansion of pump station capacity in a real-life setting. The results demonstrate the relevance of the model in comparison to the county's adaptation plans.

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TC58

CC-North 232C

Best Paper Award

Award Session

Session Chair: Alessandro Hill, California Polytechnic State University, San Luis Obispo, CA

1 Network Migration Problem: A Hybrid Logic-Based Benders Decomposition Approach

Maryam Daryalal[1], Hamed Pouya[2], Marc-Antoine De Santis[3], [1]HEC Montreal, Montreal, QC, Canada; [2]Ciena Canada, Inc., Ottawa, ON, Canada; [3]Ciena Canada, Inc., Montreal, QC, Canada

Telecommunication networks frequently face technological advancements and need to upgrade their infrastructure. Adapting legacy networks to the latest technology requires synchronized technicians responsible for migrating the equipment. The goal of the network migration problem is to find an optimal plan for this process. This is a defining step in the customer acquisition of telecommunications service suppliers, and its outcome directly impacts the network owners' purchasing behaviour. We propose the first exact method for the network migration problem, a logic-based Benders decomposition approach that benefits from a hybrid constraint programming-based column generation in its master problem and a constraint programming model in its subproblem. This integrated solution technique is applicable to any integer programming problem with similar structure, most notably the vehicle routing problem with node synchronization constraints. Comprehensive evaluation of our method over instances based on six real networks demonstrates the computational efficiency of the algorithm in obtaining quality solutions. We also show the merit of each incorporated optimization paradigm in achieving this performance.

2 Rapid Influence Maximization on Social Networks: The Positive Influence Dominating Set Problem

Rui Zhang[1], S. Raghavan[2], [1]University of Colorado Boulder, Boulder, CO, [2]University of Maryland-College Park, College Park, MD

Motivated by applications arising on social networks, we study a generalization of the celebrated dominating set problem called the Positive Influence Dominating Set (PIDS). First, we propose a strong and compact extended formulation for the PIDS problem. We then project the extended formulation onto the space of the natural node-selection variables to obtain an equivalent formulation with an exponential number of valid inequalities. Restricting our attention to trees, we show that the extended formulation is the strongest possible one. We derive the necessary and sufficient facet-defining conditions for the valid inequalities and discuss a polynomial time separation. We embed this (exponential size) formulation in a branch-and-

cut framework and conduct experiments using real-world graph instances, with up to approximately 2.5 million nodes and 8 million edges.

3 Fixed Set Search Applied to the Clique Partitioning Problem

Stefan Voß[1], Raka Jovanovic[2], Antonio P. Sanfilippo[3], [1]University of Hamburg, Hamburg, Germany; [2]Hamad bin Khalifa University, Doha, Qatar; [3]Hamad bin Khalifa University, Doha, Qatar

The Clique Partitioning Problem (CPP) seeks to decompose a set of vertices into disjoint subsets (cliques) maximizing the sum of edge weights over all cliques. The interest for the CPP comes from the fact that it represents well many practical problems from areas like data mining, engineering, etc. To address this NP-hard problem, the novel fixed set search (FSS) metaheuristic is applied. For this, firstly, we develop a GRASP using a new type of neighborhood in the local search. The GRASP is further extended to the FSS by adding a learning mechanism. The FSS application to the CPP provides a new approach for generating fixed sets for problems with solution symmetries. This opens the application of the FSS to new families of combinatorial optimization problems. The conducted computational experiments show that the FSS significantly outperforms state-of-the-art metaheuristics for the CPP.

4 Design of 5G MEC-based Networks with 1:N:K Protection Scheme

Hernani Chantre, State University of Campinas, Campinas, Brazil

With the advent of 5G networks, telecommunications InP have faced numerous challenges as they attempt to meet the stringent quality of service requirements. The placement of applications at the edgeof the mobile network in MEC and slicing techniques have provided powerful tools to enable networks to support these requirements. This paper studies the problem of locating MECs and slices in a 5G infrastructure protected by a 1:N:K protection scheme. The aim is to supporthigh reliability and low latency requirements at a minimum cost. A bi-objective non-linear formulation is proposed, and a solution is derived by employing the non-dominated sorting genetic algorithm (NSGA-II). Results show that the enhanced 1:N:K scheme is cost-effective. The proposal is evaluated on the basis of various levels of reliability, latency requirements, and probabilityof failure.

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CC-North 232B

Analytics and AI for Agriculture and Food Security

Contributed Session

Session Chair: Shanjukta Nath, University of Georgia, Athens, GA

1 Decision Support Tool for EONR Combing Crop Simulation and Ml Model

Saiara Samira Sajid[1], Baum Mitchell[2], Sotirios Archontoulis[2], Guiping Hu[1], [1]Iowa State University, Ames, IA, [2]Iowa State University, Ames, IA, Contact: sajids@iastate.edu

Knowledge of the economic optimum nitrogen rate (EONR) in farm management is crucial and can help improve nitrogen efficiency while reducing environmental impact. It is challenging to determine EONR since it varies based on site location, management practice, weather, and soil properties. Furthermore, the data availability is limited to building a machine-learning (ML) model to determine EONR. We propose a decision support tool to determine EONR, where the ML models are trained on crop models (APSIM) simulation outputs and historical weather data. The simulation outputs were generated with varying management, weather, and genotype properties to have robust data. We build a random forest multi-target regression (RFMTR) model to predict yield and EONR for a specific location. The model was evaluated for 2020 with an RRMSE of 11.88% and 22.55%, respectively.

2 Crop Detection Using Deep Learning with Satellite Images

Daisy Zhuo[1], Jack Dunn[2], Luca Mingardi[3], [1]Interpretable AI, Cambridge, MA, [2]Massachusetts Institute of Technology, Cambridge, MA, [3]Interpretable AI LLC, Cambridge, MA

Remote sensing technologies have enabled large-scale monitoring of land use. Classification of crop types is one of the most important applications, as it can inform the agricultural and economic planning at a country level. We have launched an initiative in Africa to collect in-ground labels with GPS locations, and have used this data to build machine learning models that predict crop types from satellite images. We have used a suite of deep learning models including 3D CNNs, GRU-CNNs, and transformers to extract features from both temporal and spatial aspects of the images. We show how we handled the unique challenges in Africa where the fields are smaller and most days are cloudy. The model achieves high accuracy in Senegal, Kenya, Nigeria, and other regions.

3 Field Delineation and AI for Food Security in Africa

Luca Mingardi, Interpretable AI LLC, Cambridge, MA, Contact: luca@interpretable.ai

One of the key challenges in agriculture is to accurately identify arable land, to enable farmers to optimize their resources and maximize their yields. This is especially important in less developed countries like Africa, where a growing population and climate change threaten food security. In our work, we created a framework to leverage satellite images to accurately identify cropland. The characteristics of African fields vary significantly from those of more developed countries like France, which provide publicly available field data. For example, varying field size, crop type and clouds are among the biggest challenges to achieve a strong model performance. To address these issues, we developed custom image segmentation models to identify field boundaries using deep learning and achieved competitive performance.

4 Optimization of National Grain Imports to Balance Risk and Return: A Portfolio Theory Approach

Deniz Berfin Karakoc, Megan Konar, University of Illinois at Urbana-Champaign, Urbana, IL, Contact: denizberfinkarakoc@gmail.com

Global grain trade plays a key role in food security, as many nations rely on imported grain to meet their dietary requirements. Grain imports may be at risk due to economic crises or international conflicts, and countries aim to balance the import risk with the expected return of their grain supplies. Here, we use Markowitz mean-variance optimization model for identifying opportunities to reduce risk in existing national grain import accounts without increasing cost under supply mass constraint of trade partners. Several major grain importers may reduce risk in their grain imports without increasing cost, such as wheat imports in Egypt, maize imports in Vietnam, and rice imports in Saudi Arabia. However, some countries may have to pay more for more stable grain supplies, such as wheat imports in Turkey. This study can inform future policy and decision-making in grain-trade.

5 Convenience, Personalization, and Engagement in an Agricultural Advisory Service

Shanjukta Nath[1], Susan Athey[2], Shawn Cole[3], Jessica Zhu[4], [1]University of Georgia, Athens, GA, [2]Stanford University, Stanford, CA, [3]Harvard University, Boston, MA, [4]Precision development, Newton, MA

Automated systems have been used to deliver information in areas such as public health, education, and agriculture. Automated delivery enables users to consume information at a convenient time and place. We examine whether personalizing timing of information delivery in an agricultural advisory service can lead to higher user engagement. We develop, implement, and evaluate a personalized recommendation system that customizes contact times to user characteristics. We find scope for significant gains from personalized recommendation in terms of farmers' propensity to pick-up calls, estimating an 8% increase over the baseline pick-up. We address several challenges to implementing customized policies in developing country settings, such as bandwidth constraints, equity-efficiency concerns and how technology or preference shocks affect performance of policies.

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TC59

CC-West 101A

AHP / ANP and Extensions for a Better World: New Developments and Applications II

Community Committee Choice Session

Session Chair: Birsen Karpak, Youngstown State University, Canfield, OH

Session Chair: Ilker Topcu, Istanbul Technical University, Istanbul, Turkey

1 Application of the Analytic Hierarchy Process to Evaluate the Impact and Effectiveness of School Safety Approaches

Luis G. Vargas[1], Marcel C. Minutolo[2], [1]University of Pittsburgh, Pittsburgh, PA, [2]Robert Morris University, Moon Township, PA, Contact: minutolo@rmu.edu

We put forth a model to evaluate the effectiveness of school safety approaches. The model uses the Analytic Hierarchy Process (AHP) to measure the risk associated with school safety hazards. Risk measurement uses three components, probability, severity, and manageability. The risk measurement model requires the involvement of experts and the community at large. Once developed, a web-based application specific to school districts can evaluate the programs developed to address the hazards to ameliorate the risks identified. The results are: a model to measure the risk of school safety hazards; a web-based application to collect information about how schools deal with safety hazards, that will create a knowledge base of effective policies; and, a systematic process for evaluating exiting programs used to deal with school safety hazards.

2 Determination of Forest Risk Maps and Planning of Preventive Measures

Zuhal Ozcan Yavuz[1], Özgür Kabak[2], Inci Yaylaci Caglayan[3], [1]Istanbul Technical University, Sariyer, Turkey; [2]Istanbul Technical University, Istanbul, Turkey; [3]Istanbul University, Sariyer, Turkey. Contact: zuhalozcan.09@gmail.com

This project endeavors to pioneer a novel approach to wildfire risk mapping and introduce a probabilistic optimization model for resource allocation, integrating risk maps and various situational conditions. We will initiate our work by conducting comprehensive literature reviews, followed by critical analysis of specific criteria. Based on these insights, we'll integrate climate, topography, and land cover data to generate risk maps via Analytic Hierarchy Process (AHP) and Ordered Weighted Averaging (OWA). Utilizing multi-criteria decision-making strategies, we'll optimize the distribution of first responder resources, including fire brigade, artificial pools, and aerial vehicles, through the cluster coverage method.

3 Impact of Digital Technologies on Supply Chain Resilience

Birsen Karpak[1], Gurkan I. Akalin[2], Ilker Topcu[3], [1]Youngstown State University, Canfield, OH, [2]Eastern Illinoius University, Charleston, IL, [3]Istanbul Technical University, Istanbul, Turkey. Contact: bkarpak@ysu.edu

The study explores the link between supply chain resilience and supply chain digitalization. Supply chain digitalization provides several benefits that directly contribute to the development of supply chain resilience capabilities. Digital technologies enhance visibility, support better anticipation of potential disruptions, facilitate collaboration, and enable agility and flexibility within supply chains. Considering the interactions among digital technologies as well as supply chain resilience capabilities, Analytic Network Process is used as a methodology and digital technologies influencing supply chain capabilities are prioritized. Supply chain managers should consider adopting digital technologies and leveraging their capabilities to develop resilient supply chains.

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CC-West 101B

DEIC Student Paper Competition

Award Session

Session Chair: Alice E. Smith, Auburn University, Auburn, AL

Session Chair: Margret V. Bjarnadottir, University of Maryland, College Park, MD

Tuesday, October 17, 12:45 PM - 2:00 PM

TC61

CC-West 101C

Disaster Management & Humanitarian Logistics

Community Committee Choice Session

Session Chair: Luke Muggy, 1</sup

Session Chair: Mahyar Eftekhar, New York, NY

1 Facilitating Coordination in Multi-Objective, Multi-Stakeholder Humanitarian Operations

Ayesha Farooq, Jessica Heier Stamm, Kansas State University, Manhattan, KS, Contact: ayeshafarooq@k-state.edu

Humanitarian contexts are characterized by many independent decision makers who each act based on multiple criteria. Coordination among such entities can lead to more efficient and effective operations, yet existing models do not fully capture these features. Most optimization frameworks assume a single decision maker, while game theory approaches assume each decision maker has a single objective. We integrate cooperative game theory and optimization to identify ways to facilitate coordination in multi-objective, multi-stakeholder settings. We analyze player behavior and system outcomes under several policies for allocating system-wide costs and benefits, providing insight to support improved humanitarian operations.

2 Enhancing Transportation Network Resiliency: Pre-Event Disaster Mitigation Interventions

Ahmad Ghasemkhani, University of Oklahoma, Norman, OK, Contact: a.ghasemkhani@ou.edu

Transportation network resiliency means a system's ability to recover from disruptive events like natural disasters. It's crucial to maintain mobility and access to critical services. Pre-event disaster mitigation interventions, structural retrofits, and data-driven approaches can enhance network resiliency. Ranking infrastructure components by criticality help prioritize interventions. Overall, transportation network resiliency is vital for community safety during times of crisis.

3 Developing Decision Support System in Disaster Management

Baba Nasiru Lawal[1], Joon-Yeoul Oh[2], David Hicks[3], [1]Texas A&M University-Kingsville, Kingsville, TX, [2]Texas A&M University-Kingsville, Kingsville, TX, [3]Texas A&M University-Kingsville, Kingsville, TX, Contact: kfjo000@tamuk.edu

The challenges for the resilience of the social infrastructure damages after a disaster are often associated with the effective coordination of resources with real time information. The decision support system in disaster management requires the resources coordination for emergency preparedness, responses, and resilience. The objective of this research is to propose an effective yet efficient decision support system to improve allocation of the necessary resources for recovering the damaged infrastructure in a timely manner. The proposed system integrates the damage assessment and geological data to enable real time analysis.

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TC62

CC-West 102A

Supply Chain Scheduling and Optimization

Community Committee Choice Session

Session Chair: Zhi-Long Chen, University of Maryland, MD

1 Service Costs in Assortment Projects

George Vairaktarakis, Case Western Reserve University, Cleveland, OH

When nursing home patients visit a hospital for routine or post-acute care, they experience wait in service that strain both the hospital and these vulnerable patients. Given a set R of distinct resources (e.g., medical specialties) serving an assortment of tasks in a project (i.e., all the patients of a nursing home) the problem is to minimize the total service cost over all projects. In this article we present an exhaustive list of optimality conditions that govern optimal solutions for any given number |R| of resources, develop two different - but related - fully polynomial-time approximation schemes (FPTAS) for |R| = 2, and amplify their use to generate near-optimal solutions for any fixed |R|. In particular, for up to four resources our FPTAS yields a less than 3/2-approximation.

2 Usage-Based Lease Contract for Service-Oriented Supply Chain Under Stochastic Demand: A Stackelberg Game Model

Ting Zhao[1], Zhi-Long Chen[2], Xinbao Liu[1], [1]Hefei University of Technology, Hefei, China; [2]University of Maryland, College Park, MD, Contact: tingzhao@umd.edu

We propose a Stackelberg game model for optimizing usage-based lease contracts in a service-oriented supply chain subject to stochastic demand. In such contracts, the operator pays a fixed rental plus a charge per unit of output to the manufacturer, while the manufacturer provides maintenance services during the lease period. The demand uncertainty poses challenges for both the manufacturer and operator to optimize their net profits. In our proposed model, the manufacturer acts as the leader and determines maintenance policy under uncertain demand, then the operator acts as the follower and decides the optimal production rate after knowing the actual demand. By solving this game model, we obtain new insights into the design of optimal production and maintenance policy in the lease contract.

3 Survey of Online Integrated Production and Distribution Scheduling

Zhi-Long Chen, University of Maryland, College Park, MD

We give several real-world applications of online integrated production and distribution scheduling problems. We then review the existing literature on online IPDS problems with a focus on existing online algorithms for these problems and their theoretical performance. We also derive some new results to fill several gaps left in the literature, and discuss possible topics for future research.

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CC-West 102B

Innovations in Service Operations

Community Committee Choice Session

Session Chair: Yueyang Zhong, The University of Chicago Booth School of Business, Chicago, IL

Session Chair: Neha Sharma, Kellogg School of Management, Evanston, IL

1 Algorithmic Interventions to Prevent Burnout in Icu Workforces

Ken Moon, The Wharton School, Philadelphia, PA, Contact: kenmoon@wharton.upenn.edu

In recent decades, hospitals have pursued operational efficiency at the expense of increasing on-the-job stress for their intensive care nursing staff. The resultingly “quicker and sicker” workflows lead to elevated rates of provider turnover and burnout. In collaboration with the University of Pennsylvania hospital system, we equipped the nurses staffing three highly sophisticated ICUs with biometric sensors during their shifts. We design and train learning algorithms to identify exceptionally stressful workflows and intervene based on data in near real-time.

2 Consumer Responses to Time Limits in Discretionary Services

Michelle A. Shell[1], Pnina Feldman[2], Ella Segev[3], [1]Dartmouth Tuck School of Business, Hanover, NH, [2]Boston University, Boston, MA, [3]Ben-Gurion University of the Negev, Beer Sheva, Israel

Service providers often request that customers limit their consumption of experiential goods - particularly during periods of congestion. This research seeks to shed light on trade-offs between customer satisfaction, desired operational efficiencies, and general welfare by improving our understanding of how customers respond to voluntary time limits in discretionary service environments.

3 Heterogeneous Treatment Effects Under Marketplace Interference

Arthur J. Delarue[1], Kleanthis Karakolios[2], [1]H. Milton Stewart School of Industrial and Systems Engineering at Georgia Tech, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, Contact: kleanthis@gatech.edu

Treatment effect estimators in two-sided marketplace experimentation are typically biased due to interference. We build a simple general model of a two-sided matching marketplace and propose an improved treatment effect estimator by leveraging linear programming duality, as well as scaling techniques, to develop upper and lower bounds for the treatment effect. We discuss also the estimation of heterogeneous treatment effects in marketplaces. We show that in the presence of interference, such heterogeneous treatment effects are not unique, and it is not clear which to estimate. This estimation failure suggests an optimization approach, in which the outcome of the experiment is used not to estimate treatment effects but to decide which types should be offered treatment.

4 Group-Sparse Matrix Factorization for Transfer Learning of Word Embeddings

Kan Xu[1], Xuanyi Zhao[1], Hamsa Sridhar Bastani[2], Osbert Bastani[3], [1]University of Pennsylvania, Philadelphia, PA, [2]Wharton School, Philadelphia, PA, [3]University of Pennsylvania, Shenzhen, China. Contact: kanxu@sas.upenn.edu

Unstructured text provides decision-makers with rich data source in many domains. To leverage this information, words are typically translated into word embeddings through unsupervised learning algorithms such as matrix factorization. However, learning embeddings from new domains with limited training data can be challenging, because the meaning may be different in the new domain, e.g., the word "positive" in medical notes. Intuitively, we expect that only a small number of domain-specific words have new meanings. We propose a two-stage estimator that exploits this structure via a group-sparse penalty to transfer learn domain-specific embeddings by combining large-scale text corpora (such as Wikipedia) with limited domain text data. We prove that it can achieve the same accuracy (compared to not transfer learning) with substantially less domain data.

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TC64

CC-West 102C

Analytics in social networks

Contributed Session

Session Chair: Marcel Goic, University of Chile / Instituo de Sistemas Complejos de Ingeniería, Santiago, Chile

1 The Bidirectional Relationship Between Social Networking Site use and Depression - Exploring the Impact of Usage Patterns and Active vs. Passive Engagement

Chinju Paul[1], Minsek Ko[2], [1]Mississippi State University, Mississippi State, MS, [2]Iowa State University, Ames, IA, Contact: cp2041@msstate.edu

This study examines the complex relationship between the use of social networking sites (SNS) and depression. Drawing on the reflective-impulsive model and the cognitive theory of depression, we explain the circular cause-and-effect relationship. We also explore the impact of SNS use patterns and user engagement on the relationship. Based on three cross-sectional and one longitudinal national survey datasets, we found a positive bidirectional relationship between the frequency of SNS use and depression. This relationship follows a U-shaped pattern, suggesting that individuals who are heavy users or abstain from SNS may experience greater levels of depression than moderate users. Moreover, we found that passive SNS use (e.g., watch videos via SNS) may exacerbate depression, while active use (e.g., participate in current events via SNS) does not have the same effect.

2 The Web's Great Conversation: Unveiling the Secrets of Chat-Based Search Engines

Lijia Ma, Xingchen Xu, Yong Tan, University of Washington,

Seattle, WA, Contact: lijiam@uw.edu
This study examines the selection criteria differences between chat-based search engines and their traditional counterparts, using a unique dataset compiled from queries on New Bing. The analysis focuses on the responses generated by Bing Chat and reveals a tendency to select mainstream websites for nucleus sentences and niche websites for elaboration parts, suggesting an inclination towards diverse content. However, further analyses show that Bing Chat favors specific linguistic styles, such as greater objectivity, and that the selected niche websites exhibit considerable similarity, limiting the diversity of information available to users. The findings have implications for both users and website owners and highlight the need for further research on chat-based search engines to ensure the provision of accurate and varied content.

3 Managing Influencer-Brand Collaboration: A Multitask Learning Model for Influencer Selection
Magie Cheng, Harvard Business School, Boston, MA, Contact: macheng@hbs.edu

4 Estimating Policy Effects In A Social Network With Independent Set Sampling
Eugene Ang[1], Prasanta Bhattacharya[2], Andrew E.B. Lim[3], [1]National University of Singapore, Singapore, Singapore; [2]Agency for Science, Technology and Research (A*STAR), Singapore, Singapore; [3]National University of Singapore, Singapore, Singapore. Contact: eugene.ang@u.nus.edu
Evaluating the impact of policy interventions on respondents in a social network is challenging due to the presence of network interference. We propose a strategy that combines existing work on stochastic actor-oriented models with a novel network sampling method based on the identification of independent sets. Through this sampling method, we can block any direct spillover of the treatment, thereby allowing us to isolate the direct treatment effect from the indirect network-induced effects. Thus, our method allows for the estimation of both the direct and net effect of the policy intervention, in the presence of network interference. We show that our proposed technique leads to smaller and distinct estimates for both direct and net effects of the policy, and larger and significant estimates for the relevant network effects, such as homophily.

5 Assessing the Complementary Role of Firm and Friend Recommendations in Mobile Environments
Marcel Goic[1], Jose A. Guajardo[2], Liye Ma[3], [1]University of Chile / Instituto de Sistemas Complejos de Ingeniería, Santiago, Chile; [2]University of California-Berkeley, Berkeley, CA, [3]University of Maryland, College Park, MD, Contact: mgoic@dii.uchile.cl
We investigate the effectiveness of recommendations from friends and firms, and we analyze how they interact in affecting the conversion of mobile promotions. For friend recommendations, we propose an identification approach to separate the underlying *selection* and direct *influence* effects, while controlling for *homophily*. Using a unique dataset from a mobile platform that sends geo-targeted coupons to customers and allows them to recommend to friends, we show that geo-targeting makes a consumer more likely to consider an offer, and friends' recommendations increase conversions. When disentangling the mechanisms driving the effects of friend recommendations, we found that they are mostly attributed to the selection effect and that the effect is enhanced when recommenders are more selective and have stronger ties with the recipients.

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TC65

CC-West 103A
Frontiers of Management of Technology
Community Committee Choice Session
Session Chair: Yinliang Tan, 1</sup

1 Early Patent Disclosure and Radical Innovation
Xiaojie Wang[1], Huijun Chen[2], Ying-Ju Chen[3], [1]Hong Kong University of Science and Technology, Hong Kong, Hong Kong; [2]HKUST, Hong Kong, Hong Kong; [3]The Hong Kong University of Science and Technology, Kowloon, Hong Kong. Contact: xwangdx@connect.ust.hk
How does the early publication of patents affect radical innovation? We investigate the question by exploiting a large-scale national experiment, the passage of the American Inventor's Protection Act (AIPA), which accelerates the publication by two years. We develop a novel measurement of radical innovation and focus on the heterogeneous impacts of firm size. We look into the questions using both traditional fixed effects regressions and debiased /double machine learning method where we can tease out selection bias in a more flexible way.

2 The First-Mile Problem in the Reverse Supply Chain of E-Waste
Yunke Mai, Haoying Sun, University of Kentucky, Lexington, KY, Contact: yunke.mai@uky.edu

In this paper, we study the first-mile problem in the reverse supply chain of e-waste recycling using an evolutionary game theory framework. Our analysis establishes that utilizing existing retail channels could be generally effective, but such an approach could also have ambiguous effects that regulators need to be aware of.

3 Platform Transformation Risk and the Role of Hosting Rivals

Shiva Shekhar[1], Sarvesh Bandhu[2], Marshall Van Alstyne[3], [1]Tilburg University, Tilburg, Netherlands; [2]Indian Institute of Management Bangalore, Bangalore, India; [3]Boston University, Boston, MA, Contact: S.Shekhar_1@tilburguniversity.edu

We study the decision of traditional firms to transform into digital platforms. While digital transformation enhances value through externalizing value creation, it also entails investment risk. When transformation risks are low or network effects due to transformation are very valuable, platform transformation is profitable. Interestingly, when firms choose to transform, we show that inviting rivals onto the platform can raise profits in certain cases. Apart from the benefits associated with aggregation, inviting rivals onto a proprietary platform also lowers the rival's competitive aggressiveness. This is a novel strategic rationale for inviting rivals on to the platform elicited in this paper. We provide clear managerial and policy implications from these results and use real world examples to illustrate our theory.

4 The Impact of Dual Conceptualizations of Brand Equity on Radical Product Launch Strategy

Junghee Lee[1], Mallapragada Girish[2], Mitchell Olsen[1], Daewon Sun[1], Dennis Z. Yu[3], [1]University of Notre Dame, Notre Dame, IN, [2]Indiana University, Bloomington, IN, [3]Clarkson University, Potsdam, NY, Contact: jlee93@nd.edu

We consider the follower's new product launching strategy with incorporating two different types of consumers' perception of the firm's brand equity: 1) Absolute and 2) proportional brand equity. We develop the follower's decisions about whether and when to launch a radical innovation given the dual conceptualizations of brand equity and relative product quality. The results show that the follower should more strongly consider launching the radical product and risking failure if consumers perceive brand equity absolutely, rather than proportionally. The paper provides nuanced insights into the way consumers' brand equity perceptions interact with product and market conditions to affect the firm's optimal product launch strategies.

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TC66

CC-West 103B

Robust Artificial Intelligence and Applications

Community Committee Choice Session

Session Chair: Seoung Bum Bum Kim, Korea University, Seoul, Korea, Republic of

1 Unsupervised Multi-Modal and Multi-Domain Learning for Structural Robust Stain Normalization

Minjung Kang[1], Jiyeon Kang[1], Jeeyoung Park[2], Heounjeong Go[3], Sangmin Lee[1], [1]Kwangwoon University, Seoul, Korea, Republic of; [2]Kyungpook National University School of Medicine, Seoul, Korea, Republic of; [3]Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea, Republic of. Contact: smlee5679@gmail.com

We propose an unsupervised multi-modal and multi-domain learning with structure preserving adversarial networks for histopathology. Recently, histopathology has been recognized as the gold standard for identifying cancerous tissues. Stain normalization is a processing task for fast and accurate pathology diagnosis. However, structure preserving stain normalization remains a challenge. We propose a L1-norm regularized multimodal learning with two grayscaled images of Hematoxylin and eosin-stained tissues. This study aims to obtain structural consistency to prevent inter- and intra-sacnner variations. The proposed technique was demonstrated to have superior performance quantitatively and qualitatively compared to competing algorithms through comparative experiments.

2 Noisy Label Filtering for Class Imbalanced Datasets

Sanghoon Kim, Seoung Bum Kim, Korea University, Seoul, Korea, Republic of. Contact: dawonksh@korea.ac.kr

Label noise learning is crucial for maintaining the robust performance of deep neural networks. Recent research has primarily relied on training loss-based filtering methods to separate clean and noisy samples. However, these methods face difficulties in effectively filtering noisy label in class-imbalanced data due to the use of uniform filtering rules across all classes. To overcome this limitation, we propose a methodology specifically designed for noisy label filtering in class-imbalanced scenarios. Our approach leverages class-specific training loss values to accurately identify clean

samples. Extensive experiments conducted on benchmark datasets demonstrate the effectiveness of our methodology in addressing class imbalance.

3 Improving Calibration of Deep Learning Models Through Efficient Confidence Alignment and Temperature Scaling

Jinsoo Bae, Seoung Bum Kim, Korea University, Seoul, Korea, Republic of. Contact: wlstn215@korea.ac.kr

Addressing overconfidence issues in deep neural networks is crucial for reliable confidence scores, especially in real-world applications. Various calibration methods have been developed to address overconfidence issues. However, these calibration methods fail to consider the model's accuracy, which makes it challenging to determine the appropriate degree of calibration. To overcome these limitations, we propose an efficient confidence alignment and temperature scaling method that regulates the network output distribution to an accuracy-aware confidence distribution. We demonstrate the effectiveness of our proposed method through experimental results on the CIFAR-10, CIFAR-100, and SVHN datasets, showing improved calibration.

4 Noise-Robust Graph-Based Semi-Supervised Learning with Dynamic Shaving Label Propagation

Jiyoon Lee[1], Younghoon Kim[2], Seoung Bum Kim[1], [1]Korea University, Seoul, Korea, Republic of; [2]Kyung Hee University, Yongin, Korea, Republic of. Contact: y.kim@khu.ac.kr

Graph-based semi-supervised classification is popular due to its effective use of unlabeled data. Current methods, however, overlook inherent data noise, compromising overall performance. To address this, we introduce a noise-robust model, the Dynamic Shaving Label Propagation Algorithm, with three components: graph construction, noise identification and removal, and label propagation. The graph construction phase determines *k* at the point where reverse nearest neighbors are identified for the most isolated nodes. Noise identification then classifies nodes as noise based on their reverse nearest neighbors' number and distance. Label propagation dynamically adjusts the noise removal intensity in an iterative manner. We compare our method's accuracy and noise robustness against existing methods, demonstrating its superior performance and applicability.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC67

CC-West 104A

Applied Online Learning and Decision-making

Community Committee Choice Session

Session Chair: Rafid Mahmood, Telfer School of Management, Mississauga, ON, Canada

1 Data-pooling Reinforcement Learning For Personalized Healthcare Intervention

Xinyun Chen[1], Pengyi Shi[2], Shanwen Pu[3], [1]Chinese University of Hong Kong, Shenzhen, Shenzhen, China; [2]Purdue University, West Lafayette, IN, [3]Shanghai University of Finance and Economics, Shanghai, China. Contact: chenxinyun@cuhk.edu.cn

Motivated by the emerging needs of personalized intervention, we consider a multi-stage, dynamic decision-making problem in the online setting with unknown model parameters. To deal with the pervasive issue of small sample size in personalized planning, we develop a novel data-pooling reinforcement learning (RL) algorithm. Our algorithm adaptively pools historical data, with three main innovations: (i) the weight of pooling ties directly to the performance of decision (measured by regret); (ii) no parametric assumptions are needed between historical and current data; and (iii) requiring data-sharing only via aggregate statistics. We establish a theoretical guarantee for performance improvement of the data-pooling algorithm over benchmark methods. We also record empirically better performance of our algorithm in a case study of post-discharge intervention.

2 Dynamic Pricing And Learning With Bayesian Persuasion

Wei Tang[1], Shipra Agrawal[1], Yiding Feng[2], [1]Columbia University, New York, NY, [2]University of Chicago, Chicago, IL, Contact: wt2359@columbia.edu

We consider a novel dynamic pricing and learning setting where in addition to setting prices of products in sequential rounds, the seller also ex-ante commits to `advertising schemes'. Using the popular Bayesian persuasion framework to model the effect of these signals on the buyers' valuation and purchase responses, we formulate the problem of finding an optimal design of the advertising scheme along with a pricing scheme that maximizes the seller's expected revenue. Without knowing the buyers' demand function, our goal is to design an online algorithm that can adaptively learn the optimal pricing and advertising strategy.
Our main result is a computationally efficient online algorithm that achieves O(T^{2/3}(N\log T)^{1/3}) regret when the valuation function is linear in the product quality. Here N is the # of the discrete product quality domain and T is the time horizon.

3 Contracting, Pricing, and Data Collection Under the Ai Flywheel Effect

Huseyin Gurkan[1], Francis de Véricourt[2], [1]ESMT GmbH, Berlin, Germany; [2]ESMT GmbH (VAT-ID: DE814050117), Berlin, Germany. Contact: huseyin.gurkan@esmt.org

This paper explores how firms that lack expertise in machine learning (ML) can leverage the so-called AI Flywheel effect. This effect designates a virtuous cycle by which, as an ML product is adopted and new user data are fed back to the algorithm, the product improves, enabling further adoptions. However, managing this feedback loop is difficult, especially when the algorithm is contracted out. Indeed, the additional data that the AI Flywheel effect generates may change the provider's incentives to improve the algorithm over time.

4 Optimizing Data Collection for Machine Learning

Rafid Mahmood[1,2], James Lucas[2], Jose Alvarez[3], Sanja Fidler[2], Marc Law[2], [1]Telfer School of Management, Ottawa, ON, Canada; [2]NVIDIA, Toronto, ON, Canada; [3]NVIDIA, San Jose, CA, Contact: mahmood@telfer.uottawa.ca

Training modern deep learning systems requires massive data sets, but there is little guidance on how to best collect this data. Over-collecting data incurs unnecessary present costs, while under-collecting may incur future costs and delay workflows. We introduce an optimal data collection problem, enabling designers to define performance targets, costs, time horizons, and penalties for unmet targets. This framework further permits custom analyses, such as collecting new data to upgrade an existing AI model or choosing between different collection strategies. To solve the problem, we propose Learn-Optimize-Collect (LOC), which minimizes expected future costs. Evaluating on six computer vision applications, our method outperforms conventional approaches consistently by achieving performance targets while maintaining low collection costs.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC68

CC-West 104B

Time Series Methods and Applications

Community Committee Choice Session

Session Chair: Xaimarie Hernandez Cruz, [1</sup]

1 Self-Supervised Representation Learning and Anomaly Detection in Time-Structured Datasets: Case Studies and Applications in Health

Francisca Quijada Dibarrart, Klim Drobnyh, George Runger, Arizona State University, Tempe, AZ

The time series representation and anomaly detection problems have been traditionally addressed via supervised learning. However, in practice, labeled data required for model training may sometimes be limited or nonexistent. This research learns representations of multivariate time-structured datasets. Furthermore, the methodology can be directly extended to address the anomaly detection problem by exploiting the information captured that distinguishes among instances originating from different sources. Case studies are presented for detecting abnormalities in the health domain, with a particular focus on overall human activities.

2 Improved Crop Price Predictions Using Social Media

Grace Neal, Xaimarie Hernandez Cruz, George Runger, J. Rene Villalobos, Arizona State University, Tempe, AZ, Contact: gneal2@asu.edu

There are times when disruptive events can affect fresh fruit and vegetable (FFV) produce prices, hindering the forecasting of prices solely based on the historical price time series. To address this challenge, this work evaluates the use of social media data in price prediction, applying the general public's interest in products at different times to improve the forecasting of FFV prices. Twitter data, such as the frequency of tweets and the overall sentiment values of the tweets are used to monitor the public impression of products. In addition, Google Trends data, such as the search relative frequency of the product is also explored as an exogenous variable. Through a case study, this work will compare the combined use of social media to generate a more accurate FFV market price prediction than when used individually or not at all.

3 Predicting Without Data

Xaimarie Hernandez Cruz, Grace Neal, George Runger, J. Rene Villalobos, Arizona State University, Tempe, AZ

Spatio-Temporal forecasting, as other supervised tasks, requires an ample amount of historical data to train forecasting models. Nonetheless, there are certain applications in which forecasts for a particular spatial location with little to no data availability is desired. This work addresses this challenge by developing a two-phased approach in which forecasts of locations that have data available are used to obtain predictions for a location that does not have data. An application case study is provided to illustrate the proposed approach in which crop market prices in the United States are predicted for a market for which data is not available.

4 Low-Rank Approximation of Attention in Transformer for Time Series Forecasting

Fahim T. Azad, Arizona State University, Tempe, AZ, Contact: fazad@asu.edu

Transformers have performed well in domains like natural language processing and computer vision. The use of transformers is also gaining popularity in the field of time series. A few current state-of-the-art works use the low-rank approximation of Transformer attention for long-sequence forecasting. The intuition behind that is that the attention weights are sparse, and approximate values can replace them without drastically affecting efficiency. In this presentation, we will describe their approaches and introduce our approach for low-rank approximation of the attention weights. The presentation will also include a comparison of the different techniques mentioned earlier.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC69

CC-West 105A

Data Mining and Machine Learning for Sustainable Transportation

Community Committee Choice Session

Session Chair: Jimi Oke, University of Massachusetts Amherst, Amherst

1 Shared Parking and Charging Management in Multi-Unit Dwellings

Ruolin Zhang, Eleftheria Kontou, University of Illinois at Urbana-Champaign, Urbana, IL, Contact: ruolin3@illinois.edu

In urban areas, the search for parking and charging results in vehicle cruising and congestion. However, private parking spaces and charging infrastructure in multi-unit dwellings (MUDs) could be available during daytime, when MUD residents drive their vehicles to work. We design a shared parking and charging reservation and allocation system for MUD charging hubs and public users to provide accessible parking and charging services to the general public. This system accounts for diverse stakeholders and models their objectives. To accommodate both electric and gasoline vehicles' requests, a binary integer linear programming (BILP) model incorporating a set of matching rules is formulated. Counterfactual analysis is conducted to model users' charging behavior. Results from a numerical experiment in Chicago, Illinois using real-world data will be presented.

2 An Innovative Method of Using Social Media Data to Develop Policy Sensitive Model

Rifa Tasnia[1], Daud Nabi Hridoy[2], Khondhaker Al Momin[3], Arif Mohaimin Sadri[4], Md Sami Hasnine[2], [1]North Carolina Agricultural and Technical State University, Greensboro, NC, [2]Howard University, Washington, DC, [3]University of Oklahoma, Norman, OK, [4]The University of Oklahoma, Norman, OK, Contact: hasnine@mit.edu

The objective of this study is to use social media data and develop policy sensitive model. First, this project analyzes two case studies where tweets are retrieved during Hurricane IAN and IDA. Then, tweets are transformed into various activity types and disruption types using text mining, classification, and natural language processing. Next, various data sources are used to add sociodemographic information, such as US Census, American Community Survey, Climate and Economic Justice Screening Tool, and Social Security Administration (SSA) database. Based on the final datasets, a series of econometric models are estimated. The econometric models reveal a series of policies that will help us take various disaster preparedness steps.

3 Electrifying Public Transit Benefits Public Finances in Small Island Developing States

Zakia Soomauroo[1,2], [1]Technical University of Berlin, Berlin, Germany; [2]Reiner Lemoine Institut, Berlin, Germany. Contact: zakia.soomauroo@rl-institut.de

Decarbonizing transport in small island states addresses issues of energy security, high fuel import prices, and climate change mitigation measures while ensuring higher levels of wellbeing for citizens. Electrification plays a vital role in the decarbonization process. Here, we explore transition pathways using Mauritius' public transit system as an example. We simulate a variety of public bus turnover scenarios, considering initial costs of investments, energy and fuel requirements, and reductions in emissions. We demonstrate that optimized investment into electrifying public transit pays off, with annualized investments of about $5 million superseded by annual savings on fossil fuel imports of about $15 million. We suggest that international donors can accelerate this transition by providing loan guarantees and, by this, reducing the cost of capital.

4 Metropolitan Area Road Network Typologies and Their Implications for Sustainable Mobility

Jimi Oke, University of Massachusetts Amherst, Amherst

Over 80% of commuters across America's metropolitan statistical areas (MSAs) use single or shared car rides on increasingly congested roads. The growth of ridehailing and e-commerce is further driving demand for roadway use. Understanding and managing our road networks is therefore important to current and future climate change mitigation planning. Using network data from about 300 MSAs, we employ manifold learning approaches to derive a novel latent low-dimensional description of key network features. From the latent space, we learn network typologies without supervision. Finally, we investigate the significance of the latent features and the typologies themselves in explaining longitudinal congestion patterns, car usage and other sustainability indicators.

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TC70

CC-West 105B

Analytical Modeling Research in eBusiness

Community Committee Choice Session

Session Chair: Yeongin Kim, Virginia Commonwealth University, Glen Allen

1 The Merton Model Re-Visited: Design of Optimal Incentives for Traders in Copy Trading

Kai Sun[1], Mingwen Yang[2], Vijay S. Mookerjee[3], [1]University of Texas at Dallas, Richardson, TX, [2]University of Washington, Seattle, WA, [3]University of Texas- Dallas, Richardson, TX

Copy trading allows retail investors (followers) to automatically copy the trades of experts (traders) in real time after paying the following fees to the platform. To help mitigate the potential principle-agency problem, we propose a model that compensates the trader in a way that his trading behavior will not be altered.

2 How Much Personalization Do You Want? An Analytical Model of Online Retailer Product Displays

Jordan He, James Dearden, David Zhang, Oliver Yao, Lehigh University, Bethlehem, PA, Contact: qih320@lehigh.edu

We develop a game-theoretic model to analyze the impact of web content personalization on consumer behavior, taking into account two dimensions of personalized product recommendations (depth vs. width) and consumer types (focused vs. browsing). By allowing consumers to choose their preferred content, retailers can identify their types and personalize shopping pages accordingly. The proposed model provides evidence of the efficacy of customization strategies and addresses the challenge of balancing web content personalization in theory and practice.

3 Designing Randomness in Digital Games

Xianghua Wu[1], Hong Guo[2], Kay-Yut Chen[3], Jie Zhang[4], [1]University of Houston, Houston, TX, [2]Arizona State University, Tempe, AZ, [3]University of Texas at Arlington, Mansfield, TX, [4]University of Texas, Arlington, TX, Contact: hguo@asu.edu

This paper investigates the design of randomness in digital games. Two forms of randomness are analyzed - luck and matching. Managerial implications are discussed.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC71

CC-West 105C

Managing Crowd Platforms

Community Committee Choice Session

Session Chair: Jinyang Zheng, Purdue University, West Lafayette, IN

1 When Reward Meets Donation: A Paradoxical Dilemma

Yipu Deng[1], Jinyang Zheng[2], Guo Xin Li[3], Karthik Kannan[4], [1]University of Hong Kong, Hong Kong, China; [2]Purdue University, West Lafayette, IN, [3]Harbin Institute of Technology, Harbin Heilongjiang, China; [4]University of Arizona, Tucson, AZ, Contact: yipudeng@hku.hk

Reward-based crowdfunding platforms are increasingly incorporating a donation option, which enables backers to contribute money without redeeming any rewards. While this option has been touted as a novel fundraising channel, our study highlights the negative externalities it can generate, which ultimately leads to a decline in total raised funds. We identify two mechanisms that contribute to the adverse effect. Firstly, the bystander effect, wherein prior donations diminish prospective backers' willingness to support the campaign, leading them to either opt out of reward purchases or decrease their contribution amounts. Secondly, the social conformity effect, whereby prior donations shape backers' perceptions of social norms and consequently decrease their support levels. Our study makes substantial contributions to both the literature and practice.

2 Breaking the Glass Ceiling or Breaking Trust: How a Female Fraudster Affects Crowdfunding for Female Entrepreneurs?

Stan Shi, Chen Liang, University of Connecticut, Storrs, CT

Our study examines the impact of a high-profile female entrepreneur's fraud conviction on female entrepreneurship in the context of crowdfunding. Using a matched set of projects launched by male and female creators on a prominent crowdfunding platform, we employ a difference-in-differences model to estimate the gender-differential impact of this scandal. Our findings reveal that projects launched by female creators received 21.7% less funding, 12.5% fewer backers, and 9.2% less average amount contributed per backer than projects launched by male creators. The negative effect of the scandal on female creators is more pronounced in the technology section. These results shed light on the adverse consequences of a scandal on female entrepreneurship in the crowdfunding space and underscore the need to address gender disparities in the entrepreneurial landscape.

3 A Tale of Two Channels: Monetizing Free and Paid Channels on a Video-Sharing Platform

Ian Ho[1], Dongsheng Li[2], Xiangjing Chen[3], [1]Pennsylvania State University, State College, PA, [2]Penn State University, University Park, PA, [3]University of Nebraska-Lincoln, Lincoln, NE, Contact: xchen76@unl.edu

Video-sharing platforms (e.g., YouTube) enable content creators to monetize their videos via not only the advertising commission from free channels but the subscription fees from paid channels. While such a monetization model prevails, the strategic interactions among creators, consumers, and a platform remain unclear. Thus, we develop a game-theoretical model to study how a creator optimally chooses its efforts (i.e., qualities) and subscription fee to operate the two channels. We further extend the model by incorporating the creator competition in a duopoly setting. Our analytics provide clear guidance for creators and implications for consumers.

4 Game for Brainstorm: The Impact of a Badge System on Knowledge Sharing

Lei Wang[1], Yifan Zhang[2], Ian Ho[1], [1]Pennsylvania State University, State College, PA, [2]Kennesaw State University, Kennesaw, GA, Contact: lei.wang@psu.edu

Knowledge-sharing platforms have widely adopted gamification to encourage users to contribute high-quality content. This research thus carefully evaluates the impact of a badge system regarding the volume (the number of badges), variety (the number of badge categories), and valence (the level of badges), along with the moderating effect of user membership tenure. To characterize the dynamics of user-system interactions on Stack Overflow, we specify a structural hidden Markov model (HMM) to quantify users' corresponding knowledge contributions and engagement-state transitions. This study provides new aspects to contribute to the gamification and knowledge-sharing literature and generates actionable implications for platforms and gamification-system designers.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC72

CC-West 106A

Privacy and Behavioral Economics

Community Committee Choice Session

Session Chair: Laura Brandimarte, University of Arizona, Tucson, AZ

1 What Do Parents' Comments Tell Us? Privacy and Review Quality in Children's Mobile Apps Market

Vincent Lefrere, Grazia Cecere, Institut Mines-Telecom Business School, Paris, France

This study examined a panel data of more than 27,000 mobile apps targeting children to explore the relationship between privacy intrusion and the quality of associated user reviews. Using related keywords and a specialized app category for children, we collected app reviews and evaluated their quality in terms of grammatical mistakes and readability index. Our findings indicate that apps with higher levels of privacy intrusion tend to receive lower quality comments. These results highlight the importance of addressing privacy concerns to maintain positive user experiences and promote quality in children's mobile apps.

2 Examining the Effect of Personalized PII Exposure Alerts on Individuals' Privacy Protection Motivation

Fang yu Lin, University of Arizona, Tucson, AZ

Personally Identifiable Information (PII) leakage can lead to identity theft, financial loss, reputation damage, and anxiety. However, individuals remain largely unaware of their PII exposure on the Internet, and whether providing individuals with information about the extent of their PII exposure can trigger privacy protection actions requires further investigation. In this study, grounded by Protection Motivation Theory (PMT), we examine whether receiving privacy alerts in the form of threat and countermeasure information will trigger senior citizens to engage in protective behaviors. We also examine whether providing personalized information moderates the relationship between information and individuals' perception. We contribute to the literature by shedding light on the determinants and barriers to the adoption of privacy protection behaviors.

3 Gpt or Not to Be? Measuring the Trade-Off Between Functionality and Privacy Concerns

Laura Brandimarte[1], Jerg Gutmann[2], Gerd Muehlheusser[3], Franziska Weber[4], [1]University of Arizona, Tucson, AZ, [2]University of Hamburg, Hamburg, Germany; [3]University of Hamburg, Hamburg, Georgia; [4]Rotterdam University, Rotterdam, Netherlands

The use of modern AI technologies promises efficiency and productivity gains, but it also implies privacy costs that may or may not be present in users' mind when deciding to adopt. In this ongoing work, we present the results of an experiment run in two countries (Germany and the US) in which we manipulate between subjects the salience (low or high) of the privacy loss associated with the use of an AI, as well as the stringency of the active privacy regulatory environment (low or high). We also manipulate whether the AI is preset or needs to be activated, and measure the difference between these defaults. Similar to large language models like GPT, the AI we consider is capable of writing sophisticated and authentic text after being trained with the user's email exchanges. We use incentive-compatible mechanisms to measure willingness to use the technology and discuss implications.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC73

CC-West 106B

Contemporary Studies in Finance

Community Committee Choice Session

Session Chair: Umit Gurun, University of Texas-Dallas, Richardson, TX

1 Real Estate Investors and Property Taxation

Serena Xiao, 1</sup

We study the inequality in property taxation in the U.S. single-family home market based on a property's assessed value. Comparing the assessment ratio of properties owned by investors with those of owner-occupiers, we find a 3.0%-4.7% assessment discount nationwide for properties owned by large investors relative to owner-occupied homes in the same area. This difference translates into an estimated total annual property tax savings of $66-$104 million for large investors. Further evidence based on micro-level appeals data suggests that the assessment discount results from a higher likelihood of appeal and more favorable outcomes upon a successful appeal for large investors. States with a fairer property taxation administration, a higher market share by large investors, and a higher property tax burden show a greater assessment discount for large investors.

2 Performance Attribution for Portfolio Constraints

Andrew W. Lo[1], Ruixun Zhang[2], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Peking University, Beijing, China. Contact: zhangruixun@pku.edu.cn

We propose a new performance attribution framework that decomposes a constrained portfolio's holdings, expected utility, expected returns, variance, and realized returns into components attributable to: (1) the unconstrained mean-variance optimal portfolio; (2) individual static constraints; and (3) information, if any, arising from those constraints. A key contribution of our framework is the recognition that constraints may contain information that is correlated with returns, in which case imposing such constraints can affect performance. We derive conditions for when the excess return and variance from information is positive or negative. We provide simulated and empirical examples involving constraints on ESG portfolios. Contrary to conventional wisdom, constraints may improve portfolio performance under certain scenarios.

3 Prenatal Stress and Portfolio Decisions During Adulthood

Alok Kumar, 1</sup

Using earthquake exposure during pregnancy as a proxy for *in utero* insult, we examine the impact of prenatal stress on investment decisions during adulthood. We find that, compared with investors born immediately before an earthquake, investors exposed to a major earthquake *in utero* participate less in the stock market, hold less diversified portfolios, trade excessively, and earn lower returns. Earthquake exposure in the third trimester of pregnancy has stronger impact, and female investors exhibit greater sensitivity to *in utero* insults. In contrast, the adverse impact of earthquake exposure is weaker among individuals who are exposed to extreme *in utero* insults, as surviving babies are likely to have superior characteristics.

4 Who Benefits from Anti-Corruption Enforcement?

Jim Goldman[1], Stefan Zeume[2], [1]University of Warwick, Coventry, United Kingdom; [2]UIUC, Champaign, IL, Contact: zeume@illinois.edu

We exploit enforcement actions for violations of the U.S. Foreign Corrupt Practices Act in non-OECD countries to study the effect of anti-bribery enforcement on unpunished firms. Firms in the same country-industry as the violator experience significant increases in revenue (+6.4%) and asset productivity (+4.2%). This result is driven by foreign-owned business group affiliates and amplified when affiliates are active in government-dependent industries, members of groups with limited corruption experience, and owned by productive parents. Overall, anti-bribery enforcement actions, which also reduce local corruption levels, result in reallocation of economic activity and level a playing field disrupted by corruption.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC74

CC-West 106C

Algorithmic Learning in Games

Community Committee Choice Session

Session Chair: Clemens Possnig, Vancouver School of Economics, University of British Columbia, Vancouver, BC, Canada

1 Reinforcement Learning and Collusion

Clemens Possnig, Vancouver School of Economics, University of British Columbia, Vancouver, BC, Canada

This paper presents an analytical characterization of the long run policies learned by algorithms that interact repeatedly. These algorithms update policies which are maps from observed states to actions. I show that the long run policies correspond to equilibria that are stable points of a tractable differential equation. As a running example, I consider a repeated Cournot game of quantity competition, for which learning the stage game Nash equilibrium serves as non-collusive benchmark. When algorithms determine actions based only on the past period’s price, the Nash equilibrium can be learned. However, conditioning actions on a richer type of information can preclude the Nash equilibrium from being reached. This type of information allows for the existence of a collusive equilibrium that will be learned with positive probability.

2 Efficient-Q Learning for Stochastic Games

Muhammed O. Sayin, Onur Unlu, Bilkent University, Ankara, Turkey. Contact: sayin@ee.bilkent.edu.tr

We present the new efficient-Q learning dynamics for stochastic games beyond the recent concentration of progress on provable convergence to possibly inefficient equilibrium. Agents follow log-linear learning in stage games whose payoffs are the Q-functions and estimate the Q-functions iteratively with a vanishing stepsize. This (implicitly) two-timescale dynamic makes stage games relatively stationary so that the agents can track the efficient equilibrium. We show the provable convergence of the Q-function estimates to the ones associated with (near) efficient equilibrium in identical-interest stochastic games. The key idea is to approximate the dynamics with a fictional scenario where Q-function estimates are stationary over finite-length epochs and then couple these scenarios such that the approximation error decays to zero due to the vanishing stepsize.

3 Kernelized Multiplicative Weights for 0/1-Polyhedral Games: Bridging the Gap Between Learning in Extensive-Form and Normal-Form Games

Gabriele Farina, MIT, Cambridge, MA, Contact: gfarina@mit.edu

While extensive-form games (EFGs) can be converted into normal-form games (NFGs), doing so comes at the cost of an exponential blowup of the strategy space. So, progress on NFGs and EFGs has historically followed separate tracks, with the EFG community often having to catch up with advances from the larger NFG community. I will show that the Optimistic Multiplicative Weights Update (OMWU) algorithm—the premier learning algorithm for NFGs—can be simulated on the normal-form equivalent of an EFG in linear time per iteration in the game tree size using a kernel trick. The resulting algorithm, Kernelized OMWU, applies also to convex games whose strategy space is a polytope with 0/1 integral vertices, and closes several standing gaps between NFG and EFG learning, by enabling transfer of desirable properties of learning dynamics so far known to be achievable only in NFGs.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC75

Session.Location:CC-West 208A

Optimization of Pick-up and Delivery Operations

Contributed Session

Session Chair: Elson Cibaku, New Jersey Institute of Technology, Rutherford, NJ

1 Field Experiments to Assess the Environmental, Social, and Economic Benefits of Creating Dedicated Loading-Unloading Areas for Freight Vehicles in Emerging Markets

Camilo Mora[1], Jan C. Fransoo[2], Leopoldo Cardenas Barron[1], Josue Velazquez Martinez[3], [1]Tecnologico de Monterrey, Monterrey, Mexico; [2]Tilburg University, Tilburg, Netherlands; [3]Massachusetts Institute of Technology, Cambridge, MA, Contact: camilomora@tec.mx

The lack of parking for freight vehicles in urban areas negatively impacts the distribution of goods, resulting in increased costs, and carbon emissions. As the world's urban population rises and urban freight transportation increases, this problem is expected to grow. One potential solution is the creation of dedicated loading-unloading zones. We conducted two field experiments in Mexico to assess the effects on carbon emissions, noise pollution, and traffic congestion. The results show a 4% reduction in the carbon intensity factor, over 10% savings in logistics costs, a reduction of 2.73% in CO2 in the air, a 7.94% reduction in noise pollution, and an increase in the average speed of vehicles by 1.55%. These findings suggest that creating these spaces is an effective solution for improving the efficiency and sustainability of urban freight transport in developing cities.

2 Pickup and Delivery Facilities for Small Shipments

Anton J. Kleywegt, Xinyu Liu, ISyE Georgia Tech, Atlanta, GA, Contact: xinyu.liu@gatech.edu

Large numbers of shipments are picked up and delivered at urban locations every day. Most of these shipments are relatively small, not needing loading docks for their pickups and deliveries. These pickups and deliveries often take place at curbsides, aggravating traffic congestion. Thus there is a great need for designated spaces designed for pickups and deliveries, with minimal effects on traffic. This work proposes policies for the operation of such facilities, and methods to evaluate these policies in terms of throughput capacity. We formulate the problem as an MDP, provide bounds on throughput capacities, and present numerical results.

3 Multi-Pickup and Delivery of Restaurant Orders - A Graph-Aware Reinforcement Learning Approach

Elson Cibaku[1], Sanchoy Das[2], [1]New Jersey Institute of Technology, Rutherford, NJ, [2]New Jersey Institute of Technology, Newark, NJ

This research delves into the intricate process of multiple pickup and delivery mechanisms for restaurant orders, employing a unique approach that draws upon the capabilities of graph-aware reinforcement learning (RL). Advanced graph representation learning techniques are applied to handle the food service industry's complex logistics, aiming to improve service, reduce delays, and cut costs. A promising RL model is proposed to learn from environmental interactions, refining decision-making over time. This study provides a promising perspective on the role of artificial intelligence in revolutionizing food service logistics, making a significant contribution to the growing domain of intelligent and automated delivery systems.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC76

Session.Location:CC-West 208B

Supply Chain Risk and Resilience

Contributed Session

Session Chair: Guilherme Tortorella, University of Melbourne, Docklands, Australia

1 Assessing the Resilience of Supply Chains to Climate Change:Building a Climate-Resilient Supply Chain and Enhancing Competitiveness

Laharish Guntuka, Rochester Institute of Technology, Rochester, NY, Contact: lguntuka@saunders.rit.edu

This study investigates the relationship between climate hazards, business risk exposure, supply chain susceptibility, disruption impact, resilience, and response capacity. The study aims to provide a better understanding of how firms can improve their supply chain resilience in the face of increasing climate hazards and business risk exposure. Data from a supply chain visibility firm, Resilinc, from various industries will be used to test the hypotheses. The study's findings will be relevant for managers and policymakers seeking to strengthen supply chain resilience in the face of disruptive events.

2 Research on the Impact of Supply Chain Network Structure on Firm Innovation Performance

Ying Teng[1], Jiao Liu[1], Fuying Jing[2], [1]Yangtze Delta Region Institute (Huzhou), University of Electronic Science and Technology of China, Chengdu, China; [2]Chongqing Technology and business University, Chongqing, China

With the increasing demand from consumers and rapidly shortening product cycles, supply chain partnerships between enterprises have become highly intertwined. As a result, complex network characteristics have emerged within the supply chain. To analyze the impact of these characteristics on innovation performance, this paper adopts a social network perspective and utilizes data from publicly listed companies in China's manufacturing industry as the basis of research. The findings suggest that within supply chain networks, the centrality of enterprises has a significant negative effect on their innovation performance, while the structural hole has a positive influence. Moreover, the absorptive capacity of enterprises plays a partial mediating role between the supply chain network's structure and innovation performance.

3 Forecasting Estimated Arrival Time (ETA) with Confidence for Supply Shipments in a Globalized Supply Chain

Dan Hu[1], Zuochun Tang[2], [1]IBM, San Jose, CA, [2]IBM, san francisco, CA, Contact: dan.hu@ibm.com

In today's global business landscape, companies operate supply chains spanning multiple countries, encompassing suppliers, manufacturing facilities, and shipments that navigate shared routes and ports. However, the exact shipment travel time remains uncertain, posing challenges for supply assurance managers. To address this, we propose a forecasting model that estimates the arrival time (ETA) of supply shipments along with a measure of confidence. Our model leverages features derived from suppliers' information, route information, as well as information from orders and shipments. By incorporating these factors, we offer valuable insights into understanding and anticipating ETA variations for supply assurance managers.

4 Resilience and Digital Transformation of the Food Supply Chains

Guilherme Tortorella[1], Marianne Gloet[1], Daniel Samson[1], Sherah Kurnia[1], Flavio Fogliatto[2], Michel Anzanello[2], [1]University of Melbourne, Docklands, Australia; [2]Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil. Contact: gtortorella@bol.com.br

This study investigates the relationship between resilience development and digital transformation and its effect on food supply chain performance. A survey of 208 practitioners in Australia was conducted. Findings suggest a positive impact on performance, particularly in terms of on-time, in-full delivery and inventory turnover. Organizations with low resilience can significantly improve their performance through the adoption of technologies, while those with well-established resilience display a lesser impact.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC77

Session.Location:CC-West Lecture Hall

Reinforcement Learning and Bandit Problems

Contributed Session

Session Chair: Audrey Bazerghi, Northwestern University, Evanston, IL

1 Multi-Agent and Multi-Objective Multi-Armed Bandit

Mengfan Xu[1], Diego Klabjan[2], [1]Northwestern University, Evanston, IL, [2]Northwestern University, Evanston, IL, Contact: mengfanxu2023@u.northwestern.edu

EXP-based algorithms are often used for exploration in non-stochastic bandit problems assuming rewards are bounded. Motivated by the recent advancements in reinforcement learning (RL) with rewards of any scale, we propose a new algorithm, namely EXP4.P, and extend EXP4.P from bandit to RL to incentivize exploration. Furthermore, we study Pareto optimality in multi-objective multi-armed bandit by providing a formulation of adversarial settings and defining its Pareto regrets that can be applied to both stochastic and adversarial settings. We also present new (nearly) optimal algorithms. Lastly, we study a decentralized multi-agent multi-armed bandit problem in which multiple clients are connected by graphs. We introduce a novel algorithmic framework and derive (nearly) optimal instance-dependent and instance-free regret upper bounds.

2 Transfer Reinforcement Learning for Momdps with Time-Varying Interval-Valued Parameters and Its Application in Pandemic Control

Mu Du[1], Hongtao Yu[1], Nan Kong[2], [1]Dalian University of Technology, Dalian, China; [2]Purdue University, West Lafayette, IN, Contact: dumu@dlut.edu.cn

We investigate a novel type of online sequential decision problem, namely, *mixed observability Markov decision process with time-varying interval-valued parameters*. We propose a novel transfer reinforcement learning (TRL) based algorithmic approach that ingrates transfer learning into deep reinforcement learning in an offline-online scheme. To accelerate the online re-optimization, we pre-train a collection of promising networks and fine-tune them with new observation dynamically. Our approach is the first-ever endeavor of employing intensive neural network training in solving MDPs requiring online system identification and re-optimization. TRL outperforms existing methods in solution optimality, robustness, efficiency, and scalability. A retrospective study on a pandemic control shows it improves decision making on several public health metrics.

3 Flexible Relative Value Iteration for Reinforcement Learning in Ridesharing

Audrey Bazerghi[1], Sebastien Martin[1], Garrett J. van Ryzin[2], [1]Kellogg School of Management, Northwestern University, Evanston, IL, [2]Amazon, New York, NY

We introduce a flexible relative value iteration algorithm (FlexRVI) for dynamic programming, which allows the computation of value differences between any pair of states. We prove that the Bellman operator of FlexRVI is a contraction, and that its convergence rate is equivalent to the classical relative value iteration algorithm. Applied to a large-scale reinforcement learning problem in ridesharing, the FlexRVI idea leads to simpler state approximations and better performing policies than conventional methods, two results which could extend to many important classes of problems.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC78

Session.Location:CC-West 211A

Deep Learning and Scheduling Problems

Contributed Session

Session Chair: Tianyu Wang, Fudan University, Shanghai, China

1 Minimizing Makespan for Job Shop Scheduling Problem Using Deep Learning Model Employing Critical Paths of Schedules for Large Neighborhood Search

Gwanhee Lee, Kyungduk Moon, Myungho Lee, Dongyun Kim, Yeonjun Choi, Insoo Park, Kangbok Lee, POSTECH (Pohang University of Science and Technology), Pohang, Korea, Republic of. Contact: ghlee22@postech.ac.kr

We propose a heuristic for job shop scheduling problems (JSSP) minimizing makespan by developing deep learning models to identify parts of the schedule to reconstruct in large neighborhood search. Recent studies have demonstrated that deep learning can perform well to build initial solutions of JSSP or other combinatorial optimization problems step by step. However, there have been few discussions on improving solutions after taking relationship with makespan and critical paths of the incumbent schedule into account. In this presentation, we discuss the effectiveness of developing deep learning modules trained with critical paths for makespan minimization in JSSP which carefully select the parts of the schedule which need to be rescheduled.

2 A Search Algorithm Based on Makespan Ranking for Solving Job-Shop Scheduling Problems

Yi-Wen Yang, Sheng-I Chen, National Yang Ming Chiao Tung University, Hsinchu, Taiwan. Contact: tiffan888928.mg11@nycu.edu.tw

This study considered job-shop scheduling problems with the objective of minimizing the makespan. We aim to provide a fast and quality solution to enhance manufacturer agility when making decisions. We develop a local search algorithm to explore neighbors that have the same medium completion-time jobs as the current solution. When the objective is not improved, a k-combination search is used to prevent the algorithm from stocking at the local optimum. The computational experiment compares our algorithm performances with prior works using public testing-bed instances. The result is promising where our method can obtain solutions in 4~8% gaps to the best-known solution in a restively short run time.

3 Lipschitz Bandits with Batched Feedback

Tianyu Wang, Yasong Feng, Zengfeng Huang, Fudan University, Shanghai, China. Contact: wangtianyu@fudan.edu.cn

We study Lipschitz bandit problems with batched feedback, where the expected reward is Lipschitz and the reward observations are communicated to the player in batches. We introduce a novel landscape-aware algorithm, called Batched Lipschitz Narrowing (BLiN), that optimally solves this problem. Specifically, we show that for a T-step problem with Lipschitz reward of zooming dimension d_z, our algorithm achieves theoretically optimal (up to logarithmic factors) regret rate $\widetilde{\mathcal{O}}\left(T^{\frac{d_z+1}{d_z+2}}\right)$ using only $ \mathcal{O} \left(\log\log T\right) $ batches. We also provide complexity analysis for this problem. Our theoretical lower bound implies that $\Omega(\log\log T)$ batches are necessary for any algorithm to achieve the optimal regret. Thus, BLiN achieves optimal regret rate using minimal communication.W

Tuesday, October 17, 12:45 PM - 2:00 PM

TC79

Session.Location:CC-West 211B

Optimization Approaches for Machine Learning

Contributed Session

Session Chair: Rick Willemsen, Erasmus University Rotterdam, Rotterdam, Netherlands

1 Estimation of Optimal Treatment Regime in High Dimensional Single-Index Quantile Regression

Suneel Babu Chatla[1], Indrabati Bhattacharya[2], [1]University of Texas at El Paso, El Paso, TX, [2]Florida State University, Tallahassee, FL, Contact: sbchatla@utep.edu

Estimation of the optimal treatment regime is an important problem and has useful applications in various fields. The mean-optimal treatment regime is not reliable when the outcome distribution is not symmetric. The quantile-optimal treatment regime, which optimizes some desired quantile of the potential outcome instead of the mean, may occasionally be of interest. We propose a flexible penalized single-index model which can select the important variables from high-dimensional baseline covariates. We discuss the asymptotic properties of the proposed estimators. Our results help to quantify the variability related to the estimated quantile optimal treatment regime by constructing simultaneous confidence bands. The usefulness of the proposed methodology is illustrated using simulations and data analysis.

2 Graph Neural Networks with Dynamic Programming for Workflow Scheduling

Vivek Anand Rajopanth[1], Rakesh Nagi[2], [1]University of Illinois at Urbana Champaign, Urbana, IL, [2]University of Illinois at Urbana Champaign, Urbana, IL, Contact: var4@illinois.edu

Workflow scheduling is a well-known combinatorial optimization problem for which researchers have tried designing numerous heuristics over the years. Recent advances use machine learning methods that either replace traditional algorithms with fast function approximations learned through neural networks or reinforcement learning. Our approach uses Graph Neural Networks (GNN) to create a "heatmap" of edges that describes the probability of every task-executor pairing in the optimal solution. This heatmap is learned by formulating the corresponding Mixed Integer Linear Program and training the GNN on its optimal solutions. The heatmap generated by the GNN is then leveraged to find the best solution using Dynamic Programming.

3 Exact Methods for Hierarchical Clustering

Rick Willemsen, Carlo cavicchia, Wilco van den Heuvel, Michel van de Velden, Erasmus University Rotterdam, Rotterdam, Netherlands. Contact: willemsen@ese.eur.nl

The aim of hierarchical clustering is to obtain a hierarchy of nested partitions. Researchers have proposed several objective functions and approximation algorithms. Commonly applied heuristics are not guaranteed to find an optimal solution. However, exact methods that can optimize these objective functions have received less attention. We propose several exact methods for hierarchical clustering, based on the partitional clustering literature and an objective based on a sum of partitional clustering objectives. We introduce compact linear programming formulations, as well as a set-covering formulation that can handle various objective functions. In addition, we provide a branch-and-price framework to solve the set-covering formulation. We validate our approach on labeled instances and evaluate the scalability of our method on real-world data.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC80

Session.Location:CC-West 212A

Analysis of Online Reviews and Frontiers in Conversational AI

Contributed Session

Session Chair: Ivan Belik, Norwegian School of Economics, Bergen, Norway

1 The Effect of Identity Multiplicity Signaling on Interpersonal Trust

Yi Su, Yiqi Yu, Yunlu Yin, Fudan University, Shanghai, China. Contact: suy20@fudan.edu.cn

This research investigates how and why signaling multiple identities (vs. a single identity) influences interpersonal trust. Six studies—including a field experiment, analysis of social media data, and lab and online experiments—demonstrate that identity multiplicity signaling fosters interpersonal trust by promoting perceived authenticity. We replicate this finding across studies with various measures and designs. We also show that the effect of identity multiplicity is attenuated when the identity signaling message is presented together with monetary exchange mentions as a cue that suggests lack of authenticity. Taken together, the results advance the understanding of the multifaceted nature of identity and its social cognitive consequences in contexts such as (online) communication, collaboration, and persuasion.

2 Chatbot Persuasion: An Elaboration Likelihood Model Perspective

Tianling Xie[1], Iryna Pentina[2], Benjamin T. George[3], [1]University of Toledo, Toledo, OH, [2]University of Toledo, Toledo, OH, [3]University of Toledo, Toledo, OH, Contact: tianling.xie@rockets.utoledo.edu

Conversational agents (CAs) are AI-enabled programs engaging in conversations and interactions with humans. While simple rule-based CAs primarily assist users with predefined queries and information retrieval, more advanced CAs can understand user intentions, and exhibit emotions, personality traits, and empathy. Recently, there has been a growing interest in utilizing CAs to influence users' attitudes, beliefs, and behaviours, such as AI counselors and AI coaches. Recognizing this trend, we propose a laboratory experiment design under the Elaboration Likelihood Model and the Social Response Theory, to compare the persuasion effectiveness of a chatbot and a website without the interactive conversational capability.

3 The Impact of Privacy Data Utilization and Protection on Enterprises Performance: A Structural Equation Modeling Approach

Chen Menting, Park Kwangtae, KUBS, Seoul, Korea, Republic of. Contact: douzi-zaoer@naver.com

The development of big data and AI technologies has driven enterprises to benefit from accurate analysis of user data. However, it has also raised concerns about privacy data security. Thus, this research aims to explore the impact of enterprise usage and protection of user privacy data on business performance. Hypotheses and measurement scales of this research will be designed from the perspectives of both enterprises and users, by using the privacy risk perception process. Furthermore, a structural equation model will be used for empirical testing, in order to optimize enterprises utilization and protection strategies of private data in the data revolution.

4 Analysis of Online Consumer Discussions on Reddit Based on a Machine Learning Approach

Ivan Belik, Denis Utochkin, Norwegian School of Economics, Bergen, Norway

We employ state-of-the-art data analysis techniques such as natural language processing, opinion analysis, and complex network analysis to understand customer preferences on the Reddit media platform. In particular, we collect a large-scale dataset about online discussions, extract customer opinions, and predict the distribution of information on customer networks. Specifically, we collect the dataset that encompasses all activity from nearly two million anonymized users in a twelve-month period and employ the developed approach for extracting customer opinions and forecasting dissemination of electronic word-of-mouth in real-world customer networks.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC82

Session.Location:CC-West 212C

Resource Management in Healthcare Settings

Contributed Session

Session Chair: Jaeyoung Kim, Clemson University, Clemson, SC

1 Revisiting the Operating Room Utilization Problem in Surgical Services

Saharnaz Mehrani, Ravi S. Behara, Florida Atlantic University, Boca Raton, FL, Contact: smehrani@fau.edu

Operating room (OR) scheduling significantly impacts patient and healthcare-provider satisfaction and has clinical and financial effects on hospitals. This study investigates the application of data analytics and optimization to improving OR utilization while considering patients and providers criteria. We perform numerical experiments on real data from a large urban hospital.

2 A Study on Policy Decisions to Embed Flexibility in the Planning and Scheduling in Operating Roomsconsidering Multiple Resource Stages in the Operating Room

Babak Akbarzadeh[1], Broos Maenhout[2], [1]University of Gent, Ghent, Belgium; [2]Ghent University, Ghent, Belgium. Contact: babak.akbarzadeh@ugent.be

The endeavor for operational excellence in the operating room (OR) department is hampered by uncertainty underlying patient demand for healthcare resources. Incorporating this uncertainty is complicated since planning and scheduling decisions are organized according to a hierarchical decision structure in different phases. In this study, we link the strategic, tactical, and operational decision-making in the OR department and study the impact of policy decisions embedding flexibility in the OR planning and scheduling processes to improve the operational outcome, making the trade-off between efficiency and consistency. We consider a sequential but interrelated proactive-reactive decision framework that is guided by both generic assumptions from literature and real life. Analysis is performed via computational experimentation on a real-life dataset.

3 Integer Programming for Surgery Scheduling Under Uncertainty

Nicklas Klein, Robin Hauenstein, Nicola Travaglini, Norbert Trautmann, University of Bern, Bern, Switzerland. Contact: nicklas.klein@unibe.ch

Flexible operating rooms can be used for scheduled elective surgeries and randomly arriving emergency surgeries, both with uncertain durations. The scheduling problem we deal with consists of assigning given elective surgeries to operating rooms and determining their start times to minimize the sum of the room-assignment cost and the expected cost associated with delays or cancellations of surgeries and with idle- or overtime. We formulate this problem as a two-stage mixed-integer linear program; to tackle instances of realistic size and complexity, we propose a corresponding matheuristic.

4 Optimaloperation Room Scheduling in the Large-Scale Hospital

Shao-Jen Weng, Tunghai University, Taichung City, Taiwan. Contact: sjweng@thu.edu.tw

The operating room in the hospital has high-tech, expensive medical equipment and various professional medical personnel, making the operating room to be a high cost place and one of the main incomes for the hospital. Thus, the better use of the operating room plays an important role in the operation of the hospital. If a more effective and appropriate surgical scheduling plan and effective resource allocation in the operating room can be realized, limited medical resources can be fully utilized, effective utilization rate can be improved, and medical costs can be relatively reduced. This research used simulation and optimization method to find the optimal resource allocation decision to reduce hospital operating costs and increase revenue.

5 Do New Partner and Procedure Exposure Influence Operating Room Nurse Turnover?

Jaeyoung Kim[1], Ahmet Colak[2], Lawrence Fredendall[2], [1]University of Dayton, Dayton, OH, [2]Clemson University, Clemson, SC, Contact: jkim02@udayton.edu

High operating room (OR) nurse turnover presents significant financial and operational challenges for hospitals. However, there are limited empirical insights for OR nurse turnover despite a growing stream of empirical studies on nurse turnover outside of the OR. Motivated by these recent insights, we conduct an exploratory empirical study to investigate the impact of OR nurse scheduling data on predicting nurse departure. Using granular data for 547 OR nurses across 77,046 surgeries, we show substantial connections between nurse scheduling and departure: we find new procedure and partner exposures---as well as diversity and familiarity of partners and procedures---to significantly influence nurse departure conditional on nurse tenure and role. Hence, our study documents the importance of nurse scheduling for hospital managers while reducing costly OR turnover.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC83

Session.Location:CC-West 213A

Agriculutural Applications

Contributed Session

Session Chair: Lei Xu, Georgia Tech Shenzhen Institute, Shenzhen, China

1 The Impact of Blockchain on Profit and Waste in Food Supply Chains

Fan Si, Lucy Gongtao Chen, National University of Singapore, Singapore, Singapore. Contact: e0546111@u.nus.edu

Food supply chains can incur significant waste due to different quality standards adopted by supply chain members. In this paper, we investigate the impact of blockchain technology on food waste and profitability in a supply chain with one supplier and one retailer. We find that adopting blockchain technology always improves the supplier's profit but can hurt the retailer's and the supply chain's profitability. We also find that when the supplier's quality standard is very high, the implementation of blockchain is more likely to reduce the waste in the supply chain.

2 Crop Production in Emerging Economies: The Value of Pricing Mechanisms

Jian Li[1], Guang Xiao[2], Panos Kouvelis[3], [1]Northeastern Illinois University, Chicago, IL, [2]Hong Kong Polytechnic University, Hung Hom, Hong Kong; [3]Washington University in St. Louis, ST. LOUIS, MO, Contact: j-li3@neiu.edu

This paper examines an agricultural supply chain for a particular crop, where farmers can choose to sell their product in a side market or to a processing plant. In addition, the government offers a minimum price guarantee for the crop. We explore various pricing strategies that the processing plant can use to engage with farmers regarding land and harvest allocation decisions. We develop two-stage stochastic program models to analyze these allocation and pricing decisions at an aggregate farming level.

3 Embracing the Growth of Responsibly-Driven Procurement Through an Innovative Two-Bin Strategy for Selling Short-Shelf Life Produce

Li-Ming Chen, National Chengchi University, Taipei, Taiwan. Contact: lmchen@nccu.edu.tw

We explore a supply chain problem—the application of a two-bin selling strategy by an upstream vendor to sell produce to responsible buyers (RBs) and mainstream buyers (MBs). The primary bin with the fresh goods is prepared for an RB, which is willing to provide higher-than-market procurement prices and guarantee stable procurement quantities of goods. Unsold fresh goods are then moved to the secondary bin, which is prepared for price-sensitive

RBs; in this bin, goods have new and old ages and the good consumption follows the first-in, fist-out issuing policy. We consider a periodic review model for a perishable product with fixed lifetime equal to two review periods, and analyze the optimal replenishment quantity and secondary bin price. We further investigate the benefits came from primary bin by comparing with the scenario where the vendor sells goods only to the MBs.

4 Allocation of Humanitarian Relief Budget with In-Kind and Cash Assistance

Yingling Zhao, Lei Xu, Georgia Tech Shenzhen Institute, Shenzhen, China. Contact: xulei@gtsi.edu.cn

In this paper, we consider a humanitarian relief budget allocation problem. The humanitarian organization (HO) can spend the budget on relief item purchase, on media coverage to attract in-kind and cash assistance, and on warehouse capacity operation and expansion. A two-period dynamic model is proposed to find the optimal spending decisions for the HO to maximize the total expected utility. We first analyze the optimal allocation in the second period. We observe that the warehouse's capacity influences the optimal decisions in the first period. To further explore this relationship, we establish different thresholds for the warehouse's capacity and analyze the constraints of the model to obtain different optimal allocations under various capacity values. The HO can thus better understand the key factors in budget allocation and satisfy the needs of beneficiaries.

3 Capacity Management and Modelling in the Agri-Food Supply Chain: A Systematic Literature Review

Chenqiang Yue, Dong Li, Dongping Song, University of Liverpool, Liverpool, United Kingdom. Contact: yuecq@liverpool.ac.uk

This paper conducts a systematic literature review of capacity management and modelling in the context of agri-food supply chains. Descriptive and theme-based analysis are presented to reveal how capacity management is modelled under uncertainty and risk preferences from perspectives of optimal decisions, influencing factors, and methodology. We highlight current research status and identify future research opportunities.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC84

Session.Location:CC-West 213B

Advacing Inventory and Supply Chain Management

Contributed Session

Session Chair: Austin Saragih, Massachusetts Institute of Technology, Cambridge, MA

1 Deep Inventory Management

Dhruv Madeka[1], Carson Eisenach[2], Kari Torkkola[2], Anna Luo[3], Dean P. Foster[2], Sham Kakade[4], [1]Amazon, Seattle, WA, [2]Amazon, Seattle, WA, [3]Pinterest, Seattle, WA, [4]Harvard University/Amazon, Seattle, WA

This work provides a Deep Reinforcement Learning approach to solving a periodic review inventory control system with stochastic vendor lead times, lost sales, correlated demand, and price matching. In order to train these algorithms, we develop novel techniques to convert historical data into a simulator. On the theoretical side, we present learnability results on a subclass of inventory control problems, where we provide a provable reduction of the reinforcement learning problem to that of supervised learning. On the algorithmic side, we present a model-based reinforcement learning procedure (Direct Backprop) to solve the periodic review inventory control problem by constructing a differentiable simulator. Under a variety of metrics Direct Backprop outperforms model-free RL and newsvendor baselines, in both simulations and real-world deployments.

2 The Inventory Routing Problem with Split Deliveries

Luca Bertazzi[1], Claudia Archetti[2], Nho Minh Dinh[1], [1]University of Brescia, Brescia, Italy; [2]University of Brescia, Brescia, Italy. Contact: luca.bertazzi@unibs.it

We study the benefit of introducing split deliveries in the Inventory Routing Problem, both when the Order-up-to level and the MaximumLevel replenishment policies are applied. We first propose a mathematical formulation and solve it by implementing a branch-and-cut algorithm. Then, we carry out a worst-case analysis to show the cost increase we have in the worst case by using unsplit deliveries instead of split deliveries, both for the Order-up-to level and the Maximum-Level replenishmentpolicies. Finally, we design a matheuristic algorithm. Extensive computational results on benchmark instances allow us to understand the benefit of introducing split deliveries and to show that the matheuristic algorithm is effective.

3 Tipdat: Ml Based Optimization Explainer

Brijesh Singhal, Manan Chopra, Saurabh Unercat, Amazon, Bellevue, WA, Contact: brijesh.singhal@outlook.com

Amazon's Retail Inventory is outcome of systems optimizing stochastic variables to met demand and maximize profit. Historically, we've relied on long manual subjective deep-dives to inspect defects, and improve outcomes, which have proved to be unscalable and disconnected from actual supply-chain behavior. We developed a 2 staged algorithm that can connect these inputs to inventory. Stage 1 of the algorithm trains a large-scale ML model over a billion observations to approximate a complex stochastic programming algorithm used to make buying decisions. We developed an attribution algorithm that leverages the concept from Shapley values where attribution follows efficiency, symmetry, linearity, and null player properties, it also jointly attributes to the variables in the case when variables are highly dependent and independent attribution is not desirable.

4 Plastic Waste Reverse Logistics Network Design Under Decision-Dependent Uncertainty

Austin I. Saragih[1], Milena Janjevic[1], Matthias Winkenbach[2], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: saragih@mit.edu

This paper proposes a holistic approach to large-scale plastic waste Reverse Logistics Network Design (RLND) considering strategic logistics network design and tactical collection design. It integrates flexibility, uncertainty, and decision-dependency through a two-stage stochastic program with sample average approximation and quantile regression. The case study from MIT Climate Sustainability Consortium highlights the benefits of distribution flexibility under uncertainty.

Tuesday, October 17, 12:45 PM - 2:00 PM

TC88

CC-North Exhibit Hall

INFORMS Poster Competition

Poster Session

Session Chair: Hrayer Aprahamian, Texas A&M University, College Station, TX

Session Chair: Adolfo Raphael Escobedo, Arizona State University, Tempe, AZ

Session Chair: Bjorn Berg, University of Minnesota, Minneapolis, MN

Tuesday, October 17, 2:15 PM - 3:30 PM

TD03

CC-North 120D

SAS/AMPL

Technology Tutorial

1 Building and Solving Optimization Models with SAS

Rob Pratt, SAS Institute, Inc., Cary, NC, Contact: rob.pratt@sas.com

SAS offers extensive analytic capabilities, including machine learning, deep learning, natural language processing, statistical analysis, optimization, and simulation. SAS analytic functionality is also available through the open, cloud-enabled design of SAS® Viya®. You can program in SAS, Python, Lua, Java, and R. SAS Analytics is also equipped with AI-enabled automations and modern low-code or no-code user interfaces that democratize data science usage in your organization and offer unparalleled speed to value. OPTMODEL from SAS provides a powerful and intuitive algebraic optimization modeling language and unified support for building and solving LP, MILP, QP, conic, NLP, constraint programming, network-oriented, and black-box models. This tutorial will include an overview of the optimization capabilities and demonstrate recently added features.

2 Python and AMPL: Build Prescriptive Analytics Applications Quicklywith Pandas, Colab, Streamlit, and amplpy

Filipe Brandão, Robert Fourer, AMPL Optimization, Inc., Mountain View, CA, Contact: fdabrandao@ampl.com

Python and its vast ecosystem are great for data pre-processing, solution analysis, and visualization, but Python's design as a general-purpose programming language makes it less than ideal for expressing the complex optimization problems typical of OR and prescriptive analytics. AMPL is a declarative language that is designed for describing optimization problems, and that integrates naturally with Python.In this presentation, you'll learn how the combination of AMPL modeling with Python environments and tools has made optimization software more natural to use, faster to run, and easier to integrate with enterprise systems. Following a quick introduction to model-based optimization, we will show how AMPL and Python work together in a range of contexts:•Installing AMPL and solvers as Python packages•Importing and exporting data naturally from/to Python data structures such as Pandas dataframes•Developing AMPL model formulations directly in Jupyter notebooks•Using AMPL and full-featured solvers on Google Colab,with no installation overhead and free access for courses•Turning Python scripts into prescriptive analytics applications in minutes with amplpy, Pandas, and Streamlit

Tuesday, October 17, 2:15 PM - 3:30 PM

TD04

CC-North 121A

Pricing and Other Considerations in Business Operations

Contributed Session

Session Chair: Rajeev Tyagi, University of California, Irvine, Irvine, CA

1 Fair Skill Brier Score: Evaluating Probabilistic Forecasts of One-Off Events with Different Numbers of Categorical Outcomes

Junnan Wang[1], Barbara Mellers[2], Lyle Ungar[2], Ville Satopaa[3], [1]INSEAD, Singapore, Singapore; [2]University of Pennsylvania, Philadelphia, PA, [3]INSEAD, Paris, France. Contact: junnan.wang@insead.edu

Experts' abilities to make accurate probabilistic forecasts are often evaluated with proper scoring rules. The Brier score is one of the most commonly used scoring rules when the target outcomes are categorical. The score, however, is not only influenced by the expert's forecasting skill but also by the inherent uncertainty of the events. For instance, an event with more outcomes is typically more difficult to forecast. It is then unfair to compare the Brier scores of experts who forecast events with different numbers of outcomes. In this paper, we introduce a simple fair skill adjustment to the Brier score to refine such comparisons. We introduce a behavioral model of experts' forecasts and show that the fair skill Brier score is a more reliable measure of experts' forecasting skills in general. We then find empirical support for our theoretical results from experimental data.

2 A Dynamic Choice Model-based Stated Preference Analysis Study for Tradable Goods

Myoungjn Oh, Jungwoo Shin, Kyung Hee University, Yongin, Korea, Republic of

Choice models are widely used to assess the monetary value of goods and services based on consumer preference analysis. This study, among them, presents a dynamic choice model that depicts the strategic multi- and future-ownership behavior of individuals. The model can evaluate the impact of purchase and sale decisions independently. In addition, the model can derive the phenomena of waiting demand, which moves current consumption into the future, and demand self-cannibalism, which draws future demand into the present, as a reflection of consumers' forward-looking behavior. In this study, the model is applied to the vehicle market, but it can also be used to analyze real estate, mobile phones, and subscription services.

3 Survive And Thrive: Strategic Firm Expansion Under Partially Observed Business Cycles

Zhide Wang[1], Lu Sun[2], Yanling Chang[2], Alfredo A. Garcia[2], [1]Texas A&M University, College Station, TX, [2]Texas A&M University, College Station, TX, Contact: liang93429@tamu.edu

Business cycles are a primary driver behind a firm's expansion or contraction decisions. However, there is inherent uncertainty about the state of the business cycle because observed economic fundamentals are imperfect indicators. In this paper, we develop an equilibrium model with an estimation methodology of strategic expansions. In the model, firms make entry/exit decisions based upon a *belief* distribution about the underlying *hidden* state of business cycle. The modeling and estimation methodology is tested on a dataset of Canada's fast food industry. Our estimation results show that the Canadian fast-food industry is recession-proof as its marginal profitability is largely immune to economic downturns. Moreover, a firm with high expansion base profit is not guaranteed to maintain a steadily growing market share if its not sufficiently recession-proof.

4 Approximate Linear Programs for Network Revenue Management: Reduction via Constraint Decomposition and Adaptation for Locally Separable Basis Functions

Chung-seung Lee[1], Metin Cakanyildirim[2], Xiao Zhang[3], [1]SUNY Korea, Incheon, Korea, Republic of; [2]The University of Texas at Dallas, Richardson, TX, [3]Saint Louis University, Saint Louis, MO, Contact: chungseung.lee@sunykorea.ac.kr

We develop compact approximate linear programs (ALPs) that can accommodate any type of basis function for the value function approximation. Our approach leverages an intuitive constraint decomposition method, enabling us to derive the compact ALPs in a versatile and primal form. We also propose a *local multivariate* approximation that allows for sophisticated control over the trade-off between approximation accuracy and tractability, enabling us to achieve a more favorable trade-off between the two. The employed basis functions are multivariate functions that are additively separable in specific regions of their domains.

To validate the advantage of the proposed method, we conduct an extensive numerical study, demonstrating that the larger the non-separable regions, the tighter the upper bound and the larger the expected revenue, but the longer the solution time.

5 A Model of Shrinkflation

Sreya Kolay[1], Rajeev Tyagi[2], [1]University at Albany, SUNY, Albany, NY, [2]University of California, Irvine, Irvine, CA, Contact: rktyagi@uci.edu

The practice of firms responding to their cost increases with a reduction in package size, while not decreasing the package price, has attracted considerable attention recently. Commonly called "downsizing," or "shrinkflation," this practice has often been explained as a sneaky backdoor way to increase the per-unit price, thus hurting consumers. We build formal models in which a monopolist or two competing firms sell to consumers who are aware of any change in package size. We find conditions on consumer tastes, degree of competition, and magnitude of cost increase under which seller(s) prefer to use shrinkflation in spite of consumer awareness of shrinkflation. We analyze if/when shrinkflation can be beneficial to consumers and society.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD05

CC-North 121B

Pricing and Information in Modern Marketplaces

Community Committee Choice Session

Session Chair: Yiding Feng, Microsoft Research, Cambridge, MA

Session Chair: Wei Tang, Columbia University, New York, NY

1 Information Design of a Delegated Search

Yangge Xiao[1], Zhenyu Hu[1], Shouqiang Wang[2], [1]National University of Singapore, Singapore, Singapore; [2]University of Dallas, Texas, Dallas, TX, Contact: yangge_xiao@u.nus.edu

A principal delegates a sequential search to an agent, who bears the search cost and controls when to terminate searching. Upon termination, the search payoff is split between the principal and agent. However, only the principal can evaluate each search outcome. The principal designs an information policy to strategically disclose private outcomes over time to the agent. We show the optimal policy is fully prescribed by a sequence of deterministic acceptance standards. The agent is recommended and voluntarily willing to continue the search if and only if the current termination payoff fails to meet that period's standard. When the search results are not recallable, the acceptance standards are informative and determined recursively across different periods. When the search results are recallable, the optimal policy provides no information till a cutoff period, after which the acceptance standard is determined independently of other periods.

2 Online Resource Allocation: Bandits Feedback and Advice on Time-Varying Demands

Lixing Lyu[1], Wang Chi Cheung[2], [1]National University of Singapore, Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore. Contact: lyulixing@u.nus.edu

We consider a non-stationary bandits with knapsack problem, which serves as a fundamental model for online resource allocation. The outcome distribution at each time is scaled by a non-stationary quantity that signifies changing demand volumes. Instead of studying settings with limited non-stationarity, we investigate how online predictions on the total demand volume Q allows us to improve our performance guarantees. We show that, without any prediction, any online algorithm incurs a linear-in-T regret. In contrast, with online predictions on Q, we propose an online algorithm that judiciously incorporates the predictions, and achieve regret bounds that depends on the accuracy of the predictions. These bounds are shown to be tight in settings when prediction accuracy improves across time. Our theoretical results are corroborated by our numerical findings.

3 Optimization of Scoring Rules

Yifan Wu, Northwestern University, Evanston, IL

This paper introduces an objective for optimizing proper scoring rules. The objective is to maximize the increase in payoff of a forecaster who exerts a binary level of effort to refine a posterior belief from a prior belief. In this framework we characterize optimal scoring rules in simple settings, give efficient algorithms for computing optimal scoring rules in complex settings, and identify simple scoring rules that are approximately optimal. In comparison, standard scoring rules in theory and practice - for example the quadratic rule, scoring rules for the expectation, and scoring rules for multiple tasks that are averages of single-task scoring rules - can be very far from optimal.

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TD06

CC-North 121C

Sequential Markets and Mechanism Design

Community Committee Choice Session

Session Chair: Sean Sinclair, Cornell University, Ithaca, NY

1 Statistical Inference and A/B Testing for First-Price Pacing Equilibria

Luofeng Liao[1], Christian Kroer[2], [1]Columbia University, NYC, NY, [2]Columbia University, New York, NY, Contact: ll3530@columbia.edu

We initiate the study of statistical inference and A/B testing for first-price pacing equilibria (FPPE). The FPPE model captures the dynamics resulting from large-scale first-price auction markets where buyers use pacing-based budget management. Such markets arise in the context of internet advertising, where budgets are prevalent.
We propose a statistical framework for the FPPE model, in which a limit FPPE with a continuum of items models the long-run steady-state behavior of the auction platform, and an observable FPPE consisting of a finite number of items. We develop central limit theorems and asymptotically valid confidence intervals. Furthermore, we establish the asymptotic local minimax optimality of our estimators.
We then show that the theory can be used for conducting statistically valid A/B testing on auction platforms.

2 Representation with Incomplete Votes

Daniel Halpern, Harvard University

Platforms for online civic participation rely heavily on methods for condensing thousands of comments into a relevant handful based on whether participants agree or disagree with them. We argue that these methods should guarantee fair representation of the participants, as their outcomes may affect the health of the conversation and inform impactful downstream decisions. To that end, we draw on the literature on approval-based committee elections. Our setting is novel in that the approval votes are incomplete since participants will typically not vote on all comments. We prove that this complication renders non-adaptive algorithms impractical in terms of the amount of information they must gather, and complement this with an adaptive algorithm that provably satisfies commonly used notions of fair representation.

3 Enabling Long-Term Fairness in Dynamic Resource Allocation

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We study the fairness of dynamic resource allocation problem under the ⍰-fairness criterion. We recognize two different fairness objectives that naturally arise in this problem: the well-understood slot-fairness objective that aims to ensure fairness at every timeslot, and the less explored horizon-fairness objective that aims to ensure fairness across utilities accumulated over a time horizon. We argue that horizon-fairness comes at a lower price in terms of social welfare.
We study horizon-fairness with the regret as a performance metric and show that vanishing regret cannot be achieved in presence of an unrestricted adversary. We propose restrictions on the adversary's capabilities corresponding to realistic scenarios and an online policy that indeed guarantees vanishing regret under these restrictions.

4 Robust Pseudo-Markets for Reusable Public Resources

Giannis Fikioris[1], Siddhartha Banerjee[2], Eva Tardos[2], [1]Cornell University, Ithaca, NY, [2]Cornell University, Ithaca, NY, Contact: gfikioris@cs.cornell.edu

We study mechanisms for the fair and efficient allocation of *reusable public resources*, where a limited resource is shared among some agents, each of whom requests to use the resource over multiple consecutive rounds. We design a *pseudo-market mechanism* where each agent is endowed with some budget of artificial credits. Each agent has an *ideal utility* which is her maximum utility with no competition, subject to getting at most her fair share. Our mechanism runs a first-price auction with a selective reserve. We consider this problem in a Bayesian setting and show that under a certain reserve price, irrespective of how others bid, each agent can guarantee half her ideal utility in expectation. We also show this result is tight.

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TD07

CC-North 122A

Learning and Decision-Making in Operations Management

Community Committee Choice Session

Session Chair: Zuo-Jun Max Shen, University of California Berkeley, Berkeley, CA

Session Chair: Mo Liu, UC Berkeley, Berkeley, CA

1 Data Privacy in Pricing: Estimation Bias and Implications

Ningyuan Chen[1], Ming Hu[2], Jialin Li[3], Sheng Liu[1], [1]University of Toronto, Toronto, ON, Canada; [2]University of Toronto, Minneapolis, MN, [3]University of Toronto, Toronto, ON, Canada. Contact: jln.li@rotman.utoronto.ca

We study two privacy protection mechanisms motivated by emerging privacy regulations - limited retention and self-protection, in the context of data-driven (personalized) pricing. Privacy protection affects the estimation of the demand model and, thus, the offered price. Assuming a linear demand curve, we find that which customer groups benefit from the protection depends on the product/service type. For inferior goods (as opposed to normal goods), offered prices would decrease for all customers due to limited retention, and counter-intuitively, under self-protection, only privacy-protecting customers would see a price increase. On the other hand, the magnitude of the resulting price change is greater for industries with stronger historical price personalization. We validate our theoretical findings with a real dataset of online auto loans.

2 Active Label Acquisition with Personalized Incentives in Assortment Optimization

Mo Liu[1], Junyu Cao[2], Zuo-Jun Max Shen[3], [1]University of California Berkeley, Berkeley, CA, [2]The University of Texas at Austin, Austin, TX, [3]University of California Berkeley, Berkeley, CA, Contact: mo_liu@berkeley.edu

We study how to tailor incentives to motivate customers to reveal their preferences during the survey process in the capacitated assortment optimization problem. Based on the survey responses collected, the retailer develops a model that predicts each customer's preference and customizes the assortment accordingly. To assign incentives to customers efficiently, the primary challenge lies in evaluating each customer's potential revenue contribution to the prediction model. Notably, a smaller prediction error in the customers' preference model does not necessarily guarantee better assortment decisions or higher revenue. We design efficient personalized incentive algorithms with non-asymptotic guarantees and demonstrate both theoretically and empirically that our personalized incentive policy can achieve a much smaller cost than the fixed incentive policy.

3 Estimate-then-optimize Versus Integrated-estimation-optimization Versus Sample Average Approximation: A Stochastic Dominance Perspective

Adam Elmachtoub, Henry Lam, Haofeng Zhang, Yunfan Zhao, Columbia University, New York, NY, Contact: hz2553@columbia.edu

Recent literature in data-driven stochastic optimization considers integrating the estimation and optimization processes. This integrated approach which we call integrated-estimation-optimization (IEO) can be readily shown to outperform simple estimate-then-optimize (ETO) when the model is misspecified. In this paper we show that a reverse behavior appears when the model class is well-specified and there is sufficient data: ETO outperforms IEO asymptotically when the model class covers the ground truth in the strong sense of stochastic dominance of the regret. Our results also apply to constrained, contextual optimization problems where the decision depends on observed features. Whenever applicable, we also demonstrate how standard sample average approximation (SAA) performs the worst when the model class is well-specified, and best when it is misspecified.

4 Pasta: Pessimistic Assortment Optimization

Juncheng Dong[1], Weibo Mo[2], Zhengling Qi[3], Cong Shi[4], Ethan Xingyuan Fang[1], Vahid Tarokh[1], [1]Duke University, Durham, NC, [2]Purdue University, West Lafayette, IN, [3]The George Washington University, D.C., [4]University of Michigan, Ann Arbor, MI

We consider a fundamental class of assortment optimization problems in an offline data-driven setting. Due to the combinatorial nature of assortment optimization, the problem of insufficient data coverage is likely to occur in the offline dataset. To this end, we propose a novel algorithm called Pessimistic ASsortment opTimizAtion (PASTA for short), which can correctly identify the optimal assortment by only requiring the offline data to cover the optimal assortment. In particular, we establish the first regret bound for the offline assortment optimization problem under the celebrated multinomial logit model (MNL). We also propose an efficient computational procedure to solve our pessimistic assortment optimization problem. Our numerical studies demonstrate the superiority of the proposed method over the existing baseline method.

5 Best Arm Identification in Batched Multi-Armed Bandit Problems

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Recently multi-armed bandit problem arises inmany real-life scenarios where arms must be sampled in batches and the numberof arms is large, e.g., biological experimentation and online marketing. Weconsider pure exploration in a batched multi-armed bandit problem where the armsize tends to infinity, and the number of batches is small. We introduce

alinear programming framework and propose a two-step algorithm which achievesgood theoretical properties and has good simulation performance.

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TD08

CC-North 122B

Digital Platforms: New Challenges and Directions

Community Committee Choice Session

Session Chair: Yuri Fonseca, Columbia University, New York, NY

Session Chair: Ilan Lobel, New York University, New York, NY

Session Chair: Fanyin Zheng, Columbia University, New York, NY

1 The Role of Driver Behavior in Moving the Electric Grid to Zero Emissions

Leann Thayaparan, Georgia Perakis, Massachusetts Institute of Technology, Cambridge, MA, Contact: lpgt@mit.edu

As renewable energy production increases, energy storage becomes a significant challenge. Electric Vehicles (EVs) could act as distributed storage, however complex driver behavior must be accounted for first. In this work, we model driver behavior using probability models and machine learning and show how these forecasts can be incorporated into optimizations for EV charging and discharging. We prove analytically the regimes for which the recommendations from the optimization do not negatively affect driver usage and propose a method to solve the optimization efficiently. We collaborate with an American EV manufacturer to size the capacity EVs can offer the grid as a source of distributed energy storage.

2 Design of Resale Platforms

Ilan Morgenstern[1], Daniela Saban[1], Divya Singhvi[2], Somya Singhvi[3], [1]Stanford University, Palo Alto, CA, [2]New York University, New York, NY, [3]USC Marshall School of Business, Los Angeles, CA, Contact: ilanmor@stanford.edu

We study resale platforms, an emerging type of online marketplaces in developing countries. These platforms are designed for users (resellers) to sell products to others, enabling them to supplement their income as they earn a margin on the transactions they generate. Using data from a major platform in India, we find that resellers reduce their margins and exert less effort when searching for products to sell as more of them join the platform. Motivated by these observations, we develop a model of resale platforms to understand how competition among resellers influences their product selection and margin decisions in equilibrium. Finally, we explore two potential interventions through which the platform can benefit resellers: centralizing margin decisions and optimizing its product ranking algorithm.

3 The Impact of AI Technology on the Productivity of Gig Economy Workers

Benjamin Knight[1], Dmitry Mitrofanov[2], Serguei Netessine[3], [1]Instacart, San Francisco, CA, [2]Boston College, Chestnut Hill, MA, [3]The Wharton School, Philadelphia, PA

We conducted field experiments on a grocery shopping platform that uses an AI-enabled guidance system to help shoppers find products on store shelves. We find that, as one would expect, such technology helps by reducing the number of refunds (due to the item being hard-to-find, e.g. located at a pop-up display, etc.) and that less experienced shoppers tend to use this guidance the most. However, counter-intuitively, we also find that the usage of more complex routing algorithms is not free: it takes a longer time to consult AI guidance and picking times increase as a result. Overall, we find that AI improves the effectiveness of gig workers by helping less experienced workers achieve order outcomes that are more comparable to those of more experienced workers, thus increasing both customer satisfaction and revenue per order.

4 Signaling Competition in Two-Sided Markets

Omar Besbes[1], Yuri Fonseca[1], Ilan Lobel[2], Fanyin Zheng[1], [1]Columbia University, New York, NY, [2]New York University, New York, NY, Contact: yfonseca23@gsb.columbia.edu

Consider a platform facilitating decentralized many-to-many matches between two sides. A key attribute of supply is how competitive it will be for demand to obtain the supply after the match. Should the platform reveal competition levels to potential demand? We answer this question empirically in the context of a labor platform. We partnered with a services marketplace which sells non-exclusively labor market leads to service workers. We propose and estimate a structural model in which workers internalize expected competition levels. Our counterfactual analysis finds that signaling competition significantly improves outcomes for market participants and may lead to a win-win situation for both the platform and agents depending on certain market characteristics.

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TD09

CC-North 122C

Combating Illicit Networks

Community Committee Choice Session

Session Chair: Maria Esther Mayorga, North Carolina State University, Raleigh, NC

1 Detecting Human Trafficking: Automated Classification of Online Customer Reviews of Massage Businesses

Ruoting Li, North Carolina State University, Raleigh, NC

The problem of human trafficking through illicit massage businesses (IMBs) in the United States is significant. While IMB review boards provide information for the investigation, they are likely to be shut down by law enforcement. Open websites like Yelp provides accessible information on a larger set of businesses that can be screened for risk factors of trafficking. We develop a natural language processing approach to detect online customer reviews indicating a business is engaged in trafficking. We train and evaluate different classification models, including lexicon-based and embedding-based models, and use ensemble learning to combine their strengths. The proposed models can save law enforcement countless hours by automatically flagging potential illicit activity in Yelp reviews, eliminating the need for manual screening.

2 Using Spatiotemporal Analysis to Identify Potential Sex Trafficking Victims in Commercial Sex Advertisements

Shailesh J. Divey, Nickolas K. Freeman, Gregory Bott, Burcu B. Keskin, The University of Alabama, Tuscaloosa, AL, Contact: sdivey@cba.ua.edu

In this paper, using text and image data associated with sex ads collected from websites that host advertisements for commercial sex services, we create a curated dataset that is used to construct a graphical representation for all the individuals identified in the data. By leveraging techniques from the field of machine learning and graph theory, we analyze spatiotemporal patterns of these individuals in order to isolate and cluster those that exhibit highly correlated movement patterns across space and time. The information obtained from these clusters provide insights regarding geographical circuits that are likely to be employed by sex traffickers. These insights, in turn, are important for policymakers, law-enforcement, and non-profit organizations for devising strategies to conduct effective counter-trafficking operations.

3 Labor Trafficking Disruption with Collaborating Actors

Priscila de A. Drummond[1], Kayse Lee Lee Maass[2], Arezoo Jafari[2], [1]Northeastern University, Boston, MA, [2]Northeastern University, Boston, MA, Contact: deazevedodrummond.p@northeastern.edu

Catastrophically disrupting illicit supply chains requires many hands. In anti-labor trafficking efforts, collaboration is the only way to protect the victims and disrupt the operation. Unlike nuclear material trafficking, in which we can build physical sensors to help its detection, labor trafficking can happen in many forms, usually in a spectrum of exploitation traversing different jurisdictions. Task forces and multiple interventions are necessary to address this challenge. Thus, to properly model the success of interventions in disrupting labor trafficking, we must account for collaboration. We present a stochastic network interdiction problem with multiple interventions and actors.

4 An Active Learning Approach for Training Review Classification Models to Detect Human Trafficking

Osman Ozaltin[1], Margaret Tobey[2], Maria Esther Mayorga[1], Sherrie Caltagirone[3], [1]North Carolina State University, Raleigh, NC, [2]NC State University, Raleigh, NC, [3]Global Emancipation Network, Orlando, FL

Active learning is a machine learning approach that aims to optimize the learning process by selecting and labeling the most informative data points. We formulate active learning as a decision process and learn a policy to query the most informative data points through deep reinforcement learning. We assess the effectiveness of the proposed approach for an imbalanced natural language processing classification task. Specifically, our classification task is to detect Yelp reviews that contain risk factors of human trafficking. The classifier trained on the reviews selected by the proposed query policy can achieve a similar or higher F1 score compared to uncertainty sampling. Additionally, the proposed policy is more effective than uncertainty sampling in large batch query settings.

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TD10

CC-North 123

Frontiers in Online Decision-Making: Applications to e-Commerce Fulfillment

Community Committee Choice Session

Session Chair: Chamsi Hssaine, Cornell University, Ithaca, NY

1 Approximation Schemes for Dynamic Pricing with Opaque Products

Jacob Feldman[1], Yukai Huang[2], Xingxing Chen[3], [1]Olin Business School, Saint Louis, MO, [2]WashU, St. Louis, MO, [3]University of Richmond, Richmond, VA, Contact: yukaihuang@wustl.edu

In this paper, we consider a multi-period, multi-product dynamic pricing problem in which each product is endowed with an exogenous starting inventory level, and there is the added complexity of an opaque selling option. That is, alongside traditional (transparent) products, the retailer or platform also has the option to create and price an opaque product, which corresponds to a dummy product comprised potentially of any subset of the displayed transparent products. In the event that a customer selects the opaque product, the platform has the freedom to choose any of the opaque product's constituents to satisfy this demand. All-in-all, we are left with a classical dynamic pricing problem with a twist, since the addition of the opaque selling option gives the platform an extra lever of flexibility to balance supply and demand.

2 No-Regret Learning in Two-Echelon Supply Chain with Unknown Demand Distribution

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Supply chain management has been recognized as an important discipline with applications to many industries, where the *two-echelon* stochastic inventory model plays a fundamental role. In this work, we aim at designing online algorithms for this problem with an *unknown* demand distribution, which brings distinct challenges as compared to classic online problems. Specifically, we consider the model in [CZ99] under both *centralized* and *decentralized* settings. We design algorithms achieving favorable guarantees for both regret and convergence to the best policy in both settings, and additionally for individual regret in the decentralized setting. Our algorithms are based on Online Gradient Descent and Online Newton Step, together with several new ingredients specifically designed for our problem. We also implement our algorithms and show the empirical effectiveness.

3 Joint vs. Separate Optimization in Large-Scale E-Commerce Fulfillment Systems

Boris Epstein, Will Ma, Columbia University, New York, NY

E-commerce fulfillment systems involve a wide spectrum of decisions. In practice, each of these decisions is assigned to a specific team within the organization. We take a step towards understanding the effects of this separate optimization as opposed to a joint optimization by developing a model involving inventory allocation and fulfillment decisions. The optimal allocation depends on the fulfillment policy implemented, but it is challenging to take this policy exactly into account. An approach in the literature is for the allocation team to make an assumption about how fulfillments will be made, e.g. by a Myopic policy or a clairvoyant Offline policy. We derive the structural result that assuming Offline causes the allocation team to put more inventory in flexible locations. Moreover, we show that assuming Offline provides a more robust solution than assuming Myopic.

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TD11

CC-North 124A

Stochastic Systems

Community Committee Choice Session

Session Chair: Mark S. Squillante, IBM Research, Mathematical Sciences, Yorktown Heights, NY

1 Double Pessimism is Provably Efficient for Distributionally Robust Offline Reinforcement Learning: Generic Algorithm and Robust Partial Coverage

Jose Blanchet[1], Miao Lu[1], Tong Zhang[2], Han Zhong[3], [1]Stanford University, Stanford, CA, [2]The Hong Kong University of Science and Technology, Hong Kong, Hong Kong; [3]Peking University, Beijing, China. Contact: miaolu@stanford.edu

Distributionally robust offline reinforcement learning seeks to find an optimal robust policy purely from offline data that performs well in perturbed environments. In this work, we propose a generic algorithm framework, Doubly Pessimistic Model-based Policy Optimization, for sample-efficient distributionally robust offline RL with function approximations. In algorithmic design, the *double pessimism* principle is crucial to overcome the distributional shift incurred by i) the mismatch between behavior policy and the family of target

policies; and ii) the perturbation of the nominal model. Our work first showed that the principle of double pessimism achieves sample-efficient learning for distributionally robust offline RL with general function approximations.

2 Exact Description of Limiting SIR and SEIR Dynamics on Locally Tree-like Graphs

Juniper Cocomello, Kavita Ramanan, Brown University, Providence, RI

We study the Susceptible-Infected-Recovered (SIR) and the Susceptible-Exposed-Infected-Recovered (SEIR) models of epidemics with time-varying rates on a class of locally tree-like networks, which includes sparse Erdős-Rényi graphs, regular graphs, and other configuration models. We identify tractable systems of ODEs that exactly describe the dynamics of the SIR and SEIR processes in a suitable asymptotic regime where the population size goes to infinity. Furthermore, we use this ODE characterization to study the outbreak size under both constant and time-varying recovery rates. We demonstrate via simulations the efficacy of the dynamics and outbreak size approximations for populations of moderate size.

3 Rare-Event Simulation for Machine Learning Models: Challenges and Remedies

Henry Lam, Columbia University, New York, NY

In estimating rare-event probabilities, naive Monte Carlo is inefficient due to its infrequent hits on the target rare events, which motivates variance reduction techniques such as importance sampling (IS) to speed up simulation. However, these techniques are often "double-edged swords", i.e., while they can substantially increase the estimation efficiency when properly configured, they could also significantly hurt the estimation if poorly designed. We discuss some challenges in applying IS to safe-AI applications, which arise from the interplay of model sophistication and the subtlety in IS design. We also present some (partial) remedies including IS search algorithms via mathematical programming, the revisit of statistical criteria to evaluate algorithms, and adaptivity that allows the incorporation of rare-event estimation into safe model training.

4 Distributionally Robust Optimization of Boosting for Efficient Ensemble Learning

Mark S. Squillante[1], Soumyadip Ghosh[2], [1]IBM Research, Mathematical Sciences Department, Yorktown Heights, NY, [2]IBM TJ Watson Research Center, Yorktown Heights, NY, Contact: mss@us.ibm.com

Boosting is an approach in learning theory that combines weak learners into an ensemble, adaptively picking learners by training on data re-weighted to emphasize those points on which the current ensemble performs poorly, and ensembling a weighted combination of the outputs of the individual learners. Various algorithms have been proposed to determine the data and weak learner weights, most notably the AdaBoost multiplicative weights scheme. We propose and analyze a sequence of distributionally robust formulations for both re-weighting problems seeking to pick a compact ensemble that optimizes generalization performance. We devise computationally efficient estimation algorithms for these formulations that provably balance a fundamental tradeoff between computation and variance. Numerical experiments demonstrate the significant benefits of our approach.

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TD12

CC-North 124B

Bayesian Optimization

Community Committee Choice Session

Session Chair: Peter Frazier, Cornell / Uber, Ithaca, NY
Session Chair: David Eriksson, Meta, Boulder, CO
Session Chair: Jana Doppa, Washington State University, Pullman, WA

1 Bayesian Optimization over Combinatorial Spaces: Progress and Outstanding Challenges

Jana Doppa, Aryan Deshwal, Washington State University, Pullman, WA

The problem of optimizing combinatorial spaces (e.g., sequences, graphs, sets, and permutations) using expensive black-box function evaluations arises in many science and engineering applications. For example, optimizing hardware architecture using computational simulations. There are two key challenges in solving this problem within the framework of Bayesian Optimization (BO). First, effective surrogate modeling in the small-data setting. Second, solving a hard combinatorial optimization problem as part of the acquisition strategy. This talk will present a holistic view of current progress in this problem space with a focus on principles. We will end the talk with lessons learned and some outstanding challenges.

2 Sparse Bayesian Optimization

David Eriksson, Meta, Boulder, CO

Bayesian optimization (BO) is a powerful approach to sample-efficient optimization of black-box objective functions. However, the application of BO to areas such as recommendation systems often requires taking the interpretability and simplicity into consideration, a setting that has not been previously studied in the BO literature. To make BO applicable in this setting, we present several regularization-based approaches that allow us to discover sparse and more interpretable configurations. We propose a novel differentiable relaxation based on homotopy continuation that makes it possible to target sparsity by working directly with L0 regularization. We identify failure modes for regularized BO and develop a hyperparameter-free method, sparsity exploring Bayesian optimization (SEBO) that seeks to simultaneously maximize a target objective and sparsity.

3 Bayesian Optimization of Function Networks with Partial Evaluations

Poompol Buathong[1], Jiayue Wan[1], Samuel Daulton[2], Raul Astudillo[3], Maximilian Balandat[2], Eytan Bakshy[2], Peter Frazier[4], [1]Cornell University, Ithaca, NY, [2]Meta, Menlo Park, CA, [3]California Institute of Technology, Pasadena, CA, [4]Cornell / Uber, Ithaca, NY, Contact: pb482@cornell.edu

Bayesian optimization of function networks (BOFN) aims to optimize the final output of a network of functions. It leverages intermediate outputs of the network to achieve better experimental design than standard Bayesian optimization algorithms. However, existing BOFN algorithms either require evaluating every function node at every iteration or are applicable to a limited class of networks. To address these issues, we propose a knowledge gradient (KG) acquisition function that chooses which nodes to evaluate and the inputs for that node in a cost-aware fashion. We provide an efficient approach to optimizing our acquisition function, and show that it outperforms existing BOFN methods across several synthetic and real-world applications.

4 Conjunctive Bayesian Optimization for Min/max of Multiple Functions

Surdeep Chotaliya, Arizona State University, Tempe, AZ, Contact: surdeepchotaliya541997@gmail.com

This work proposes a novel approach called conjunctive Bayesian optimization (conBO) for optimizing functions comprising multiple nonlinear components. Unlike previous methods, conBO explicitly considers dependencies between components, enhancing optimization accuracy. It introduces a paired sampling algorithm (conBO-PS) that leverages mutual contributions from function pairs. To handle large-scale problems, the conBO-LS framework employs conBO-PS on adaptively chosen component subsets, allowing control over computational resources. Experimental results demonstrate conBO's superiority in solution quality and computational efficiency across various scenarios, including complex analytical functions and industrial challenges.

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TD13

CC-North 125A

Empirical Analysis for Agri-Food Supply Chain Decision-Making

Community Committee Choice Session

Session Chair: Deniz Berfin Karakoc, University of Illinois at Urbana-Champaign, Urbana, IL

1 Dynamic Irrigation Management Under Temporal and Spatial Variability

Erkut Sonmez[1], Baris Ata[2], Derek Heeren[3], [1]University of Nebraska Lincoln, Lincoln, NE, [2]University of Chicago, Chicago, IL, [3]University of Nebraska Lincoln, Lincoln, NE

Agricultural productivity must improve significantly soon following increasing food demand. One way to improve productivity is irrigation. However, freshwater scarcity, increasing costs, and climate change necessitate sustainable and efficient methods for irrigation. We study dynamic irrigation management under uncertainty considering temporal variability and spatial soil heterogeneity of the field.

2 Enhancing Effectiveness of USAID's Humanitarian Supply Chain Operations for Both On-Going and Sudden-Onset Food Aid Needs

Lluvia (Weijia) Jing[1], Ozlem Ergun[2], [1]Northeastern University, Boston, MA, [2]Northeastern University, Newton, MA, Contact: jing.we@northeastern.edu

Millions of tons of food aid are distributed each year by the U.S. Agency for International Development's Bureau for Humanitarian Assistance and the legacy Office of Food for Peace (BHA/FFP). However, the need always exceeds available food aid resources. Efficiency gains in existing supply chains offer potential for closing this gap. Through analytics and optimization, we build data-driven models to help the organization achieve more effective decision making for food aid procurement, preposition and distribution. We generate scenarios to develop insights on strategic planning - warehouse location selection and prepositioning decision for a merged supply chain serving both long-tern operations and emergency response.

3 Equitable Distribution of Perishable Items in a Food Bank Supply Chain

Irem Sengul Orgut[1], Emmett J. Lodree[2], [1]University of Alabama, Tuscaloosa, AL, [2]University of Alabama, Tuscaloosa, AL, Contact: isorgut@cba.ua.edu

In the United States, food banks help reduce food insecurity by distributing donated food among the population in need. They aim to equitably distribute food donations among their clients while minimizing waste that occurs due to spoilage and capacity limitations. Perishable food items present specific challenges since they are susceptible to spoilage and need to be distributed before their expiry dates. Based on our partnership with a large food bank, we present a capacitated, multi-period, multi-product network flow model to help them equitably and effectively distribute perishable food donations. The model is applied within the context of a case study and reveals managerial insights that would be useful to practitioners. Given the inevitability of inequitable food allocations in practice, we provide guidance on how to strategically control inequities.

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TD14

CC-North 125B

Information Disclosure and Behavior on Networks

Community Committee Choice Session

Session Chair: Guangwen Kong, 1</sup

Session Chair: Ankur Mani, University of Minnesota - Twin Cities, Minneapolis, MN

1 Information Disclosure and Consumer Search on the Experience Goods: Theory and Empirical Evidence of Online Platforms

Yushu Zeng[1], Hu Huang[2], Ying-Ju Chen[3], Xin Wang[4], [1]Hong Kong University of Science and Technology, Hong Kong, China; [2]HKUST, Hong Kong, China; [3]The Hong Kong University of Science and Technology, Kowloon, Hong Kong; [4]The Hong Kong University of Science and Technology, Hong Kong, China. Contact: yzengao@connect.ust.hk

In this paper, we develop a stylized game-theoretical model to study the information disclosure strategies of a firm that sells experience goods through an online platform. The platform can offer vertical quality information and the firm may disclose the horizontal quality attributes. We find that the firm is more likely to reveal its horizontal attribute information when its vertical quality level is lower, the search cost is lower, or the vertical quality information is public. We also find that the platform should not provide consumers with the vertical quality information of the product when the search cost is low. Moreover, we also conduct an empirical study on an online web novel platform and find that the lower-level authors (with lower vertical quality) of web novels tend to choose longer book names (more attribute information), which confirms the theoretical results.

2 Advice Provision in the Pandemic: The Impact of Information Granularity on Social Protection

Guangwen (Crystal) Kong[1], Yang Zhang[2], Jingjing Weng[1], [1]Temple University, Philadelphia, PA, [2]University of Kent, Uxbridge, United Kingdom. Contact: jingjing.weng@temple.edu

This paper explores advice provision against a pandemic outbreak (COVID-19, or similar future diseases). We investigate how the granularity of information provided by the social planner impacts people's pandemic protection efforts. The planner can either provide decomposed statistics for each social group---e.g. death rate at each age (referred as targeted strategy), or provide a simple aggregate over all social groups---e.g. average death rate for all ages (referred as uniform strategy). Surprisingly, our findings challenge the conventional wisdom that granular data is always superior. Instead, we reveal instances where the uniform strategy outperforms the targeted strategy in pandemic response.

3 The Value of Community Information for Pricing Under Network Externalities

Calvin Roth[1], Jiali Huang[2], Ankur Mani[1], [1]University of Minnesota, Minneapolis, MN, [2]Meta Platforms, Inc., Cambridge, MA

We study the value of network information for pricing decisions when selling divisible goods with positive network externalities to consumers in a social network. We consider consumers whose utility functions are homogeneous except for their position in the network and examine the value of network information for dense stochastic block models which give information on how communities on average interact with the rest of the network instead of consumers. We find that for this class of networks there will be significant losses when pricing with no information about the network. We also find that for asymptotically large networks making pricing decisions using only the information about community structure and community memberships of the consumers does not introduce any significant change in expected profits over optimal pricing under full network information.

4 Solving Present Bias Inefficiency with Deadlines

Nicholas Hall[1], Zhixin Liu[2], [1]The Ohio State University,

Columbus, OH, [2]University of Michigan-Dearborn, Dearborn, MI, Contact: hall.33@osu.edu
Present bias without self-awareness causes a significant loss of utility in operational decisions through poor task choice and procrastination. We study the use of a deadline to mitigate the loss. We use a backward recursion procedure to identify critical times at which task choice and timing tradeoffs are evaluated, leading to a closed-form characterization of a schedule under imperfect self-awareness. The task completion times increase monotonically or change cyclically with the deadline under different self-awareness levels. Times at which the decision-maker fails to follow an anticipated decision are learning opportunities, which suggest a scheme for developing self-awareness. This leads to specific recommendations for deadline setting.

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TD15

CC-North 126A

On Security and Rescue Operations

Contributed Session

Session Chair: Michael Morin, Université Laval, Québec, QC, Canada

2 A Stochastic Game Framework for Patrolling a Border

Matthew Darlington[1], Kevin Glazebrook[1], David Leslie[1], Rob Shone[1], Roberto Szechtman[2], [1]Lancaster University, Lancaster, United Kingdom; [2]Naval Postgraduate School, Monterey, CA, Contact: m.darlington@lancaster.ac.uk
We consider a stochastic game for modelling the interactions between smugglers and a patroller along a border. The problem we examine is a group of cooperating smugglers making regular attempts at bringing small amounts of illicit goods across a border. A single patroller has the goal of preventing the smugglers from doing so, but must pay a cost to travel from location to location. We have proven a number of properties of the Nash equilibria in the game that lead towards new methods of calculating them. The methods we have developed are then significantly more computationally efficient than existing general ways to find Nash equilibria in our model. We explore how parameters such as the penalties applied to the smugglers by the patroller and topology of the border can affect the patroller's strategy.

3 Maximal Coverage Information Collection Problem Using Kriging

Esther Jose, Moises Sudit, Rajan Batta, University at Buffalo (SUNY), Buffalo, NY, Contact: estherjo@buffalo.edu
The goal of this project is to identify which image sensors in an ISR mission should collect data from which cells at which resolutions to maximize information gain. However, information is not only gained from cells where data is directly collected from; data fusion techniques such as Kriging can be used to collect information from other cells as well. Using Kriging, the estimated error of the prediction in each cell can be calculated. We can say a cell is "confidently covered" if this estimated error is below a certain acceptable level.
While Kriging is non-linear, we develop an approximate MIP to solve this problem called Simplified Kriging (SK). SK obtains solutions within 1% of optimality. We also show that SK is equivalent to the Maximal Coverage location problem (MCLP) and we test different heuristics and solution methods to solve the information collection problem.

4 Metamodels of a Search Simulator for Maritime Search Operations Efficiency Evaluation

Michael Morin, Thomas Laperrière-Robillard, Irene Abi-Zeid, Université Laval, Québec, QC, Canada
Planning an efficient maritime search and rescue operation (MSAR) requires estimating the quality of search plans. Nowadays, decision support systems (DSS) for MSAR planning use Monte Carlo drift simulation and search simulators. Carrying multiple simulations is computationally intensive. We present supervised learning-based metamodels to reduce the time required to find high-quality search plans and answer the following questions: Can the probability of success be closely approximated? To what extent does our approach improve the current system?

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CC-North 126B

Frontiers of Algorithmic Fairness

Community Committee Choice Session

Session Chair: Vahideh Manshadi, Yale University, New Haven, CT

Session Chair: Rad Niazadeh, Chicago Booth School of Business, CHICAGO, IL

1 Algorithmic Precision and Human Decision: A Study of Interactive Optimization for School Schedules

Arthur J. Delarue[1], Zhen Lian[2], Sebastien Martin[3], [1]H. Milton Stewart School of Industrial and Systems Engineering at Georgia Tech, Atlanta, GA, [2]Yale, New haven, NY, [3]Kellogg School of Management, Northwestern University, Evanston, IL, Contact: sebastien.martin@kellogg.northwestern.edu

Motivated by a collaboration with the San Francisco Unified School District (SFUSD), this paper presents an interactive optimization framework for addressing complex public policy problems. Our framework addresses this challenge by combining three key elements: (1) an efficient optimization algorithm that can solve the problem given certain known objectives, (2) a method for generating a large set of diverse, near-optimal solutions, and (3) an interface that facilitates exploration of the solution space. We illustrate the effectiveness of this framework by applying it to the problem of improving school schedules at SFUSD. The resulting schedule, implemented in August 2021, saved the district over $5 million and, to our knowledge, represents the first successful optimization-driven school start time change in the United States.

2 A Theory of Dynamic Benchmarks

Ali Shirali[1], Rediet Abebe[2], Moritz Hardt[3], [1]University of California, Berkeley, Berkeley, CA, [2]Harvard University, Cambridge, MA, [3]Max-Planck Institute for Intelligent Systems, Tübingen, Tübingen, Germany

Dynamic benchmarks interweave model fitting and data collection in an attempt to mitigate the limitations of static benchmarks. In contrast to an extensive theoretical and empirical study of the static setting, the dynamic counterpart lags behind due to limited empirical studies and no apparent theoretical foundation to date. Responding to this deficit, we initiate a theoretical study of dynamic benchmarking. Our results illuminate the benefits and practical limitations of dynamic benchmarking, providing both a theoretical foundation and an explanation for observed bottlenecks. Although our study centers around lowering risk or improving the accuracy of the induced models, our framework opens up a new way for future works to address other concerns surrounding dynamic benchmarks including robustness and fairness.

3 Auditing for Human Expertise

Rohan Alur, Massachusetts Institute of Technology, Cambridge, MA, Contact: ralur@mit.edu

High-stakes prediction tasks (e.g., patient diagnosis) are often handled by human experts. One source of concern about automation in these settings is that experts may exercise intuition that is difficult to model and/or have access to information (e.g., conversations with a patient) that is unavailable to a would-be algorithm. This raises a natural question whether human experts add value which could not be captured by an algorithmic predictor.
We develop a statistical framework under which this becomes a natural hypothesis test. Indeed, as our framework highlights, answering this question is more subtle than simply comparing expert performance to that of an algorithm. Instead our procedure takes the form of a conditional independence test, and can be viewed as assessing whether human experts may value to *any* algorithm trained on the available data.

4 Multi-Objective Learning: A Unifying Perspective on Fairness

Eric Zhao, University of California, Berkeley, Berkeley, CA, Contact: eric.zh@berkeley.edu

Addressing fairness in machine learning has far-reaching implications for the robustness, equity, and collaborative aspects of real-world systems*. Various formalizations of fair data-driven decision-making have been proposed, among which multicalibration and multidistribution learning have emerged as especially foundational and versatile frameworks. In this talk, we will explore how an algorithmic toolbox of no-regret learning and dynamic decision-making enables the design of efficient algorithms for these frameworks. Specifically, we will highlight the significance of game dynamics as a unifying perspective, allowing us to obtain optimal guarantees for these problems through multi-objective learning.

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CC-North 127A

Understanding Customer Attitudes Towards Waiting

Community Committee Choice Session

Session Chair: Kyle Hyndman, University of Texas at Dallas, Richardson, TX

1 Experienced and Prospective Wait in Queues: A Behavioral Investigation

Jing Luo[1], Leon Valdes[2], Sera Linardi[2], [1]University of

Science and Technology Beijing, Beijing, China; [2]University of Pittsburgh, Pittsburgh, PA, Contact: lvaldes@katz.pitt.edu

Contrary to rational predictions, empirical evidence suggests that queuing disutility does not depend solely on waiting time. However, how the speed, length, and waiting time of a queue jointly affect disutility is not well understood. Similarly, it remains unclear whether and how the *experience* of wait—controlling for the *remaining* wait—impacts people's responses. In this paper, we conduct a series of controlled incentivized experiments to study these questions in observable queues. Our results show that, in contrast to rational models, the length and service speed of the residual queue affect individuals' costs additively, not multiplicatively. We also find that the experience of wait does not typically affect completion costs, except when both the service time and amount of progress are large.

2 AI Chatbots in Customer Service: Adoption Hurdles and Simple Remedies

Evgeny Kagan[1], Maqbool Dada[2], Brett Hathaway[3], [1]Johns Hopkins Carey Business School, Baltimore, MD, [2]Johns Hopkins University, Baltimore, MD, [3]Brigham Young University, Provo, UT, Contact: ekagan@jhu.edu

We conduct experiments in which participants choose, and then experience, the chatbot or the live agent channel as we vary operational (i.e., times spent and chatbot success rates) and qualitative features of the chatbot. We find that users respond positively to improvements in chatbot operational performance; however, the chatbot channel remains underutilized relative to what expected time minimization would predict. Additional experiments show that this is caused by two mechanisms: algorithm aversion (aversion to an algorithmic service provider), and gatekeeper aversion (aversion to any service format that may involve multiple stages). Examining potential remedies, we find that algorithm aversion can be mitigated by making salient the expected time savings offered by the chatbot. However, gatekeeper aversion is more persistent and harder to overcome

3 Understanding How Individuals Perceive Waiting

Kyle Hyndman[1], Andrew M. Davis[2], Evgeny Kagan[3], [1]University of Texas at Dallas, Richardson, TX, [2]Cornell University, Ithaca, NY, [3]Johns Hopkins Carey Business School, Baltimore, MD

We conduct a series of experiments where we elicit valuations for waiting in order to receive a high prize. We consider known, risky and uncertain (i.e., ambiguous) wait times. We also attempt to identify the role of expectations and information on valuations for waiting.

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CC-North 127B

Data-Driven Decision-Making in Healthcare

Community Committee Choice Session

Session Chair: Yingchao Lan, University of Nebraska-Lincoln, Lincoln, NE

Session Chair: Vishal Ahuja, Southern Methodist University, Dallas, TX

1 Crowdsourced Drug Discovery

Brian Lee, Hui Zhao, Pennsylvania State University, University Park, PA

This paper presents a novel setting to explore crowdsourcing as a new approach to the lengthy and risky drug discovery process. We leverage a quasi-experimental setup to examine how collaborative crowdsourcing can help drug discovery. In particular, we study how availability of the prior design's effectiveness information affects the effectiveness the crowdsourced drug designs. In light of the rising cost and many challenges in drug discovery, our paper has significant theoretical and practical meaning. It represents the first study to explore the mechanisms driving successful crowdsourced drug discovery.

2 Colocation of Family Medicine with Rural and Urban Hospitals

Benjamin Grant[1], Peter Tilkemeier[2], [1]Clemson University, Greenville, SC, [2]Prisma Health, Greenville, SC, Contact: bngrant@clemson.edu

We examine the impact of colocation of Family Medicine practices on both hospital operations and patient outcomes for urban and rural locations.

3 Causal Effects of Telehealth Follow-Up Visits on Postdischarge Adverse Events

Jaeyoung Park, Julia Ran, Shah Sachin, Daniel Adelman, University of Chicago, Chicago, IL

Following COVID-19, the use of telehealth surged due to pandemic-related restrictions but declined as pandemic mitigation. Physicians and patients were found to prefer in-person care to telehealth in the recent literature, suggesting the current telehealth care setting is not optimal. In this study, we examined the role of telehealth in improving post-discharge health outcomes, especially 90-day unplanned readmission, for heart failure patients. We hypothesized 1) telehealth can complement the in-person modality for follow-up visits, and 2) for a specific type of patients, it can substitute the in-person modality for follow-up visits. We identified the causal effects and tested the hypotheses, using the Medicare claims data and controlling for observed and unobserved confounders. Finally, we proposed improved telehealth care delivery based on our findings.

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CC-North 127C

Social Media Analytics in Health and Medicine

Community Committee Choice Session

Session Chair: Naoru Koizumi, George Mason University, Arlington, VA

Session Chair: Hadi El-Amine, George Mason University, Fairfax, VA

1 Analyzing the Formation of Transnational Kidney Trafficking Networks

Zifu Wang, Meng-Hao Li, Patrick Baxter, Jiaxin Wei, Naoru Koizumi, George Mason University, Fairfax, VA

Transnational kidney trafficking networks involve multiple actors, including buyers, sellers, brokers, and surgeons, operating across international borders. However, the lack of systematic kidney trafficking data collection and network analysis hinders our understanding of the formation and dynamics of these networks. In this study, we utilized OpenAI's GPT-3.5 model to identify the role of countries involved in kidney trafficking, using a large dataset of 50,228 newspaper articles extracted from LexisNexis between 2000 and 2022. We then applied Temporal Exponential Random Graph Models to analyze how country characteristics (i.e., GDP, rule of law quality, human rights scores, cultural distance, and healthcare resources) influence the formation of transnational kidney trafficking networks.

2 The Role of Kidney Broker Countries in Global Buyer-Seller Networks

Meng-Hao Li, Zifu Wang, Anna Matthei, Gabriel Yossick, Yu Yang, Naoru Koizumi, George Mason University, Arlington, VA

Kidney buyers, sellers, and brokers play vital roles in transnational kidney trafficking networks. However, the precise ways in which kidney broker countries mediate relationships between buyer and seller countries remain unclear. In this study, we collected 975 kidney trafficking-related newspaper articles from LexisNexis spanning 2000 to 2019 to identify the countries involved in kidney sellers, buyers, or brokers. We then used exponential random graph models to analyze how country characteristics - such as GDP, rule of law quality, human rights scores, religions, migration networks, and international trade - affect the formation of transnational kidney buyer-broker-seller networks.

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CC-North 128A

Workforce and Capacity Management for Healthcare

Community Committee Choice Session

Session Chair: Sandeep Rath, University of North Carolina at Chapel Hill - Kenan Flagler, Chapel Hill, NC

1 The Impact of Historical Workload on Nurses Perceived Workload

Carri Chan[1], Yi Chen[2], Jing Dong[3], Sarah Rossetti[4], [1]Columbia Business School, New York, NY, [2]Hong Kong University of Science and Technology, Hong Kong, Hong Kong; [3]Columbia University, New York, NY, [4]Columbia University Medical Center, New York City, NY, Contact: yichen@ust.hk

Recent and ongoing nursing shortages have highlighted the work that nurses provide round the clock in hospital inpatient care. Intense and sustained high nursing workload has been linked to nurse burnout and patient safety concerns, necessitating targeted approaches to better managing nursing workload. In this work, we take an empirical approach to understanding the effect of historical workload on nurses' perceived workload. Our estimation results show that one level of increase in historical order-based workload can lead to a 0.629 increase in the discrepancy between the clinically perceived workload and the order-based workload. Based on the temporal effect of nursing workload, we design an integer program-based patient-to-nurse assignment policy that achieves a more balanced workload over time while maintaining a high level of continuity of care.

2 Delta Coverage: The Analytics Journey to Implement a Novel Nurse Deployment Solution

Jonathan Eugene Helm[1], Pengyi Shi[2], Mary Drewes[3], [1]Indiana University, Bloomington, IN, [2]Purdue University, West Lafayette, IN, [3]IU Health, Indianapolis, IN, Contact: helmj@indiana.edu

This talk describes an academia industry collaboration to design and execute a new *internal travel nursing program* at IU Health that moves flexible nurses between the 16 system hospitals to respond short term geographic fluctuations in demand. For adoptability, we developed decision support to create an on-call list of how many nurses will move and where 2 weeks in advance and deployment decisions 24-48 hours in advance. This required developing a machine-learning-based occupancy forecasting model that accounts for different levels of patient acuity and outputs distributional information that can be used to characterize stochastic nurse demand across the network that feed a stochastic optimization. Implemented in Oct 202, subsequent 5 months indicates reductions of 5% understaffing, 3% misallocation of nurses, and 1% overstaffing. Annual savings >$400K.

3 The Impact of Introducing Release Times for Operating Rooms on Surgery Waiting Times

Guang Cheng[1], Mitchell H. Tsai[2], Joel Goh[3], [1]National University of Singapore, Singapore, Singapore; [2]University of Vermont Medical Center, South Burlington, VT, [3]NUS Business School, Singapore, Singapore. Contact: gcheng@u.nus.edu

The relationship between the implementation of a block release policy and surgery waiting times has not been studied. To evaluate the relationship of implementing a 7-day release policy on surgery waiting times at an academic medical center. At this center, a 7-day release policy was implemented on May 1, 2019, although not all specialties adopted this policy. A difference-in-differences regression was used to assess how the policy impacted surgery waiting times differentially between adopters and non-adopters. Our results show that waiting times in the follow-up period increased by 3.59 (95% CI: 1.84 - 5.35) days relative to baseline on average. Specialties that adopted the 7-day waiting time policy, however, saw a reduction of 6.89 (95% CI: 4.64 - 9.14) days of waiting relative to specialties that did not.

4 Nurse Workload Balancing Using Real-Time Location Data

Beste Kucukyazici[1], Pouya Hoseinpour[2], Vedat Verter[3], [1]Queen's University, Kingston, ON, Canada; [2]Amirkabir University of Technology, Tehran, Iran, Islamic Republic of; [3]Queen's University, Kingston, ON, Canada. Contact: beste.kucukyazici@queensu.ca

In this research, we develop a data-driven analytical framework to achieve balanced nurse workloads by optimizing the nurse-patient assignment decisions. To this end, we utilize an extensive data set collected by a real-time location system installed in the surgical services department of a large tertiary hospital. This enabled us to track the care providers as well as the surgical patients through their journey from the emergency department to the operating room, and the surgical ward. The nurse workload is modeled as a multi-attribute, multilinear function, where the significance of each attribute is elicited using an inverse optimization procedure integrated into a clustering method. The nurse workload balancing problem is then formulated for the upcoming shift, whereby the nurse-patient assignment decisions constitute the primary lever.

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Health Care Models

Community Committee Choice Session

Session Chair: Martin L. Puterman, University of British Columbia, Vancouver, BC, Canada

Session Chair: Seyed Amirhossein Moosavi, University of Ottawa, Ottawa, ON, Canada

1 Dynamic Policies for Inter-Hospital Patient Transfers

Timothy Chan, Jangwon Park, Vahid Sarhangian, University of Toronto, Toronto, ON, Canada. Contact: jangwon.park@mail.utoronto.ca

During the COVID-19 pandemic, inter-hospital patient transfers have emerged as a key strategy to rectify imbalanced congestion in many countries including the U.S. and Canada. To gain insights into the structure of "good" transfer policies, we propose a class of transient queueing control problems. We consider multiple parallel queues, starting with a large imbalanced initial state, and seek discrete-time dynamic transfer policies that minimize the expected total cost over a finite horizon or until the system reaches a desirable state. We characterize the structure of the optimal policy for an associated fluid control problem and investigate the robustness of the structure for the original stochastic problem. Using simulation experiments, we illustrate the performance of fluid-based policies and examine the value of optimal transfers.

2 A Hybridized Approximate Dynamic Programming and Neural Network for Distributed Ambulatory Care Scheduling

Amirhossein Moosavi[1], Onur Ozturk[1], Jonathan Patrick[2], [1]University of Ottawa, Ottawa, ON, Canada; [2]University of Ottawa, Ottawa, ON, Canada

This work studies an ambulatory care scheduling problem that offers multi-appointment, multi-class, multi-priority treatments in geographically distributed campuses with multiple resources. A dynamic setting is considered with uncertain patient arrival and use of the emergency department. The problem is formulated as an infinite-horizon Markov decision process model and is accelerated using a neural network. An affine approximation architecture is used to approximate the value function. Then, an equivalent linear programming model is solved through column generation to compute approximate optimal policies. Simulation results demonstrate that the approximate optimal policy outperforms alternative scheduling policies and can equip a booking clerk with intelligent scheduling rules that are difficult to predict in real-time.

3 Inverse Learning of Radiotherapy Treatment Planning Criteria

Houra Mahmoudzadeh[1], Kimia Ghobadi[2], Sara Ebrahimkhani[1], Bradley Hallett[1], Ernest Osei[3], Johnson Darko[3], [1]University of Waterloo, Waterloo, ON, Canada; [2]Johns Hopkins University, Baltimore, MD, [3]Grand River Regional Cancer Centre, Waterloo, ON, Canada. Contact: houra.mahmoudzadeh@uwaterloo.ca

In radiotherapy treatment planning, the goal is to find an acceptable treatment plan that best meets a set of clinical guidelines. These guidelines, however, are not universally agreed upon and are often violated in approved plans or made looser/stricter based on the opinion of an oncologist. Using a large number of historically approved plans, we use inverse optimization to learn these implicit clinical acceptability criteria for different patient cohorts. The proposed inverse models learn the feasible region of a mathematical optimization problem based on a set of past observations that are either approved or rejected. We discuss several recent approaches in inverse optimization for feasible region inference and compare their performance in practice.

4 Dynamic Assignment of Capacity and Fair Balancing of Covid-19 Patients over Hospitals

Richard J. Boucherie, University of Twente, Enschede, Netherlands. Contact: r.j.boucherie@utwente.nl

We introduce models that support dynamic fair balancing of COVID-19 patients over hospitals in a region and across regions. Patient flow is captured in an infinite server queueing network. Input for the model is an accurate real-time forecast of the number of COVID-19 patients hospitalised in the ward and the Intensive Care Unit of the hospitals based on the predicted inflow of patients, their Length of Stay and patient transfer probabilities among ward and ICU. For a given number of available beds, we introduce a dynamic load balancing model for assignment of patients to hospitals within a region, and a stochastic program for allocation of patients across regions. Subsequently, we consider optimal up- and downscaling of capacity for COVID-19 patients, leaving maximum capacity for regular (non-COVID) patients.

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CC-North 129A

Tackling Challenges in Healthcare Using Operations Research

Community Committee Choice Session

Session Chair: Lauren Lindley Czerniak, 1</sup

1 Sequential Hypothesis Testing to Detect Arrhythmia in Electrocardiogram Data

Yousef Oleyaeimotlagh[1], Taposh Banerjee[2], [1]University of Pittsburgh, Pittsburgh, PA, [2]University of Pittsburgh, Pittsburgh, PA, Contact: taposh.banerjee@pitt.edu

The problem of sequential hypothesis testing in statistically periodic data is studied. Statistically periodic data is observed in neuroscience, medicine, and cyber-physical systems, and has the property that the statistical behavior of data repeats after a fixed amount of time. Using a novel optimal control theory, it is shown that the optimal test is a likelihood ratio-based test with a periodic sequence of thresholds. It is further shown that a single threshold test is asymptotically optimal. The effectiveness of the algorithm is shown by applying it to electrocardiogram data.

2 Decision Making for Type Ii Fetal Heart Rate Tracing Using Deep Learning

Jaber Qezelbash-Chamak[1], Karen T. Hicklin[2], [1]University of Florida, Gainesville, FL, [2]University of Florida, Gainesville, FL, Contact: qezelbashc.jaber@ufl.edu

Fetal heart rate monitoring during labor helps healthcare providers to identify fetal hypoxia in an effort to reduce the risk of permanent neurologic damage. However, rates of fetal brain injury and cerebral palsy have remained unchanged, and there has been an increase in operative interventions. To address this, we developed a computer-aided system using deep learning convolutional neural networks to predict and classify neonatal intensive care unit admissions with cooling versus no cooling, which may be needed to allow the body to heal faster at lower body temperatures. The system provides sufficient prediction accuracy that helps physicians intervene more effectively.

3 Privacy-preserving Health Monitoring Via Federated Online Collaborative Learning

Tanapol Kosolwattana[1], Huazheng Wang[2], Ying Lin[3], [1]University of Houston, Houston, TX, [2]Oregon State University, Corvallis, OR, [3]University of Houston, Houston, TX, Contact: tkosolwa@cougarnet.uh.edu

Personalized health modeling and monitoring is critical for cost-effective disease prevention. Due to limited information and dependencies of disease progression between patients, it requires data sharing across patients to obtain an accurate monitoring strategy. However, it leads to a risk of privacy leakage in real-world healthcare systems. To solve this issue, this study proposed a federated online collaborative learning algorithm that allows decentralized online modeling and monitoring of patients without sharing raw data. It real-time integrates monitoring data into local statistics to infer patients' health conditions and allocates monitoring resources based on a patient's availability and risk. The efficiency of the proposed method is demonstrated through theoretical analysis, simulation studies, and cognitive monitoring in Alzheimer's disease.

4 When is It Worth It for Two Hospital Network Pharmacies to Operate as an Integrated Inventory System?

Lauren L. Czerniak, Mariel S. Lavieri, Mark S. Daskin, Burgunda V. Sweet, Jennifer Leja, Matthew A. Tupps, Karl Renius, University of Michigan, Ann Arbor, MI, Contact: czernl@umich.edu

Hospital network pharmacies provide drugs that are critical to patient care. However, it is unclear if lateral transshipments between two hospital network pharmacies benefit the inventory systems in the presence of supply chain disruptions. We create a modeling framework to solve for continuous review inventory policies in a two-hospital network pharmacy perishable inventory system with supply chain disruptions and lateral transshipments. We find that (i) the cost of a lateral transshipment must be sufficiently less than the cost of shortage for it to be beneficial to operate as an integrated inventory system. We also find that (ii) hospital network pharmacies need to consider the supply chain disruption characteristics (i.e., disruption and recovery rate) of the partner hospital network pharmacy and (iii) hoarding inventory can cause significantly more shortages.

5 Forecasting Organ Transplant Allocation Scores Using Machine Learning Models

Hyunwoo Shin, Xi Chen, Sait Tunc, Virginia Tech, Blacksburg, VA

Allocation scores significantly influence patient prioritization for organ transplants across the United States. The forecasting accuracy of these scores (e.g. Lung Allocation Score (LAS), Model for End-stage Liver Disease (MELD)) is a key determinant in the enhancement of patient care and in the critical analysis of the existing transplant infrastructure. In our study, we devised machine learning models for time series estimation and forecasting to accurately predict allocation scores across varying time horizons. We further undertook an in-depth examination of an intricate tree-based model embedded within the prediction model to elucidate its interpretability. Our research outcomes hold substantial potential to advance patient care, to improve decision-making, and to provide critical assessment metrics for the organ transplant systems.

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SOLA Rising Star Award

Community Committee Choice Session

Session Chair: Ismail Capar, Texas A&M University, College Station, TX

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TD24

CC-North 130

Social Responsibility in Operations

Contributed Session

Session Chair: Robert Eberhart, Stanford University, Palo Alto, CA

1 Buyer-Imposed and Supplier-Initiated Social Responsibility Codes of Conduct

Han Zhang, Mevan Jayasinghe, Sriram Narayanan, Michigan State University, East Lansing, MI, Contact: hzhang@broad.msu.edu

A buyer procuring from a socially irresponsible supplier will impose the buyer's code of conduct on the supplier. The supplier may voluntarily adopt a code of conduct to signal social responsibility. We show in equilibrium the buyer always waives the buyer's code when the supplier has adopted a voluntary code.

2 CSR Violations & Media Reactions - Domestic vs. Foreign Firms Operating in the U.S.

Stewart R. Miller[1], Kefeng Xu[2], Sarfraz Khan[3], Lorraine Eden[4], [1]University of Texas-San Antonio, San Antonio, TX, [2]University of North Carolina at Greensboro, Greensboro, NC, [3]University of Louisiana at Lafayette, Lafayette, LA, [4]Texas A&M University, College Station, TX, Contact: kefeng.xu@uncg.edu

We develop a conceptual framework to examine major media reactions to CSR violations by domestic and foreign firms. Based on EPA's environmental violation data, we draw upon expectancy violation theory and ingroup-outgroup literature to empirically examine how foreignness influences the likelihood of media coverage following environmental misconduct and moderates the effect of CSR reputation on media coverage.

4 Unlocking Blockchain Technology for Sustaining Plastic Recycling

Nesreen El-Rayes, Aichih (Jasmine) Chang, Jim Shi, NJIT (New Jersey Institute of Technology), Newark, NJ, Contact: nde4@njit.edu

To study the growing challenge of the plastic crisis, we devise a mathematical model that investigates the potential of Blockchain Technology in enhancing recycling. The model envisions a comprehensive and systematic coordination of the plastic value chain, from production to disposal, emphasizing optimal interoperability. We aim to foster effective and efficient recycling processes, which can profoundly improve plastic waste management.

5 Entrepreneurialism and the Acceptance of Inequality: What Causedit, What Keeps It Going, and What to Do About It

Robert Eberhart[1], Andrew J. Nelson[2], [1]UCLA, Los Angeles, CA, [2]University of Oregon, Eugene, OR, Contact: robert.eberhart@anderson.ucla.edu

We take up Thomas Piketty's challenge to uncover the ideology the underpins and facilitates acceptance of the inequality we observe. We capture an emergent entrepreneurial ideology that is a new ideology the stabilizes the social order by making it acceptable as to who garners the benefits of an entrepreneurial society and hold out hope that we all might someday be an entrepreneurial success. This new entrepreneurial ideology explains and creates a justification for social inequality. Attributing wealth to individual actions rather than personal attributes establishes a narrative that makes it more challenging to address the systemic factors contributing to inequality. Moreover, suggesting that the disadvantaged are responsible for their fate, but ought to try again to succeed, justifies the growing divide between the rich and the poor and stabilizes our social order.

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TD25

CC-North 131A

Improving Health Decision-Making: Screening, Diagnosis, and Policy

Community Committee Choice Session

Session Chair: Jacob Jameson, Allston, MA

Session Chair: SIDIAN Lin, Harvard University, Cambridge, MA

1 The Impact of Batch vs Sequential Ordering of Diagnostic Tests in the Emergency Department

Jacob Jameson[1], Arshya Feizi[2], Soroush Saghafian[1], [1]Harvard University, Cambridge, MA, [2]Boston University, Boston, MA, Contact: jacobjameson@g.harvard.edu

The accurate and expeditious diagnosis of patients in the emergency department (ED) is crucial for initiating appropriate treatment in a timely manner. Nevertheless, the optimal number of tests required to minimize diagnostic uncertainty remains unknown a priori. In situations where more than one diagnostic test is needed, it is more effecient for physicians to order theses tests in a batch. This study examines the comparative effects of sequential and batched test ordering strategies in the ED, specifically analyzing their implications for patient length of stay, hospital readmission, and resource utilization. We conduct a retrospective analysis of ED operational data to assess the causal impact of batching given various levels of patient complexity.

2 Should Race and Ethnicity be Used in Predictive Risk Models? Evidence from Diabetes Screening

Madison Coots[1], Soroush Saghafian[2], David Kent[3], Sharad Goel[4], [1]Harvard University, Cambridge, MA, [2]Harvard University, Cambridge, MA, [3]Tufts University, Boston, MA, [4]Harvard University, Harvard, MA, Contact: mcoots@g.harvard.edu

Predictive algorithms are used to inform patient screening decisions for many diseases, including diabetes. Some recent work recommends using race and ethnicity in risk assessments to improve accuracy, but other work argues that doing so risks stigmatizing marginalized communities. We introduce a utility framework and show that there is, perhaps surprisingly, minimal benefit from improved accuracy—both across the entire patient population and within patient subgroups—from including race and ethnicity in diabetes risk models. This is because few patients receive different screening decisions under different models, and, for those who do, the decision to screen is a close call, making them largely ambivalent. These findings suggest that past recommendations in diabetes screening likely overestimated the statistical benefits of using race and ethnicity.

3 Health Policy Modeling of Breast Cancer in Mexico

Melissa Franco[1], Karla Unger Saldaña[2], Jeremy Goldhaber-Fiebert[1], Joshua Salomon[1], Fernando Alarid Escudero[1], [1]Stanford University, Stanford, CA, [2]National Cancer Institute, Mexico, Mexico City, Mexico. Contact: mifranco@stanford.edu

Policymakers in resourced-constrained-low-to-middle-income-countries face a unique barrier in implementing breast cancer control policies that reduce the time from symptom presentation to diagnosis and treatment. We developed an age-structured ordinary differential equation (ODE) population-level model to simulate the dynamics of the natural history of breast cancer for women in Mexico, including both detection through screening and breast cancer symptom presentation. Using this population-level decision-analytical model, we critically consider a realistic capacity constraint in Mexico that has not been previously evaluated on breast cancer outcomes.

4 A Novel Evaluation of the Dose Constraints of an Adaptive Intervention Algorithm

Xiang Meng[1], Walter Dempsey[2], Nick Reid[3], Pedja Klasnja[2], Susan Murphy[1], [1]Harvard University, Cambridge, MA, [2]University of Michigan, Ann Arbor, MI, [3]University of Washington, Seattle, WA, Contact: xmeng@g.harvard.edu

Online adaptive algorithms in mobile health have transformed interventions, yielding promising health outcomes. Optimizing dose constraints is crucial for effective treatment delivery and maximizing user benefits. Two key constraints are the avg. treatment and uniformity constraints. The former limits treatment frequency to balance intervention effectiveness and user engagement, while the latter ensures even treatment randomization across potential risk times. To meet these constraints, the Sequential Risk Time Sampling (SeqRTS) algorithm was developed and used in a trial to evaluate anti-sedentary messages' effectiveness during sedentary behavior. We present an analytical framework assessing whether SeqRTS satisfies these constraints and evaluates its efficacy, offering insights for algorithm improvement.

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CC-North 131B

Analytics in Complex Supply Chains

Community Committee Choice Session

Session Chair: Dan Andrei Iancu, Stanford University, Stanford, CA

1 Clustering and Reinforcement Learning Approaches in Digital Supply Chains Analytics

Kevin Hu, Benjamin Siegel, Retsef Levi, Raphael (Rafi) Yahalom, MIT, Cambridge, MA, Contact: kevinkhu@mit.edu

The increasing frequency and severity of cyberattacks has made reliable cyber risk assessment a critical concern for organizations worldwide. Traditional cyber risk methodologies focus on the enterprise's level of cyber maturity. Moreover, several commercial companies provide cyber ratings using information about the organization accessible by outside parties, often called outside-in ratings. However, merely focusing on the enterprise's own cyber maturity may be insufficient given the increasing number of cyberattacks that exploit vulnerabilities in the organization's supply chain. This presentation introduces innovative approaches to cyber risk assessment that incorporate attributes of the digital supply chain.

2 Optimal Resource Allocation for Remediating Networked Contagions

Marios Papachristou[1], Siddhartha Banerjee[2], Jon M. Kleinberg[2], [1]Cornell University, Ithaca, NY, [2]Cornell University, Ithaca, NY

We study the problem of designing intervention policies for minimizing failures in dynamic networked contagion settings. Formally, we consider an extension of the Eisenberg-Noe model of financial network liabilities and use this to study the design of external intervention policies subject to budget constraints. We show how we can leverage the problem structure to efficiently compute optimal intervention policies with continuous interventions and provide approximation algorithms for discrete interventions. Going beyond financial networks, we argue that our model captures network intervention in a much broader class of demand/supply settings with networked inter-dependencies.

3 Platform Design for the First Mile of Commodity Supply Chains

Sergio Camelo[1], Dan Andrei Iancu[1], Joann de Zegher[2], [1]Stanford University, Stanford, CA, [2]MIT Sloan, Cambridge, MA, Contact: camelo@stanford.edu

We propose a data-driven platform that provides traceability to the first mile of agricultural supply chains by coordinating the transactions of farmers and intermediaries. We model unique aspects of the supply chain, including pre-existing informal relationships between farmers and intermediaries, and we develop algorithms to solve real-world instances. We test the results on data from the palm oil supply chain and show the platform's potential to reduce costs and increase farmers' welfare.

4 The Operational Origins of Child Labor in Cocoa Production

Andreas K. Gernert[1], Andre Du Pin Calmon[2], Dan Andrei Iancu[3], Luk N. Van Wassenhove[4], [1]KLU, Hamburg, Germany; [2]Scheller College of Business, Georgia Institute of Technology, Atlanta, GA, [3]Stanford University, Stanford, CA, [4]INSEAD, Fontainebleau Cedex, France

In the cocoa supply chains of Ghana and Ivory Coast, many smallholder farmers still rely on child labor for cocoa production. Our work examines, both analytically and empirically, how aspects of farmers' operations and financing can exacerbate or mitigate child labor use. Based on an analytical model capturing a farming household's key decisions, we characterize several relevant comparative statics and derive insights concerning the impact of distinct interventions aimed at mitigating child labor. We find, for instance, that the availability of loans increases the use of child labor for higher-income farmers but that it either increases or decreases the use of child labor for very low-income farmers, depending on uncertainties in yield, prices, or costs. We then leverage two distinct datasets to empirically validate some of our findings.

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CC-North 131C

Service Design and Pricing under Customers' Choice Behavior

Community Committee Choice Session

Session Chair: Ruxian Wang, Johns Hopkins University, Carey Business School, Kensington, MD

Session Chair: Chenxu Ke, 1</sup

1 Discrete Choice Models with Piecewise Linear Utility: Modeling, Estimation and Pricing

Zifeng Zhao, University of Notre Dame, Notre Dame, IN

This paper incorporates a piecewise linear structure into the utility-price relationship of the classic multinomial logit (MNL) model, and studies the associated operations problems such as estimation and pricing. The derived model provides greater modeling flexibility by allowing consumers to exhibit asymmetric price sensitivities around unknown inflection points. We study the model identification for the piecewise MNL and further propose an MLE for its calibration. Due to the presence of inflection points, the likelihood is non-differentiable, which poses major challenges to both numerical and statistical analyses. We propose a novel profile-based numerical optimization procedure which locates the MLE efficiently and further establish statistical guarantees for the MLE based on the empirical process theory.

2 Search And Choice: Modeling, Optimization And Estimation

Ruxian Wang, Johns Hopkins University, Carey Business School, Kensington, MD, Contact: ruxian.wang@jhu.edu

In this paper, we present a new model that captures new features in customer choice behavior. The analytical results and estimation validation show that the new model can describe customers' purchase behavior more accurately and model misspecification can lead to substantial losses for firms.

3 A Simple Way to Fair Assortment Planning: Market Exposure and Welfare Implications

Wentao Lu[1], Ruxian Wang[2], Ozge Sahin[3], [1]Johns Hopkins Carey Business School, Baltimore, MD, [2]Johns Hopkins University, Carey Business School, Kensington, MD, [3]Johns Hopkins Carey Business School, Brooklyn, NY, Contact: wlu25@jhu.edu

We consider the fair assortment planning problem where we propose new fairness constraints for the platform. We show that the optimal solution admits nice structure and can be found in polynomial time. We then consider cases where there are additional constraints and develop efficient heuristics. We investigate the welfare implications of imposing the fairness constraints and find that overall welfare for consumers, sellers, and the platform could increase .

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CC-North 132A

Recent Empirical and Theoretical Work in Operations

Community Committee Choice Session

Session Chair: Damian Beil, University of Michigan, Ann Arbor, MI

Session Chair: Andrew Wu, Ross School of Business, University of Michigan, Ann Arbor, MI

1 Behavioral Externalities of Process Automation

Ruth Beer[1], Anyan Qi[2], Ignacio Rios[2], [1]Baruch College, CUNY, New York, NY, [2]The University of Texas at Dallas, Richardson, TX, Contact: axq140430@utdallas.edu

We study the behavioral effects of process automation on human workers interacting with automated tasks. A stylized model with two workers completing their tasks sequentially predicts that workers do not delay their tasks if the early completion bonus is high enough. Our behavioral experiment shows that workers actually tend to delay their tasks. Process automation improves the project completion rate and time but reduces the productivity of the worker who collaborates with the robot.

2 Does Business Leaders' Operational Experience Generate Firm Operational Performance?

Hyungchan Cho[1], Damian Beil[2], Andrew Wu[3], [1]Ross School of Business, University of Michigan, Ann arbor, MI, [2]University of Michigan, Ann Arbor, MI, [3]Ross School of Business, University of Michigan, Ann Arbor, MI, Contact: chohc@umich.edu

Firms hire business leaders (executives, board members, etc.) for their experience and expertise. In this paper, we examine whether business leaders' operational excellence translates into firm operational performance. Using historical panel data on public firms' operational performance and senior leadership, we first formulate a measure of business leaders' operational excellence based on their employment history. Then, using this measure, we find that good operational excellence scores of business leaders are associated with better operational outcomes for firms. We find evidence of causality in this relationship by leveraging exogenous changes in firms' senior leadership, and perform a variety of checks to establish the robustness of our findings.

3 Exploit or Explore? an Empirical Study of Resource Allocation in Scientific Labs

Ran Zhuo, University of Michigan

Allocating innovation resources to their most productive uses is a challenge because innovators have incomplete information about which projects are productive. I empirically study how a group of large scientific labs traded off the exploitation of safe projects to maximize short-term productivity versus the exploration of high-variance projects to acquire information and improve long-term productivity. To recover how these labs made the tradeoff, I estimate a dynamic decision model, assuming the labs approximated the value of exploration with an Upper Confidence Bound (UCB) index. The model captures the labs' decisions well. Estimates of its free parameters suggest that the labs explored extensively. Counterfactual simulations show that, had the labs not explored, their output quantity would have decreased by 51%, and their citations would have decreased by 57%.

4 The Whiplash Effect: Congestion Dissipation and Mitigation in a Circulatory Transportation System

Ming Hu[1], Chaoyu Zhang[2], [1]University of Toronto, Minneapolis, MN, [2]University of Toronto, Toronto, ON, Canada. Contact: cyu.zhang@rotman.utoronto.ca

We build an analytical fluid model to investigate how disruptions at one port can affect the disrupted port and its counterpart in another country. Our analysis reveals two main effects of port disruption: the inbound backlog and the outbound backlog. We provide an analytical expression for the recovery time of two ports and track the evolution of backlogs of goods and ships. In addition, we identify a whiplash effect that occurs in the outbound backlog level at two ports, resembling the commonly known "bullwhip effect". Furthermore, we extend our analysis to a network of ports and show that the key findings still hold in the multi-port system. Finally, we apply machine learning techniques to predict the time vessels spend in the Shanghai port and show that our proposed model reduces prediction errors compared to the benchmark, indicating the application potential of our model.

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CC-North 132B

Emerging Research within Social Sustainability

Community Committee Choice Session

Session Chair: Priyank Arora, University of South Carolina, Columbia, SC

Session Chair: Wei Wei, University of New Hampshire, Durham, NH

1 Subsidizing Social Welfare Programs: Contracted Slots or Vouchers?

Wei Wei[1], Priyank Arora[2], Senay Solak[3], [1]University of New Hampshire, Durham, NH, [2]University of South Carolina, Columbia, SC, [3]University of Massachusetts Amherst, Amherst, MA

We study the interplay of decisions by multiple players within two popular service-focused subsidy welfare programs--subsidy vouchers and contracted slots. Through game-theoretic models, we analyze how program-related factors influence the quantity and quality of services provided by local providers. We also compare the societal outcomes generated by these two programs.

2 Competing with Cause Marketing: Transactional vs. Non-Transactional Campaigns

Mike M. Gordon[1], Arian Aflaki[2], Esther Gal-Or[2], Jennifer Shang[2], [1]Virginia Tech, Blacksburg, VA, [2]University of Pittsburgh, Pittsburgh, PA, Contact: mmgordon@vt.edu

Firms increasingly invest in corporate social responsibility (CSR) as a competitive strategy. Cause Marketing is a type of CSR where a firm donates to a cause to attract prosocial customers. Donations broadly belong to two categories: *Transactional CM (T-CM)*, based on units sold; and *Non-Transactional CM (N-CM)*, independent of customer purchases. We study various CM types and the choice of CM type under competition for different stakeholders, including firms, consumers, nonprofits, and society.

3 Matching Volunteers with Clients in a Non-Profit Organization

Shikha Safaya[1], Basak Kalkanci[2], Ravi Subramanian[3], [1]Scheller College of Business Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, [3]Georgia Tech, Atlanta, GA, Contact: ssafaya3@gatech.edu

Non-profit organizations are often challenged with volunteer participation and retention in the absence of monetary incentives. We explore the tradeoff between incorporating volunteer preferences in task assignments versus pooling volunteers to alleviate mismatch between supply and demand. In doing so, we endogenize volunteers' decisions to participate based on their expected utilities from serving clients and from their outside options. We analytically derive the conditions under which a particular policy may be preferred by all the stakeholders (the non-profit, volunteers, and clients). Consequently, we suggest levers that can be utilized by non-profits to better align the incentives of all the stakeholders.

4 Approaches for Identifying Hotspots of Low or Variable Crop Yields

Sanchita Das[1], Leonard Boussioux[2], Shweta Manjunath[3], [1]University of Washington, Seattle, WA, [2]MIT, Operations Research Center, Cambridge, MA, [3]University of Washington, Seattle, WA, Contact: sanchd20@uw.edu

We use a multimodal deep learning approach to combine survey data and satellite imagery to assess hotspots where agriculture yield for major crops in India is significantly lower or more variable compared to the country average. Farmers are resource constrained but have found significant efficiencies in agriculture operations for certain crops by using precision agriculture technology like sensors. Despite their proven efficiency, sensors are very expensive for implementation at scale. Hence there is value in exploring hotspots which should be prioritized for deploying sensors. Combining multimodal deep learning on satellite imagery and NLP on tab text data we provide a step in this direction, which can be an important decision making tool for farmers.

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CC-North 132C

Data-Driven Demand Modeling and Fulfillment Optimization in E-commerce

Community Committee Choice Session

Session Chair: Sheng Liu, University of Toronto, ON, Canada

Session Chair: Stefanus Jasin, University of Michigan, Ann Arbor, MI

1 Online Demand Fulfillment Problem with Initial Inventory Placement: A Regret Analysis

Alessandro Arlotto, Irem Nur Keskin, Yehua Wei, Duke University, Durham, NC, Contact: iremnur.keskin@duke.edu

We investigate a joint inventory placement and online fulfillment problem. We consider two state-of-the-art resolving policies: probabilistic fulfillment and score-based fulfillment. We study the minimum inventory regret of these policies, a measure that considers both the performance of the policies and initial inventory selection. We provide a regret bound for the score-based fulfillment policy that is independent of the time horizon and polynomial with respect to the number of warehouses and demand regions. In contrast, the minimum inventory regret for probabilistic fulfillment scales with the square root of the time horizon. Our findings suggest that score-based fulfillment is preferable to probabilistic fulfillment for this problem.

2 Data-Driven Nonparametric Deep Newsvendor

Jinhui Han[1], Ming Hu[2], Guohao Shen[3], [1]University of Toronto, Toronto, ON, Canada; [2]University of Toronto, Minneapolis, MN, [3]The Hong Kong Polytechnic University, Hong Kong, Hong Kong

We propose utilizing a nonparametric deep neural network (DNN) method to address the data-driven Newsvendor problem. The remarkable representational power of DNN enables our framework to incorporate or approximate various extant data-driven models. We provide analytical theoretical guarantees that bound the excess risk of DNN solution in terms of the network structure and sample size in a non-asymptotic manner, justifying the applicability of DNN in relevant contexts. Furthermore, our theoretical framework can be extended to cover the data-dependent scenario, where the historical data follows any stochastic process and the future demand is not necessarily an independent sample, which is highly relevant for practical prediction problems based on time series data. We apply the DNN method to a dataset from a deli company to illustrate its practical performance.

3 Does Locker Alliance Network Improve Last Mile Delivery Efficiency?

Quanmeng Wang[1], Guodong Lyu[2], Long He[3], Chung Piaw Teo[4], [1]National University of Singapore, Singapore, Singapore; [2]The Hong Kong University of Science and Technology, Hong Kong, China; [3]George Washington University, Washington, [4]National University of Singapore Business School, Singapore, Singapore. Contact: e0210515@u.nus.edu

We study the locker network design problem in last-mile delivery. The challenge lies in the characterization of home delivery cost reduction for a Logistic Service Provider (LSP) when some customers are attracted to use locker instead of requesting home delivery. We propose a generalization of BHH theorem to capture this effect, and subsequently formulate a Prize-collecting Travelling Salesman Problem. The model allows us to derive insights for the following two important issues: (1) does locker network improves delivery efficiency for a single LSP, and (2) how should the government build one common network facility for all LSPs in the region. We illustrate the insights on the case study of Locker Alliance Network project in Singapore.

4 Pooling and Boosting for Demand Prediction in Retail: A Transfer Learning Approach

Dazhou Lei[1], Hao Hu[2], Dongyang Geng[3], Jianshen Zhang[3], Yongzhi Qi[3], Sheng Liu[4], Zuo-Jun Max Shen[5], [1]Tsinghua university, Beijing, China; [2]JD, Beijing, China; [3]JD.com, Beijing, China; [4]University of Toronto, Toronto, ON, Canada; [5]University of California Berkeley, Berkeley, CA, Contact: ldz19@mails.tsinghua.edu.cn

How should retailers leverage aggregate (category) sales information for individual product demand prediction? Motivated by inventory risk pooling, we develop a new prediction framework that integrates category-product sales information to exploit the benefit of pooling. We propose to combine data from different aggregation levels in a transfer learning framework. We characterize the error performance of our model in linear cases and demonstrate the benefit of pooling. Moreover, our approach exploits a natural connection to regularized gradient boosting trees that enable a scalable implementation for large-scale applications. Based real data, we show the better out-of-sample forecasting performance of our approach than state-of-the-art benchmarks. We further validate its generalizability through alternative pooling and prediction methods.

5 E-Fulfillment Strategies Under Stochastic Orders and Cancellations

Tirui Cao[1], Lei Zhao[1], Yang Wang[2], Yiqiang Su[2], [1]Department of Industrial Engineering, Tsinghua University, Beijing, China; [2]Alibaba Group, Beijing, China. Contact: ctr20@mails.tsinghua.edu.cn

In the order fulfillment process of an online retailer, holding the received order for a while before dispatching it to a warehouse can help hedge the risk of future order cancellations and reduce the order fulfillment cost. In this paper, we consider customers' stochastic order cancellation behavior and study how to design order-holding strategies to reduce the fulfillment cost while not significantly disturbing the existing order fulfillment process (e.g., work schedules of the warehouses). We formulate the problem as a Markov Decision Process, design a cost function approximation (CFA) policy, and apply the optimal computing budget allocation method to search for the optimal policy parameters. Preliminary numerical results demonstrate that the CFA policy can better capture the uncertainty in order arrivals and cancellations and outperform the benchmark policies.

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CC-North 221A

Outbound Transportation Network Optimization

Community Committee Choice Session

Session Chair: Meltem Ozmadenci, Amazon, Bothell, WA

1 Better Delivery Promises at Lower Cost: Concurrent Optimization of Truck and Labor Schedules in Amazon's Middle Mile

Nicholas D. Kullman, Amazon, Bellevue, WA

We introduce a mixed-integer program that optimizes the schedule of Critical Pull Times (CPTs) that define connections in Amazon's Middle Mile network. The model recommends modifications to the existing CPT schedule, navigating tradeoffs between conflicting objectives: maximizing Volume Availability (alignment between inbound volume and scheduled labor) at Sort Centers (SCs) and Delivery Stations (DSs); maximizing the delivery speeds Amazon offers customers; and minimizing violations of operational constraints at Fulfillment Centers (FCs), SCs, and DSs. Moreover, the model recommends changes to labor plans at SCs and DSs, allowing objective improvement with fewer or no modifications to the CPT schedule. We showcase the effectiveness of the model under various scenarios, emphasizing the benefits of concurrently optimizing CPT schedules and labor plans.

2 Volume Accumulation Prediction and Optimization in near Real Time

Martin Bagaram[1], Shauna Robertson[2], Sam Hansen[1], Bryan Maybee[1], Theodoros Pantelidis[3], Meltem Ozmadenci[4], [1]Amazon.com, Bellevue, WA, [2]Amazon.com, Denver, CO, [3]Amazon.com, Dallas, TX, [4]Amazon.com, Bellevue, WA, Contact: mbagaram@amazon.com

Amazon Middle-Mile schedules truck departure times via volume accumulation curves (VAC). VAC represent future package accrual at an Amazon facility when they are ready to depart for a destination. We introduce our model that i) predicts the end-to-end package flow through the network and ii) builds VAC that are optimal for Linehaul and Amazon Logistics metrics. In the first step, package paths from start to finish are simulated via upstream constraints with varying levels of uncertainty to produce probable accumulation scenarios. In the second step, a two-stage stochastic MIP model schedules trucks on each lane without the full knowledge of the forecasted volume; then, we take two recourse actions: a) schedule cancellations if the actual volume does not warrant trucks, and b) schedule additional trucks if the materialized volume requires less equipment than first stage.

3 Modeling Promise in Fulfillment Execution

Daniel Chen[1,2], Tolga Cezik[3], Zsolt Csizmadia[4], [1]Amazon, Singapore, Singapore; [2]Institute of High Performance Computing, Singapore, Singapore; [3]Amazon.com, Seattle, WA, [4]Amazon, London, United Kingdom. Contact: danielchen1987@gmail.com

Every customer shipment ordered at Amazon has to be assigned a fulfillment path that is feasible for the promised delivery date. In order to account for future usage of resources on these fulfillment paths, future demand is modeled as shipments with similar promise feasibility requirements. However, when demand is high, this model may be unable to meet the promise of forecasted shipments, incurring large penalties. This distorts the implied costs of resource utilization and potentially results in under-utilized capacity. Therefore, we propose modeling the ability to offer slower promises on forecasted demand so as to more accurately reflect promises on future shipments and utilize resources better. We discuss preliminary simulation results.

4 Amazon Last Mile Sort Center Functionality Optimization

Shanshan Zhang, Amazon, Bellevue, WA

Last Mile Sort centers (LMSCs) are a critical component of Amazon's logistic network, sorting packages for downstream last mile nodes operated by different carriers, such as Amazon owned carrier AMZL delivery station (DSs) and United States Postal Service (USPS) destination delivery units. The functionality of a LMSC determines the sorting resources for packages, directly impacting the efficiency of the entire LMSC network. This talk presents a scientific methodology that quantifies the material trade-offs related to LMSC functionality, guiding Amazon's LMSC network design. The methodology uses machine learning and optimization models to estimate various cost components in the network. These cost components are then fed into a centralized mixed-integer optimization model, incorporating piece-wise linear approximations, to determine LMSC functionality.

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CC-North 221B

Amazon Last Mile Geospatial Optimization

Community Committee Choice Session

Session Chair: Yaniv Mordecai, [1</sup]
Session Chair: Liron Yedidsion, Amazon, Redmond, WA

1 Contiguous Spatial Unit Allocation Through Resource Constrained Shortest Path

Julie Poullet[1], Andre Snoeck[2], [1]Amazon - Last Mile, Seattle, WA, [2]Amazon, Austin, TX

At Amazon, 95% of the deliveries are made by our 3000+ Delivery Service Partners (DSPs) which are independent local business. DSPs operate out of a given station and are assigned to areas of the station's jurisdiction to produce consistent routes for their drivers. We present PAAT, a spatial unit allocation model that assigns areas to each DSP, maximizing consistency while balancing labor and workload. While this problem can be formulated as a MIP, solving it using commercial solvers quickly becomes intractable for real-world instances. Therefore, we develop a graph model that reduces the problem to a classical set covering problem, which we solved through a column-generation. Its key point is a novel application of resource based bounds in the pricing sub-problem algorithm, modeled as a Resource Constrained Shortest Path problem. It is 10 times faster than the MIP approach.

2 Revolutionizing Last Mile Delivery Through Multiple Modes of Transport

Dipal Gupta[1], Jin Ye[2], Vasanth Ramasamy[1], Rohit Malshe[1], Marc Anderson[3], Ehsan Jafari[3], [1]Amazon, Seattle, WA, [2]Amazon, Kirkland, WA, [3]Amazon, Austin, TX

The expansion of Amazon Logistics (AMZL) is one of the key enablers for the continued growth of Amazon's consumer business. Sustaining this growth rate is dependent on our ability to leverage alternative delivery methods, such as Hub Delivery Partners, walkers, and cargo electric bikes, to supplement traditional delivery modes. The Multiple Modes of Transportation (MMOT) program aims to combine these modes of delivery in flexible, cost-efficient, and sustainable ways to support last-mile delivery. Amazon Logistics (AMZL) needs to determine the most suitable combination of delivery methods for a given geography to ensure optimal efficiency and lower cost.

3 Reducing Geo-Temporal Anti-Coincidence of Multiple Shipping Methods

Yaniv Mordecai[1], Rohit Malshe[2], Liron Yedidsion[3], [1]Amazon, Redmond, WA, [2]Amazon, Bellevue, WA, [3]Amazon, Redmond, WA, Contact: yvm@amazon.com

We introduce an optimization model for last-mile multi-channel anti-coincidence reduction. Anti-coincidence occurs when two or more different delivery agents visit the same place on the same day. This can happen due to Amazon's offering of speed options next to traditional Prime service. We defined a new Geo-Temporal Anti-Coincidence (GTAC) metric, which relies on entropy across shipping channels' share distribution. We identified ZIP codes suffering from consistently high GTAC. We adapted the multi-commodity flow optimization (MCFO) problem formulation. Our model accounts for resource pool differences across channels, e.g., professional vs. gig economy drivers. We applied the model to a representative scenario in the Austin, TX metro to pick volume consolidation strategies that lead to significant savings in cost, mileage, service time, and GTAC.

4 Overlapping Jurisdictions to Increase Speed and Capacity Utilization

Rohit Malshe, Vasanth Ramasamy, Dipal Gupta, Chinmoy Mohapatra, Amazon, Seattle, WA

We discuss the benefits of implementing an Overlapping Jurisdiction (OJ) strategy in Amazon's delivery network. By allowing multiple delivery stations to service a single customer address, we can enhance connectivity, minimize volume loss, and increase fulfillment speeds. This technique has already resulted in over $50 million in savings and improved customer satisfaction. We will also explore the use of OJ selection algorithms and their impact on savings. Additionally, we will present research on the Variability Reduction use case, which is projected to drive $70 million in annual savings.

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CC-North 221C

Security Applications

Community Committee Choice Session

Session Chair: Hugh Medal, University of Tennessee, Knoxville, TN

1 Joint UAV and Truck Routing Under Uncertainty: Measuring the Value of Information

Leonardo Lozano[1], Juan Sebastian Borrero[2], [1]University of Cincinnati, Cincinnati, OH, [2]Oklahoma State University, Stillwater, OK, Contact: leolozano@uc.edu

We consider a joint truck and UAV routing problem subject to uncertain disruptions. The planner can refine her knowledge about the disruptions by spending resources to probe, removing the uncertainty for the probed nodes. To determine the best route, the planner requires measuring the value of information, which is computed by a two-stage stochastic optimization problem. In the first stage, the planner selects the locations to probe, and in the second stage, the planner selects the route based on the results of the probes. We reformulate the problem as a bilevel problem with multiple followers, propose two formulations for the joint UAV and truck routing problem, and develop two exact approaches to solve the bilevel problem. Our results show that probing, even if it is only on a small subset of locations, can yield significant gains in solution quality.

2 A Two�Stage Network Interdiction� Monitoring Game
Di Nguyen[1], Yongjia Song[2], Cole Smith[3], [1]University College Dublin, Dublin, Ireland; [2]Clemson University, Clemson, SC, [3]Syracuse University, Syracuse, NY
We study a network interdiction problem involving two agents: a defender and an evader. The evader seeks to traverse a path from a source node to a sink node in a directed network without being detected. The game takes place in two stages. In the first stage, the defender removes a set of arcs in the network. In the second stage, the defender and evader play a simultaneous game. The defender monitors a set of arcs, thus increasing the probability that the evader will be detected on that arc. The evader selects a source-sink path. Because the second stage is played simultaneously, both agents use mixed-strategy solutions. The second-stage problem is solved using a constraint-and-column generation algorithm. Then, to link the first- and second-stage problems, we model the original problem using an epigraph reformulation, which we solve using Benders decomposition.

3 Maximum Flow Network Problem with Imperfect Protection and Imperfect Interdiction
Hugh Medal, University of Tennessee, Knoxville, TN, Contact: hmedal@utk.edu
We investigate a network protection-interdiction problem in which a defender allocates resources to arcs in order to protect them from attack. Subsequently, an attacker allocates resources in order to destroy the arcs. Arcs fail with a probability determined by the amount of defense and attack resources allocated to it. The defender's objective is to maximize the expected flow through the network after arcs have failed. We formulate the problem as a stochastic program with decision-dependent uncertainty due to the fact that the uncertainty in the problem depend on defense and attack decisions. To solve this non-convex problem, we employ a column-and-constraint-generation approach.

4 An Optimization Approach for Network Biosurveillance
Ankan Mitra[1], Jorge A. Sefair[2], Tony H. Grubesic[3], Edward Helderop[3], [1]Arizona State University, Tempe, AZ, [2]University of Florida, Gainesville, FL, [3]University of California at Riverside, Riverside, CA
Network biosurveillance efforts focus on disease activity and threats to human, animal, or plant health to improve situational awareness and provide early warnings of disease emergence or activity. The goal is to monitor the consumption of, or exposure to, chemicals and pathogens at the community/population level. This talk presents a network optimization model for sensor placement in a wastewater network. The overarching goal is to maximize the amount of information captured from the network while narrowing down the potential geographical source of chemical or biological markers (i.e., signals) in the system.

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TD34

CC-North 222A
Advances in Nonlinear Stochastic Optimization I
Community Committee Choice Session
Session Chair: Albert Berahas, 1</sup
Session Chair: Raghu Bollapragada, The University of Texas at Austin, Austin, TX

1 Community/Committee'S Choice Submission
Michael O'Neill, University of Wisconsin-Madison, Madison, WI

2 Reliable Adaptive Stochastic Optimization with High Probability Guarantees
Miaolan Xie, Billy Jin, Katya Scheinberg, Cornell University, Ithaca, NY, Contact: mx229@cornell.edu
To handle real-world data that is noisy, biased and even corrupted, we consider a simple adaptive framework for stochastic optimization where the step size is adaptively adjusted according to the algorithm's progress instead of manual tuning or using a pre-specified sequence. Function value, gradient and possibly Hessian estimates are provided by probabilistic oracles and can be biased and arbitrarily corrupted, capturing multiple settings including expected loss minimization in machine learning, zeroth-order and low-precision optimization. This framework is very general and encompasses stochastic variants of line search, quasi-Newton, cubic regularized Newton and SQP methods for unconstrained and constrained problems. Under reasonable conditions on the oracles, we show high probability bounds on the sample (and iteration) complexity of the algorithms.

3 Retrospective Approximation for Stochastic Equality Constrained Problems Using Sequential Quadratic Programming

Shagun Gupta[1], Raghu Bollapragada[2], Albert Solomon Berahas[3], [1]University of Texas at Austin, Austin, TX, [2]The University of Texas at Austin, Austin, TX, [3]University of Michigan, Ann Arbor, MI, Contact: shagungupta@utexas.edu

Sequential Quadratic Programming (SQP) is one of the state of the art algorithms to solve deterministic equality constrained problems. In recent years the framework has been extended to solve equality constrained problems with stochastic objective functions. To adapt the step size in stochastic settings, new schemes like stochastic line search, Lipschitz constant estimation, hessian averaging have been introduced in SQP. We use SQP algorithms in a Retrospective approximation framework that allows us to solve a series of subsampled deterministic subproblems to solve the the stochastic constrained problem. This framework decouples the stochasticity from the SQP algorithm allowing us to use legacy deterministic solvers (other than SQP as well) to solve constrained stochastic programs.

4 On the Convergence of a Decomposition Algorithm for Nonlinear Two-Stage Optimization

Yuchen Lou[1], Andreas Waechter[1], Xinyi Luo[1], Ermin Wei[2], [1]Northwestern University, Evanston, IL, [2]Northwestern University, Evanston, IL

We consider the theoretical convergence properties of an algorithm for nonlinear continuous two-stage optimization problems that is based on a novel log-barrier-based smoothing technique. In particular, we explore how fast local convergence can be obtained with extrapolation steps and what global convergence guarantees can be obtained for nonconvex instances.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD35

CC-North 222B

Large-Scale Structured Optimization

Community Committee Choice Session

Session Chair: David Huckleberry Gutman, Texas Tech University, Lubbock, TX

1 Tangent Subspace Descent on Reductive Homogeneous Spaces

David Huckleberry Gutman[1], Nam Ho-Nguyen[2], Daniel Grady[3], Bruno Mello[4], Guilherme Menezes[5], [1]Texas A&M University, College Station, TX, [2]The University of Sydney, The University of Sydney, Australia; [3]Wichita State University, Wichita, KS, [4]Aetos Tech, Rio de Janeiro, Brazil; [5]INOA, Rio de Janeiro, Brazil. Contact: david.gutman@ttu.edu

The tangent subspace descent method (TSD) extends the coordinate descent algorithm to manifold domains. The key insight underlying TSD is to draw an analogy between coordinate blocks in Euclidean space and tangent subspaces of a manifold. The core principle behind ensuring convergence of TSD for smooth functions is the appropriate choice of subspace at each iteration. In this talk, we will show that it is always possible to appropriately pick such subspaces on the broad class of manifolds known as reductive homogeneous spaces. This class includes Grassmannians, flag manifolds, and the positive definite manifold when endowed with an appropriate geometry. As a result of our developments we derive new and efficient methods for large-scale optimization on these domains.

2 The Inexact Block Proximal Gradient Method

Leandro Maia[1], David Huckleberry Gutman[1], Ryan C. Hughes[2], [1]Texas Tech University, Lubbock, TX, [2]Addx Corporation, Alexandria, VA, Contact: leandro.maia@ttu.edu

In this talk, we expand the Cyclic Block Proximal Gradient method for block separable, composite minimization to allow for inexactly computed gradients and proximal maps. The resultant algorithm, the Inexact Cyclic Block Proximal Gradient (I-CBPG) method, shares the same convergence rate as its exactly computed analogue, provided how the allowable errors decrease. The foundation of our convergence analysis is our proposed ⍰-Second Prox Theorem, which contains a tight relationship between inexact proximal map evaluations and ⍰-subgradients. Further, we highlight numerical experiments that showcase the practical computational advantage of I-CBPG for certain fixed tolerances of approximation error and for a dynamically decreasing error tolerance regime in particular.

3 Distributed Nonconvex Functional Constrained Optimization via Ghost Penalty

Ying Sun, 1</sup

This talk considers distributed optimization problems with nonconvex functional constraints. Such problems have received increasing importance due to their flexibility in capturing real-world demands, including resource limitations, safety guarantees, fairness, and system dynamics. Leveraging the technique of successive convexification and average consensus, we develop an SQP-type algorithm that can handle common/shared/private types of constraints in a unified fashion. We prove the convergence of the algorithm based on a Lyapunov function consisting of a non-smooth exact penalty function and consensus violation measures. Sublinear convergence rate is established with a diminishing step size; whereas for the shared common constraint setting, we prove the algorithm attains faster convergence with a constant step size.

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TD36

CC-North 222C

Global Guarantees in Nonconvex Optimization

Community Committee Choice Session

Session Chair: Salar Fattahi, University of Michigan, Ann Arbor, MI

1 Implicit Regularization Leads to Benign Overfitting for Sparse Linear Regression

Mo Zhou, Duke University, Durham, NC, Contact: mo.zhou7@duke.edu

In deep learning, often the training process finds an interpolator (a solution with 0 training loss), but test loss is still low. This is known as benign overfitting and is a major mystery in deep learning. One common mechanism is implicit regularization, where training process leads to additional properties for the interpolator, often characterized by minimizing certain norms. However, even for simple sparse linear regression, neither minimum L_1 or L_2 norm interpolator gives the optimal test loss. In this work, we give a new parametrization of the model that combines the benefit of L_1 and L_2 interpolators. We show that training new model via gradient descent leads to an interpolator with near-optimal test loss. Our result is based on careful analysis of training dynamics and provides another example of implicit regularization effect that goes beyond norm minimization.

2 The Power of Preconditioning in Overparameterized Low-Rank Matrix Sensing

Xingyu Xu[1], Yandi Shen[2], Yuejie Chi[1], Cong Ma[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]University of Chicago, Chicago, IL, Contact: xingyuxu@andrew.cmu.edu

We propose ScaledGD(?), a preconditioned gradient method to tackle the low-rank matrix sensing problem when the true rank is unknown and when the matrix is possibly ill-conditioned. Using overparameterized factor representations, ScaledGD(?) starts from a small random initialization and proceeds by gradient descent with a certain form of *damped* preconditioning to combat bad curvatures induced by overparameterization and ill-conditioning. We prove that at the expense of light overhead incurred by preconditioners, ScaledGD(?) is remarkably robust to ill-conditioning even with overparameterization, converging to the ground truth in a number of iterations almost independent of the condition number. Our work provides evidence on the power of preconditioning in accelerating the convergence without hurting generalization in overparameterized learning.

3 Nonconvex Optimization: When Can Gradient Descent Escape Saddle Points in Linear Time?

Rishabh Dixit, Rutgers University, Piscataway, NJ

The large-scale nature of many of the data driven problems also necessitates the use of first-order optimization methods for computational purposes. But the first-order methods, which include the gradient descent algorithm, face a major hurdle in nonconvex optimization: first-order methods can potentially get stuck at the saddle points of the objective function. And while recent works have established that gradient descent almost surely escapes the saddle points, there remains a concern that first-order methods can spend an inordinate amount of time in the saddle neighborhoods. It is in this regard that we revisit the behavior of the gradient descent trajectories within the saddle neighborhoods and ask whether it is possible to provide conditions under which these trajectories escape the saddle neighborhoods in linear time.

4 Invariant Low-dimensional Subspaces In Gradient Descent For Learning Deep Linear Networks

Can Yaras, University of Michigan

In this presentation, we reveal a surprising simplicity in the learning dynamics of deep linear networks, showing that gradient descent only affects a minimal portion of singular vector spaces across all weight matrices when there is low-dimensional structure in the data. In other words, the learning process occurs only within a minimal subspace of each weight matrix, despite the fact that all weight parameters are updated throughout training. This result enables us to considerably improve training efficiency by taking advantage of the low-dimensional structure in learning dynamics by constructing smaller, equivalent deep linear networks. Second, it allows us to better understand deep representation learning by elucidating the linear progressive separation and concentration of representations from shallow to deep layers.

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CC-North 223

Towards Understanding Offline Reinforcement Learning: Theory and Applications

Community Committee Choice Session

Session Chair: Jiawei Zhang, MIT, Cambridge, MA
Session Chair: Kaiqing Zhang, MIT, Cambridge, MA
Session Chair: Asuman Ozdaglar, Massachusetts Institute of Technology, Cambridge, MA

1 A Finite-Sample Analysis of Multi-Step Temporal Difference Estimates

Yaqi Duan, [1]</sup

We consider the problem of estimating the value function of an infinite-horizon ⍰-discounted Markov reward process (MRP). We establish non-asymptotic guarantees for a general family of multi-step temporal difference (TD) estimates, including canonical *K*-step look-ahead TD for *K* = 1, 2, ... and the TD(⍰) family for ⍰ [0,1) as special cases. Our bounds capture the dependence of these estimates on both the variance as defined by Bellman fluctuations, and the bias arising from possible model mis-specification. Our results reveal that the variance component shows limited sensitivity to the choice of look-ahead defining the estimator itself, while increasing the look-ahead can reduce the bias term. This highlights the benefit of using a larger look-ahead: it reduces bias but need not increase the variance.

2 Optimal Conservative Offline Reinforcement Learning with General Function Approximation via Augmented Lagrangian

Jiantao Jiao, University of California, Berkeley, Berkeley, CA

Offline reinforcement learning (RL), which aims at learning good policies from historical data, has received significant attention over the past years. We leverage the marginalized importance sampling (MIS) formulation of RL and present the first set of offline RL algorithms that are statistically optimal and practical under general function approximation and single-policy concentrability, bypassing the need for uncertainty quantification. We identify that the key to successfully solving the sample-based approximation of the MIS problem is ensuring that certain occupancy validity constraints are nearly satisfied. We enforce these constraints by a novel application of the augmented Lagrangian method and prove the following result: with the MIS formulation, augmented Lagrangian is enough for statistically optimal offline RL.

3 Provable Statistical Benefits of Hybrid Reinforcement Learning

Yuxin Chen, [1]</sup

In this paper, we study tabular reinforcement learning (RL) in the hybrid setting, where we have access to both an offline dataset and online interactions with the unknown environment. A key question boils down to how to efficiently utilize online data collection to strengthen and complement the offline dataset and improve policy fine-tuning. Leveraging recent advances in reward-agnostic exploration and model-based offline RL, we design a three-stage hybrid RL algorithm that beats the best of both worlds --- pure offline RL and pure online RL --- in terms of sample complexities. Our theory is developed based on a new notion called single-policy partial concentrability, which captures the trade-off between distribution mismatch and lack of coverage, and guides the interplay between offline data and online exploration.

4 Offline Reinforcement Learning with Differentiable Function Approximation is Provably Efficient

Ming Yin[1], Mengdi Wang[2], Yu-Xiang Wang[1], [1]UC Santa Barbara, Santa Barbara, CA, [2]Princeton University, Princeton, NJ, Contact: ming_yin@ucsb.edu

Offline reinforcement learning has been extensively applied in real-life applications. State-Of-The-Art algorithms usually leverage powerful function approximators to alleviate the sample complexity hurdle for better empirical performances. Despite the successes, a more systematic understanding of the statistical complexity for function approximation remains lacking. Towards bridging the gap, we take a step by considering offline reinforcement learning with differentiable function class approximation (DFA). This function class naturally incorporates a wide range of models with nonlinear structures. We show offline RL with differentiable function approximation is provably efficient by analyzing the pessimistic fitted Q-learning (PFQL) algorithm. In addition, we further improve our guarantee with a tighter instance-dependent characterization.

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CC-North 224A

Advances in Stochastic Optimization

Community Committee Choice Session

Session Chair: Jimmy Zhang, [1]</sup
Session Chair: Digvijay Boob, Southern Methodist

University, Dallas, TX

1 First-Order Methods for Stochastic Variational Inequality Problems with Function Constraints

Digvijay Boob[1], Qi Deng[2], [1]Southern Methodist University, Dallas, TX, [2]Shanghai University of Finance and Economics, Shanghai, WY, China. Contact: dboob@smu.edu

This talk introduces novel single-loop first-order methods for function-constrained VI (FCVI) problems which can be smooth or nonsmooth with a stochastic operator and/or constraints. We present the (stochastic) OpConEx method, which employs extrapolation of the operator and constraint functions. This method achieves optimal operator or sample complexities when the FCVI problem is either (i) deterministic nonsmooth, or (ii) stochastic, including smooth or nonsmooth stochastic constraints without requiring the knowledge of Lagrange multipliers. We also present the AdLagEx that achieves optimal operator complexity for smooth deterministic problems without knowledge of Lagrange multipliers. Our methods also apply to saddle point problems with coupled function constraints. To our best knowledge, many of these complexities are new in the literature.

2 Accelerated Primal-Dual Methods for Convex-Strongly-Concave Saddle Point Problems

Mohammad Khalafi[1], Digvijay Boob[2], [1]Southern Methodist University, Dallas, TX, [2]Southern Methodist University, Dallas, TX, Contact: mohamadk@smu.edu

We investigate a primal-dual (PD) method for the saddle point problem (SPP) that uses a linear approximation of the primal function instead of the standard proximal step, resulting in a linearized PD (LPD) method. For convex-strongly concave SPP, we observe that the LPD method has a suboptimal dependence on the Lipschitz constant of the primal function. To fix this, we combine features of Accelerated Gradient Descent with the LPD method resulting in a single-loop Accelerated Linearized Primal-Dual(ALPD) method. ALPD method achieves the optimal gradient complexity when the SPP has a semi-linear coupling function. We also present an inexact ALPD method for SPPs with a general nonlinear coupling function that maintains the optimal gradient evaluations of the primal parts and significantly improves the gradient evaluations of the coupling term compared to the ALPD method.

3 Exact Matrix-Vector Multiplication Complexity for Kernel Projection and Its Application on Distributed Consensus Optimization

Yibo Xu[1], Yuyuan Ouyang[1], Yunheng Jiang[2], [1]Clemson University, Clemson, SC, [2]Clemson University, Central, SC, Contact: yibox@clemson.edu

We study the problem of computing a matrix kernel projection of a vector, when the matrix is not known, but its matrix-vector oracle is accessible. We first explore three perspectives: in control, the best-known method is not optimal; in optimization, we can device a novel accelerated gradient method, yet it is only optimal in the order of linear convergence; in linear algebra, there is known study of exact oracle complexity for solving a linear equation provided with the same matrix-vector oracle, yet this result is not readily applicable to our problem. Based on our observations, under a linear-span assumption, we propose a novel iterative method which attains the exact oracle complexity. In the realm of general methods, we provide an exact lower complexity bound under the assumption that the dimension of our problem is sufficiently large.

4 Nonconvex Stochastic Bregman Proximal Gradient Method with Application to Deep Learning

Kuangyu Ding, National University of Singapore, Singapore, Singapore. Contact: e0444161@u.nus.edu

Classical gradient methods to solve nonconvex composite optimization problems assume Lipschitz smoothness of the differentiable part, which does not hold true for problem classes such as training neural networks. To address this issue, we investigate stochastic Bregman proximal gradient (SBPG) methods, which only require smooth adaptivity of the differentiable part, which captures the non-Lipschitz gradients of the nonconvex objective. We establish the vanilla SBPG's convergence properties and propose a momentum-based SBPG and prove its improved convergence properties. We apply this momentum-based SBPG to train deep neural networks with a polynomial-type kernel, which ensures the smooth adaptivity of the loss function. Experimental results on representative benchmarks demonstrate the effectiveness and robustness of SBPG in training neural networks.

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CC-North 224B

Food and Agricultural Distribution and Transportation

Community Committee Choice Session

Session Chair: Christine Vi Nguyen, Northern Illinois University, Dekalb, IL

1 Modeling the Impact of Decentralization in Food Supply Chain Systems on Food Loss

Tejas Bhatt, Shahram Sarkani, Thomas A. Mazzuchi, George Washington University, Washington, DC, Contact: tejasbhatt@gwu.edu

It is unknown what impact new trends in food supply chain systems, such as e-Commerce and Industry 4.0, will have on food loss and waste which costs up to $400 billion annually and is getting worse. In response to recent global crises, another new trend emerging in food supply chains is decentralization to become less vertically integrated. This research study aims to quantify the impact of decentralization of food supply chain systems on food loss using an agent-based simulation model. Such a model could be used by food companies designing their sourcing, procurement, and logistics strategies as well as by policymakers designing incentives to fight food insecurity. The research is broadly applicable to any industry where waste occurs due to perishability, such as food and agriculture.

2 Assessing Food Supply Chain Risk

Isabella T. Sanders, United States Military Academy at West Point, West Point, NY, Contact: isabella.sanders@westpoint.edu

Though COVID may be waning, food supply chains continue to be vulnerable to unintentional and intentional attacks. This presentation provides a new model to assess food supply chain risk starting at the farm and finishing with the consumer. We present a study of Meals Ready to Eat or MRE's (and similar) a staple in Military Foods as well as disaster relief.

3 Forecasting Egg Price Rise Using Machine Learning

Luyana Franco[1], Wen-Chyuan Chiang[1], Weiping Pei[2], [1]University of Tulsa, Tulsa, OK, [2]University of Tulsa, Tulsa, OK, Contact: lpf4772@utulsa.edu

This study investigates the feasibility of using machine learning models for egg price prediction. We train machine learning models based on historical pricing data and economic indicators and evaluate the performance of models. The prediction results enable stakeholders to make informed decisions regarding production, distribution, and purchasing strategies, while policymakers can address challenges related to the affordability and accessibility of eggs.

4 Enhancing Food Bank Supply Chain Efficiency an Optimal Model Considering Perishable & Non-Perishable Items with Uncertain Supply and Demand

Christine Vi Nguyen[1], Michael Hewitt[2], Mahsa Mahdavisharif[3], [1]Northern Illinois University, Dekalb, IL, [2]LOYOLA UNIVERSITY, Chicago, IL, [3]Northern illinois university, Dekalb, IL

The study proposes a model of a food bank's supply chain operations. Our motivating application is a 3PL that connects food donors to food banks and pantries (e.g. Feeding America). We consider a 3PL that seeks to match uncertain product supply levels (i.e. donations) with uncertain product demand levels from a set of demand points. Demand points can also purchase items to meet their needs. The 3PL seeks to maintain a service level, driven by the organizational mission, to meet demand point needs, and a service level of accepting donations. The 3PL operates distribution centers that serve as inventory and consolidation points for goods. The proposed model aims to minimize the transportation and inventory costs.

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CC-North 225A

Planning Multi-tier City Logistics Systems

Community Committee Choice Session

Session Chair: Julia Lange, RPTU Kaiserslautern-Landau, Kaiserslautern, Germany

1 Two-Echelon Vehicle Routing Problems: A Review, Some Models and Direction for Future Research

Tom Van Woensel, Eindhoven University of Technology, Eindhoven, Netherlands

The distribution network is split into two echelons in the two-echelon vehicle routing problem (2E-VRP). Different vehicles are operated on the first and second echelons to maintain economies of scale and adhere to any vehicle restrictions that may be present in either echelon. Intermediate facilities are located at the borders of the echelons to facilitate the consolidation and transshipment of goods between echelons. The literature on the 2E-VRP has expanded significantly in recent years. In this presentation, mathematical formulations and benchmark datasets used to test and evaluate new algorithms are reviewed and discussed.

2 A Location-Network Design Problem with Vehicle Selection in City Logistics

Francesco Contu[1], Teodor Gabriel Crainic[2], Massimo Di Francesco[1], Enrico Gorgone[1], [1]University of Cagliari, Cagliari, Italy; [2]Université du Québec à

Montréal, Montréal, QC, Canada. Contact: francesco.contu97@unica.it

We study a location-network design problem arising in the field of city logistics [1], [2]. A set of containers must be moved from a port to satellites, where pallets are unpacked from the containers, loaded on vehicles and sent to final destinations. We must select satellites and vehicles, assign containers to satellites, determine paths for selected vehicles, and the flows of pallets. A mixed integer programming formulation and an iterative solution method are proposed; in this method the overall problem can be split at each step into two subproblems: (i) we select satellites, assign containers to satellites, select and assign vehicles to satellites; (ii) we solve a network design problem with routing constraints to determine the paths of vehicles and pallets from satellites to customers. We propose an adaptive large neighbourhood search (ALNS) algorithm for problem(ii).

3 Uncertainty in City Logistics Location-Routing

Teodor Gabriel Crainic[1], David Escobar-Vargas[2], Walter Rei[3], [1]Université du Québec à Montréal, Montréal, QC, Canada; [2]Université de Montréal, Montréal, QC, Canada; [3]University of Quebec-Montreal, Saint-Lambert, QC, Canada. Contact: teodorgabriel.crainic@cirrelt.net

We address the Multi-attribute Two-Echelon Location-Routing Problem with Stochastic Travel Times, where location and routing decisions are to be taken on both tiers of City Logistics systems under uncertainty regarding travel times and demand availability. The problem setting includes time-dependent origin-destination demand, time windows at customers, limited storage capacity at intermediate facilities, and tight synchronization requirements at these facilities of the fleets operating on different tiers. We briefly present the problem, our modelling and algorithmic developments, and the results of an extensive experimentation campaign.

4 Efficient Move Selection in Classical Non-Overlapping Neighborhoods for Routing Optimization

Cesar Rego, University of Mississippi, University, MS

Emerging logistics, transportation, and distribution applications require routing methods exhibiting fast response time, high accuracy, stability, and conciseness. At their core, modern approaches harness classical local search operators prized for their ease of implementation, replicability, and adaptability to diverse routing constraints. However, a significant limitation arises from the sequential examination of non-overlapping neighborhoods during local search, which escalates complexity and limits exploration to one neighborhood type at each step. Our research offers a remedy by revealing properties that identify the best solution within the composite set of neighborhoods in the time required to examine just one of them.

5 Planning Scheduled Services in Multimodal Synchronized City Logistics Systems

Julia Lange[1], Teodor Gabriel Crainic[2], Timo Gschwind[1], Walter Rei[3], [1]RPTU Kaiserslautern-Landau, Kaiserslautern, Germany; [2]Université du Québec à Montréal, Montréal, QC, Canada; [3]University of Quebec-Montreal, Saint-Lambert, QC, Canada. Contact: julia.lange@rptu.de

Future city logistics systems focus on multi-tier and multimodal transportation, an integration of freight movements into mobility and minimal spatial requirements. The presented planning approach is based on two-tier service network design, where transportation services with routes, departure time windows and capacities are given, and waiting time policies exist for customer and handover locations. Demands involve inbound, outbound and inner-city commodity flows. The goal is to find a selection of operated services, an assignment of all demands and a precise schedule for each service so that operating costs and waiting times are minimal. Exact synchronization of services to avoid storage space necessity is a major challenge. Promising results are obtained by general mixed-integer programming methods with enhancements through fixing and bounding techniques.

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CC-North 225B

Data-driven Transit Optimization

Community Committee Choice Session

Session Chair: Ayan Mukhopadhyay, Vanderbilt University, Nashville, TN

1 Designing Equitable Transit Network

Sophie Pavia, Vanderbilt University, Nashville, TN, Contact: sophie.r.pavia@vanderbilt.edu

Public transit is an essential infrastructure enabling access to employment, healthcare, education, and recreational facilities. While accessibility to transit is important in general, some sections of the population depend critically on transit. However, existing design paradigms for public transit do not explicitly consider equity, which is often added as an additional objective post hoc. We present a mathematical formulation for transit network design that explicitly considers different notions of equity and welfare. Our formulation is an integer linear program based on a piece-wise linear utility function that quantifies the utility of a passenger from the installed transit network compared to the use of personal vehicles. We study the interaction between network design and different concepts of equity and present trade-offs and results.

2 I-24 Motion: An Instrument for Freeway Traffic Science

Gergely Zachar, Vanderbilt University, Nashville, TN

The Interstate-24 MObility Technology Interstate Observation Network (I-24 MOTION) is a new instrument for traffic science located near Nashville, Tennessee. I-24 MOTION consists of 276 pole-mounted high-resolution traffic cameras that provide seamless coverage of approximately 4.2 miles on I-24, a 4-5 lane (each direction) freeway with frequently observed congestion. Vehicle trajectories are extracted from the video using computer vision techniques. Approximately 230 million vehicle miles of travel occur within I-24 MOTION annually. The main output of the instrument are vehicle trajectory datasets that contain the position of each vehicle, as well as other supplementary information, like vehicle dimensions, and class. This presentation introduces the design and creation of the instrument, and provides insight into the first publicly available datasets.

3 Request-Vehicle Matching with Consumer Choice Modeling in High-Capacity Ride-Pooling

Youngseo Kim[1], Vindula Jayawardana[2], Samitha Samaranayake[1], [1]Cornell University, Ithaca, NY, [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: yk796@cornell.edu

Demand-responsive transit services have received attention due to their flexibility and sustainability. However, developing request-vehicle matching algorithms for pooling services proves more challenging than for ride-hailing services due to the additional complexity of shared rides. One such complexity is the maximum detour time that a service induces on a shared rider. This research proposes a novel matching algorithm that optimizes the system performance while considering user preferences on maximum detours. Our approach estimates the expected future value of matchings for non-myopic solutions to the online optimization. To achieve this, we utilize discrete choice modeling and a reinforcement learning framework to estimate the values of matchings, then solve an integer linear programming to find the best matching pairs and maximum detours.

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CC-North 226A

Developing a Health Disparities Working Group within ORMS

Panel Session

Session Chair: Karen Hicklin, Icahn School of Medicine at Mount Sinai, New York, NY

Session Chair: Jennifer Mason Lobo, University of Virginia, Charlottesville, VA

Tuesday, October 17, 2:15 PM - 3:30 PM

TD43

CC-North 226B

UAS Traffic Management (UTM) Risk Assessment

Community Committee Choice Session

Session Chair: Valentin Polishchuk, 1</sup

1 Understanding Different Connector Buses' Effect on People's Choices in Selecting Itinerary

Junzhe Cao[1], Xuan Jiang[1], Yuhan Tang[1], Qiyang Mo[2], Hao Yang[3], [1]University of California, Berkeley, Berkeley, CA, [2]Shanghai University, Shanghai, China; [3]University of Washington, Seattle, WA, Contact: j.cao@berkeley.edu

Airline Connector Buses can transform air travel with their potential to address the 'last hundred miles' challenge. This study investigates their impact on airline itinerary choices, considering direct or re-entry security options. The convenience and reduced security hassle may result in higher utility for travelers, as assessed in an extended airline itinerary choice survey. By employing a nested logit model, we capture passenger behavior shifts and trade-offs among itinerary attributes. The study utilizes survey data to understand passenger preferences in different scenarios. Findings guide airlines, policymakers, and transport researchers in comprehending the Airline Connector Buses' potential to reshape air travel. A proposed framework outlines the implementation of this model, fostering a more efficient and passenger-centric air travel ecosystem.

2 Remote Identification Trajectory Coverage and Plausible Deniability Trajectory Planning

Max Z. Li, University of Michigan, Ann Arbor, Ann Arbor, MI, Contact: maxzli@umich.edu

As Urban and Advanced Air Mobility (UAM/AAM) continue to mature, a safety-critical system that will need to be implemented in tandem is Remote Identification (Remote ID) for uncrewed aircraft systems (UAS). To ensure successful and efficient deployment, as well as to better understand secondary impacts (e.g., consumer privacy risks in collecting real-time UAS trajectory information), the *coverage* of broadcast-receive Remote ID architectures needs to be characterized. Motivated by this need, we examine theoretical and empirical trajectory coverage of several common Remote ID technologies (e.g., Bluetooth, Wi-Fi) deployed for urban package delivery missions, a commonly-cited use case for UAM and AAM.

3 Drone Routing Problems Under Stochastic Urban Wind Conditions

Minghao Chen[1], Max Zhaoyu Li[2], Marco Giometto[3], Andrew Smyth[3], [1]Columbia University, New York, NY, [2]University of Michigan, Ann Arbor, Ann Arbor, MI, [3]Columbia University, New York, NY, Contact: mc5276@columbia.edu

This paper addresses the challenges of drone routing in windy urban areas by proposing a novel method that incorporates the stochastic and spatial diversity of urban wind fields. We develop stochastic mixed integer programs (S-MILPs) that integrate the realistic wind scenarios generated by the large eddy simulation (LES) into the stochastic drone routing problem (SDRP). We employ the simulated annealing (SA) algorithm, which effectively explores the solution space and handles visits for hundreds of locations in a short time. Through extensive numerical experiments, we demonstrate the effectiveness of our approach under different wind conditions. We also conduct sensitivity analysis of key factors such as operational altitude on performance. Our results provide valuable insights for optimizing drone routing decisions in windy urban environments.

4 Towards Sustainable UAV Operations: Balancing Economic Optimization with Environmental and Social Considerations in Path Planning

Zhangchen Hu[1], Heng Chen[2], Senay Solak[3], Eric Lyons[3], Michael Zink[3], [1]California State University, Fullerton, Fullerton, CA, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]University of Massachusetts Amherst, Amherst, MA, Contact: zhhu@fullertton.edu

Unmanned aerial vehicles (UAVs) are expected to be widely used in the near future as an alternative transportation mode to mitigate congestion and pollution in a variety of applications. We design a dynamic and data-driven decision support system for UAV path planning through stochastic programming based implementation, where both weather uncertainty and environmental impacts are directly considered.

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CC-North 226C

Human-AI Interaction

Community Committee Choice Session

Session Chair: Nasim Mousavi, Emory University, Atlanta, GA

1 When the Internet of Things Meets Algorithms and the Impacts on the Multi-Stakeholder Service-Profit Chain

Liwei Chen[1], J.j. Po-An Hsieh[2], Kimmy Wa Chan[3], [1]University of Cincinatti, Cincinnatti, OH, [2]Georgia State University, Atlanta, GA, [3]Hong Kong Baptist University, Ithaca, Hong Kong

We propose a techno-service-profit chain to understand how agentic technologies (e.g., IoT-enabled algorithmic customer service systems [IACSs]) impact customer service. We test our model using a sequential mixed-method design with longitudinal data from employees, supervisors, and customers before and after IACS implementation. We theorize the interactions between human and technology agents and scrutinize how technology agents affect the linkages between internal employee management and external customer service. Our findings further reveal the emerging issues of competing bosses, competing employees, and the unintended dehumanization effects of IACSs on supervisors and employees.

2 Overcoming the Stigma Barrier: Information-Seeking from AI Chatbots vs. Human Experts

Bojd Behnaz[1], Aravinda Garimella[2], Haonan Yin[1], [1]University of California - Irvine, Irvine, CA, [2]University Of Illinois - Urbana-Champaign, Champaign, IL

Timely access to information plays a key role in mitigating the impact of challenging circumstances and crises. However, stigma presents a significant barrier to seeking information. Our research examines attitudes towards AI chatbots for information-seeking in stigmatized situations. We conduct online randomized controlled experiments to analyze the effect of stigma on individuals' likelihood of seeking information from AI chatbots compared to human experts, while considering the roles of fear of judgment and the need

for empathy. Our results display that people are unlikely to seek information from both AI chatbots and human experts, but they show less unwilling to talk to AI chatbots. Our study provides insights for practitioners on how to help people overcome the barriers of stigma and seek the information they need in an efficient and cost-effective way manner.

3 Do We Trust AI Agents as Much as We Trust Their Creators? Investigating the Crucial Role of AI Alignment

Kambiz Saffarizadeh[1], Mark Keil[2], Likoebe Maruping[2], [1]Marquette University, Milwaukee, WI, [2]Georgia State University, Atlanta, GA

The technology companies that create AI agents (i.e., AI creators) have been the subject of negative news coverage and are not trusted among the general public. This raises an important question for managers about the extent to which users' trust (or lack thereof) in the AI creator might extend to their trust in the creator's AI agent. In this paper, we leverage the agentic IS framework to explain why AI alignment plays a major role in trust transference in the context of AI agents. We conduct four randomized experiments with 1,140 participants and find that users' assessment of creator-based steerability, user-based steerability, and autonomy—three important alignment-related attributes of AI agents—influence trust transference. We discuss the implications of our findings for research and practice.

4 Counterfactual Explanations for Incorrect Predictions Made by Machine Learning Models

Amir Asrzad, Xiaobai Li, University of Massachusetts Lowell, Lowell, MA

The lack of interpretability in black-box machine learning models poses significant challenges in high-stakes applications such as finance and healthcare. Interpretable machine learning (IML) aims to address this challenge. However, existing IML approaches are limited to generate explanations for correct predictions. To address this issue, our study aims to rectify and explain incorrect predictions made by machine learning models. We propose a novel decision tree-based counterfactual explanation method that provides explanations for both correctly and incorrectly classified cases. The proposed method is validated in an empirical evaluation study using real-world data.

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Finding and Adjusting for Data Bias (in ML)

Community Committee Choice Session

Session Chair: Andrew Ilyas, MIT EECS, Cambridge, MA

Session Chair: Manolis Zampetakis, 1</sup

1 Quantifying Distributional Uncertainty

Dominik Rothenhaeusler, Stanford University, Palo Alto, CA

How can we draw trustworthy scientific conclusions? It has been argued that trustworthy scientific conclusions require disparate sources of evidence. For example, in causal inference from observational data, it is common to compute regression-adjusted estimators for different choices of adjustment sets. Then stability investigations can be done by studying the estimator-to-estimator variability between sensible choices of adjustment sets. However, different methods might have shared biases, making it difficult to judge the theoretical guarantees of this practice. We introduce a "distributional uncertainty model", which captures biases in the data collection process. We show that a stability analysis on a single data set allows to construct confidence intervals that account for both sampling uncertainty and distributional uncertainty.

2 Diagnosing Model Performance Under Distribution Shift

Tiffany Cai, Columbia University

Prediction models can perform poorly when deployed to target distributions different from training. In response, we develop a method to attribute a drop in performance to different types of distribution shifts, as different shifts require different interventions. Our method decomposes the performance drop into terms for 1) an increase in harder but frequently seen examples from training, 2) changes in the relationship between features and outcomes, and 3) poor performance on examples infrequent or unseen during training. Empirically, we show how our method can 1) guide model improvements across distribution shifts for employment prediction on tabular census data, and 2) help to explain why certain domain adaptation methods fail to improve model performance for satellite image classification.

3 What Makes a Good Fisherman? Linear Regression Under Self-Selection Bias

Andrew Ilyas[1], Yeshwanth Cherapanamjeri[2], Constantinos Daskalakis[1], Manolis Zampetakis[2], [1]MIT EECS, Cambridge, MA, [2]UC Berkeley, Berkeley, CA

What makes a good fisherman? A reasonable approach to figure this out is to collect data comprising features of fishermen and their daily catch, and then learn a model mapping the former to the latter. Reasonable as this approach may sound, it will likely result in a biased model. The reason for this bias is that the data will miss the individuals who were not good enough at fishing and decided to become hunters instead. Such self-selection bias is pervasive. From understanding what it takes to be a good student to to studying strategic behavior in markets, data available for learning statistical models are the results of strategic decisions that have filtered out some of the relevant data. We discuss recent progress on estimating linear models under self-selection bias and identification of non-parametric auction models, and present some open directions for future investigation.

4 More Data, More Problems: How Sampling Bias Compromises Data Scaling Properties in Machine Learning

Irene Chen[1], Judy Shen[2], Inioluwa Deborah Raji[1], [1]UC Berkeley, Berkeley, CA, [2]Stanford, Palo Alto, CA, Contact: iychen@berkeley.edu

The accumulation of data in the machine learning setting is often presented as a panacea to address its many modeling problems---including issues with correctness, robustness, and bias. But when does adding more data help, and when does it hinder progress on desired model outcomes? We model data accumulation from multiple sources and present analysis of two practical strategies that result the addition of more data degrading overall model performance. We then demonstrate empirically on three real-world datasets that adding training data can result in reduced overall accuracy and reduced worst-subgroup performance while introducing further accuracy disparities between subgroups. We conclude with a discussion on considerations for data collection and the importance of data composition in the age of increasingly large models.

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CC-North 227B

Scheduling Problems in Varied Settings

Contributed Session

Session Chair: Eman Almehdawe, University of Regina, Regina, SK, Canada

1 Analysis of Combining LPT and Multifit Algorithms for Identical Parallel Machine Scheduling to Minimize the Makespan

Insoo Park, Kyungduk Moon, Kangbok Lee, POSTECH, Pohang, Korea, Republic of. Contact: factorpark@postech.ac.kr

The parallel machine scheduling problem to minimize the makespan is one of the most studied problems in scheduling theory. Two famous algorithms are LPT(Longest Processing Time first) and MULTIFIT. Interestingly, several worst-case instances of LPT can be optimally solved by MULTIFIT and vice versa. Taking advantage of this fact, Lee and Massey (1988) proposed the COMBINE algorithm, which combines LPT and MULTIFIT algorithms. Despite the importance of LPT and Multifit, theoretical analysis of the COMBINE algorithm has been limited. We provide its theoretical analysis by proving the approximation ratio. We introduce a MIP-based approach to prove this ratio, which is extensible to any other algorithms that can be described as a mathematical programming model.

2 Minimizing the Maximum Flow Loss in the Network Maintenance Scheduling Problem with Flexible Arc Outages

SHUANG JIN, YING LIU, JING ZHOU, QIAN HU, Nanjing University, Nanjing, China. Contact: shuangjin@smail.nju.edu.cn

We investigate a network maintenance scheduling problem where maintenance tasks are carried out on the arcs within flexible time windows. During the maintenance, the arc is interrupted and no flow can pass through. The problem is to find a feasible schedule so that the maximum flow loss during the horizon is minimized. We study the min-max formulation and introduce a Benders reformulation. A Benders decomposition algorithm is designed, in which effective cutting planes, strengthened initial cuts and an efficient separation procedure are proposed. There are two extensions to minimize the total flow loss and the duration of maximum flow loss, respectively, via hierarchical optimization to select more desirable schedules. Computational experiments show the outstanding performance of the proposed algorithm. The schedules of these problems are analyzed in a number of ways.

3 The Technician Routing and Scheduling Problem: A Genetic Algorithm Approach Versus a Simulated Annealing Approach

Eman Almehdawe, University of Regina, Regina, SK, Canada. Contact: eman.almehdawe@uregina.ca

We develop a Technician Routing and Scheduling Problem (TRSP) model that is motivated by a telecom provider in Saskatchewan, Canada. The problem becomes more complex when a group of technicians must be assigned to a set of tasks with different service times and time windows.

The technicians are expected to serve customers that are distributed across a vast working area. To treat the large-scale instances of the model, we develop a Simulated Annealing (SA) algorithm and a Genetic Algorithm (GA), which generate high-quality solutions. The obtained results demonstrate that our designed metaheuristics outperform the commercial exact solver in terms of the CPU-time. Moreover, findings show that the proposed GA generates better solutions than the SA with respect to the obtained optimality gaps.

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QSR: A Gallery of Research Activities

Flash Session

Session Chair: Andi Wang, Arizona State University, Mesa, AZ

1 From Reliability to Resilience

Elsayed A. Elsayed, Rutgers University, East Brunswick, NJ

This is a short flash presentation that focuses on quantifying systems' resilience and relating it to the systems' availability. Approaches for resilience quantifications for both repairable and nonrepairable systems will be addressed. A case study of assessing the reliability of a supply chain will be presented.

2 Overview of IoT Enabled System Monitoring, Prognosis, and Decision Making

Shiyu Zhou, 1</sup

In this talk, I will provide an overview of the research topics of my group on Internet of Things enabled system monitoring, prognosis, and maintenance decision making.

3 Tensor Analysis for Systems Modeling and Improvement

Mostafa Reisi, 1</sup

This talk discusses different aspects of tensor data analysis, including distributed and robust tensor modeling, applied to various applications such as healthcare and agriculture.

4 Characterizations of Mechanical Nanomachining Using Advanced Machine Learning Method

Zimo Wang[1], Qiyang Ma[2], [1]SUNY Binghamton, Binghamton, NY, [2]State University of New York at Binghamton, Vestal, NY

We present a framework of sensor-based modeling that enables real-time characterizations for mechanical-based nanomachining. The extensive experimental case study suggests that the presented autonomous ensemble classification and prediction models allow in-process characterization and quality inspection, with an accuracy of over 90% for real-time remapping on the surface profile, for complicated machining structures under nanoscale precision.

5 A Prototype of Digital Twin for Multi-stage Distributed Manufacturing Systems

Hongyue Sun, University at Buffalo, Buffalo, NY

Smart manufacturing and Industry 4.0 are bringing disruptive changes to the manufacturing sector. Smart manufacturing increases productivity, creates safer conditions for workers, and simplifies product customization, all while decreasing business expenses. In this talk, I will introduce an architecture for remote machine management, using it to build a digital twin prototype of a multi-stage smart manufacturing system. This twin provides users with the ability to monitor and control the machine from anywhere in the world through a web interface. The framework is flexible, capable of supporting many different machines.

6 Modeling, Monitoring, and Diagnosis of Complex Systems with High-dimensional Streaming Data

Ana Maria Estrada Gomez, Purdue University, West Lafayette, IN

Nowadays, most complex systems are continuously monitored by a large number of sensors. The low implementation cost, high acquisition rate, and variety of sensing systems allow for the collection of a large volume of data. Modeling and analyzing such rich datasets provide unique opportunities for real-time process monitoring and control, and for accurate fault diagnosis, in a wide range of applications. However, the intricate characteristics of the high-dimensional streaming data pose significant analytical and computational challenges yet to be addressed. The data might be decentralized, high-dimensional, incomplete, correlated, and/or heterogeneous. This talk focuses on my group's recent efforts to tackle some of these challenges.

7 Data Science in Biointelligent Manufacturing

Bianca Maria Colosimo, Politecnico di Milano, Milan, Italy. Contact: biancamaria.colosimo@polimi.it

Biointelligent manufacturing is a cutting-edge field that fuses biology, artificial intelligence, and advanced manufacturing techniques to revolutionize the production of tissues, organs, and even bio-inspired materials, holding immense potential for regenerative medicine and personalized healthcare.

Together, the synergy of bioprinting and data modeling and monitoring in biointelligent manufacturing opens up unprecedented possibilities for advancements in healthcare, sustainable materials, and numerous other industries, shaping a brighter and more sustainable future.

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Computer Experiments: Methods, Theory & Applications

Community Committee Choice Session

Session Chair: Simon Mak, Duke University, Durham, NC

1 In Situ Uncertainty Quantification

Earl Lawrence, Los Alamos National Laboratory, Los Alamos, NM

The Department of Energy's investment in exascale computing will enable simulations with unprecedented resolution. This will let scientists investigate fine-scale behavior in areas of interest to DOE such as climate and space physics. However, the computational power of exascale machines has outstripped their I/O and storage capacity which will make some forms of post hoc analysis impossible. To address this, we are working on methods for in situ uncertainty quantification, that is analysis done inside the simulations as they are running. I will provide an overview of the problem and describe some of the work that we are doing at LANL to fit Bayesian hierarchical models to data inside of simulations of climate and space weather.

2 Sequential Designs for Causal Inference

Difan Song[1], Simon Mak[2], C F Jeff Wu[1], [1]Georgia Institute of Technology, Atlanta, GA, [2]Duke University, Durham, NC, Contact: dfsong@gatech.edu

Experiments are the gold standard for causal inference. In many applications, experimental units are recruited or chosen sequentially; therefore, short-term outcomes can provide valuable information for the design of experiments for later units. This work studies the role of sequential designs in causal inference problems in which we can either design the user included in the study or the treatment applied. We employ Gaussian process (GP) models to allow for flexible modeling of the potential outcomes. More importantly, the GP model allows for uncertainty quantification of a variety of causal estimands. We develop acquisition functions for sequential designs based on minimizing the prediction variance of these estimands. We demonstrate the broad applicability of our approach through several semi-synthetic examples in behavioral and marketing experiments.

3 A Scalable Gaussian Process for Large Scale Periodic Data

Yongxiang Li[1], Yuting Pu[1], Changming Cheng[1], QIAN XIAO[2], [1]Shanghai Jiaotong University, Shanghai, China; [2]THE UNIVERSITY OF GEORGIA, Athens, GA, Contact: qian.xiao@uga.edu

The periodic Gaussian process (PGP) has been increasingly used to model periodic data due to its high accuracy. Yet, computing the likelihood of PGP has a high computational complexity of $\mathcal{O}\left(n^{3}\right)$ (n is the data size), which hinders its wide application. To address this issue, we propose a novel circulant PGP (CPGP) model for large-scale periodic data collected at grids that are commonly seen in signal processing applications. The proposed CPGP decomposes the log-likelihood of PGP into the sum of two computationally scalable composite log-likelihoods, which do not involve any approximations. Computing the likelihood of CPGP requires only $O(p^{2})$ (or $Op\log(p))$ in some special cases) time for grid observations, where the segment length p is independent of and much smaller than n.

4 Energetic Variational Gaussian Process Regression for Computer Experiments

Lulu Kang, University of Massachusetts Amherst, Chicago, IL, Contact: lulukang@umass.edu

The Gaussian process (GP) regression model is a popular surrogate modeling approach for computer experiments. Both frequentist and In this talk, we build the GP model via variational inference, specifically, the newly proposed energetic variational inference by Wang et al. (2021). Following the GP model assumption, we first derive the posterior distributions of the parameters for the GP model with non-zero mean functions. The energetic variational inference method is used to generate samples of the posterior distributions. It can bridge the Bayesian sampling and optimization and provides a much more computationally efficient solution. With a normal prior on the mean component of the GP model, shrinkage estimation is also applied to the parameters to achieve model sparsity of the mean function.

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Surrogates for Digital Twin

Community Committee Choice Session

Session Chair: Chiwoo Park, Florida State University, Tallahassee, FL

1 Spatiotemporal Predictions of Toxic Urban Plumes Using Deep Learning

Yinan Wang[1], M. Giselle Fernández-Godino[2], Nipun Gunawardena[2], Donald Lucas[2], Xiaowei Yue[3], [1]Rensselaer Polytechnic Institute, Troy, NY, [2]Lawrence Livermore National Lab, Livermore, CA, [3]Virginia Tech, Blacksburg, VA, Contact: wangy88@rpi.edu

Industrial accidents, chemical spills, and similar events can release large amounts of harmful materials that disperse into urban atmospheres and can impact populated areas. Computer models are typically used to predict the transport of toxic plumes by solving fluid dynamical equations. However, these models can be computationally expensive. In emergency response situations, alternative methods are needed that can run quickly and adequately resolve important spatial features. Here, we present a novel deep learning model called ST-GasNet was inspired by the mathematical equations that govern the behavior of plumes as they disperse through the atmosphere. ST-GasNet predicts the spatiotemporal evolution of a toxic plume in a complex city, using a limited set of temporal sequences of ground-level toxic urban plumes.

2 Surrogate Model-Based Simulation Optimization of Vehicle Positioning Strategy in a Semiconductor Fab

Bonggwon Kang[1], Chiwoo Park[2], Haejoong Kim[3], Soondo Hong[1], [1]Pusan National University, Busan, Korea, Republic of; [2]Florida State University, Tallahassee, FL, [3]Kyonggi University, Suwon, Korea, Republic of

Semiconductor fabs often rely on simulation-based optimization to position vehicles considering complex, large-scale operations and demand uncertainty. Simulation-based optimization is challenging due to the high computational cost of simulation runs and the vast search space with numerous control variables. We propose Bayesian optimization with a Gaussian process (GP) to obtain efficient vehicle positioning for upcoming transportation demands. The proposed method expedites the simulation optimization by replacing a computationally expensive simulation with a GP surrogate model. Experiments demonstrate that the proposed method significantly decreases vehicle utilization and delivery time within limited simulation runs.

3 Community/Committee'S Choice Submission

Syed Bahauddin Alam, MO

4 Adaptive Reduced-Order Models Using Wrapped Gaussian Processes

Xiao Liu, University of Arkansas, Fayetteville, AR

A ROM can be obtained, using the well-known Proper Orthogonal Decomposition (POD), by projecting the full-order model to a subspace spanned by modal basis modes which are learned from experimental, simulated or observational data, i.e., training data. However, the optimal basis can change with the parameter settings. When a ROM, constructed using the POD basis obtained from training data, is applied to new parameter settings, the model often lacks robustness against the change of parameters in design, control, and other real-time operation problems. This talk proposes an approach that learns the mapping between parameters and POD bases using Wrapped Gaussian Processes (WGP).

5 Jump Gaussian Process Surrogates for Digital Twin

Chiwoo Park, Florida State University, Tallahassee, FL

Active learning of Gaussian process (GP) surrogates has been useful for optimizing experimental designs for physical/computer simulation experiments and constructing digital twins. In this talk, we present a method for active learning of piecewise, Jump GP surrogates. Jump GPs are continuous within, but discontinuous across, regions of a design space, as required for applications spanning autonomous materials design, configuration of smart factory systems, and many others. We demonstrate that additionally accounting for model bias, as opposed to the usual model uncertainty, is essential for effective learning of the Jump GP.

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Integrating Weather and Climate Uncertainty into Energy Systems Planning and Management

Community Committee Choice Session

Session Chair: Jordan Kern, North Carolina State University, Raleigh, NC

1 Balancing Accuracy and Computing Costs: Are Decomposition Methods Still Needed in the Era of Optimization Packages?

Phumthep Bunnak, Stefano Galelli, Singapore University of Technology and Design, Singapore, Singapore. Contact: stefano_galelli@sutd.edu.sg

A big challenge with the integration of weather uncertainty into power system models is the increase in computational requirements. Energy system modelers have typically traded-off model accuracy with tractability by simplifying temporal, spatial, or technological dimensions. Few production cost models have instead relied on decomposition methods that preserve the 'original' problem formulation. Here, we explore this direction and contribute a novel computational framework that implements the Dantzig-Wolfe decomposition while supporting popular algebraic modeling languages in Python. Extensive experiments on country-scale grids reveal speed-up reaching two orders of magnitude.

2 Exploring How Changing Hydropower Operations Can Facilitate Renewable Energy Transitions and Sustainable Climate Change Adaptation

Julianne Quinn[1], Samarth Singh[1], Jacob Wessel[2], Jordan Kern[3], Jonathan Herman[4], [1]University of Virginia, Charlottesville, VA, [2]Tufts University, Medford, MA, [3]North Carolina State University, Durham, NC, [4]University of California, Davis, Davis, CA, Contact: jdq6nn@virginia.edu

Meeting global carbon mitigation targets will require a rapid transition to more renewable energy sources, but doing so will make energy supply more variable and out of phase with demand. Hydropower operations can be adapted to balance these loads, but at the expense of sustaining environmental flows for wildlife and ensuring sufficient flood protection. This project investigates how alternative reservoir operations influence water-energy systems under different grid decarbonization and climate change scenarios in the Columbia River Basin. Our analysis reveals that systems exhibiting these changing dynamics could benefit from re-designing operations to prioritize hydropower production and load balancing at high-capacity dams while meeting flood protection and environmental spills objectives through coordination across multiple smaller reservoirs.

3 Identifying Robust Energy Decarbonization Pathways in the Presence of Deep Climate Uncertainty

Srihari Sundar[1], Flavio Lehner[2], Nathalie Voisin[3], Michael Craig[1], [1]University of Michigan, Ann Arbor, MI, [2]Cornell University, Ithaca, NY, [3]Pacific Northwest National Lab., Seattle, WA

Uncertainty in policy and technology adoption has led to a suite of plausible energy system decarbonization pathways. In all pathways though, system operations will be increasingly driven by meteorology, and climate projections used to model operations have large uncertainties. In the near term, internal variability is a significant source of this uncertainty and is quantified using large ensemble (LE) climate data. Here, we apply the robust decision making (RDM) framework to identify decarbonization pathways for the Western United States that are robust against many climate realizations from the CESM2 LE. Using metrics such as regret and satisficing from the RDM framework, we find climate realizations and extremes that cause significant failures across pathways. Our research will help utilities make decarbonization decisions that are robust to climate change.

4 Synchronous Stochastic Simulation of U.S. Bulk Electric Power and Natural Gas Markets

Jordan Kern, Cameron Lisy, North Carolina State University, Raleigh, NC

The Eastern and Western parts of the U.S. electric power grid are not electrically connected, but winter extremes in the East put pressure on natural gas prices nationwide. In 2014 and 2021, severe winter weather in the East was then compounded by summers marked by historical droughts and heatwaves in the West, forcing Western power producers to rely more on expensive natural gas in short supply. Key challenges exist in exploring this phenomenon. This talk will discuss progress in linking open-source models of the U.S. bulk power system with a network model of the natural gas market.

5 Power System Expansion Planning for California Under Variable Climate Projections

Amelia Musselman[1], Tomas Valencia Zuluaga[2,1], Jean-Paul Watson[1], [1]Lawrence Livermore National Laboratory, Livermore, CA, [2]University of California, Berkeley, Livermore, CA

Climate change impacts power system operations through factors such as increased temperatures, droughts, changing wind patterns, and solar irradiance shifts. In this work, we develop a novel climate-resilient capacity expansion planning model, which seeks to minimize costs while ensuring power system resilience. We model the problem as a stochastic mixed-integer program, which we implement in Pyomo and solve using mpi-sppy and Gurobi. We extend an existing synthetic but realistic test case for California. Leveraging climate data from the CMIP6 model repository, we map future climate projections onto power system parameters, focusing initially on changes in temperature, wind speed, and solar irradiance. We compare investment decision based on present-day climate with future-climate resilient solutions. Prepared by LLNL under Contract DE-AC52-07NA27344.

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Optimizing Energy Systems

Community Committee Choice Session

Session Chair: Alexandra M. Newman, Colorado School of Mines, Golden, CO

1 Grid-Aware Tradeoff Analysis for Outage Mitigation Microgrids at Emerging Resilience Hubs

Arnav Gautam[1], Destenie S. Nock[1], Amritanshu Pandey[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]University of Vermont, Burlington, VT, Contact: ajgautam@andrew.cmu.edu

Sustained power outages are growing primarily due to i) disasters and ii) decarbonization and electrification-driven changes on the grid. Outage mitigation technologies can provide vital electricity access during disasters, but their adoption is inequitable due to individual- or community-level barriers. We postulate that community-based Resilience Hubs (RHs) can be expanded to address this inequity by supplying backup power to marginalized communities during disasters. We present a Grid-Aware Tradeoff Analysis framework to identify the best backup power systems for expanded RHs. We use three-phase power flow to enforce the electrical feasibility of RH microgrid options, and multi-criteria decision analysis to quantify the economic, environmental, and equity-weighted outage mitigation performance. We evaluate a case study based on the city of Richmond, CA.

2 Policy Recommendations for a Microgrid with Mixed Energy

Karoline Hood, US Army, Lakewood, CO

The frequency of power outages has significantly increased over the past twenty years due to climate change and a rise in natural disasters. These outages put at risk the operation of critical infrastructure. The integration of microgrids, using mixed-energy technology to include solid oxide fuel cells, provides relief during outages. We use an existing mixed-integer nonlinear model that provides a cost minimizing design and dispatch strategy. Our extension of the model includes case studies of different communities which have unique demands due to the size and design of the community. We provide analysis and policy recommendations on the deployment of microgrids to the communities to include the use of solid oxide fuel cells.

3 Transitioning from Diesel Backup Generators to PV-Plus-Storage Microgrids in California Public Buildings

Sunjoo Hwang, University of North Carolina, Chapel Hill, NC, Contact: shwang2@unc.edu

Frequent power outages including Public Safety Power Shutoffs have increased demands for backup generators in California, whereas the state aims to achieve 100% clean electricity by 2045. This research quantifies the value of replacing diesel backup generators with PV-plus-storage microgrids in California public buildings. The results show that replacing diesel generators in one building would save ~$3M of public expenditures and reduce ~10,000 tons of CO_2 emissions over 20 years. It implies that the same application in the state's 22 air districts could save $31-385M annually. Also, this research develops a marginal resilience curve for the cost and environmental impact of extended outages, which demonstrates that increasing energy storage capacity greatly outweighs increasing PV or generator capacity to enhance resilience, while reducing costs and emissions.

4 Wasserstein Metric-Based Clustering for Large-Scale Power Distribution System Modeling

Alfredo Oneto, Blazhe Gjorgiev, Giovanni Sansavini, ETH Zurich, Zurich, Switzerland

The electric power system comprises many distribution grids supplying various customers. These grids are complex infrastructures due to the interconnections between their components. Therefore, it is computationally challenging to assess a large number of such systems. To address this challenge, we propose a method that finds representative grids. The method performs spatial pattern aggregation by combining clustering and differential geometry concepts. We extend classic clustering ideas in Euclidean spaces to the Wasserstein metric space, leveraging techniques of Riemannian geometry. When applied to a large set of distribution grids, this method can produce a small representative subset. Moreover, we provide a case study of the clustering of distribution networks in Switzerland to demonstrate a real-world application.

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Decarbonizing China's Energy Systems: Pathways and Challenges

Community Committee Choice Session

Session Chair: Qingyu Xu, Tsinghua University, Beijing, China
Session Chair: Qingyu Xu, Princeton University, Princeton, NJ
Session Chair: Jing Dai, Tsinghua University, Beijing, China

1 A Fully Open-Source Power Dataset for Policy Applications in China

Michael R. Davidson, Ming Wei, Boyu Yao, University of California, San Diego, La Jolla, CA, Contact: mrdavidson@ucsd.edu

China's power system is the largest in the world. Analysis on it is crucial to addressing climate change and other environmental challenges, yet this is complicated by a lack of easily accessible open datasets. In this presentation, we introduce a new open dataset containing transmission network (500kV and select 220kV and above), generators, and demand s(provincial and sub-provincial) collected and simulated from a vast range of publicly available data. A unit commitment model is developed with this dataset for the case of assessing resource adequacy in northeast China in light of recent power shortages. Findings show that key institutional and policy drivers are primary contributors to shortages, and that new coal capacity development is not needed to maintain energy security.

2 Spatially Resolved Land and Grid Model of Carbon Neutrality in China

Da Zhang, Tsinghua University, Beijing, China. Contact: zhangda@tsinghua.edu.cn

China has committed to achieve net carbon neutrality by 2060 to combat global climate change, which will require unprecedented deployment of negative emissions technologies, renewable energies (RE) and complementary infrastructure. At terawatt-scale deployment, land use limitations interact with operational and economic features of power systems. To address this, we developed a spatially resolved resource assessment and power systems planning optimization that models a full year of power system operations, sub-provincial RE siting criteria, and transmission connections. Our modeling results show that wind and solar must be expanded to 2,000-3,900 GW each, with one plausible pathway leading to 300 GW/yr combined annual additions in 2045--2060, a four-fold increase from today.

3 Short-Term Interval-Valued Load Forecasting with a Combined Strategy of Ihw and Multioutput Machine Learning

Feng Gao[1], Jie Song[1], Xueyan Shao[2], [1]Peking University, Beijing, China; [2]Chinese Academy of Sciences, Beijing, China

Interval-valued load forecasting can provide more comprehensive and richer information for decision-making. However, the existing literature mainly focused on point-valued load forecasting and neglect the significance of interval-valued load forecasting. In this paper, we propose a combined framework based on interval Holt-Winters and multioutput machine leaning method to predict daily interval-valued load. We improve traditional Holt-Winters and proposed interval Holt-Winters taking account of the seasonal characteristics of daily load. Multiple multioutput machine learning models are employed to predict residual series of interval Holt-Winters. Empirical results show that the proposed combined interval model outperforms the corresponding single interval model and has excellent robustness.

4 Where to Go? Transition of China's Coal-Fired Generation in a Power Sector Under Decarbonization and Deregulation

Qingyu Xu, Jing Dai, Peixin Qin, Yao Meng, Geye Lu, Tsinghua University, Beijing, China. Contact: xuqingyu@tsinghua.edu.cn

China's power sector is facing unprecedented pressure: establishing organized wholesale markets and steadily decarbonizing its generation fleets. A rapidly increasing penetration of wind and solar generation would lead to an unstable system, while the overprotection over coal power could mean China missing its decarbonization goal. With a capacity expansion planning model, we evaluate strategies for coal power transition in China, including retiring, mothballing, and retrofitting for post-combustion CCS or renewables. Then we discuss each coal-power transition option's monetary and environmental benefits under uncertainties.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD53

CC-North 231A

Circular Economy and Sustainable Manufacturing

Community Committee Choice Session

Session Chair: Sidi Deng, Purdue University, West Lafayette, IN

1 Optimizing Reverse Logistics Supply Chain Network for Sustainable Value Recovery from Li-Ion Batteries in the United States

Apurba Kumar Saha[1], Hongyue Jin[2], [1]The University of Arizona, Tucson, AZ, [2]University of Arizona, Tucson, AZ
Value recovery from spent LIBs could facilitate sustainable EOL management and recover valuable materials to create a resilient supply of the critical raw materials such as lithium and cobalt. This study focuses on the design of an optimal reverse logistic supply chain network for sustainable collection and recycling of spent LIBs. Optimization models have been developed to (1) evaluate the impact of governmental policies on the adoption of LIB recycling technologies and (2) maximize the economic and environmental benefits from LIB recycling in the next ten years. The model was applied to the case of United States and suggested the optimal facility locations, processing capacities, recycling technology, and material flows for LIB recyclers.

2 Development of Manufacturing-Relevant Indicators for Measuring Progress Towards Circular Economy
Yong Han Kim, Sidi Deng, Thomas Maani, John W. Sutherland, Purdue University, West Lafayette, IN, Contact: kim3822@purdue.edu
The manufacturing sector plays a key role in the U.S. economy while at the same time being responsible for a large portion of energy/material consumption and environmental burdens. However, there is a lack of standardized manufacturing-relevant indicators for measuring progress toward a circular economy. Without standardized indicators in the manufacturing sector, it is difficult for decision-makers to create appropriate decisions, and will make them challenging to assess the effectiveness of their efforts to adopt circular practices. Therefore, the objective of this research is to develop indicators that will allow decision-makers to understand the consequences of their strategies in terms of end-of-life product management (and more broadly in terms of closing loops within product life cycles).

3 A Two-Stage Distributed Learning-Based Framework for Dynamic Electric Vehicle Sharing
Wentao Zhao[1], Maged M. Dessouky[2], [1]University of Southern California, Los Angeles, CA, [2]University of Southern California, Los Angeles, CA, Contact: wzhao009@usc.edu
We study the dynamic relocation of an electric vehicle-sharing system providing on-demand service. We propose a two-stage framework. First, we develop a multi-agent reinforcement learning model that treats stations as agents and trains them to determine their relocation requests independently. Then, the obtained requests are transformed into an executable relocation strategy that satisfies all systematic constraints, like fleet conservation, by solving an auxiliary optimization problem.

4 Observed and Optimal EV Charging Behavior and Their Impact on the Grid
Hannah Davalos[1], Shmuel S. Oren[2], Candace Arai Yano[3], [1]University of California, Berkeley, Berkeley, CA, [2]UC Berkeley, Berkeley, CA, [3]University of California-Berkeley, Berkeley, CA
How electric vehicle drivers charge their vehicles has a major impact on the pattern of loads on the electrical grid. In addition to range anxiety, the capacity of the grid to support EV charging is a concern for prospective EV purchasers and thus also for auto manufacturers. Using results of a survey of EV drivers who work at a large university, we analyze self-reported EV charging patterns and develop a model to optimize charging for prototypical classes of drivers in view of time-of-use rates for residential and public charging. We then compare observed and "optimal" charging patterns and discuss differences in their impact on the electrical grid. We also explore the fraction of charging likely to be from renewable resources.

5 Planning a Remanufacturing System for Electric Vehicles Using Network Analysis
Sidi Deng[1], Yuehwern Yih[2], John W. Sutherland[3], [1]Purdue University, West Lafayette, IN, [2]Purdue University, West Lafayette, IN, [3]Purdue University, West Lafayette, IN, Contact: deng100@purdue.edu
This study discusses a potential EV Renewal System (EVRS) that aims to directly rebuild used EVs and recover maximum value from EoL components and materials. The designed process chain coordinates and synergizes concomitant procedures such as disassembly, processing, and reassembly. The EVRS was modeled as an activity-on-arc (AoA) network, and a simulation approach based on a stochastic activity network (SAN) is employed. Moreover, based on network topology analysis, proxy variables are defined to characterize system complexity under different operating scenarios. To enable mass-scale processing of used EVs, the EVRS is further compartmentalized into serially located workstations. The proposed network analysis framework is adaptable to a diverse range of industries and can galvanize more remanufacturing practices.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD54

CC-North 231B

Optimization Modeling Software and Software Engineering

Community Committee Choice Session

Session Chair: Ryan O'Neil, Nextmv
Session Chair: Susanne Heipcke, FICO, Birmingham, United Kingdom

1 The Sushi is Ready, How Do I Deliver It? Developing, Deploying and Managing Real-Time Optimization Systems

Sebastian Quintero, Nextmv, Bogota, Colombia. Contact: sebas@nextmv.io

We propose a holistic approach towards real-time optimization systems (such as food & groceries delivery, ride sharing) that transcends traditional OR boundaries. We assert that real-time planning is not an isolated analytical problem, but an integral part of a decision "supply chain", deeply interconnected with other decision models.We treat these systems as engineered software components in a production stack. We emphasize the necessity of rigorous testing and seamless integration with other software systems. This leads to a more resilient, adaptive, and real-time planning process.

2 Adapting to Change in On-Demand Delivery: Unpacking a Suite of Testing Methodologies

Nicole Misek, Ryan O'Neil, Nextmv, Philadelphia, PA, Contact: nicole@nextmv.io

The volatile world of on-demand, gig-economy delivery employs a diverse suite of testing methodologies to master change and operational risk. We explore common testing techniques, in the context of a multi-sided marketplace. We discuss historical testing, batch experimentation, acceptance testing, shadow testing, switchback testing, and digital twin simulation. We present these not as isolated tools, but as a cohesive toolbox deployed against real-world examples.

3 Pyddopt: Solving Dynamic Programming Models with Decision Diagram-Based Optimization

Timothy Curry[1], Laurent Michel[1], Willem-Jan van Hoeve[2], [1]University of Connecticut, Storrs, CT, [2]Carnegie Mellon University, Pittsburgh, PA, Contact: vanhoeve@andrew.cmu.edu

We present PyDDOpt, a Python modeling interface for solving combinatorial optimization problems using decision diagram-based optimization solvers. Currently this optimization technology is accessible via lower-level programming languages which limits easy modeling experimentation and wider adoption. PyDDOpt allows to represent state-based (dynamic programming) models in an intuitive manner. These models are converted into specifications which are used to automatically compile relaxed and restricted decision diagrams, as well as the search process. We demonstrate the functionality of PyDDOpt on applications such as the traveling salesperson problem, the maximum independent set problem, and the Golomb ruler problem.

4 The Best of Both Worlds: Integrating Python and Gams

Steven P. Dirkse, GAMS Development Corporation, Fairfax, VA

Optimization applications combine technology and expertise from many different areas, including model-building, algorithms, and data-handling. Often, the gathering, pre/post-processing, and visualization of the data is done by a diverse organization-spanning group that shares a common bond: their skill in and appreciation for Python and the vast array of available packages it provides. For this reason, GAMS offers multiple ways to integrate with Python on the data-handling side, as well as offering some packages of our own (e.g. GAMS Transfer, GAMS Connect). In this talk, we will explore the benefits of this integration and demonstrate them using a real-world example complete with results on performance.

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TD55

CC-North 231C

Improving Efficiency and Resilience of Power System Infrastructure

Contributed Session

Session Chair: Heraldo Rozas, Georgia Institute of Technology, Atlanta, GA

1 Bio-Inspired Self-Healing for Enhancing Resilience in Power Systems

Tianye Wang, George Washington University, Washington, DC, Contact: twang87@gwu.edu

Inspired by self-healing in biological systems, this study proposes a novel framework to enhance the resilience of integrated energy systems. The self-healing operation borrows from morphogenesis, i.e., cell recombination and tissue formation, implemented through sectioning of faulted zones in the event of a disruption. The objective is to determine restoration pathways with the least cost of optimally configured capacities. Specifically, how much should be invested in building such redundant capacities? What electricity generating technologies should make up the portfolio? An IEEE reference network model is used to validate the restorative intervention.

2 Integrated Modeling of Thermal Power Plants and Regasification Terminal for Lng Load Allocation Under Operational Uncertainties

Lucas Guerreiro[1], Guilherme Bodin[1], Joaquim Masset Lacombe Dias Garcia[1], Tiago Coutinho Carneiro de Andrade[2], [1]PSR, Rio de Janeiro, Brazil; [2]PSR-inc, Rio de Janeiro, Brazil. Contact: lucasaguerreiro@psr-inc.com

This study presents an integrated modeling approach for the allocation of liquefied natural gas (LNG) loads, considering both thermal power plants and a regasification terminal. The model addresses operational uncertainties and aims to optimize the allocation decisions. By combining mathematical programming and decision tree techniques, the model provides insights into the optimal operation under different conditions. It considers factors such as fuel allocation, storage, gas supply, and marketing. The model's implementation is available as an open-source package and demonstrates its potential to enhance efficiency and decision-making in the thermal power generation sector.

3 Assessing the Effects of Various Assumptions on Equilibrium Models in Power System Expansion Planning

Jonghwan Kwon[1], Todd Levin[2], Audun Botterud[3], Zhi Zhou[4], [1]Argonne National Laboratory, LEMONT, IL, [2]Argonne National Laboratory, Lemont, IL, [3]Argonne National Laboratory, Lemon, IL, [4]Argonne National Laboratory, Argonne, IL, Contact: kwonj@anl.gov

The modeling of strategic interactions between competing profit-seeking entities in the context of power system expansion planning has been investigated in the literature. Game-theory based equilibrium modeling approaches have been commonly employed for this purpose. However, due to computational complexities associated with these equilibrium models, many simulation models tend to make simplifications and assumptions. This presentation aims to explore the impact of different assumptions on the solutions derived from equilibrium models.

4 Computing Optimal Replacement Policies for Offshore Wind Farms via Approximate Dynamic Programming

Morteza Soltani[1], Amin Khademi[2], Jeffrey P. Kharoufeh[2], [1]Clemson University, Clemson, SC, [2]Clemson University, Clemson, SC

We study the problem of replacing degrading turbines in an offshore wind farm affected by normal usage and random environmental factors. Considering the economic and stochastic dependence arising from shared setup costs and the common environment, our aim is to determine the optimal replacement policy that minimizes total discounted costs, including setup, replacement, and lost power production. To address the curse of dimensionality resulting from the increase in the number of turbines, we utilize Approximate Dynamic Programming (ADP) to approximate the value function. Bounds are also established to evaluate the accuracy of our approximation method.

5 Condition-Based Maintenance for Wind Farms Using a Distributionally Robust Chance Constrained Program

Heraldo Rozas, Weijun Xie, Nagi Gebraeel, Georgia Institute of Technology, Atlanta, GA, Contact: heraldo.rozas@gatech.edu

Existing Condition-based maintenance (CBM) strategies for wind farms rely on the assumption that prognostic algorithms can accurately predict wind turbines' remaining lifetime distribution (RLD), allowing for the implementation of stochastic programming or simulation-based optimization methods. However, this assumption might not hold in practice. This talk addresses this issue by presenting a new CBM strategy for wind farms that uses a Distributionally Robust Chance Constrained (DRCC) optimization model. This formulation acknowledges that estimated distributions may be incorrect and seeks robust solutions against distribution fluctuations. We show that the DRCC optimization problem can be reformulated as an integer linear program. The strategy is validated through computational studies using synthetic and real-world degradation data.

6 Solar And Storage Hybrid Operational Optimization Model For Energy And Ancillary Services Markets

Gaurav S. Mahamuni, Eina Ooka, The Energy Authority, Bellevue, WA, Contact: gmahamuni@teainc.org

Storage + renewable hybrid resources can now operate as a single generation and load resource in California Independent System Operator (CAISO) market. However, given the uncertainties around prices, renewable generation, and ancillary services (AS) dispatch, optimizing a hybrid resource's market offering to maximize revenue without curtailing energy or missing dispatch is challenging.
We present a mixed integer linear programming (MILP) model that has been operational to bid a 2.3 MW solar + 2.3 MW 4-hour storage hybrid resource in CAISO's day-ahead and real-time markets for energy and ancillary

services. We introduce constraints to capture dispatch uncertainty and solar curtailment due to AS. The model helps reduce curtailment and follows dispatch while simultaneously generating twice the revenue compared to the solar component alone.

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CC-North 232A

Transitioning to Sustainable Systems

Contributed Session

Session Chair: Robin Mutschler, Swiss Federal Laboratories for Materials Science and Technology, Empa, Dübendorf, Switzerland

1 Optimizing Lignin Valorization in Biorefinery Systems with Biological Upgrading: Assessing Economic Viability and Uncertainty Analysis

Yajie Wu[1], Juan Manuel Restrepo Florez[2], Juliana Vasco-Correa[1], [1]The Pennsylvania State University, State College, PA, [2]University of Florida, Gainesville, FL, Contact: yzw301@psu.edu

We study the economic optimization of lignin valorization with biological upgrading in biorefinery system. Using a superstructure-based process optimization method, we identify the optimal pathway and assess the impact of parameters such as feedstock and production costs, bioproduct price, and process yield through uncertainty analysis. The deterministic case reveals the optimal process involves using herbaceous plants as feedstock, undergoing base catalyzed depolymerization, resulting a maximum net present value of $1,627.39 million and internal rate of return 25.20%. Uncertainty analysis via stochastic programming demonstrates that the optimal strategy depends significantly on economic scenarios. Our findings lay the groundwork for developing lignin valorization biorefineries, furthering climate change mitigation and circular economy efforts.

2 Assessing and Enabling the Feasibility of the European Energy Transition Under Myopic and Constrained Technology Deployment

Jacob Mannhardt[1], Paolo Gabrielli[2], Giovanni Sansavini[2], [1]ETH Zurich, Zurich, Switzerland; [2]ETH Zurich, Zurich, Switzerland

Current evidence casts doubt on the feasibility of performing an energy transition that complies with the 1.5°C climate goal. Yet, an abundant body of energy system optimization models (ESOMs) proposes guidelines to achieve the transition. However, ESOMs often simplify the capacity expansion process by assuming perfect foresight and instantaneous technology deployment, resulting in potentially unrealistic and ineffective transition recommendations. Focusing on Europe, we investigate two barriers to the optimal decision-making: i) myopic foresight, and ii) real-world constraints on technology deployment. We find that the combination of the two barriers might delay the energy transition and make Europe miss its climate targets. Based on these insights, we explore and propose measures to enable a successful transition.

3 Do Homeowners Care About Sustainability?

Milind Goel, London Business School, London, United Kingdom. Contact: mgoel@london.edu

We compile a comprehensive dataset containing 55% of all residential property transactions in the UK from 2010 to 2020, and provide large-scale evidence that homeowners derive both pecuniary and non-pecuniary benefits from the energy efficiency of their dwellings. Homeowners price energy efficiency based on the expected utility savings and on their ability to recoup their investments. The market uses a social discount rate (SDR) of 4.83% to value investments in sustainability. Homeowners who purchase greener dwellings pay a premium in excess of the present value of future energy savings. We observe a commensurate increase in proportion of energy upgrades across market segments impacted and not impacted by regulation, but absence of a price-impact. This suggests that government interventions facilitated sustainable development through an indirect channel.

4 Learning from Stress: Decision Making in Dynamic Events

Louise K. Comfort, University of California, Berkeley, Oakland, CA, Contact: comfort@gspia.pitt.edu

Dynamic conditions create unique tensions for decision processes. As conditions change, decision makers need to remain open to incoming information and update their understanding of the operational context in real time. Yet, mobilizing response to changing conditions requires sufficient control over information to maintain a coherent operational framework and logic of action. This tension between openness and control varies with intensity, severity of threat and capacity of decision makers to comprehend the rate of change and adapt their actions accordingly. Balancing openness with control goes beyond resilience to achieve a stronger antifragile state. Data drawn from CalFire 209 field reports of wildfire operations document the rate of change in key operational functions entered as parameters in a system dynamics model to explore learning from stress in practice.

5 The Energy Carbon Nexus of Sustainable Energy Systems

Robin Mutschler, Swiss Federal Laboratories for Materials Science and Technology, Dübendorf, Switzerland. Contact: robin.mutschler@empa.ch

To achieve carbon neutrality by 2050, Switzerland needs a comprehensive understanding of its energy system and the potential for using carbon as a recyclable commodity in Energy-X paths. Our study uses a MILP method to investigate the Energy-Carbon nexus and demonstrates the critical role of Energy-X in supplying sustainable fuels and achieving net-zero CO2 emissions. Leveraging OR/MS techniques and data-driven approaches, our work optimizes energy system design and provides a scientific basis for decision-makers. Integration of Energy-X results in cost-effective storage solutions during times of limited import capacities or high prices. Our insights are applicable to other national energy systems.

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TD57

CC-North 232B

Analytics in Emerging Areas

Contributed Session

Session Chair: Giyoon Kwag, Clemson University, Clemson, SC

1 Verification and Validation: Building Trust in Digital Twins

Julia Bitencourt, Gregory Harris, Auburn University, Auburn, AL

Digital Twin (DT) involves the integration of Internet-of-Things (IoT), Machine Learning (ML), Artificial Intelligence (AI), cloud computing, and other innovative technologies to predict the outcomes of its physical counterpart, as well as to generate what-if scenarios and to support decision-making. Although the definition of DT varies among experts, DTs are models, and as with any model, a DT needs to be verified and validated in order to be trusted and used in real-world environments. Our research investigated the status of DT verification and validation (V&V). We found that very few studies reported V&V procedures and that there is disagreement over what verification and validation in the context of DTs represent. To address this gap, we developed a methodology and demonstrated it in a case study.

2 User-Generated Content Shapes Judicial Reasoning: Evidence from a Randomized Control Trial on Wikipedia

Neil Thompson[1], XUEYUN LUO[2], Brian McKenzie[3], Edana Richardson[4], Brian Flanagan[4], [1]MIT, Cambridge, MA, [2]Cornell University, Ithaca, NY, [3]Maynooth University, maynooth, Ireland; [4]Maynooth University, Maynooth, Ireland

While Wikipedia articles are easily accessible, they have unknown provenance and reliability and is problematic to be used in professional settings. Using an RCT, we find that the presence of a Wikipedia article about Irish Supreme Court decisions makes it more likely that the corresponding case will be cited in subsequent judgments. These effects are only present for citations by the High Court, not for the higher levels of the judiciary. Since the High Court faces higher caseloads, this may indicate that settings with greater time pressures encourage greater reliance on Wikipedia. Our results add to the growing recognition that Wikipedia and other frequently-accessed sources of user-generated content have profound effects on important social outcomes. Greater attention should therefore be paid to ensuring that they contain the highest quality of information.

3 What is Missing: A Meta-Analysis of User Participation Behavior in Online Communities

Giyoon Kwag[1], Russell L. Purvis[2], Jennifer E. Pullin[3], [1]Clemson University, Clemson, SC, [2]Clemson University, Clemson, SC, [3]Virginia Military Institute, Lexington, VA, Contact: gkwag@clemson.edu

Active user participation is essential for sustainable and successful online communities. However, research on the key drivers of user participation and their performance under different conditions remains inconsistent. To address this, we conducted a meta-analysis of over 200 empirical papers, classifying their antecedents into 20+ categories based on established theoretical frameworks of technology acceptance model and social capital theory. We analyze each category's relationship with user participation and multiple moderators that affect these relationships to address variations in online community research thoroughly. Practitioners can use our results to enhance user engagement and sustainability through informed design and management of online communities.

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TD58

CC-North 232C

Stochastic Models on Cancer Treatment and Learning

Contributed Session

Session Chair: Clyde Fare, 1</sup

1 Using Birth-death Processes to Infer Tumor Subpopulation Structure from Live-cell Imaging Drug Screening Data

Chenyu Wu[1], Einar Bjarki Gunnarsson[2], Even Moa Myklebust[3], Alvaro Köhn-Luque[3], Arnoldo Frigessi[3], Kevin Leder[4], Jasmine Foo[5], [1]University of Minnesota - Industrial and Systems Engineering, Minneapolis, MN, [2]University of Minnesota, Minneapolis, MN, [3]University of Oslo, Oslo, Norway; [4]University of Minnesota - Industrial and Systems Engineering, MINNEAPOLIS, MN, [5]University of Minnesota-Twin Cities, Minneapolis, MN, Contact: wu000766@umn.edu

Tumor heterogeneity is a complex trait that poses significant challenges in the development of effective cancer therapies. Accurately characterizing the subpopulation structure within a tumor is crucial. One possible strategy is to analyze the differential responses of subpopulations to various drugs using live-cell imaging high throughput drug screen techniques. However, such data exhibits dynamic variance and positive correlation in time, making analysis difficult.To address this challenge, we propose a stochastic model based on the linear birth-death process. Our newly developed model can provide more precise and robust estimations than the existing methods. We conclude our study by testing our model on both simulated data (in silico) and experimental data (in vitro), which supports our argument about its advantages.

2 Single Sample Estimation For Cancer Recurrence

Kevin Leder[1], Zicheng Wang[2], Xuanming Zhang[3], [1]University of Minnesota - Industrial and Systems Engineering, MINNEAPOLIS, MN, [2]University of Minnesota, Minneapolis, MN, [3]University of Minnesota - Industrial and Systems Engineering, Minneapolis, MN, Contact: zhan8093@umn.edu

In this work, we derive consistent estimators for key parameters that govern the evolution of a tumor cell population in response to therapy. The therapy decreases the population of sensitive cells, but eventually, a population of drug-resistant cells takes over, and the tumor burden increases again. We study this phenomenon using a collection of mathematical models of increasing complexity. Based on our theoretical results, we derive estimators for our model parameters based on a single observation of the tumor at the recurrence time.

3 Enhancing Breast Cancer Survival Prediction with a Graph Neural Network

Roya Aghaeifar[1,2], Mohammad Khasawneh[2], [1]Binghamton University, Binghamton, NY, [2]Binghamton University, Binghamton, NY, Contact: raghaei1@binghamton.edu

Cancer results from genetic mutations disrupting cell growth and can lead to the formation of tumors. Breast cancer is the most common cancer in women. Microarray technology enables scientists to measure the activity of thousands genes simultaneously, but analyzing the data can be challenging, especially when there is many genetic information but limited observation data. In this study, a novel Graph Neural Network is developed to predict the survival time of patients with breast cancer. The model incorporates the patient's age at diagnosis and whether they have a mutation in a gene associated with breast cancer. The proposed approach may provide insights into breast cancer survival prediction and could be useful in developing personalized treatment plans.

4 Driving Data Generation in Molecular Discovery Through Development of Benchmark Reinforcement Learning Environments

Clyde Fare[1], Lamogha Chiazor[1], Lan Hoang[2], [1]IBM, Daresbury, United Kingdom; [2]IBM, Warrington, United Kingdom. Contact: clyde.fare@ibm.com

Molecular and materials discovery is an area of great technological significance that continues to greatly benefit from the data revolution. Here we present a series of benchmark reinforcement learning environments that allow mixing and matching different design goals, different representations, and different molecular spaces with different reinforcement learning agents. These provide both a set of standards to evaluate different reinforcement learning algorithms applied to molecular design but also a standardised way of generating molecular datasets capturing the molecular design process.

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TD59

CC-West 101A

Methodological Advancements in Multiobjective Optimization II

Community Committee Choice Session

Session Chair: Margaret M. Wiecek, Clemson University, Clemson, SC

1 Re-Visiting the Parametric Simplex Algorithm in the Context of Equitable Optimization

Özlem Karsu[1], **Firdevs Ulus[2], [1]Bilkent University - Industrial Engineering Department, Ankara, Turkey; [2]Bilkent University, Ankara, Turkey**

We consider equitable linear optimization problems (ELOP), which are multiobjective optimization problems, with each objective representing the benefit that one entity receives. In such problems, the concept of dominance is replaced by equitable dominance. The aim is finding the set of equitably nondominated points, which lie within a spectrum between the utilitarian and Rawlsian solutions. Between these two extremes, each solution corresponds to a different degree of inequity-aversion. We discuss a novel use of the parametric simplex algorithm to address ELOP. The algorithm not only provides the set of equitably nondominated solutions, but also informs the decision maker on the degree of inequity-aversion each solution corresponds to. This analysis would be of great value as it facilitates making informed decisions in various resource allocation settings.

2 Solving Bi-Objective Knapsack Problem Using Deep Reinforcement Learning

Hanieh Rastegar Moghaddam[1], Hadi Charkhgard[1], Ali Eshragh[2], [1]University of South Florida, Tampa, FL, [2]Johns Hopkins University, Baltimore, MD

This study introduces the first Deep Reinforcement Learning (DRL) approach to solve the Bi-Objective Knapsack Problem (BOKP). An exact Q-learning method is developed for smaller problems, while a deep reinforcement learning model is designed to handle larger instances. Challenging BOKPs beyond the solvability of exact solvers are generated to evaluate the DRL approach. Results demonstrate that the proposed DRL method outperforms state-of-the-art heuristics in solving these difficult problems. This research contributes to combinatorial optimization by offering a novel paradigm for solving the BOKP through DRL, showcasing the potential of DRL as a promising technique for addressing complex and computationally demanding BOKPs.

3 Solution Approaches to Two-Stage Robust Biobjective Linear Programs

Rakhi Goswami[1], Margaret M. Wiecek[2], Herve Louis-Marie Kerivin[3], [1]VIPR-GS, ICAR, Clemson, SC, Clemson, SC, [2]Clemson University, Clemson, SC, [3]University Clermont Auvergne, Aubiere, France. Contact: rgoswam@g.clemson.edu

Two-stage biobjective linear programs (TSBOLPs) model decision situations under uncertainty having conflicting objectives at every stage. The assumptions about discrete or continuous uncertainty, and the number of objectives in the second stage, and the application of weighted-sum scalarization lead to four parametric single objective optimization problems (SOPs) resulting from the robust counterpart to TSBOLP. These SOPs have bilinear terms composed of parameters and variables in different configurations. Solution approaches using MATLAB Multiparametric Toolbox, Benders' decomposition and the Biconvex Approximation Simplex Method are proposed and illustrated with numerical examples.

4 Computing Set-Based Regret in Online Multiobjective Optimization

Kristen Savary, Margaret M. Wiecek, Clemson University, Clemson, SC, Contact: ksavary@g.clemson.edu

In online multiobjective optimization (OMO), solutions are computed before the objective functions are revealed and set-based regret measures the cost of not achieving the Pareto solutions of the associated offline multiobjective problem. To compute this regret, auxiliary single-objective optimization problems (SOPs) are solved in OMO settings. The SOPs involve minimization of a performance indicator such as the generational distance or hypervolume. It is shown that the computed set-based regret achieves similar upper bounds to those obtained in online single-objective optimization. Numerical examples are included.

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CC-West 101B

Community-engaged OR and Diversity, Equity, and Inclusion in OR/analytics.

Community Committee Choice Session

Session Chair: Michael P. P. Johnson, University of Massachusetts Boston, Boston, MA

Session Chair: Christopher W. Zobel, Virginia Tech, Blacksburg, VA

Session Chair: Mahyar Eftekhar, 1</sup

1 Home-Matching Preferences Among Disadvantaged Residents: A Value-Focused Thinking Approach

Mubarak Idrissu, University of Massachusetts Boston, Boston, MA, Contact: mubarak.iddrisu001@umb.edu

The housing crisis in urban areas arises from a shortage of affordable housing, unaffordable housing stock and underutilized housing units. While government policies have failed to address the challenges faced by low-income renters, home-matching programs have emerged as potential solutions. Using a community-engaged operations research approach, we study the housing challenges faced by marginalized groups such as the elderly, disabled, and low-income earners. By applying value-focused thinking and collaborating with Front Porch, a community-based organization, we construct objective hierarchies for home-matching the elderly and disabled with other low-income renters. Our findings will contribute to the literature by learning the complexities of the housing crisis and recommend effective strategies for promoting policies aimed at sustainable solutions.

2 Diversity, Equity, and Inclusion in Operations Research and Analytics Fields: National Survey of Program Directors

Elham Hesari[1], Michael Johnson[1], Tayo Fabusuyi[2], [1]University of Massachusetts Boston, Boston, MA, [2]University of Michigan, Ann Arbor, MI

Despite the fact that the US population is becoming more diverse, women and minorities remain underrepresented in OR/Analytics fields. As a result, many different disciplines have shifted their program emphasis to include strategies that help them represent society more accurately. This study project's main goal is to better comprehend DEI among OR/ Analytics university programs at undergrad and graduate academic levels. The study's participants were the program directors of academic OR/Analytic programs in the US. 376 program directors were surveyed by Qualtrics with 49 institutionally reviewed and validated items. Analyses were conducted using quantitative and descriptive statistics. The results reveals that, despite some improvement, women and minority students and faculties representation continue to be underrepresented in OR/Analytics programs.

3 How Does OR/Analytics Scholarship Engage with Diversity, Equity and Inclusion? An Analysis of Published Journal Articles

Michael P. P. Johnson[1], Tayo Fabusuyi[2], Elham Hesari[1], Samanthi Dijkstra-Silva[3], Sebastian Oelrich[4], [1]University of Massachusetts Boston, Boston, MA, [2]University of Michigan, Ann Arbor, MI, [3]TU Dresden, Dresden, Germany; [4]TU Dresden, Dresden, Germany. Contact: michael.johnson@umb.edu

We seek to better understand how operations research and operations management scholars engage with concepts of diversity, equity and inclusion in their research. We evaluate peer-reviewed articles in four different volumes to understand how authors exploit opportunities to address DEI across a range of application areas and analytic methods - even if a paper's topic does not specifically address DEI. We also perform a systematic review of articles whose titles or abstracts contain evidence of DEI-related content to understand the types of diversity dimensions that appear in these works. Through a critical approach and a focus on intersectionality, we identify unmet opportunities to incorporate DEI�related themes into research where such perspectives can amplify the theoretical, empirical and application�oriented impact of this work.

4 We'Re Here: Lgbtq+ Stories of Identity, Mentorship, and Community from Informs Members

Tyler Perini[1,2], [1]US Naval Academy, Anapolis, MD, [2]Rice University, Houston, TX, Contact: tyler.perini@rice.edu

This presentation shares samples from an interview study initiated as a 2021 INFORMS DEI Ambassador project. The experiences of 11 LGBTQ+ INFORMS members, whose identities are protected using pseudonyms, are summarized. Unmet needs of these community members are identified, including: (i) an absence of mentorship from senior LGBTQ+ professionals, (ii) broader inclusion of gender identities and ("professional") gender presentations, and (iii) representation or guidance for starting a family as an LGBTQ+ academic. The participants display a variety of preferences for coming out in professional relationships, i.e., with respect to advisors, students, and colleagues. Some advice is shared on strategies for the academic job market, finding a "fulfilling" LGBTQ+ community, and how to become a (better) ally.

5 Racial and Ethnic Health Disparities in Patient Experience of Care Between Children Enrolled in Medicaid Managed Care Organizations

Sara Abu-Aridah[1], Paul Griffin[1], Areen Alsaid[2], [1]The Pennsylvania State University, University Park, PA, [2]University of Michigan, Dearborn, MI

Medicaid children enrollees who are members of racial and ethnic minority groups have historically reported worse healthcare experiences. Consumer assessments of healthcare are used as an indicator of the care quality provided by health plans and providers. Health disparities among adults and the elderly received significant attention in the literature within the last two decades, while disparities in younger populations remain understudied. To understand the reasons behind disparities in Medicaid plans for children; using The Consumer Assessment of Healthcare Providers and Systems (CAHPS®) health plan survey, this study examines parents' responses to the experience-of-care assessments to investigate the current situation of racial and ethnic disparities within children's healthcare plans in the United States.

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CC-West 101C

Operations and Resource Management in Nonprofit Organizations

Community Committee Choice Session

Session Chair: Milan Preet Kaur, RPI

1 A Dynamic Model for Managing Volunteer Engagement

Mustafa Hayri Tongarlak[1], Deishin Lee[2], Baris Ata[3], Joy Field[4], [1]Ivey Business School - Western University, London, ON, Canada; [2]Ivey Business School, London, ON, Canada; [3]University of Chicago, Chicago, IL, [4]Boston College, Boston, MA, Contact: mtongarlak@ivey.ca

Non-profit organizations that provide food, shelter, and other services to people in need, rely on volunteers to deliver their services. Unlike paid labor, non-profit organizations have less control over unpaid volunteers' schedules, efforts, and reliability. However, these organizations can invest in volunteer engagement activities to ensure a steady and adequate supply of volunteer labor. We study a key operational question of how a non-profit organization can manage its volunteer workforce capacity to ensure consistent provision of services. In particular, we formulate a multiclass queueing network model to characterize the optimal engagement activities for the non-profit organization to minimize the costs of enhancing volunteer engagement, while maximizing productive work done by volunteers.

2 A Recommender System for Crowdsourcing Food Rescue Platforms

Ryan Shi, Fei Fang, Carnegie Mellon University, Pittsburgh, PA, Contact: ryanshi@cmu.edu

Food rescue organizations match food donations to the non-profits that serve low-resource communities. However, they rely on external volunteers to pick up and deliver the food, which bring significant uncertainty. Working with 412 Food Rescue, we develop a recommender system to send push notifications to the most likely volunteers for each given rescue. We leverage a mathematical programming based approach to diversify our recommendations, and propose an online algorithm to dynamically select the volunteers to notify without the knowledge of future rescues. Our recommendation system improves the hit ratio from 44% achieved by the previous method to 73% on historical data. We designed and ran a randomized trial for the recommender system. The trial showed that the algorithm significantly improved the claim rate and hit rate.

3 How Should Volunteers be Dispatched to Out-Of-Hospital Medical Emergencies?

Pieter van den Berg[1], Shane Henderson[2], Caroline Jagtenberg[3], Hemeng Li[2], [1]Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands; [2]Cornell University, Ithaca, NY, [3]Vrije Universiteit Amsterdam, Amsterdam, Netherlands. Contact: hl2359@cornell.edu

When out-of-hospital medical emergencies occur, in addition to the traditional ambulance response, smartphone-enabled volunteer schemes can help alert volunteers near patients through an app on their phone. While alerting all volunteers increases patient survival probability, it could also lead to volunteers receiving too many alerts and reduce their acceptance probabilities in the future. Hence, the problem is to choose which volunteers should receive an alert and when to maximize the survival probability while considering volunteer fatigue. In this talk, we present a model of this problem through dynamic programming and discuss important characteristics of an optimal dispatch policy.

4 Creation of Personalized Task Recommendation Menus to Form and Assign Volunteer Groups

Milan Preet Kaur, Jennifer A. Pazour, Rensselaer Polytechnic Institute, Troy, NY, Contact: milankaur22@gmail.com

We introduce an integer programming-based framework for nonprofit organizations to form groups of volunteers and assign them to nonprofit tasks. Creating volunteer groups requires balancing the nonprofit's need to successfully complete tasks, with the volunteers' motivations to get the opportunity for successful engagement, skill learning, and skill utilization during their experience. Further, nonprofits make group formation decisions in the face of uncertain volunteer preference information. To address these challenges, our framework creates personalized recommendation menus to be presented to volunteers to select tasks they are available and willing to work on, and then feeds this willingness information into a group formation optimization model to form ideal groups. Performance is tested based on an online volunteer crowdsourcing platform case study.

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CC-West 102A

Methodology and Applications in Scheduling

Community Committee Choice Session

Session Chair: Wenhui Zhao, China

1 Present Bias in Scheduling Decisions

Zhixin Liu[1], Nicholas Hall[2], [1]University of Michigan-Dearborn, Dearborn, MI, [2]Ohio State University, Columbus, OH, Contact: zhixin@umich.edu

This talk discusses the effect of present bias in a simple scheduling system that requires decisions about project timing and sequencing. We design algorithms that enable optimization of value less cost under present bias for both naive and sophisticated (i.e., self-aware) decision-makers. We describe managerial insights about the relative performance of time-consistent, naive, and sophisticated decision-makers and how to mitigate the effects of present bias.

2 Outpatients Appointment Scheduling with Patient Preferences on Time-Windows and Walk-In Patients

Shenghai Zhou[1], Guohua Wan[2], [1]Central South University, Changsha, China; [2]Shanghai Jiao Tong University, Shanghai, China. Contact: ghwan@sjtu.edu.cn

We consider an appointment scheduling problem with both walk-in patients and scheduled patients. Each scheduled patient has preference on the service time windows captured by MNL Model. The objective is to make appointments for scheduled patients, in anticipation of walk-in patients, so as maximize the total reward from the services less the total waiting costs. We consider both preemptive and nonpreemptive cases. For the preemptive case, we study the structural properties of the optimal policy and formulate the problem as a second order cone program. For the nonpreemptive case, we model the problem as a dynamic program with knapsack-type of constraints. The computational experiments, together with sensitivity analyses, show that the models and algorithms may significantly improve the schedules generated by two typical scheduling policies widely used in practices.

3 A Decomposition Method for the Group-Based Quay Crane Scheduling Problem

Defeng Sun[1], Lixin Tang[2], Roberto Baldacci[3,4], Zihan Chen[5], [1]Northeastern University, China, Shenyang, China; [2]Northeastern University, Shenyang, China; [3]University of Bologna, Cesena, Italy; [4]Hamad Bin Khalifa University, Doha, Qatar; [5]Huawei Cloud Computing Technologies Co., Ltd, Beijing, China. Contact: sundefeng@ise.neu.edu.cn

This study considers the Quay Crane Scheduling Problem (QCSP), wherein a fixed number of quay cranes must be scheduled to load and unload containers into and from a ship to minimize the completion time subject to precedence, safety margin and non-crossing constraints. For solving the QCSP, we consider alternative schedule directions for the quay cranes, namely, unidirectional, bidirectional, and multi-directional, and we describe a new compact mathematical formulation for the bidirectional QCSP. To compute valid lower bounds on the optimal completion time, we derive different relaxations of the new formulation under the different schedule directions. The new formulation is used in an exact solution framework based on the logic-based Benders decomposition, where the problem is decomposed into an assignment master problem and operation-sequence slave sub-problems.

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CC-West 102B

Social Commerce and Platforms

Community Committee Choice Session

Session Chair: Kejia Hu, Vanderbilt University

Session Chair: Jiding Zhang, New York University Shanghai, Shanghai, China

1 Deal Now or Later? Transaction Mechanisms for Home Sales

Chenhao Zhang[1], Yixin Lu[2], Luyi Gui[3], [1]Northwestern University, Evanston, IL, [2]George Washington University, Washington, [3]The Paul Merage School of Business, UC Irvine, Irvine, CA

Instant buyers (iBuyers) are online platforms that leverage technology to make instant cash offers to homeowners in real estate transactions. iBuyers' profitability hinges on their ability to effectively manage the risks of instant home transactions.To strike timely deals, iBuyers typically skip inspections and rely on seller-reported home attributes, which makes it difficult for them to obtain accurate information about the quality of a property. In this paper, we adopt a signaling game framework to examine the tradeoff between the iBuyer's appeal to home sellers and its susceptibility to adverse selection. We propose a hybrid mechanism combining an instant, guaranteed upfront payment and an ex-post payment contingent on the resale price. We show that adopting such a mechanism can improve the platform's profit when the platform has limited market power.

2 Information-Enhanced Position Auction

shaoyu wang[1], Pin Gao[2], Yang Li[3], Ying-Ju Chen[4], [1]The Chinese University of Hong Kong, Shenzhen, Shenzhen, China; [2]The Chinese University of Hong Kong, Shen Zhen, Shenzhen, China; [3]Ivey Business School, Western University, London, ON, Canada; [4]The Hong Kong University of Science and Technology, Kowloon, Hong Kong

Live-streaming and video advertising commerce have gained popularity as effective means of showcasing products. Both Amazon and Alibaba have successfully implemented this marketing strategy to attract consumers. In this paper, we examine a live-streaming platform's revenue-maximizing problem in which sellers with private information bid for a limited number of Ad spots. Unlike traditional position auction literature that aims solely to maximize platform revenue from Ad spot allocation, we allow the platform to customize information provision at each Ad spot. The analysis highlights the crucial role of information provision in enhancing the matching efficiency between products and heterogeneous consumers. Furthermore, we establish that information provision can deter competition among sellers, thereby reaping the payoffs of both the platform and sellers.

3 Does Kol Matter in Live Ecommerce: An Empirical Study on Tiktok

Kai Tian[1], Rui Jie Zhang[2], Yun Fong Lim[2], Ke Jia Hu[3], [1]Singapore Management University, Singapore, Singapore; [2]Singapore Management University, Singapore, Singapore; [3]Vanderbilt University, Nashville, TN, Contact: kai.tian.2020@pbs.smu.edu.sg

We utilized PSM (Propensity Score Matching) and auto-regressive linear models to investigate the impact of targeting audiences of KOL (Key Opinion Leaders) followers on advertising outcomes. Based on marketing theories and PSM criteria, we gradually incorporated matching variables into the PSM and identified four categories of marketing outcomes that reflect customers' willingness to buy the advertised products, in increasing order of customer valuation and willingness-to-buy: traffic, purchase intention, engagement, and loyalty. Our results indicate that targeting audiences of KOL followers enhances traffic volume, but has no effect on other types of marketing outcomes. Therefore, our findings suggest that practitioners can benefit from targeting audiences of KOL followers when their advertising objective is to increase traffic.

4 The Role of Within-day Learning on Gig Workers' Performance and Task Allocation: Evidence from an On-Demand Platform

Reeju Guha, Daniel S. Corsten, IE Business School, Madrid, Spain. Contact: reejuguha@student.ie.edu

Most platforms allocate tasks without considering gig worker behaviors. Experience-based allocations are not useful when workers are new. We investigate whether same-day learning (SDL) impacts worker performance and be utilized for ranking. Using data from an on-demand platform, we analyze worker performance based on SDL while accounting for sample selection & endogeneity. Our findings reveal that as SDL increases performance improves. Furthermore, when workers batch orders, SDL reduces delays, but also reduces substitutions. Similarly, for complex tasks, a moderate level of SDL is most beneficial. We rank workers based on prior & same-day experience and develop an algorithm to allocate tasks based on rank & complexity. We predict improvements in performance & demonstrate that allocating higher-ranked workers to complex tasks leads to performance improvements.

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CC-West 102C

Advanced Analytics for Socially Impactful Operations

Contributed Session

Session Chair: Zlatana Dobrilova Nenova, University of Denver, Denver, CO

1 Enhancing Energy Forecasts in Public Transit Using Advanced Machine Learning Techniques and High-Level Planning Metrics

Zhuo Han, Eleni Christofa, Eric Gonzales, Jimi Oke, University of Massachusetts Amherst, Amherst, MA, Contact: zhuohan@umass.edu

This research represents a groundbreaking approach to forecasting energy usage in public transit systems, specifically the Massachusetts Bay Transportation Authority (MBTA) urban rail network in Boston. Building on previous work that achieved a 3.95% test error in energy estimation, this study utilizes high-level planning metrics to model low-level variables, contributing significantly to energy efficiency. We then estimated vector autoregressive models and long-short term memory networks to develop a robust energy forecasting model. This study offers a generative model trained to map high-level metrics to movement variables, proving its effectiveness in driving energy efficiency.

2 Multiobjective Algorithm for the Political Redistricting Problem

Blake Splitter[1], Matthew J. Saltzman[2], [1]Clemson University, Clemson, SC, [2]Clemson University, Clemson, SC, Contact: bsplitt@clemson.edu

This presentation continues on previous work by the authors towards creating a multicriteria model for solving the political districting problem in South Carolina. We consider four key objectives: population equality, county divisions, district compactness, and political fairness. By utilizing a non-dominated sorting genetic algorithm (NSGA-II), we can find a set of high-quality solutions approximating a Pareto Front for the state of South Carolina.

3 Analytically Focused Business Intelligence Solution for Bus Operation Safety Improvement

Xiaotong Ding[1], John Maleyeff[2], [1]MBTA, Boston, MA, [2]Boston University, Boston, MA, Contact: XDing@mbta.com

A business intelligent system was designed for users to customize analyses concerning bus operation safety at the MBTA in Boston. It integrates data sources to form a data eco-system. Its application includes: KPI management, targeted actions used to flag issues and alert operation personnel, and issue investigation designed for routine or ad-hoc analyses. Various analytical methods were used to rank feature relevancy and importance. The presentation will demonstrate the system and discuss the development and implementation challenges.

4 Tolerance of Ambiguity Among People with Different Political Affiliations

Zlatana Dobrilova Nenova[1], Dennis F. Galletta[2], Valerie Bartelt[3], [1]University of Denver, Denver, CO, [2]University of Pittsburgh, Pittsburgh, PA, [3]University of Denver, Highlands Ranch, CO, Contact: zlatana.nenova@du.edu

We surveyed individuals on Mechanical Turk and Prolific. We collected data from 2,180 individuals, and disqualified all but 1,244 of the participants because 936 did not pass various attention checks. We examined participants' tolerance of ambiguity (TA). Additionally, we collected data on their willingness to read news articles on two different in terms of polarization topics originating from left-leaning, independent and right-leaning news sources. Through our analysis we identified that liberals and independents had significantly higher TA and propensity to select articles with balanced and diverse political affiliations than conservatives. This analysis provides some preliminary evidence that one innate trait, TA, leads consumers of news to avoid seeing arguments counter to their opinions, thus preventing more balanced reading choices.

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CC-West 103A

Blockchain and New Technologies

Community Committee Choice Session

Session Chair: Jingxing (Rowena) Gan, Cox School of Business, Southern Methodist University, Dallas, TX

1 Exploring Multihoming Behavior of dApps and Their Users Across Layer 2 Blockchains

Daniel Obermeier, NYU Stern School of Business, New York, NY

With the proliferation of Ethereum as a leading blockchain platform for dApp development, the network's scalability and congestion issues have prompted developers and users to explore alternative solutions. One solution is to evade congestion on Ethereum by moving to more scalable and less congested Layer 2Blockchain platforms. This study analyzes the migration patterns of dApps across multiple platforms and investigates how network effects and congestion drive multihoming decisions. Based on a sample of 3450 dApps and their users, we find that most dApps stay on Ethereum even in periods of severe congestion, but multihoming increases with an increase of the installed based on layer 2platforms. Interestingly, users of multihoming dApps use layer 2 platforms only temporarily to evade high gas fees.

2 The Economics of Federated Learning in Online Advertising

Luoying Chen, Jianqing Chen, Amit Mehra, The University of Texas at Dallas, Richardson, TX, Contact: luoying.chen@utdallas.edu

Federated learning (FL) techniques allow firms to train machine learning models without collecting user data. Instead of transferring raw data to a central server, models are trained collaboratively on users' devices and only model updates are shared to the server, ensuring sensitive user information being protected. Due to the growing restrictions pertaining to privacy protection that diminishes ads targeting, FL has garnered amplified recognition in the realm of online advertising. In this paper, we study the economic implications when a platform adopts FL in online advertising and examine the platform's strategy in setting up monetary rewards to attract users' enrollment in FL.

3 Contract Tokenization in the Renewable Energy Market

Rowena J. Gan[1], Rong Li[2], [1]Cox School of Business, Southern Methodist University, Dallas, TX, [2]Syracuse University, Syracuse, NY, Contact: jingxingg@smu.edu
Endorsed by the blockchain technology, contracts can be digitally recorded and stored in crypto tokens, which is referred to as being tokenized. Using the renewable energy market as a backdrop, we study the impact of contract tokenization on different parties in the industry based on their respective incentives.

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CC-West 103B

Knowledge Graph and Graph Analytics Applications

Community Committee Choice Session

Session Chair: Lili Zhang, Hewlett Packard Enterprise

1 A Random Graph Algorithm for Modeling Social Networks

Ryan A. Parker, Kennesaw State University, Kennesaw, GA
A common goal in network analysis is the modeling of social network graphs, which tend to exhibit low average path length, high clustering, and a power law degree distribution. However, most existing attempts to do so fall short on one or more of these properties. Here, a novel approach is utilized, which uses an older algorithm over many iterations to generate the bulk of the nodes, as well as a modified version the highly connected 'influencer' nodes. Several expectations of the model were derived and compared to values calculated from scaled-down simulations. The model, when tuned correctly, reasonably mimics the properties displayed by social network graphs. This algorithm not only provides a quick-performing method to model social network graphs, but also a possible alternative for modeling other types of graphs, given proper appropriate hyperparameter tuning.

2 AI Biases in Graph Neural Networks

Henry Han, Baylor University, Waco, TX
GNN have revolutionized the field of graph representation learning by enabling effective modeling and analysis of complex relational data. They have been successfully applied in various AI and data science domains. However, they may introduce potential biases, particularly when dealing with imbalanced data. This study aims to investigate different mechanisms behind AI bias generation in graph neural networks and explore their impacts on credit risk prediction applications. By examining the biases inherent in GNN and their variants, we develop effective strategies to mitigate bias and improve the fairness and accuracy of credit risk prediction models. We have found that those AI biases generated under those imbalanced learning-hard problems may demonstrate different characteristics than other datasets in credit risk applications.

3 A B2B Persona Knowledge Graph Framework

Lili Zhang[1], Zainab Jamal[2], Swarup Chandra[1], [1]Hewlett Packard Enterprise, San Jose, CA, [2]HPE, Saratoga, CA
Identification of core buyer personas in B2B is critical for marketing and sales to streamline the efforts of influencing a purchase decision making process. In B2B, a persona represents the customers' job function and job seniority. In this work, we showcase how we have built a knowledge graph to classify the millions of job titles and identify core buyer personas. The outcome has been strategically improving the contact data quality and creating more relevant audience for marketing campaigns.

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CC-West 104A

DEI Research: How Can Your Research Promote DEI in Public Policy and Health?

Community Committee Choice Session

Session Chair: Bing Si, State University of New York at Binghamton, Binghamton, NY

Session Chair: Ying Lin, University of Houston, Houston, TX

1 Optimal Design of Diabetic Retinopathy Telescreening Program for Patients at Risk

Taewoo Lee, University of Pittsburgh, Pittsburgh, PA
Diabetic retinopathy (DR) is the leading cause of blindness among working-age Americans. Teleretinal imaging (TRI) has emerged as an affordable tool that has the potential to increase screening rates among patients with limited access to care. However, little is known how TRI-based screening should be recommended in conjunction with traditional screening exams for patients with different levels of financial or geographic access to care. We develop a POMDP model that determines personalized screening policies that take into account patient-specific characteristics.

2 Optimal Vaccine Promotion Campaigns Considering Disease Transmission and Opinion Propagation with Fairness

Serin Lee, Shan Liu, Zelda B. Zabinsky, University of Washington, Seattle, WA, Contact: serinlee@uw.edu

Efforts are underway to promote vaccination and increase vaccine willingness, which can alleviate disease burden. Our study identifies near-optimal solutions for vaccine promotion campaigns across different age and geographic groups with the goal of of minimizing disease burden. We take fairness into consideration and ensure equitable budget allocation. The model is a coupled dynamics on disease transmission and opinion propagation within a networked compartmental model. We use representative calibration parameters for disease and opinion parameters to address model uncertainties that is calibrated to the COVID-19 pandemic data in Clark County, WA between January and February 2023. We use an optimization algorithm to determine a range of optimal solutions and explore different scenarios such as changes in vaccine effectiveness or transmissibility.

3 Addressing Disparities in College Mental Health: A Quantitative Framework for Improved Access and Personalized Care

Sohom Chatterjee, Youssef Hebaish, Hrayer Aprahamian, Lewis Ntaimo, Texas A&M University, College Station, TX

We consider the timely issue of rising mental health problems among college students. Studies highlight the alarming disparity in unmet mental health needs among minority students, as they have unique requirements that are not always adequately addressed by conventional treatments. Moreover, resource limitations hinder access to critical services, exacerbating the situation. In this project, we consider a quantitative framework to optimize the operations of college counseling centers, addressing disparities in access to care among diverse groups. Additionally, we seek to enhance service quality by analyzing student outcome data to construct more effective personalized treatments based on students' specific needs. A case study on Texas A&M's counseling center reveals the substantial benefits of the approach in improving both service quality and availability.

4 Fairness Constrained Adaptive Boosting Algorithm

Ying Lin, Muyun Lu, University of Houston, Houston, TX, Contact: ylin58@uh.edu

Adaptive boosting (AdaBoost) is an efficient and simple ensemble learning algorithm widely used in many prediction tasks. However, the training of AdaBoost only focuses on reducing the average loss of whole population, which can result in potential discrimination of different groups of samples if the training data is biased or imbalanced. Although there are a few fairness-aware AdaBoost models, none of them can guarantee the convergence of the algorithms. To mitigate this gap, this project proposes a new fairness-constrained objective function for AdaBoost and designs a novel mechanism to estimate the parameters, so that the fairness-constrained objective function is minimized. The proposed algorithm is applied to a cardiovascular disease prediction problem and its effectiveness is demonstrated.

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CC-West 104B

Recent Methodological Advances for Large-Scale Learning and Inference

Community Committee Choice Session

Session Chair: Trambak Banerjee, University of Kansas, Lawrence, KS

1 Decision-Aware Denoising for Linear Optimization

Michael Huang[1], Vishal Gupta[2], Paat Rusmevichientong[3], [1]University of Southern California, Seattle, WA, [2]University of Southern California, Los Angeles, CA, [3]USC Marshall School of Business, Los Angeles, CA

Many modern problems in urban planning, climate change, and healthcare leverage large-scale geospatial data to make decisions. In most settings, such data is noisy and challenging to analyze with out-of-the-box machine learning methods, resulting in low quality decisions. We propose a decision-aware denoising approach that integrates information about underlying decision problem into the training of out-of-the-box machine learning methods. We prove our approach can learn the best-in-class decision-making policies for a large-class of linear optimization problems and highlight its effectiveness in a case-study about placing speed humps to reduce fatalities in NYC.

2 The Doctor Knows Best: Model-Agnostic Physician-In-The-Loop Explainability via Counterfactually-Guided Deep Reinforcement Learning

Michael Lash, University of Kansas, Lawrence, KS, Contact: michael.lash@ku.edu

In recent years machine learning models have been increasingly integrated into high-stakes decision-making domains, such as healthcare. Yet, physicians and other healthcare professionals are reluctant to rely on and trust such models since they do not understand their inner workings. Machine learning explainability (MLX) promises to bridge this gap by showing *why* a prediction was made. Yet, many past MLX methods do not consider healthcare practitioners' domain knowledge and may thus produce counter-intuitive explanations. In this work, we propose a novel physician-in-the-loop machine learning explainability method that explicitly considers a physician's preferences when producing explanations. We embed these preferences in a novel counterfactually-guided off-policy reinforcement learning scheme to synthesize a physician-specific prediction explainer.

3 Unrestricted Hypothesis Testing

Bradley Rava, University of Sydney Business School, Sydney, Australia. Contact: bradley.rava@sydney.edu.au

We present a novel multiple hypothesis testing approach that improves upon existing state-of-the-art benchmarks by directly utilising p-values to preform calibration in order to control the local FDR. Our methodology has broad applications across multiple fields and works in a variety of settings. In this presentation, we will discuss the key insights and findings of our research.

4 Optimal Nonparametric Inference with Two-Scale Distributional Nearest Neighbors

Emre Demirkaya, University of Tennessee, Knoxville, TN

The weighted nearest neighbors estimator has been popularly used as a flexible and easy-to-implement nonparametric tool for mean regression estimation. The bagging technique automatically chooses weights to form the distributional nearest neighbors (DNN) estimator. We provide an in-depth technical analysis of the DNN, based on which we suggest a bias reduction for the DNN estimator by combining two DNN estimators, resulting in the novel two-scale DNN estimator. We prove that the two-scale DNN estimator enjoys the optimal nonparametric rate of convergence and asymptotic normality. For the practical implementation, we provide variance estimators and a distribution estimator using the jackknife and bootstrap techniques. These estimators can be exploited for constructing valid confidence intervals for nonparametric inference of the regression function.

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CC-West 105A

Data Mining for Power System Resilience and Reliability

Community Committee Choice Session

Session Chair: Feng Qiu, [1</sup]

1 Monitoring and Novelty Detection in Energy Assets, Applications in Battery and Solar Inverters

Mohammad Badfar, Murat Yildirim, Ratna Babu Chinnam, Wayne State University, Detroit, MI, Contact: hi8578@wayne.edu

Shrinking product development cycles and increasing complexity of assets necessitates a new generation of monitoring and diagnostic algorithms that can demonstrate more autonomy and adaptivity. In many real-world applications, available data doesn't conform to the strict assumptions of conventional approaches. We present the results for a novelty detection-based autonomous monitoring framework that flags anomalies under real-world data. Results from applying the proposed framework to 12-volt battery systems and solar inverters are promising.

2 Spatio-Temporal Wildfire Prediction Using Multi-Modal Data

Chen Xu, [1</sup]

Wildfire prediction using multi-modal sensing data is essential to a more informed understanding of wildfire activities. In this paper, we develop a flexible spatio-temporal wildfire prediction framework using multi-modal time series data. We first predict the wildfire risk (the chance of a wildfire event) in real-time, considering the historical events using discrete mutually exciting point process models. Then we further develop a wildfire magnitude prediction set method based on the time-series conformal prediction (CP) approach. Theoretically, we prove a risk model parameter recovery guarantee, as well as coverage and set size guarantees for the \rev{CP} sets. Through extensive real-data experiments with wildfire data in California, we demonstrate the effectiveness of our methods, as well as their flexibility and scalability in large regions.

3 Diagnosis and Prognosis of Multivariate Battery State of Health

Susan Babinec, Noah Paulson, Argonne National Lab, Lemont, IL, Contact: sbabinec@anl.gov

Batteries are a cornerstone technology for deep decarbonization and the fight of climate change. Li-ion dominates all markets due to its excellent performance and cost but remains challenged due its complex degradation behaviors. *In this presentation we described state-of-the-art capabilities to predict advanced Li-ion state of health characteristics for thousands of cycles over years of use after several days' characterization.*

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CC-West 105B

Digital Economy and Emerging Technologies

Community Committee Choice Session

Session Chair: Leting Zhang, University of Delaware, Bear, DE

1 AI Opponents in Online Gaming: Evidence from a Quasi-Field Experiment

Qinglai He[1], Haoyu Yuan[2], Lingli Wang[3], Jiayin Zhang[2], Nina Huang[4], Qiang Wei[2], [1]University of Wisconsin - Madison, Madison, WI, [2]Tsinghua University, Beijing, China; [3]Beijing University of Posts and Telecommunications, Beijing, China; [4]University of Miami, Miami, FL

There is a growing trend in the online gaming industry of introducing AI agents as virtual opponents (AI opponents) to create better gaming experiences and boost player engagement. Leveraging a large-scale quasi-field experiment in a multiplayer online racing game, we employ difference-in-differences (DID) analyses and find that the adoption of AI-powered virtual opponents can result in reduced player engagement and lower performance. Remarkably, the mechanism exploration further reveals that introducing AI opponents increases competition intensity and immersion in the game. These two factors exhibit opposing influences on players' subsequent behavior. A more competitive game hinders players' further engagement, whereas a more immersive experience encourages more gaming participation and better performance.

2 Peer Data Breaches and Cyber Risk Disclosure Quality: Evidence from U.S. Public Firms

Leting Zhang[1], Taha Havakhor[2], Sunil Wattal[3], [1]University of Delaware, Newark, DE, [2]McGill University, Montreal, QC, Canada; [3]Temple University, Philadelphia, PA

Public firms' cyber risk disclosure (CRD) is valuable in reducing information asymmetry in the financial market. However, there is limited understanding of whether and how data breach incidents affect a bystander firm's cyber risk disclosure (CRD) quality. To explore the question, we leverage textual data on more than 3,000 US public firms' CRD from 2011 to 2017 and perform empirical analyses. We find that bystander firms strategically lower their CRD quality after a firm's breach. The result is robust to instrumental variable analysis, different model specifications, and alternative measurements. We further show that the quality of CRD decreases at a larger magnitude if public attention to data breaches is higher, or a firm spends more on advertising, or is more vulnerable to cyber risks. Lastly, peer breaches lower the positive association between CRD quality and a firm's market returns but exert no significant impact on the association between CRD quality and a firm's breach likelihood. We discuss the implications for research and practice.

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TD72

CC-West 106A

Financial Technologies

Community Committee Choice Session

Session Chair: Rich Zhu, Georgia Institute of Technology

1 Beyond the Financial Value of Crowdfunding: Evidence from an Interpretable Machine Learning Approach

Jiayu Yao[1], Mingfeng Lin[1], Xuan Wei[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]University of Arizona, Tucson, AZ

The paper studies the nonfinancial value of crowdfunding for entrepreneurs' success in mass markets. While previous literature has primarily focused on the financial impacts of crowdfunding, our study examines the value of crowdfunding in validating innovative ideas and accessing early feedback. Using data from a US reward-based crowdfunding platform, we build explanatory machine learning models to predict entrepreneurs' market performance. Our study highlights the critical role of early market feedback.

2 The Effect of Merger and Acquisition Rumors on Investor Behaviors

Ruiqi Rich Zhu[1], Hailiang Chen[2], Yinghua Li[3], Yu Jeffrey Hu[4], [1]Georgia Institute of Technology, Atlanta, GA, [2]The

University of Hong Kong, Hong Kong, Hong Kong; [3]Arizona State University, Tempe, AZ, [4]Georgia Institute of Technologuy, Atlanta, GA

Investors increasingly rely on social media platforms as crucial sources of information for making investment decisions. While these platforms offer a wealth of insights, it is essential to acknowledge the prevalence of misinformation, such as merger and acquisition (M&A) rumors, can lead to irrational choices. While M&A information is valuable in predicting future stock movements, M&A rumors circulating on social media may not always be reliable, potentially resulting in poor investment decisions. To investigate this phenomenon, we collect M&A rumors from both Seeking Alpha, a prominent social media website, and traditional news media. We compare the accuracy of these rumors against realized events, explore whether investors tend to follow these rumors, and examine how the content of the rumors influences their decision-making process.

3 The Egalitarian Tale of Decentralization in Automated Market Making

Allen Zhao[1], Zixuan Meng[1], Zhiqiang Eric Zheng[2], [1]The University of Texas at Dallas, Richardson, TX, [2]University of Texas-Dallas, Richardson, TX, Contact: allenz@utdallas.edu

Blockchain technologies have revolutionized the financial market with Decentralized Finance (DeFi), particularly decentralized automated market making (AMM). This study examines if AMM truly offers equal benefits to all participants. Findings reveal that profits still largely go to large, sophisticated liquidity providers (LPs), contradicting DeFi's intent. This disparity is partly due to individual LPs' lack of sophistication. Smart contracts have been used to aid LPs' decision-making, but low-performing LPs benefit less as they are less likely to adopt this technology. The study concludes that simply providing equal market access and tools isn't enough to create an egalitarian market.

4 Mobile Effects on Two-Sided Financial Decisions: Evidence from Field Experiments on Peer-To-Peer Lending Platforms

Sihan Fang[1], Hyeokkoo Eric Kwon[1], Tian Lu[2], Yingjie Zhang[3], [1]Nanyang Technological University, Singapore, Singapore; [2]Arizona State University, Tempe, AZ, [3]Peking University, Beijing, China. Contact: sihan001@e.ntu.edu.sg

We investigate how mobile channels shape the behaviors of both borrowers and lenders in peer-to-peer (P2P) lending platforms, as well as the corresponding impacts on credit risk management and economic return. Empirically, we collaborate with a leading P2P lending platform to launch two-sided field experiments, in which we randomly assign mobile treatments to borrowers and lenders. We illustrate that mobile borrowers are more likely to terminate loan submissions, especially during peak commuting hours. By contrast, mobile lenders have a higher tendency to approve loan applications within a shorter period. Surprisingly, we observe no change in the quality of submitted or approved loans. Considering the improved debt collection capability of the platform, we reveal that mobile adoption brings profit enhancement. We offer theoretical and managerial implications.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD73

CC-West 106B

Consumer Credit

Community Committee Choice Session

Session Chair: Taylor Begley, University of Kentucky, Lexington, KY

1 Risk in the Shadows: Leverage and Liquidity in Nonbanks

Taylor Begley[1], Kardarp Srinivasan[2], [1]University of Kentucky, Lexington, KY, [2]Northeastern University, Boston, MA

Nonbank mortgage companies (NMCs) use high levels of short-term leverage, leading to concerns about their individual fragility and systemic risk. We find that NMCs also hold very risky assets, with revenue growth ranging from -30% to +100% at the 10th-90th percentile. Surprisingly, we also observe extremely low bankruptcy rates. We address this puzzle by examining the dynamics of NMCs' costs following negative shocks. Our findings show that NMCs have the flexibility to quickly and substantially reduce both their operating expenses and financing costs (interest expense and debt levels). These dynamics lower their credit risk compared to what static measures of leverage and asset risk suggest. The collateralized nature of originators' borrowing plays a fundamental role in debt flexibility. Servicers, who lack high-quality collateral, compensate by holding more cash.

2 How Resilient is Mortgage Credit Supply? Evidence from the Covid-19 Pandemic

Andreas Fuster[1], Aurel Hizmo[2], Lauren Lambie-Hanson[2], James Vickery[2], Paul Willen[3], [1]Ecole Polytechnique Fédérale de Lausanne, Luasanne, Switzerland; [2]Federal Reserve Bank of Philadelphia, Philadelphia, PA, [3]Federal Reserve Bank of Boston, Boston, MA

We study the evolution of mortgage credit supply during the COVID-19 pandemic. The mortgage market experienced a historic boom in 2020, but a large increase in intermediation margins limited the pass-through of low rates to borrowers. This rise is only partially explained by the historical relationship between demand shocks and the price of intermediation. Labor market frictions and operational bottlenecks contributed to unusually inelastic credit supply, and technology-based lenders gained market share for difficult-to-process loans. Rising forbearance and default risk did not significantly reduce supply for "plain vanilla" conforming mortgages, but constrained credit availability for loans without government guarantees and mortgages to the riskiest borrowers. Federal Reserve bond purchases also supported credit supply in the conforming segment.

3 Fraud Litigation and FHA Mortgage Lending

Erik Mayer, University of Wisconsin-Madison, Madison, WI

We study the impact of recent increases in mortgage lenders' litigation risk on borrowers. In the last decade, the U.S. Department of Justice brought suits against many of the largest lenders in the FHA mortgage market, alleging fraud under the False Claims Act. These suits led to over $5.4 billion in settlements and caused targeted banks and their peers to precipitously exit the FHA market. A combination of difference-in-differences and triple differences tests exploiting geographic variation in exposure to exiting banks show a 19% reduction in aggregate FHA lending in heavily affected areas. Smaller non-bank lenders with higher historical misconduct rates partially filled the void in the FHA market, highlighting potential unintended consequences of aggressive consumer financial protection litigation.

4 The Rise of Non-Banks in Servicing Household Debt

Brittany A. Lewis[1], Erica Jiang[2], Manisha Padi[3], Avantika Pal[1], [1]Washington University in St. Louis, St Louis, MO, [2]USC, LA, CA, [3]Berkeley, San Francisco, CA, Contact: lewis.b@wustl.edu

Over the past two decades, the mortgage industry has been transformed from the traditional bank-centered deposit taking, lending, and servicing model to a fragmented market with high non-bank participation. We document a novel mechanism for this unbundling -- mortgage servicing transfers -- and study the role of bank regulation in transforming servicing. Using a near universe of consumer credit records, we show that banks increase transfers of mortgage servicing rights (MSRs) to non-banks following the announcement of Basel III's higher regulatory costs of holding MSR assets for banks. Based on predictions of a simple model of servicing transfers, we demonstrate which types of banks and loans experience the highest transfer rates. We find that banks selectively transferred below-median income, subprime, and 60+ day delinquent MSRs to non-banks. Loans subject to transfer due to regulatory pressure experienced more foreclosures and personal bankruptcies. Our results suggest that growth in the unbundling of mortgage servicing increased existing disparities in financial risks across households.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD74

CC-West 106C

Learning and Mechanism Design

Community Committee Choice Session

Session Chair: Michael Albert, University of Virginia, Charlottesville, VA

1 Delegating Data Collection for Learning

Nivasini Ananthakrishnan, Stephen Bates, Michael Jordan, Nika Haghtalab, UC Berkeley, Berkeley, CA, Contact: nivasini@berkeley.edu

Motivated by the emergence of decentralized machine learning ecosystems, we initiate the study of the delegation of data collection. Taking the field of contract theory as our starting point, we design optimal and near-optimal contracts that deal with two fundamental machine learning challenges: lack of certainty in the assessment of model quality and lack of knowledge regarding the optimal performance of any model. We show that lack of certainty can be dealt with via simple linear contracts that achieve a $1-1/e$ fraction of the first-best utility, even if the principal has a small test set. We also discuss considerations in delegation over multiple rounds.

2 Competition, Alignment, and Equilibria in Digital Marketplaces

Meena Jagadeesan, Michael I. Jordan, Nika Haghtalab, UC Berkeley, Berkeley, CA, Contact: mjagadeesan@berkeley.edu

Competition between traditional platforms is known to improve user utility by aligning the platform's actions with user preferences. But to what extent is alignment exhibited in data-driven marketplaces? To study this question from a theoretical perspective, we introduce a duopoly market where platform actions are bandit algorithms and the two platforms compete for user participation. A salient feature of this market is that the quality of recommendations depends on both the bandit algorithm and the amount of data provided by interactions from users. Our main finding is that competition in this market does not perfectly align market outcomes with user utility. Interestingly, market outcomes exhibit misalignment not only when the platforms have separate data repositories, but also when the platforms have a shared data repository.

3 Imitative Buyer Deception in Repeated Posted-Price Auctions

Minbiao Han, University of Chicago

A ubiquitous learning problem in today's digital market is, during repeated interactions between a seller and a buyer, how a seller can learn optimal pricing based on the buyer's past purchase responses. A fundamental challenge of learning in such a strategic setup is that the buyer naturally has incentives to manipulate his responses in order to induce more favorable learning outcomes. To understand the limits of the seller's learning when facing such a strategic buyer, we study a natural yet powerful buyer manipulation strategy. That is, before the game starts, the buyer simply commits to imitate a different value function by pretending to always react optimally according to this imitative value function. We fully characterize the optimal imitative value function of the buyer as well as the resultant seller revenue and buyer surplus under this optimal buyer manipulation.

4 From Dynamic Pricing to Dynamic Stackelberg Games: Going Beyond the No Learning Theorem

Minbiao Han[1], Dawkins Quinn[2], Michael Albert[2], Haifeng Xu[1], [1]University of Chicago, Chicago, IL, [2]University of Virginia, Charlottesville, VA

In this work, we study dynamic Stackelberg games, i.e. games in which a leader and a follower repeatedly interact, where the follower's type is unknown and the follower is non-myopic. A natural question to ask is, can the leader learn the optimal strategy against the unknown follower through these repeated interactions? The No Learning Theorem from dynamic pricing, a particular type of dynamic Stackelberg game, would suggest that the leader cannot learn effectively from the follower. In contrast, we demonstrate that in general dynamic Stackelberg games, the leader can improve her utility through learning in repeated play. We show that this dynamic policy is provably nearly optimal, even when compared to stronger equilibrium concepts that permit communication between the leader and follower.

5 Scalable Strategyproof Mechanism Design via Differentiable Economics

Michael Curry, University of Zurich, Zurich, Switzerland

A recent approach to automated mechanism design, differentiable economics, represents auctions by rich function approximators and optimizes their performance by gradient descent. We present recent work in differentiable economics, including new architectures that can guarantee exact strategyproofness of the mechanism, and new extensions of the techniques of differentiable economics that can be applied to dynamic problems.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD75

Session.Location:CC-West 208A

Collaborative Vehicle Routing and Network Design

Contributed Session

Session Chair: Himani Ananthula, Kellogg School of Management, Northwestern University, Evansotn, IL

1 Anticipatory Request Acceptance in Dynamic and Collaborative Vehicle Routing

Yannick Scherr[1], Margaretha Gansterer[2], Richard F. Hartl[3], [1]University of Klagenfurt & University of Vienna, Vienna, Austria; [2]Univiersity of Klagenfurt, Klagenfurt, Austria; [3]University of Vienna, Wien, Austria. Contact: margaretha.gansterer@aau.at

We consider the problem setting of serving stochastic customer requests that must be answered dynamically. Accepted requests are served in routes using a set of vehicles with limited load capacity and route duration. Multiple carriers participate in a combinatorial auction to exchange a subset of requests. After carriers place bids on bundles of requests, an auctioneer allocates the bundles to carriers in a cost-minimizing way. We consider overbooking policies for prior to the auction and the strategic rejection of requests in anticipation of more profitable new requests. Experiments show that carriers' request acceptance decisions impact their individual profits and the overall collaboration savings. The largest benefits can be achieved with an overbooking policy that is applied by all carriers and considers the locations of both the request and the carriers' depots.

2 Integrated Optimization of Auto-Carrier Loading and Routing Decisions in Automobile Shipping

Sajeeb Kirtonia, Yanshuo Sun, Florida State University, Tallahassee, FL

The underlying pickup and delivery problem in automobile shipping is interesting because of the special configuration of a roadway auto-carrier, which further leads to auto-carrier loading decisions to be intertwined with routing decisions. First, for given auto-carrier routes, we design a unified space-state network formulation for auto-carrier loading optimization. Then, we use supervised learning to predict the number of reloads for a given auto-carrier route, thus avoiding solving a lengthy loading optimization problem. This data-driven module can be plugged into an auto-carrier routing optimization engine based on a column generation approach, to evaluate the impact of routing decisions on loading in real-time. Eventually, we jointly optimize two interrelated decisions and demonstrate the proposed methods with a case study in the Southeastern U.S.

3 Gig Workers for Relay Network Model: Factors to Consider

Himani Ananthula, Kellogg School of Management, Northwestern University, Evansotn, IL, Contact: himani.ananthula@kellogg.northwestern.edu

A relay point is a physical location in the transportation network where shipments can be relayed. We study the optimal relay network design problem robust to labor(drivers/supply) shocks under a queuing framework. We discuss managerial insights and factors to consider while designing relay networks with such daily-level supply uncertainties.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD76

Session.Location:CC-West 208B

Elements of Logistical Operations

Contributed Session

Session Chair: Mingwei Guo, North Dakota State University, Fargo, ND

1 Sustainable Multi-period Last-mile Delivery with Anticipatory Postponement

Tingting Chen[1], Jiantong Zhang[2], [1]Tongji University, Shanghai, China; [2]Tongji University, Shanghai, China. Contact: aryatt120999@gmail.com

E-retailing reshapes shopping habits, but raises sustainability issues and parcel growth strains couriers physically and mentally.This research pioneers simultaneous route and package workload balance in the context of multi-period last-mile delivery. An anticipatory postponement policy is proposed using Sample Average Approximation (SAA) and policy-gradient method to balance package workload and reduce costs. An enhanced multi-objective optimization algorithm combines NSGAII with hybrid Simulated Annealing and Variable Neighborhood Search (SAVNS) to achieve route workload balance and efficient distribution with respect to sustainability. Computational results based on realistic data show the effectiveness of our policy. Comparative experiments also validate the proposed optimization algorithm against other state-of-the-art methods.

2 Setting Customized Service Level Targets for Parts in a Repair Kit

Jingran Xu, John Maleyeff, Boston University, Boston, MA, Contact: xujr21@bu.edu

The presentation details a stochastic approach to determine the service level for a part contained in a repair kit, where the repair cannot be started until all parts are available. Our model features a unique cost structure that considers the shortage cost to be the cost of holding other parts in the repair kit while the part being ordered is in transit. Using data from a transportation company, a k-means clustering analysis showed the demand distribution to be Poisson for intermittent demand repairs. Sensitivity and joint effect analyses were used to evaluate the effects of lead time, part cost, and demand rate on optimal service levels. An important result is that a part with a higher unit cost should be assigned a lower service level.

3 Direct and Mitigation Factors of Crowdsourced Last-Mile Delivery Workers' Willingness to Work in a Rural Setting

Mingwei Guo[1], Joseph Gerard Szmerekovsky[2], [1]North Dakota State University, Fargo, ND, [2]North Dakota State University, Fargo, ND, Contact: mingweiguo@live.com

The motivation of the practitioners(drivers) in crowdsourced delivery is often neglected when more attention is given to the decision making and scheduling process. When temporary workers from phone APPs taking more third-party last-mile delivery tasks, the supply of practitioners may be in shortage if certain factors are not considered. This research aims to find and test the direct and mitigation factors for crowdsourced last-mile practitioners' willingness to work (WTW), with specialization and focus on the rural areas and commuting workers who might be potential last mile delivery workers. A combination of qualitative and quantitative research methods will be utilized, from which, descriptive and exploratory survey will be the main method. Phase I results will be expected by September. It will be the job market paper of the presenter.

Tuesday, October 17, 2:15

PM - 3:30 PM

TD77

Session.Location:CC-West Lecture Hall

Machine Learning Methods and AI in Practice

Contributed Session

Session Chair: Mostafa Amini, Oklahoma State University, Oklahoma City, OK

1 The Effect of Interpretable Artificial Intelligence on Repeated Managerial Decision-Making Under Uncertainty

Onur Altintas[1], Abraham Seidmann[2], Bin Gu[1], Nina Mažar[1], [1]Boston University, Boston, MA, [2]Boston University, NEWTON, MA, MA

Many business decisions, such as managing investment instruments, selecting medical care, and managing various supply chains, are being made repetitively in uncertain environments. At times, decisions under uncertainty could be perceived as wrong ex-post even though they are really ex-ante optimal. Therefore, decision-makers tend to intuitively resist taking algorithmic advice under high uncertainty. In our study, we empirically investigate the impact of various common interpretability formats on AI adoption and trust under uncertainty. Interestingly, we show that explaining the inner workings of a model in fact decreases AI adoption. On the other hand, frequently sharing the cumulative performance over time of both the users and the AI improves users' trust in the model. On the other hand, it had no negative impact on the AI adoption rate.

2 Valid Inequalities for Verification of Binarized Neural Networks

Woojin Kim[1], Jim R. Luedtke[2], [1]University of Wisconsin-Madison, Madison, WI, [2]University of Wisconsin-Madison, Madison, WI, Contact: wkim73@wisc.edu

Binarized neural networks(BNNs) are neural networks with binary weights, and activation functions are the sign function. Verification of BNNs against input perturbation is one way to measure robustness of BNNs. BNN verification can be formulated as a mixed integer linear optimization problem. The natural formulation is often difficult to solve due to large integrality gap induced by big-M constraints. We explore techniques for generating valid inequalities that improve the integrality gap. Numerical results will be presented.

3 High-Dimensional Parameter Estimation for Complex Chemical Reaction Networks Using a Hybrid Bayesian Optimization and Gradient Descent Approach

You Peng[1], Lingxun Kong[2], Ivan Castillo[3], Ricardo Rendall[4], [1]The Dow Chemical Company, Columbus, OH, [2]Dow Chemical Company, Lake Jackson, TX, [3]The Dow Chemical Company, Houston, TX, [4]The Dow Chemical Company, Terneuzen, Netherlands

Chemical processes often involve complex reaction networks. The rate for each reaction depends on various factors such as concentration and temperature. Each factor can have multiple parameters whose values are usually unknown and can only be estimated from data. For this work, we propose a hybrid approach that combines global and local optimization strategy to tackle such high-dimensional parameter estimation problem efficiently. The method involves using high-dimensional Bayesian Optimization (SAASBO) to search the full parameter space and then reduce problem dimension by eliminating the less sensitive parameters. Then the current best set of parameters found by SAASBO were further refined using gradient based methods which are computationally more efficient. Additionally, the posterior distribution was also quantified using a MCMC sampling approach.

4 A Hybrid AI and Optimization Framework to Address the Issue of Frequent Missing Values; the Case of a Clinical Decision Support System for Parkinson's Disease

Mostafa Amini[1], Ali Bagheri[2], Dursun Delen[3], [1]California State University Long Beach, Long Beach, CA, [2]Oklahoma State University, Stillwater, OK, [3]Oklahoma State University, Tulsa, OK

Analyzing electronic health record (EHR) data can improve clinical decision support systems (CDSS). However, the volume of data presents significant challenges, including handling missing values. Employing explainable AI techniques, optimization, and predictive analytics, we introduce a framework that addresses the issue of incompleteness in EHR data, enabling researchers to select the most critical variables at an acceptable level of missing data. We demonstrate the effectiveness of this framework by applying it to developing a CDSS for detecting Parkinson's disease, where in practice, Parkinson's disease is hard to diagnose, and even specialists' diagnoses can be inaccurate. Our results show that the framework improves the accuracy of predictive models and identifies patients with Parkinson's disease who might otherwise go undiagnosed.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD78

Session.Location:CC-West 211A

Intersection of Optimization and Learning

Contributed Session

Session Chair: Zhiqiang Liao, Aalto University, Espoo, Finland

1 Carousel Greedy Algorithms for Feature Selection in Linear Regression

Jiaqi Wang[1], Bruce L. Golden[2], Carmine Cerrone[3], [1]University of Maryland-College Park, College Park, MD, [2]University of Maryland-College Park, Columbia, MD, [3]University of Genoa, Genoa, Italy. Contact: jqwang@terpmail.umd.edu

The carousel greedy algorithm (CGA) was proposed several years ago as a generalized greedy algorithm. In this paper, we implement the CGA to solve linear regression problems with a cardinality constraint on the number of variables. We compare this against stepwise regression and more sophisticated approaches, one using integer programming and a second using LASSO.

2 Consistency Regularization for Distortion-Robust Supervised Learning

Hyungu Kang, Seokho Kang, Sungkyunkwan University, Suwon, Korea, Republic of. Contact: viamonoh@skku.edu

Convolutional neural networks (CNNs) have shown high accuracy in various image classification tasks. However, their performance can be significantly degraded for distorted images. To address this issue, we propose an improved training method for building a CNN robust to image distortions. It utilizes consistency regularization, a technique commonly used for semi-supervised learning, for supervised learning. By incorporating a consistency regularization term into the objective function, the CNN is encouraged to produce similar outputs for strong and weak transformations of the same input image, thereby enhancing the robustness against image distortions. Experimental results on image classification benchmarks demonstrate that the proposed method improves both classification accuracy and robustness against image distortions.

3 A Machine Learning-Based Warm Start Approach to Improve the Solvability of Lps

Jitamitra Desai, Ronit Neogy, Indian Institute of Management - Bangalore, Bangalore, India. Contact: jmdesai@iimb.ac.in

In this research, we explore the use of machine learning techniques, notably logistic regression and decision tree algorithms, for improving the solvability of optimization problems. Recognizing that the computational time required to solve a linear programming problem can be heavily influenced by the choice of a starting basis (referred to as “warm start”), we apply classification techniques to apriori decide the decision variables that are most likely to be part of the optimal basis. Problem parameters and their combinations that yield the most effective warm start basis are identified and our detailed computations show that the use of advanced ML techniques can significantly improve the solvability of optimization problems.

5 Overfitting Reduction in Convex Regression

Zhiqiang Liao, Aalto University, Espoo, Finland. Contact: zhiqiang.liao@aalto.fi

We study the problem of overfitting in multivariate convex regression. We investigate the inconsistency of the multivariate convex regression and the unboundedness of its subgradients near the boundary. To reduce overfitting, we propose the augmented Lipschitz convex regression and weight-restricted convex regression method. We identify their behavior near the boundary by providing the theoretical results of consistency and boundedness. A Monte Carlo study is performed to illustrate the advantage of the proposed methods. The proposed approaches are further applied to benchmark the operations efficiency of Finnish electricity companies.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD79

Session.Location:CC-West 211B

Mixed Integer Linear Programming for Scheduling

Contributed Session

Session Chair: Nathan Adelgren, United States Naval Academy, Annapolis, MD

1 Robust Concurrent Algorithms for Unstructured Mixed Integer Linear Programs

Utku Koc, MEF University, Istanbul, Turkey. Contact: utku.koc@mef.edu.tr

In this study, we propose robust concurrent heuristics for Mixed Integer Linear Programs that runs in massively parallel platforms in distributed memory settings. Specifically, both feasibility pump and objective feasibility pump are run in parallel starting from alternative points in the feasible region. Information generated by a subroutine is

collectively used by all subroutines. The algorithm continues to provide good solutions even if some of the computing nodes are unreachable.

2 Finding Locally Maximal Boolean Patterns from Numerical Data

Sunung Kim, Hong Seo Ryoo, Korea University, Seoul, Korea, Republic of. Contact: tjsdndrla1@korea.ac.kr

This study proposes a metaheuristic procedure for discovering Pareto-optimal Boolean patterns from fuzzy numerical datasets. Toward this end, we first build an initial set of clusters of homogeneous data to obtain a set of literals for classifying different types of data without contradiction. Next, we sequentially expand each cluster in reference to clusters nearby via the determination of a direction for expansion and through the generation of new literals. This yields a set of Pareto-optimal patterns that best describe the local traits of the data that they contain. With preliminary experiments on public machine learning datasets, we test efficacy and efficiency of the proposed algorithm in comparison with approaches from the literature.

3 A New Discrete-Time-Based Branch-And-Cut Strategy for Solving Single-Stage Scheduling Problems

Nathan Adelgren[1], Shamik Misra[2], Christos Maravelias[3], [1]Andlinger Center for Energy and the Environment, Princeton University, Princeton, NJ, [2]Indian Institute of Technology Tirupati, Tirupati, India; [3]Princeton University, Princeton, NJ, Contact: na4592@princeton.edu

We present a new hybrid MILP/CP approach for solving single-stage scheduling problems. In contrast to existing hybrid MILP/CP approaches for these problems, all of which have been proposed within a continuous-time framework, the technique we present is designed within a discrete-time framework. The proposed approach builds upon the so-called Discrete-Continuous Algorithm by embedding it within a branch-and-cut solution strategy. Several variants of the proposed approach will be presented together with computational results that demonstrate their utility. All computational tests also include comparisons with current state-of-the-art approaches.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD80

Session.Location:CC-West 212A

Live Stream Ecommerce

Contributed Session

Session Chair: Sung Hyun Kwon, University of Maryland, College Park, MD

1 Supply Chain Strategies in the Presence of Livestream E-Commerce: Channel Leadership and Low-Carbon Promotion

Wei Liu[1], Xinyan Cao[2], Xueqi Niu[1], Xiang Fang[3], Jason Choi[4], [1]Dongbei University of Finance and Economics, Dalian, China; [2]Northern Illinois University, Chicago, IL, [3]University of Colorado Denver, Denver, CO, [4]University of Liverpool, Liverpool, United Kingdom. Contact: xiang.fang@ucdenver.edu

Livestream e-commerce is an emerging phenomenon, and its impacts on supply chains are largely unknown. Motivated by this important growing market, we propose an analytical model to study a decentralized supply chain with an upstream manufacturer (he) selling his product to a downstream retailer (she) via a wholesale price contract. We solve the equilibrium solutions under both the traditional e-commerce mode and the livestream mode. Our results show that the traditional e-commerce mode is always dominated by the livestream mode such that both parties are more profitable when participating in the livestream e-commerce. However, when the wholesale price is sufficiently high, the livestream e-commerce is no longer feasible for both parties such that the market becomes manufacturer-monopolistic.

2 The Role of Live-Streaming Commerce in Dual-Channel Supply Chain

Haiying Yang[1], Zhuang Qian[2], Zhengping Wu[3], [1]Missouri State University, Springfield, MO, [2]Pennsylvania State University, Dunmore, PA, [3]Syracuse University, Syracuse, NY

Live-streaming shopping has become a significant sales force and it allows viewers to watch and shop through real-time interactions over the phone. We investigate how a supplier responds to the fast-growing live-streaming commerce. We examine multiple centralized settings when a supplier builds his own live-streaming teams and hosts live sessions. We also design a two-stage game to formulate one decentralized case that the supplier offers a revenue-sharing contract and sells products through a key opinion leader's stream. Our results show that the supplier and the key opinion leaders may be discouraged compared with the centralized models, which might decrease the supplier's expected profit eventually.

3 Live-Stream Platform Strategies: Drive Traffic or Not?

Yuhan Yan[1], Rongyi Huang[2], [1]School of Business, Renmin University of China, Beijing, China; [2]School of Economics and Management, Fuzhou University, Fuzhou, China. Contact: rmbsyuhanyan@ruc.edu.cn

Live-stream, with its diverse content and real-time interaction with the audience, has become a powerful means of boosting online traffic. In order to benefit from the massive traffic, live-stream platforms have begun to encourage live promotions driving potential consumers to traditional e-commerce platforms, while attempting to incorporate e-commerce features into themselves. We develop a stylized model consisting of a third-party seller, a live-stream platform and a traditional e-commerce platform to investigate their strategic interactions, and consumer's switching behavior between traditional and live-stream channels. We share managerial insights in live-stream platform design, and channel strategies for third-party sellers.

4 Catching the Viewer's Eye: Examining Exploration and Exploitation Strategies in the Live Streaming Market

Sung Hyun Kwon, Il-Horn Hann, University of Maryland, College Park, MD

More and more creators are competing on live streaming platforms like Twitch to maximize the attention they receive from viewers. To attract and maintain attention, it is crucial for content creators to effectively develop innovative content that captures consumer interest and facilitates the discovery of their content. We examine how these content creators employ an exploration-exploitation strategy to design their content and attract viewership. We combine traditional methods with recent NLP techniques to measure exploration, exploitation, and learning from viewers and streamers to assess the positioning of content creators. Utilizing our proposed metrics, we estimate consumer utility derived from the varying strategies using the BLP model. Our findings hold implications for content creators, platform businesses, and several streams of literature.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD81

Session.Location:CC-West 212B

Topics in Finance

Contributed Session

Session Chair: Pedro Júdice, ISCTE Business Research Unit, Lisbon, Portugal

1 Credit Line and Interest Rate Optimization

Wenyou Wang, Yao Yang, Sirong Luo, Shanghai University of Finance and Economics, Shanghai, China. Contact: luo.sirong@mail.shufe.edu.cn

Interest rate and credit line are critical decisions in lending industry, which need to consider the market acceptance, credit loss and interest income. We propose a model for joint interest rate and credit line optimization. We find the optimality conditions for credit line and interest rate when either interest rate or credit line is given. We show that the optimal credit line is decreasing with loss given default and risk-free rate and the optimal interest rate is decreasing with loss given default and credit line. Then, we extend the analysis by considering the market acceptance. We prove the optimality conditions with respect to credit line and interest rate separately. We show that the optimal interest rate is increasing with risk-free rate. And we prove that the optimal credit line is higher and the optimal interest rate is lower when considering the market acceptance.

2 Leveraging Dynamic Multilayer Networks for Modelling Credit Risk Contagion in Smes

Sahab Zandi[1], Kamesh Korangi[2], María Óskarsdóttir[3], Christophe Mues[2], Cristián Bravo[1], [1]Western University, London, ON, Canada; [2]University of Southampton, Southampton, United Kingdom; [3]Reykjavík University, Reykjavík, Iceland. Contact: szandi@uwo.ca

Researchers in the field of credit risk management have recently focused on improving the performance of these models by incorporating alternative data sources such as network data. This study uses complex, multilayer network data on SMEs from a large financial institution to estimate credit risk. We propose a novel model leveraging dynamic graph attention networks to predict SME default, with two sources of connections, namely shared ownership of companies and financial transactions between them, resulting in a two-layer network. We show how this information, when combined with traditional structured data, contributes to application credit scoring performance, and explicitly models contagion risk across companies.

3 Simulation-Optimization for Dynamic Bank Asset Allocation

Pedro Júdice, ISCTE Business Research Unit, Lisbon, Portugal. Contact: pedro.judice@iscte-iul.pt

Bank asset allocation is a major determinant of banks' long-term performance and financial sustainability. Current bank asset allocation models fail simultaneously to use realistic scenarios and produce time-dependent asset allocations, so do not take advantage of the changes in business cycles. Using a multi-objective genetic algorithm, we develop a simulation-optimization method that uses variable selection and determines dynamic optimal asset allocation rules based on environment variables such as interest rates. We conduct a performance analysis in a separate testing set, indicating the algorithm's superior performance compared to other established methodologies, namely optimizing constant allocations or choosing equal-weight policies. The method can thus be used in practice to support banks' senior management dynamic decisions.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD82

Session.Location:CC-West 212C

Opioid Crisis and Other Health Systems Management

Contributed Session

Session Chair: Justin Rist, The Pennsylvania State University, State College, PA

1 Data-Driven Resource Allocation for the Opioid Crisis in Chicago

Rashid Anzoom[1], Rakesh Nagi[2], Chrysafis Vogiatzis[3], Hyojung Kang[4], [1]University of Illinois Urbana-Champaign, Urbana, IL, [2]Industrial Enterprise Systems University of Illinois, Urbana, IL, [3]University of Illinois at Urbana-Champaign, Urbana, IL, [4]University of Illinois at Urbana-Champaign, Champaign, IL, Contact: ranzoom2@illinois.edu

The opioid crisis has emerged as a serious problem across the USA, with fatalities from opioid overdoses soaring rapidly over time. This necessitates a careful evaluation of allocation strategies for different resources (e.g., NARCAN) to help individuals with opioid overdose and misuse. In this talk, we discuss a data-driven approach to accurately forecast the demands for such resources and design an integer programming-based allocation scheme to ensure fairness of benefits across different regions. We illustrate the efficacy of our approach in the context of Chicago's neighborhood communities.

2 Access Versus Physical Access: An Examination of Telehealth Adoption

Eric Xu, Mississippi State University, Mississippi State, MS

While our current conception of telemedicine has existed for half a century, beginning with the Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC), only recent telecommunication advancements have increased the pace of adoption amongst patients and practitioners. Therefore, we examine the impact of telemedicine adoption on primary care use, specifically examining the conditions by which telehealth consultations become a substitute for in-person care or a compliment to in-person care. Using a unique dataset of insurance claims for primary care visits, we examine in-person, asynchronous, and synchronous primary care visits.

3 Identifying Access and Attendance Disparities to Opioid- Related Prevention Programs in Pennsylvania

Justin Rist, Pennsylvania State University, State College, PA, Contact: jsr5605@psu.edu

The opioid epidemic is a significant public health crisis in the United States, with rural areas experiencing greater challenges in access to prevention programs. This study examines the impact of county population density on access and attendance to opioid-related prevention programs in Pennsylvania. Using data from four counties and multilevel OLS regression models, the analysis reveals that rural counties have reduced access and attendance compared to urban counties. Findings suggest the need for targeted strategies to improve access and attendance in rural areas, thereby reducing the burden of opioid overdoses.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD83

Session.Location:CC-West 213A

Economic Analysis of Supply Chains

Contributed Session

Session Chair: Wangsheng Zhu, University of Texas at Dallas, Plano, TX

1 Value Allocation in Make-To-Order (MTO) and Make-To-Stock (MTS): An Experimental Study

Wei-Shiun Chang[1,2], Sarah Ereneo[3], [1]Institute of International Management, National Cheng Kung University, Tainan City, Taiwan; [2]Center for Innovative FinTech Business Models, NCKU, Tainan City 701, Taiwan; [3]National Cheng Kung University, Tainan City, Taiwan. Contact: wschang@mail.ncku.edu.tw

We explore the value allocation in two major production procedures, Make to Order (MTO) and Make to Stock (MTS). Weighing in the preference of value creation associated with producers' technology, we posit that the producers' selection of cost for production out of the price in MTO is influenced by the level of producers' technology. This preference is absent in MTS when producers negotiate the price with the customers. Holding value creation constant, we test the value allocation between MTO and MTS with a series of experiments and we find producers' spitting rate would favor customers more when their technology is more advanced in MTO while the splitting rate remains constant in MTS.

2 A Novel Way Based on Behavioral Cognition and Human-Machine Collaboration: The Stochastic Adaptation Method for Beer Game

Gong Yu, Yu Hui, Chongqing University, ChongQing, China. Contact: gongyu_96@163.com

The beer game is a classic problem in inventory management and is widely used to demonstrate the bullwhip effect. Given bounded rationality, it makes sense to explore behavioral cognition. We propose the Stochastic Adaptation(SA) method to play the beer game. It originates from the characterization of similar behaviors between humans and AI algorithms. The SA provides a unified framework, allowing players to decide with limited options under partial information. Experiments show that the SA achieves stable operation in different supply chain scenarios. Each player develops a policy around its local adaptation but ultimately can realize global adaptability. Under certain conditions, the SA can exhibit a smaller cost and the bullwhip effect than other methods. Human-machine collaboration helps further optimize its performance.

3 Managing Ad Campaigns On Digital Billboards Under Supply Disruptions

Wangsheng Zhu[1], Shaojie Tang[2], Vijay S. Mookerjee[3], [1]University of Texas at Dallas, Plano, TX, [2]University of Texas-Dallas, Mckinney, TX, [3]University of Texas- Dallas, Richardson, TX, Contact: zhuws199211@gmail.com

The digitization of billboards has facilitated the sale of advertising slots through real-time auctions, leading to a rise in agents who assist advertisers in bidding and acquiring slots. These agents enter into contracts with advertisers to secure a specific number of slots within designated time periods. However, accepting numerous contracts may require the agent to place higher bids in auctions, potentially impacting their profitability. Therefore, it is crucial to strike a balance between contract acceptance and the bidding strategy employed. This study addresses two key aspects: (1) identifying the optimal set of advertisers for the agent to contract with, and (2) determining the appropriate bidding strategy. We formulate a two-stage optimization problem for agents, followed by the proposal of a near-optimal solution to the bidding optimization problem.

Tuesday, October 17, 2:15 PM - 3:30 PM

TD84

Session.Location:CC-West 213B

Optimization in Supply Chain Management

Contributed Session

Session Chair: Abdurrezzak Sener, Penn State University, Pittsburgh, PA

1 Who Gets the Whip? How Supplier Diversification Influences Bullwhip Effect in a Supply Chain

Tyler Burrows, Max Hamilton, David Grimsman, Brigham Young University, Provo, UT, Contact: tnburrows@me.com

Emergent technologies, such as the 'blockchain,' are enabling unprecedented coordination across firms in Supply Chains (SC). Firm decision-makers ultimately are going to need to understand how they can control (and optimize) such a network of relationships. However, current approaches to the study of SC-level behavior typically assume a focal firm, and the modeling of SC behavior is usually limited to single-product serial networks. This paper aims to understand how the 'bullwhip effect' propagates and intensifies throughout a SC with multiple suppliers. We find that SC the structure has to be accompanied with a dynamic policy to see changes in demand disturbances. We also explicate a novel SC model that can be used to test the implications of our main result: diversifying a firm's supplier-base has the potential to amplify disturbances more quickly.

2 Newsvendor's Supplier Selection Problem with Correlated Supply and Demand Uncertainties

Liao Wang[1], Jin YAO[2], Sean Zhou[3], [1]University of Hong Kong, Hong Kong, Hong Kong; [2]The University of Hong Kong, Hong Kong, Hong Kong; [3]Chinese University of Hong Kong, New Territories, China. Contact: lwang98@hku.hk

It is established in literature (Dada et al., A Newsvendor's Procurement Problem when Suppliers Are Unreliable, M&SOM, 2007, 9(1), 9-32) that for a newsvendor facing multiple suppliers, the optimal selection rule ("DPS's rule") is that the cheaper ones are always selected first. Two crucial assumptions are made: the demand and supply risks are independent, and the newsvendor is risk neutral. In this research, we relax these assumptions. We first study the supplier selection problem with correlated supply and demand risks and identify conditions that preserve or do not preserve the DPS's rule . We find that a positive demand-supply relationship can lead to violation of the rule. With a

CVaR objective, we find that risk aversion per se does not affect DPS's rule and study the impact of supply-demand correlation on the selection rule.
*This research is supported by the GRF of HK RGC.

3 Analyzing Trade Agents Decisions in B2B Transactions
Itir Z. Karaesmen, Ozden Engin Cakici, American University, Washington, VA
We formulate and analyze the procurement decisions of a trade agent in B2B markets. We cast the problem as a new type of newsvendor problem where the trade agent bids to purchase a predetermined supply from seller(s). We analyze the conditions under which the optimal bids are monotonic. We also show the effect of yield uncertainty on optimal bids and that it may not be optimal for the trade agent to prefer a more reliable seller when all other supply parameters are the same.

4 Modeling Purchase Premium Using Binomial Tree Options
Mei-Ting TSAI, Hau-Cheng WEN, National Chung Hsing University, Taichung, Taiwan. Contact: mtsai@dragon.nchu.edu.tw
In 2020, black swan events, such as Covid-19 and the Ukrainian-Russian War, cause serious uncertainty in the supply chain. To share risks between suppliers and manufactures, this study designs a purchase premium contract. By paying the premium in advance, the manufacturer has a right to terminate or continue the purchase contract with the supplier according to the actual needs. On the other hand, the supplier could diminish inventory risks. We develop the pricing model using the binomial tree options method. For the numerical analysis, we collect sales data from a technology company in Taiwan and analyze the effects of the proposed contract design on three different periods--before, during and after Covid-19. The differences in cost sharing under the current contract and the premium contract are discussed.

5 Flow of Information and Its Preservation
Abdurrezzak Sener[1], Alparslan Ersoz[2], [1]Penn State University, Pittsburgh, PA, [2]Carnegie Mellon University, Pittsburgh, PA
In this research, we investigate flow of information among members of a supply chain and preservation of shared and used information. Simulation of our theoretical model is also discussed.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE03

CC-North 120D
JMP/AIZOTH
Technology Tutorial

1 Exploring Unstructured Text Data to Extract Meaning and Sentiment
Kevin J. Potcner, JMP Statistical Discovery, SAS, San Francisco, CA, Contact: kevin.potcner@jmp.com
Asking students what data they are most familiar with will inevitably result in the answer: "Text Data" From social media posts, texting, product and movie reviews, among so many others, this generation of students live in a world of constantly sending, receiving, and looking at unstructured text data. Requiring no prior experience in the concepts of formal statistical analyses (confidence intervals, p-values, models, etc.), extracting meaning from a large collection of text can be successfully done by a wide range of students including those with just a basic knowledge of data analysis. Due to today's students being intimately familiar with this type of data, the value of exploring text data to extract meaning is easily appreciated by students, with most finding it quite fun and engaging. Using JMP statistical software, the presenter will step through examples of analyzing text data in a "No Code" interactive environment.

2 Multi-Sigma: An Integrated AI Platform of Prediction and Optimization for Multiple Target Objectives Simultaneously
Kotaro Kawajiri, AIZOTH, Tsukuba-shi, Japan. Contact: kotaro.kawajiri@aizoth.com
AIZOTH provides AI services such as Multi-Sigma, AI consulting, spot support to optimize manufacturing conditions, and commissioned R&D. Multi-Sigma is the cloud-based AI software for R&D to reduce the effort of experiment drastically and also to help researchers finding the innovative solutions for their actual problems with minimum experimental dataset. Multi-Sigma was already introduced by large manufacturing enterprises and top universities. We will demonstrate how a Multi-Sigma can be used with sample datasets.
Key feature of Multi-Sigma: •Numerical analysis using deep learning: Deep learning techniques of both neural network and Bayesian optimization can be used with minimum dataset. High precision prediction of multiple objective variables. Factor analysis using sensitivity analysis for explainable AI. Multi-objective optimization in trade-off (maximization, minimization, target value, tailor-made optimization, constraint of explanatory variables). It can handle a large number of explanatory variables (up to 200)

and objective variables (up to 100), •No-code cloud-based software: Multi-Sigma is the advanced cloud-based AI platform which can be used with no-code on the browser. Anyone can use Multi-Sigma anytime, anywhere, and by any hardware (even by smartphones). •Innovative Design of Experiment using Artificial Intelligence (AI-DOE): Researchers can utilize our 'AI-DOE' techniques easily on Multi-Sigma. AI-DOE is developed by incorporating AI techniques into the traditional DOE basing on statistics. It can guides researchers to find the optimal solution for multi-input and multi-objective systems. •Versatility: Multi-Sigma can be utilized for any issue of R&D. Main users are manufacturing companies such as automobile, chemical, pharmaceutical companies. Also it can be used for management issues such as prediction of sales, marketing, and inventory management. Tailor-made optimization is the brand-new techniques with great potential in the field of medical care, material science, and sales management.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE04

CC-North 121A

Learning in Games and Applications

Community Committee Choice Session

Session Chair: S. Rasoul Etesami, University of Illinois at Urbana-Champaign, Champaign, IL

1 Optimizing in the Presence of Strategic Behavior

Eric Mazumdar, California Institute of Technology, CA

Machine learning algorithms are increasingly being deployed into environments in which they must contend with other strategic agents with potentially misaligned objectives. The presence of these other agents breaks many of the underlying assumptions on which machine learning algorithms are built and can cause non-stationarity in the environment that can give rise to surprising dynamics and behaviors. In this talk, we will discuss two facets of this problem. In the first, we will describe a new approach for learning in zero-sum Markov games based on Q-learning and best-response-type dynamics which is independent, pay-off based, rational, and provably convergent.

2 Impacts of Different Information Sharing Modalities on Multi-Agent Reinforcement Learning

Parinaz Naghizadeh, University of California, San Diego, San Diego, CA

We explore the impacts of different information sharing modalities, namely parameter sharing vs. observation sharing, on the performance of multi-agent RL algorithms. We are specifically interested in the impacts of information sharing delay and intermittency (e.g., due to an underlying communication network) on the effectiveness of information sharing in enhancing learning in cooperative tasks. We provide analytical and numerical experiments to support our findings.

3 Dynamic Information Provision in Bayesian Exploration

Tianyi Lin, University of California, Berkeley, Berkeley, CA

We consider the dynamic information provision in Bayesian exploration. The principal controls the information flow to incentivize the agents, to coordinate them toward a socially optimal balance between exploration and exploitation. Each agent is self-interested, which necessitates the design of incentive-compatible policies for the principal. Notably, our setting features two considerations: 1) there are multiple agents interacting in a common environment; 2) the realized state is evolving over time. The first one has been studied before, while the second one, though making the problem more realistic, poses significant technical challenges, as the uncertainty of the agents not only comes from the actions of other agents, but also from the dynamics of the game. Our contribution is to show that the principal achieves constant regret for deterministic utilities.

4 Learning Stationary Nash Equilibrium Policies in N-Player Stochastic Games with Independent Chains

S. Rasoul Etesami, University of Illinois Urbana-Champaign, Champaign, IL

We consider a subclass of n-player stochastic games, in which players have their own independent chains while they are coupled through their payoff functions. Moreover, players can receive only realizations of their payoffs, and cannot observe each other's states/actions. We first show that finding a stationary Nash equilibrium (NE) policy without any assumption on the reward functions is interactable. However, for general reward functions, we develop polynomial-time learning algorithms based on dual averaging and dual mirror descent, which converge in terms of the averaged Nikaido-Isoda distance to the set of epsilon-NE policies almost surely or in expectation. In particular, under extra assumptions on the reward functions such as social concavity, we derive polynomial upper bounds on the number of iterates to achieve an epsilon-NE policy with high probability.

Tuesday, October 17, 4:00

PM - 5:15 PM

TE05

CC-North 121B

Designing Online Marketplaces

Community Committee Choice Session

Session Chair: Neha Sharma, Kellogg School of Management, Evanston, IL

1 Rating System Design: Structure, Incentives, and Fees

Titing Cui[1], Michael L. Hamilton[2], Su Jia[3], [1]University of Pittsburgh, Pittsburgh, PA, [2]University of Pittsburgh, Pittsburgh, PA, [3]Cornell, Ithaca, NY, Contact: mhamilton@katz.pitt.edu

We model a two-sided online platform which facilitates interactions between workers and customers, and where workers can receive reviews after completing jobs. In this ecosystem we design and analyze rating systems which must process the sequence of reviews, including cases where no review is given. Specifically, we propose a class of ARMA inspired rating systems that down-weight older reviews. We demonstrate that this approach creates an incentive constraint that prevents workers from disintermediating on the platform, and characterize the achievable fees the platform can collect under these constraints.

2 Spatial Matching with Resource Competition

Alireza Amanihamedani[1], Ali Aouad[1], Daniel Freund[2], [1]London Business School, London, United Kingdom; [2]MIT, Cambridge, MA

Motivated by ride-hailing marketplaces, we present a model of two-sided matching platforms in a duopoly market with spatial frictions. Both platforms face disjoint streams of rider requests, but they share the same resources on the supply side, i.e., drivers multi-home. Due to spatial frictions, supply efficiency requires an admission control to maintain a buffer of available drivers to balance matching distances with other supply costs. For both controls, we find that a duopoly equilibrium entails at least one platform undercutting, by accepting all requests, to gain market share. When both platforms undercut, the supply buffer is not maintained and inefficiencies ensue. We provide a classifier of market characteristics that delineates the two regimes and allows us to characterize the prices of anarchy and stability in these settings.

3 Near-Optimal Control in Ride-Hailing Platforms with Strategic Servers

Sushil Varma[1], Francisco Castro[2], Siva Theja Maguluri[3], [1]Georgia Institute of Technology, Atlanta, GA, [2]UCLA Anderson School of Management, Los Angeles, CA, [3]ISyE Georgia Tech, Atlanta, GA, Contact: sushil@gatech.edu

Motivated by applications in online marketplaces such as ride-hailing, we study how strategic servers impact the system's performance. We consider a discrete-time process in which heterogeneous types of customers and servers arrive. Each customer joins their type's queue, while servers might join a different type's queue depending on the prices posted by the system operator and an inconvenience cost. Then the system operator, constrained by a compatibility graph, decides the matching. The objective is to design an optimal control (pricing and matching scheme) to maximize the profit minus the expected waiting times. We develop a general framework that enables us to analyze a broad range of strategic behaviors. In particular, we encode servers' behavior in a properly defined cost function that can be tailored to various settings. Using this general cost function, we introduce a novel probabilistic fluid problem and show that it provides an upper bound on the achievable net profit. We then study the system under a large market regime in which the arrival rates are scaled by ￼ and present a probabilistic two-price policy and a random matching policy which results in a net profit-loss of at most O(￼1/3). Under a maximally probabilistic fluid model condition, we show that the net profit-loss can be further improved to O(1). We conclude the discussion by underlining the necessity of the probabilistic fluid model by showing that the classical fluid model can result in arbitrarily low profit compared to the probabilistic fluid model.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE06

CC-North 121C

Causal Machine Learning in Operations Management (Ruomeng Cui and Zhikun Lu)

Community Committee Choice Session

Session Chair: Ruomeng Cui, Emory University, Decatur, GA

Session Chair: Zhikun Lu, Emory University, Decatur, GA

1 Deep-Learning-Based Causal Inference for Large-Scale Combinatorial Experiments: Theory and Empirical Evidence

Zikun Ye[1], Zhiqi Zhang[2], Dennis Zhang[3], Heng Zhang[4], Renyu Zhang[5], [1]University of Illinois, Urbana-Champaign,

Urbana, IL, [2]Washington University in St. Louis, St. Louis, MO, [3]Washington University in St Louis, ST LOUIS, MO, [4]Arizona State University, Tempe, AZ, [5]The Chinese University of Hong Kong, Hong Kong, China. Contact: zikunye2@illinois.edu

We develop a framework combining deep learning and double machine learning to estimate and infer the causal effect of any treatment combination of multiple treatments when observing only a small subset of treatment combinations. Our proposed framework exploits Neyman orthogonality and combines interpretable and flexible structural layers in deep learning. To empirically validate our method, we collaborated with a large-scale video-sharing platform and implemented our framework for three experiments involving three treatments where each combination of treatments is tested.

2 The Value of Last-Mile Delivery in Online Retail

Zhikun Lu[1,2], Ruomeng Cui[1], Tianshu Sun[3], Lixia Wu[2], [1]Emory University, Decatur, GA, [2]Cainiao Network, Hangzhou, China; [3]University of Southern California, Los Angeles, CA

We study the value of last-mile delivery in the context of online retail. Leveraging a quasi-experiment with Alibaba's logistics arm, Cainiao, we evaluate the causal impact of last-mile home delivery on customers purchasing behaviors. Our difference-in-differences analysis shows that last-mile home delivery significantly increases customer spending at Alibaba's online retail platform, and the effects are highly heterogeneous across customers. Motivated by such heterogeneity, we propose a causal machine learning approach to optimally allocate the limited delivery capacity. We demonstrate that our approach can further increase the value of last-mile delivery without incurring additional labor costs.

3 Learning from a Biased Sample

Roshni Sahoo[1], Lihua Lei[2], Stefan Wager[2], [1]Stanford University, Stanford, CA, [2]Stanford GSB, Stanford, CA

The empirical risk minimization approach to data-driven decision making assumes that we can learn a decision rule from training data drawn under the same conditions as the ones we want to deploy it in. However, we may be concerned that our training sample is biased, and that some groups may be under- or over-represented relative to the general population; and in this setting empirical risk minimization may fail to yield rules that perform well at deployment. We propose a model of sampling bias called □-biased sampling, where observed covariates can affect the probability of sample selection arbitrarily much but the amount of unexplained variation in the probability of sample selection is bounded by a constant factor. We then develop a method for learning a decision rule that minimizes the worst-case risk incurred under this model via augmented convex risk minimization.

4 Does the Seller's Response Time Affect the Buyer's Concession? Evidence from Online Bargaining

Guihua Wang[1], Wen Zhang[2], [1]The University of Texas at Dallas, RICHARDSON, TX, [2]Baylor University, Waco, TX, Contact: Wen_Zhang1@baylor.edu

In this paper, we study the effect of the seller's response time on the buyer's concession in online-marketplace bargaining. In the average treatment effect analysis, we employ an instrumental variable (IV) approach and find the seller's response time has a nonlinear effect on the buyer's concession. In the heterogeneous treatment effect analysis, we develop a multi-treatment instrumental variables forest (MT-IVF) approach that incorporates multiple treatment effects into the IV forest approach. We find the treatment effects are heterogeneous across item categories and conditions. We also find that using the thread-average best response time from the average treatment effect analysis could increase the buyer's offer price in each item category or condition, and using the thread-specific best response time from the MT-IVF can achieve additional increases.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE07

CC-North 122A

Information, Learning and Incentive Design in Societal Scale Systems

Community Committee Choice Session

Session Chair: Manxi Wu, Cornell University, ORIE, Ithaca, NY

1 Information Design for Spatial Resource Allocation

Ozan Candogan[1], Manxi Wu[2], [1]University of Chicago, Chicago, IL, [2]Cornell University, ORIE, Ithaca, NY, Contact: manxiwu@cornell.edu

We study platforms where resources and jobs are spatially distributed, and resources have the flexibility to strategically move to different locations for better payoffs. The price of the service at each location depends on the number of resources and the market size, which is a random state. We focus on how the platform can utilize information about the underlying state to influence resource repositioning decisions and increase commission revenues. We establish that in many practically relevant settings a simple monotone partitional information mechanism is optimal. This mechanism reveals state realizations below a threshold and above a second (higher) threshold, and pools all states in between to create a unique signal. We also provide algorithmic approaches for obtaining (near-)optimal information structures that are monotone partitional in general settings.

2 Markov α-potential Games: A New Framework for Multi-agent Reinforcement Learning

Chinmay Maheshwari[1], Manxi Wu[2], Druv Pai[1], Shankar Sastry[1], Xin Guo[3], Xinyu Li[4], [1]University of California Berkeley, Berkeley, CA, [2]Cornell University, ORIE, Ithaca, NY, [3]University of California-Berkeley, Piedmont, CA, [4]UC Berkeley, Berkeley, CA, Contact: chinmay_maheshwari@berkeley.edu

We propose a new framework to study multi-agent interaction in Markov games -- Markov α-potential games. Markov potential games are special case of Markov α-potential games, so are two important and practically significant classes of games: Markov congestion games and perturbed Markov team games, which cannot be studied through existing MARL frameworks. We introduce two algorithms - the projected gradient-ascent and the sequential smoothed best response - for approximating the stationary Nash equilibrium in Markov alpha-potential games. We show that Nash-regret scales sub-linearly in time horizon. For the special case of Markov potential games, we present a independent and decentralized learning algorithm which requires minimal coordination and communication between agents, and asymptotically converges to Nash equilibrium.

3 Market Design for Dynamic Pricing and Pooling in Capacitated Networks

Saurabh Amin[1], Patrick Jaillet[1], Haripriya Pulyassary[2], Manxi Wu[2], [1]MIT, Cambridge, MA, [2]Cornell University, ORIE, Ithaca, NY, Contact: hp297@cornell.edu

We study a market mechanism that sets edge prices to incentivize strategic agents to organize trips that efficiently share limited network capacity. This market allows agents to form groups to share trips, make decisions on departure times and route choices, and make payments to cover edge prices and other costs. We develop a new approach to analyze the existence and computation of market equilibrium, using ideas from combinatorial auctions and dynamic network flows. We provide sufficient conditions on the network topology and agents' preferences that ensure the existence and polynomial-time computation of market equilibrium. We also identify a particular equilibrium that maximizes agent utilities. Finally, we extend our results to general networks with multiple populations and apply them to compute dynamic tolls for efficient carpooling in San Francisco Bay Area.

4 Capacity Allocation and Pricing of High Occupancy Toll Lane Systems with Heterogeneous Travelers

Haripriya Pulyassary[1], Ruifan Yang[1], Zhanhao Zhang[2], Manxi Wu[3], [1]Cornell University, Ithaca, NY, [2]Cornell University, Ithaca, NY, [3]Cornell University, ORIE, Ithaca, NY, Contact: zz564@cornell.edu

We study the optimal design of High Occupancy Toll (HOT) lanes. In our setup, the traffic authority determines the road capacity allocation between HOT lanes and ordinary lanes, as well as the toll price charged for travelers who use the HOT lanes but do not meet the high-occupancy eligible criteria. We build a game-theoretic model to analyze the decisions made by travelers with heterogeneous values of time and carpool disutilities, who choose between paying or forming carpools to take the HOT lanes, or taking the ordinary lanes. Travelers' payoffs depend on the congestion cost of the lane they take, the payment and the carpool disutilities. We provide a complete characterization of travelers' equilibrium strategies for any capacity allocation and toll price. Additionally, we characterize the equilibria that yield minimum total emissions or maximum revenue.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE08

CC-North 122B

Ride-Hailing and Platform Operations

Community Committee Choice Session

Session Chair: Yuexing Li, Johns Hopkins Carey Business School, Baltimore, MD

Session Chair: Nur Sunar, UNC Kenan-Flagler Business School, Chapel Hill, NC

1 Recommender Systems Under Privacy Protection

Can Kucukgul[1], Ozalp Ozer[2], Shouqiang Wang[3], [1]Rutgers University - Camden, Philadelphia, PA, [2]Amazon, Richardson, TX, [3]The University of Texas at Dallas, Richardson, TX, Contact: can.kucukgul@rutgers.edu

The hallmark feature of digital platforms is their capability of keeping track of users' online browsing activities and using this information to personalize recommendations. Various regulations are established to grant users of these

platforms the right to privacy, i.e., they can choose whether to share their personal data with the platforms for product recommendation purposes. Using an information design framework, we study how an online platform should design its recommender policy under such regulatory provisions. We show that when the platform and users' incentives are sufficiently aligned, it is optimal for the platform to adopt a personalized recommender policy. Perhaps surprisingly, when the incentives are sufficiently misaligned, we find that the right to privacy may in fact reduce the overall user surplus.

2 Rating and Service Quality Prediction in Online Labor Markets: Models and Implications

Guanting Wu[1], Hai Wang[2], Peter Zhang[3], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Singapore Management University, Singapore, Singapore; [3]Carnegie Mellon University, Pittsburgh, PA, Contact: guantingwu@cmu.edu

Online labor markets (OLMs) are experiencing rapid growth, in which online labor platforms provide search functions that enable clients and workers to find each other. Numerical ratings for workers serve as crucial metrics of service quality, the prediction of which plays a significant role in numerous platform operation decisions. In this study, we employ a data-driven approach to predict service quality based on various features of projects, workers, and their interactions. Using a large and unique dataset from a leading online labor platform, we apply our method to gain insights into how different features influence service quality. Subsequently, we offer actionable insights for enhancing service quality in OLMs, including designing effective recommendation systems, implementing soft-skills training programs, and using project decomposition.

3 Greening Ride-Hailing: Impact on Environment and Consumers

N. Bora Keskin[1], Yuexing Li[2], Nur Sunar[3], [1]Duke University, Durham, NC, [2]Johns Hopkins Carey Business School, Baltimore, MD, [3]UNC Kenan-Flagler Business School, Chapel Hill, NC

Rapidly growing ride-hailing platforms offer customers convenience while raising concerns about their environmental impact. Many ride-hailing platforms have launched green initiatives, but their impact on the environment and customers is unclear. To our knowledge, we are the first to analyze this impact theoretically. We build a model with drivers deciding between local rides and repositioning, and we find that adding green vehicles may increase emissions and decrease the surplus of less environmentally sensitive consumers. Besides, for minimizing total emissions, the optimal price margin for green vehicles over gas-fueled ones can be positive or negative. We also study several extensions and confirm the robustness of our findings. These results emphasize the need for prudent decision-making to reduce emissions and avoid unintended consequences.

4 Courier Dedication vs. Sharing in On-Demand Delivery

Arseniy Gorbushin[1], Ming Hu[2], Yun Zhou[3], [1]Rotman School of Management, Toronto, ON, Canada; [2]University of Toronto, Minneapolis, MN, [3]McMaster University, Hamilton, ON, Canada. Contact: zhouy185@mcmaster.ca

On-demand delivery platforms have grown rapidly. To study whether courier sharing contributes to the reduction of delivery costs, we consider a spatial queueing model and compare the performance of a dedicated courier policy where couriers work for a single vendor and a sharing policy where couriers can be shared between different vendors and travel to the closest vendor. Surprisingly, we find that the dedicated policy can often perform better than the sharing one. Under the "growth target" strategy, if the market is sufficiently large, the sharing policy achieves a higher profit than the dedicated; if the market is small, the dedicated policy is more profitable. Under the "profit maximization" strategy, it is even more likely the dedicated policy is optimal: in addition to the market size condition, a high service value is required for the sharing policy to be optimal.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE09

CC-North 122C

Control in Stochastic Processing Networks

Community Committee Choice Session

Session Chair: Mendelson Gal, Faculty of Data and Decision Sciences, Technion, Adi, Israel

1 Exponential Tail Bounds on Queue Length in Heavy Traffic

Prakirt Raj Jhunjhunwala[1], Daniela Hurtado-Lange[2], Siva Theja Maguluri[3], [1]Georgia Institute of Technology, Atlanta, GA, [2]William & Mary, Williamsburg, VA, [3]ISyE Georgia Tech, Atlanta, GA, Contact: prakirt@gatech.edu

A popular approach to computing performance measures of queueing systems (such as delay and queue length) is studying the system in an asymptotic regime. However, these results are only valid in the limit and often provide bounds for the pre-limit systems that are not optimized and, hence, give loose bounds for the tail probabilities. In this work, we provide optimized bounds for the tail probabilities of the scaled total queue length in a load-balancing system under Join the Shortest Queue (JSQ). Our bounds characterize the rate of convergence of the tail probabilities to the corresponding heavy traffic values. For the tail probability of the JSQ system, our bounds yield a multiplicative error that arises from three factors: pre-limit errors, pre-exponent errors, and State-Space Collapse (SSC) error.

2 Optimal Rate-Matrix Pruning for Large-Scale Heterogeneous Systems

Zhisheng Zhao, Debankur Mukherjee, ISyE Georgia Tech, Atlanta, GA, Contact: zzhao388@gatech.edu

We consider large-scale load balancing systems where processing time distribution of tasks depend on both task and server types. We analyze the system in the asymptotic regime where both the number of task and server types tend proportionally to infinity. In such heterogeneous setting, popular policies like JFIQ, JFSQ are known to perform poorly and they even shrink the stability region. Moreover, to the best of our knowledge, in this setup, finding a scalable policy with provable performance guarantee has been an open question prior to this work.In this paper, we propose and analyze two asymptotically delay-optimal dynamic load balancing policies. Exploiting a framework inspired by the graphon literature and using the mean-field method and stochastic coupling arguments, we prove that both policies above achieve asymptotic zero queueing.

3 Sizing and Scheduling Flexible Resources

Jinsheng Chen[1], Jing Dong[2], [1]Singapore Institute of Manufacturing Technology, Singapore, Singapore; [2]Columbia University, New York, NY, Contact: jc4823@ columbia.edu

Flexible resources are an important part of many service and manufacturing systems. In this work, we study the problem of jointly sizing and scheduling flexible resources when they may incur a higher cost or a loss of efficiency. We consider different degrees of demand uncertainty and obtain asymptotically optimal joint staffing and sizing policies.

4 A Hierarchical Approach to Robust Stability of Multiclass Queueing Networks

Feiyang Zhao[1], Itai Gurvich[2], John Hasenbein[1], [1]The University of Texas at Austin, Austin, TX, [2]Northwestern University, Kellogg School of Management, Evanston, IL, Contact: feiyang_zhao@utexas.edu

The focus of this research is on the robust stability of stochastic processing networks, under a wide class of control policies. A framework for robust stability is developed, in which the resources are given freedom to decide their own priority policy, under some general constraints. We offer a new approach for determining sufficient conditions for robust stability, which builds on, and makes connections to, suitable robust optimization problems, with the collection of priority policies as the uncertainty set. We also show how robust stability of a family of policies is inherited from the stability of some special policies, i.e., static-priority policies.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE10

CC-North 123

Navigating the Use of Technology in Stochastic Service Systems

Community Committee Choice Session

Session Chair: Yue Hu, University of Chicago, Chicago, IL
Session Chair: Yueyang Zhong, The University of Chicago Booth School of Business, Chicago, IL

1 Multi-Channel Healthcare Operations: The Impact of Video Visits on the Usage of In-Person Care

Tan (Suparerk) Lekwijit[1], Hummy Song[2], Christian Terwiesch[3], Krisda Chaiyachati[4], [1]W. P. Carey School of Business, Arizona State University, Tempe, AZ, [2]The Wharton School, University of Pennsylvania, Philadelphia, PA, [3]University of Pennsylvania, Philadelphia, PA, [4]The Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA, Contact: tan.lekwijit@asu.edu

The impact of a new digital channel on care demand within existing physical channels has not been thoroughly investigated in the primary care context of a traditional healthcare organization. We study a large healthcare system that made video visits available to a subset of its patients for primary care needs and find that the introduction of video visits increases the demand for in-person PCP visits by 20% and the demand for ED visits by 30%. We also find that patients who have poorer access to in-person care are more likely to initiate care via a video visit rather than an in-person visit, and that the increase in in-person demand arises primarily from patients who live farther from their place of care and who seek an appointment with a PCP who is busier than usual. Furthermore, compared to in-person visits, we find that video visits are less likely to provide definitive care.

2 The Effects of Information on Abandonment and Congestion in Non-Stationary Priority Queues

Philipp Afèche[1], Junqi Hu[2], Rouba Ibrahim[3], Vahid Sarhangian[4], [1]University of Toronto, Toronto, ON, Canada;

[2]University of Illinois Urbana-Champaign, Champaign, IL, [3]University College London, London, United Kingdom; [4]University of Toronto, Toronto, ON, Canada. Contact: junqihu@illinois.edu

Motivated by empirical studies on the impact of information on abandonment in service systems, we study novel queueing models with abandonment rates that depend on the system state, customers' consumed waiting time, and the granularity of customers' state information.
We provide insights on the effects of information on the average queue length and abandonment rate, and how these effects depend on time-varying arrivals and priority service.

3 AI and Incentives and Agency, Oh My! Incentive Design in the Age of Generative Artificial Intelligence

Tinglong Dai[1], Terry Taylor[2], [1]Johns Hopkins University, Baltimore, MD, [2]U.C. Berkeley, Berkeley, CA, Contact: dai@jhu.edu

The advent of generative artificial intelligence (AI) has significant transformative implications for autonomous work ecosystems, where the client's visibility into the contractor's efforts and instrumental choices is minimal. This paper proposes a theoretical framework to capture the impact of generative AI on incentive design, and extrapolates scenarios in which a client may seek to limit the contractor's AI toolbox options. It also discusses scenarios in which generative AI could potentially mitigate traditional principal-agent challenges, thereby facilitating welfare enhancement.

4 Is Telemedicine Here to Stay? Equilibrium Analysis of an Outpatient Care Queueing Game

Xiaole (Alyssa) Liu, Mor Armony, New York University Stern School of Business, New York, NY, Contact: xiaole.liu@stern.nyu.edu

Current trends suggest that telemedicine will continue to play a key role in post-pandemic care delivery. As observed in some empirical studies, however, the use of telemedicine can trigger more demand for in-person visits and overcrowd the clinic. We develop a queueing game model to assess the impact of telemedicine in equilibrium. Analyzing this model allows us to characterize the optimal resource allocation for outpatient clinic and characterize the conditions under which introducing telemedicine is beneficial.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE11

CC-North 124A

Community Detection in Networks

Community Committee Choice Session

Session Chair: Anirudh Sridhar, Princeton University, Issaquah, WA

1 Community Detection with Censoring

Souvik Dhara, Brown University, Providence, RI

Recovering latent communities is a key unsupervised learning task in network data with applications spanning across a multitude of disciplines. For example, identifying communities in web pages can lead to faster search, classifying regions of the human brain in communities can be used to predict onset of psychosis, and identifying communities of assets can help investors manage risk by investing in different communities of assets. However, the scale of these massive networks has become so large that it is often impossible to work with the entire network data. In this talk, I will talk about some theoretical progress for community detection in a probabilistic set up especially when we have missing data about the network. Based on joint works with Julia Gaudio, Elchanan Mossel and Colin Sandon.

2 Fundamental Limits of Spectral Clustering in Stochastic Block Models

Anderson Ye Zhang, University of Pennsylvania, Philadelphia, PA, Contact: ayz@wharton.upenn.edu

We give a precise characterization of the performance of spectral clustering for community detection under Stochastic Block Models by carrying out sharp statistical analysis. We show spectral clustering has an exponentially small error with matching upper and lower bounds that have the same exponent, including the sharp leading constant. The fundamental limits established for the spectral clustering hold for networks with multiple and imbalanced communities and sparse networks with degrees far smaller than $\log n$. The key to our results is a novel truncated ℓ_2 perturbation analysis for eigenvectors and a new analysis idea of eigenvectors truncation.

3 Graph Matching and Robust Community Recovery in Correlated Stochastic Block Models

Anirudh Sridhar, Princeton University, Princeton, NJ

We consider the problem of learning latent community structure from multiple edge-correlated stochastic block models (SBMs). We show that community recovery from a single graph can be improved by combining the correlated networks via an appropriate graph matching algorithm and applying a *robust* community recovery algorithm to the synthesized network. In the case where the average degree of the correlated stochastic block models is constant with respect to the number of vertices, we show that community detection beyond the Kesten-Stigum threshold for single graphs is possible. When the average degree is slowly growing in the number of vertices, graph matching followed by robust community recovery attains the optimal error rate for community recovery. This is based on joint work with Julia Gaudio and Miklós Rácz.

4 Differentially Private Community Detection in Networks: Algorithms and Fundamental Limits

Mohamed Mohamed, Andrea Goldsmith, H. Vincent Poor, Princeton University, Princeton, NJ, Contact: mseif@princeton.edu

Community detection is a fundamental problem arising in graph mining and machine learning. The goal of community detection over graphs is to recover underlying labels/attributes of users (e.g., political affiliation) given the connectivity information between users. There has been significant recent progress on understanding the fundamental limits of community detection when the graph is generated from a stochastic block model (SBM). In this talk, we will present some of our recent work on differentially private (DP) community detection for SBM. Focusing on edge-differential privacy, we will present results that highlight fundamental tradeoffs between SBM parameters, privacy budget and computational efficiency and their impact on community recovery. If time permits, I will conclude with several open problems and challenges in this topic.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE12

CC-North 124B

Simulation Flash Talks

Flash Session

Session Chair: Enlu Zhou, ISyE Georgia Tech, Atlanta, GA

1 Does Regret-Based Dro Minimize Regret?

Arindam Roy Chowdhury, Columbia University, New York, NY, Contact: ar4445@columbia.edu

Distributionally Robust Optimization (DRO) is a popular methodology for decision-making under uncertainty that advocates minimizing the worst-case loss. While it advantageously provides protection on the attained objective value, it does not guarantee a good performance regarding the regret, or equivalently the optimality gap with respect to the oracle true solution. To this end, one could formulate the protection on the worst-case regret, giving rise to the so-called regret-based DRO (R-DRO). We show that, in terms of local behavior, R-DRO could not outperform even simple empirical optimization in terms of regret both from a statistical view when data are i.i.d., and a robust view when distribution shift is present. Our assertions appear to be in complete contrast to the natural belief on the advantage of R-DRO.

2 Data-Driven Ranking and Selection

Enlu Zhou, ISyE Georgia Tech, Atlanta, GA

We consider ranking and selection with streaming input data, which arrive in batches, possibly of varying sizes, sequentially over time. We develop a sequential elimination framework for the fixed confidence setting, where the goal is to achieve a specified probability of correct selection (PCS) with as few simulation replications as possible. We also develop procedures based on optimal computing budget allocation for the fixed budget setting, where the goal is to achieve a PCS as high as possible with a given simulation budget.

3 Actively Learning a Bayesian Matrix Fusion Model with Deep Side Information

Yangyang Yu, Stevens Institute of Technology, Hoboken, NJ, Contact: yyu44@stevens.edu

High-dimensional deep network representations of images and concepts can be aligned to predict human annotations of diverse stimuli. However, such alignment requires the costly collection of behavioral responses, such that, in practice, the deep-feature spaces are only sparsely sampled. Here, we propose an active learning approach adaptively sampling experimental stimuli to efficiently learn a Bayesian matrix factorization model with deep side information. We observe a significant efficiency gain over a passive baseline. Moreover, with a sequential batched sampling strategy, the algorithm is applicable not only to small datasets collected from traditional laboratory experiments but to settings where large-scale crowdsourced data collection is needed to accurately align the high-dimensional deep feature representations derived from pre-trained networks.

4 Flash Paper Submission (5-Minute Presentation)

Haoting Zhang, University of California, Berkeley, Berkeley, CA, Contact: haoting_zhang@berkeley.edu

Contextual Bayesian optimization problems have extensive applications such as healthcare and autonomous vehicles, where the core challenge is to select a suitable surrogate model for unknown objective functions. In this work, we propose a neural network-accompanied Gaussian process (NN-AGP) model, which leverages neural networks to approximate the unknown objective function regarding contextual variables, and maintains a Gaussian process with the decision variable. Our model outperforms existing approaches by offering better approximation accuracy thanks to the neural networks and possessing explicit uncertainty quantification from the Gaussian process. We prove the regret bounds for the optimization algorithm associated with our model. We also conduct experiments on both synthetic and real problems, demonstrating the effectiveness of our approach.

5 Flash Paper Submission (5-Minute Presentation)

Dilara Aykanat[1], Nian Si[2], Zeyu Zheng[3], [1]University of California at Berkeley, Berkeley, CA, [2]The University of Chicago Booth School of Business, Chicago, IL, [3]University of California, Berkeley, Berkeley, CA

One approach to construct or calibrate simulators, when representative real data exist, is to ensure that the synthetic data generated by the simulated match the empirical distribution of the real data. However, such approach to construct simulators does not take into consideration where the constructed simulators will be used. For some applications, there are clear tasks (such as performance evaluation of different decisions) in users' mind where the simulated data will serve as input to the tasks. In this work, we propose an approach to use the knowledge of these tasks to guide the construction of simulators, in addition to the distribution match of simulated data and real data. We conduct a preliminary numerical study of this approach to illustrate the effectiveness compared to not taking into consideration the specific tasks of the simulators.

6 Parameter Optimization with Conscious Allocation (POCA)

Joshua Inman, Arizona State University

The performance of machine learning algorithms depends upon the selection of a set of hyperparameters. Independently from the specific ML model, the budget used to evaluate potential hyperparameter configurations is a critical decision to the performance of a hyperparameter optimization algorithm. Here, we introduce a hyperparameter optimization algorithm, Parameter Optimization with Conscious Allocation (POCA), that focuses on how the overall budget is allocated to hyperparameter configurations and on how the data collected are used to update the posterior distribution to select novel configurations. We introduce the algorithm and compare POCA to its nearest competitor at optimizing the hyperparameters of an artificial toy function and a convolutional neural network, finding that POCA discovers strong configurations faster in both settings.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE13

CC-North 125A

Districting for Modern Service Systems

Community Committee Choice Session

Session Chair: Yao Xie, Georgia Institute of Technology, Atlanta, GA

Session Chair: Woody Zhu, Carnegie Mellon University, Pittsburgh, PA

1 Generalized Hypercube Queuing Models with Overlapping Service Regions

Shixiang Zhu[1], Yao Xie[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Carnegie Mellon University, Atlanta, GA

We present a generalized hypercube queue model, building upon the original model by Larson, with a particular focus on its application to overlapping service regions such as police beats. The traditional hypercube queue model is constrained to light-traffic operations, where officers are either ``busy'' or ``not busy''. However, contemporary service operations often experience saturation, necessitating the inclusion of heavy-traffic operations with queue lengths greater than one. The motivation to address the heavy-traffic regime stems from the increased workload and staff shortages prevalent in modern service systems. The design of overlapping regions is inspired by boundary effects in crime incidents, which require overlapping patrol regions for efficient resource allocation. Our proposed model addresses these issues using a Markov model with a large state space represented by integer-valued vectors. By leveraging the sparsity structure of the transition matrix, where transitions occur between states whose vectors differ by 1 in the ℓ distance, we can accurately solve the steady-state distribution of states. This solution can then be used to evaluate general performance metrics for the service system. We demonstrate the reasonable accuracy of our model through simulation.

2 A Comparative Analysis of School District Design Formulations

Aysu Ozel, Karen Smilowitz, Northwestern University, Evanston, IL, Contact: AysuOzel2025@u.northwestern.edu

We revisit the school districting problem, introducing a stream-based approach that incorporates multiple assignment decisions simultaneously. This leads to a compact formulation building on advances in the literature and extending the capabilities of such models. We create benchmark school districts that represent the range of public school districts throughout the U.S. and compare the performances of the existing formulations and the stream-based formulation.

3 Heterogeneous Multi-Agent Reinforcement Learning for Joint Patrol and Dispatch

Matthew Repasky, He Wang, Yao Xie, Georgia Institute of Technology, Atlanta, GA, Contact: mwrepasky@gatech.edu

Multi-agent patrol is concerned with learning the policies of a group of patrollers, often employing methods such as reinforcement learning. A separate but related problem is the dispatch of spatially-distributed servers, which has mostly been studied in the context of police operations from the perspective of multi-server priority queues. Such works often use rudimentary patrol policies paired with dispatch. We propose a method to jointly optimize multi-agent patrol and dispatch and learn policies yielding rapid response times. We exploit similarity in patrol policies by treating the patrollers as independent Q-learners with a shared deep Q network. The dispatcher uses mixed-integer programming to select actions from a combinatorial action space. This approach is capable of learning joint policies which outperform those optimized for patrol or dispatch alone.

4 Districting With Overlapping Service Regions

Wenqian Xing[1], Shixiang Zhu[2], [1]Stanford University, Palo Alto, CA, [2]Carnegie Mellon University, Pittsburgh, PA, Contact: wxing@stanford.edu

Districting is a crucial problem for modern service systems, such as transportation, healthcare, and emergency response. The goal is to partition a geographical region into districts to provide efficient and effective services to the population. However, traditional non-overlapping districting schemes may suffer from inefficient service delivery when the demand is not evenly distributed across the district. In this talk, we highlight the importance of overlapping districting, which allows for a more flexible and responsive allocation of resources based on the actual service demand. We investigate heuristic algorithms and Bayesian optimization to address the overlapping districting problem under realistic constraints. We hope our research could raise awareness of overlapping districting and stimulate novel research in the modern world.

5 Demand Learning and Supply Optimization of Last-Mile Transportation Services

Yidi Miao, Peter Zhang, Carnegie Mellon University, Pittsburgh, PA

We consider the problem of designing service modes facing the unknown and evolving travel demands for a non-profit mobility provider. Firstly we learn from the past data to capture the underlying evolving travel demands; then we incorporate the forecasted demand ambiguity set into our distributionally robust optimziation models for different service modes, and determine the worst demand distribution; finally we adopt heuristics and numerical experiments to propose districting decisions for the service modes to encounter the worst scenarios. Through this research, we aim to enable the provider to adapt their service modes to unknown and evolving demands. By leveraging various methods, we enhance the provider's ability to anticipate, respond to, and effectively serve the dynamic mobility needs, and hence improve the equity of transportation resource allocations.

6 Data-Driven Optimization for Police Staffing Schedule

Weiqing Xu, Georgia Institute of Technology, Atlanta, GA

We present a data-driven optimization framework to determine the police staffing schedule in Atlanta, in a way that maximizes resource use while minimizing incident response time. We particularly focus on floating "umbrella" units that cover multiple police beats. Using 911 call data from the Atlanta Police Department, we estimate travel time between patrol units and incident locations. We then develop a two-stage stochastic optimization formulation of the staffing problem, where staffing decisions are made in the first stage and dispatch decisions in the second stage.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE14

CC-North 125B

Emerging Topics in Social Operations Management

Community Committee Choice Session

Session Chair: Junhao Vincent Yu, Miami University, Oxford, OH

Session Chair: Tim Kraft, NC State - Poole College of Management, Raleigh, NC

1 The Effects of CSR Performance and Price on Consumer Purchase Decisions: A Moderated Mediation Analysis

Junhao Vincent Yu[1], Tim Kraft[2], Robert Handfield[2], Rejaul Hasan[2], Marguerite Moore[2], [1]Miami University, Oxford, OH, [2]NC State University, Raleigh, NC

We use controlled experiments in an online purchase context to examine how consumers' willingness to buy is influenced by a retailer's disclosure of a manufacturer's CSR performance. We show that disclosing CSR performance is more challenging (and potentially riskier) with consumers who typically pay a higher price.

2 Examining Sustainability as a Service Model in Retail

Huseyn Abdulla[1], Seulchan Lee[2], Hankyul Oh[3], [1]University of Tennessee, Knoxville, TN, [2]Michigan Technological University, Houghton, MI, [3]Tilburg University, Utrecht, Netherlands. Contact: slee12@mtu.edu

As the pressure from investors, government institutions, and consumers on firms to improve environmental sustainability performance increases, new business models emerge to facilitate the firms' sustainability efforts while generating profit. One such model, Sustainability as a Service (SaaS), helps retailers offset emissions from the delivery and return shipments of online orders in real time by offering a "green shipment" option to consumers for a fee. In this paper, we analytically examine this new business model in the context of an online retailer who has made a sustainability commitment to become carbon neutral and a SaaS provider.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE15

CC-North 126A

Assortment Planning

Contributed Session

Session Chair: Young-San Lin, Melbourne Business School, Carlton, Australia

1 Assortment Planning Under History-Dependent Utility

Yating Zhang, Taotao He, Huan Zheng, Shanghai Jiao Tong University, Shanghai, China. Contact: ytzhang20@sjtu.edu.cn

This paper studies a multiperiod assortment planning problem where consumers' utility depends on previous assortments. For instance, repeated exposure to the same product satiates consumers. We formulate this problem as a large-scale integer programming model involving a nonlinear history-dependent utility function. We show that a cyclic policy is asymptotically optimal. In the non-asymptotical regime, we characterize the envelope of the history-dependent utility function to obtain a strong integer programming formulation. A case study on a catering service dataset shows our model has good fitness and potentially increases revenue.

2 Seasonal Assortment and Allocation Planning at Target

Timothy Murray, Shobhit Jain, Target Corporation, Minneapolis, MN, Contact: shobhit.jain@target.com

As a Fortune 50 company and one of America's 10 largest retailers, the Target Corporation has a complex supply chain with a wide range of product offerings. In this talk we discuss how Target makes decisions for seasonal assortment and allocation planning related to our in-store apparel items. The problem is first formalized as a non-convex Bilinear Integer Program before we explore our solution method, which follows a pattern of initialization, solution iteration, and final greedy heuristic improvements.

3 In-Store Product Planning of Multichannel Retailer with Product-Fit Uncertainty and Competition

Raunak Joshi[1], Sumanta Basu[2], Balram Avittathur[2], Sreelata Jonnalagedda[3], [1]O.P. Jindal Global University, Delhi, India; [2]Indian Institute of Management Calcutta, Kolkata, India; [3]Indian Institute of Management-Bangalore, Bangalore, India

We address the problem of in-store assortment planning, service level determination and pricing when the product-fit is uncertain, and the multichannel retailer faces competition. The consumers decide whether to purchase based on online information or visit the store for verification, with uncertain product availability in store.

4 Pricing and Convenience Consideration in Omnichannel Assortment Planning

Joshua Gladstone[1], Ahmed Ghoniem[2], Bacel Maddah[3], [1]University of Massachusetts Amherst, Amherst, MA, [2]Isenberg School of Management, UMass Amherst, Amherst, MA, [3]American University of Beirut, Beirut, Lebanon. Contact: jdgladstone@umass.edu

We address the problem of assortment planning and pricing optimization for omnichannel grocery retailers. In the proposed mixed-integer nonlinear program, the decision-maker jointly optimizes channel assortments and prices, endogenously driven by consumer price and convenience preferences, while accounting for limited brick-and-mortar shelf space. Linearizing our model enables computational analysis and provides managerial insights for optimizing online and in-store product lines.

5 Assortment Optimization with Customer Information Exploration

Young-San Lin[1], YALCIN AKCAY[2], Gerardo Berbeglia[3], [1]Melbourne Business School, Carlton, Australia; [2]MBS, CARLTON, Australia; [3]Melbourne Business School - Centre for Business Analytics, carlton, Australia. Contact: nilnamuh@gmail.com

We introduce a general assortment optimization problem for the Random Utility Model (RUM) when the seller is inattentive to the customer's utility. The firm strives to maximize its objective, the expected revenue deducted by an entropy-based information processing cost.
Our framework is based on the seminal work of Matejka and Mckay (American Economic Review, 2015). Towards the extremals, our model captures the traditional assortment optimization problem when processing information is expensive, and the scenario that the seller is clairvoyant when processing information is free.
We present structural results for specific RUMs. There is a closed-form optimal seller solution with two products. For Multinomial Logit, a mixed strategy on revenue-ordered offer sets might not be optimal. With two or three revenue values, the problem can be reduced by an aggregate property.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE16

CC-North 126B

Optimization Approaches to Modeling Fairness

Community Committee Choice Session

Session Chair: David B. Shmoys, Cornell University, Ithaca, NY

1 Bicriteria Approximation Algorithms for Priority Matroid Median

Tanvi Bajpai, Chandra Chekuri, University of Illinois at Urbana-Champaign, Urbana, IL, Contact: tbajpai2@illinois.edu

Fairness considerations have motivated new clustering problems and algorithms in recent years. In this talk we consider clustering under the Priority model, which recently resurfaced as a means of creating clusterings with individual fairness. In this model, the clustering is required to ensure that no individual travels farther than their desired radius (given as part of the input specification). In previous work we gave algorithms for Priority Supplier problems with outliers. We now study the Priority Matroid Median problem, a generalization of the recently studied Priority k-Median problem. We obtain the first bicriteria approximation algorithms for this problem, and obtain improved bounds for the special case of uniform radii. We explore various cost and fairness tradeoffs that can be accomplished via our algorithm, and discuss avenues for further study.

2 Fair Submodular Maximization

Ashkan Norouzi Fard, Google Research, Zurich, Switzerland. Contact: ashkannorouzi@google.com

Recent studies have shown that automated data-driven methods can have unintended biases and discriminatory effects. Our proposed algorithms aim to prevent these issues in applications which can be modeled as a submodular maximization over a cardinality or matroid constraint problem. Such applications arise in a variety of contexts, including selection of political representatives, committees, candidates for outreach programs, and content selection for search engines and news feeds.

3 Fair Joint Replenishment with Bounded Outliers

Varun Suriyanarayana[1], Varun Sivashankar[2], Siddharth Gollapudi[2], David B. Shmoys[3], [1]Cornell University, Ithaca, NY, [2]Microsoft Research, Bengaluru, India; [3]Cornell University, Ithaca, NY, Contact: vs478@cornell.edu

The joint replenishment problem (JRP) is a classical inventory management problem. We consider a natural generalization with outliers,where we are allowed to reject (that is, not service) a subset of demand points. In this paper, we are motivated by issues of fairness - if we do not serve all of the demands, we wish to ``spread out the pain'' in a balanced way among customers, communities, or any specified market segmentation.One approach is to constrain the rejections allowed, and to have separate bounds for each given customer. In our most general setting, we consider a set of C features, where each demand point has an associated rejection cost for each feature, and we have a given bound on the allowed rejection cost incurred in total for each feature. This generalizes a model of fairness introduced in earlier work on the Colorful $k-$Center problem in which (analogously) each demand point has a given color, and we bound the number of rejections of each color class. In the JRP, we seek to balance the cost incurred by a fixed ordering overhead with the cost of maintaining on-hand inventory over a longer period in advance of when it is needed. More precisely, there a given set of item types, for which there is specified demand over a finite, discrete-time horizon, and placing any order at a given time incurs a general ordering cost and item-specific ordering costs (independent of the total demand serviced); in addition, for each unit of demand held in inventory for an interval of time, there is a corresponding item-specific holding cost incurred; the aim is to minimize the total cost.
We give the first constant approximation algorithms for the fairness-constrained JRP with a constant number of features; specifically, we give a 2.86-approximation algorithm in this case. Even for the special case in which we bound the total (weighted) number of outliers, this performance guarantee improves upon bounds previously known for this case. Our approach is an LP-based algorithm that splits the instance

into two subinstances. One is solved by a novel iterative rounding approach and the other by pipage-based rounding. The standard LP relaxation has an unbounded integrality gap, and hence another key element of our algorithm is to strengthen the relaxation by correctly guessing key attributes of the optimal solution, which are sufficiently concise, so that we can enumerate over all possible guesses in polynomial time - albeit exponential in C, the number of features.

4 Fairness in Algorithmic Combinatorial Optimization

Aravind Srinivasan, University of Maryland, College Park, MD

We discuss a family of approaches to provable fairness in combinatorial optimization, with an emphasis on clustering problems. One primary idea here is to let randomization be an inherent part of the algorithm, and to develop efficient randomized algorithms that satisfy a traditional global objective (such as the maximum cluster radius in k-center clustering) and deliver probabilistic per-user or per-demographic-group guarantees for the quality of service obtained. This talk will present joint work with several colleagues who will be acknowledged in the presentation.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE17

CC-North 127A

Behavioral Aspects in Humanitarian, Non-profit and Retail Operations with Societal Impact

Community Committee Choice Session

Session Chair: Pelin Pekgun, University of South Carolina, Columbia, SC

1 Volunteering Experience and Monetary Donation

Mahyar Eftekhar, Chao Wu, Arizona State University, Tempe, AZ, Contact: eftekhar@asu.edu

Charities are cautioned against providing volunteer opportunities to potential donors because volunteers are considered as unreliable source of labor supply, and volunteering is assumed to crowd out monetary donation. In this study, we examine the causal relationship between individuals' volunteering and their subsequent donation decisions through two sets of experiments.

2 Balancing Act: How Nonprofit Organizations Can use Cause Marketing for Effective Fundraising

Vinit Tipnis[1], Sebastian Villa[2], fei gao[3], Alfonso J. Pedraza-Martinez[4], [1]Kelley School of Business, Indiana University Bloomington, Bloomington, IN, [2]University of New Mexico, Albuquerque, NM, [3]Indiana University Bloomington, Bloomington, IN, [4]Indiana University, Bloomington, IN, Contact: svillab@unm.edu

In cause marketing campaigns, firms donate a percentage of their sales revenue to partnering non-governmental organizations as a strategy to increase sales. We investigate how and when earmarked (i.e., restricted) and flexible (i.e., unrestricted) donations affect consumers' purchase intent. Our study provides clear recommendations both to firms and NGOs.

3 Enhancing Fundraising Productivity Through Strategic Staffing and Revenue Diversification Decisions: Evidence from Food Banks

Yingru Han, Luv Sharma, Pelin Pekgun, University of South Carolina, Columbia, SC, Contact: yingru.han@grad.moore.sc.edu

Food banks, a major solution to close this gap between food supply and demand and relieve hunger, are non-profit organizations that rely on fundraising to support operations. The success of fundraising, a labor-intensive process, relies heavily on staffing strategies and how to allocate them to different fundraising tasks. We use data from 105 food banks within Feeding America to better understand the role of staffing levels and revenue concentration levels on fundraising productivity. We also study the moderating roles of passive vs active solicitation methods as well as team composition in the above relationships.

4 Food Surplus Management: A Global Perspective

Arzum E. Akkas, Boston University, Boston, MA

In this study, we explain varying approaches to grocery retailers' management of food surplus. Through two round interviews with 20 retailers from the US, UK, European Union, Africa, and Australia, we identify how practices related to food repurposing, markdowns, donations, composting and anaerobic digestion vary across different geographies.

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TE18

CC-North 127B

Data-driven Decision Making in Healthcare

Community Committee Choice Session

Session Chair: Maria Esther Mayorga, North Carolina State

University, Raleigh, NC
Session Chair: Erik Rosenstrom, North Carolina State University, Raleigh, NC

1 Interpretable Predictions for Unplanned Hospitalization of Urinary Tract Infection

Nasrin Alizadeh, Kimia Vahdat, Osman Ozaltin, Sara Shashaani, Julie L. Swann, North Carolina State University, Raleigh, NC

This research introduces two risk scores for predicting unplanned hospitalizations due to urinary tract infections. These scores were trained and tested on elderly patients aged 65 years and above using data from the Centers for Medicare and Medicaid Services. Both approaches utilize logistic regression models, but they differ in terms of coefficient scaling. The strengths and weaknesses of each score are thoroughly discussed. Furthermore, the study demonstrates how these scores offer insights into the significant features and their impacts on the risk of unplanned hospitalization for urinary tract infections.

2 Identifying Clinical Characteristics of Patients at Risk of Cardiovascular Events with Prescription Stimulants Use: A Machine Learning Approach

Yifang Yan[1], Qiushi Chen[1], Wen-Jan Tuan[2], Paul Griffin[1], [1]The Pennsylvania State University, University Park, PA, [2]The Pennsylvania State University, Hershey, PA, Contact: yvy5478@psu.edu

With the rapidly growing use of prescription stimulants in the US, concerns have been raised about major adverse cardiovascular events (MACEs) as side effects associated with the use of prescription stimulants. However, there is a lack of research in predicting the risk of MACEs with stimulants use and identifying the characteristics of the patients who are more adversely affected by stimulants use. To fill the gap, we first developed machine learning models to predict MACEs based on individual's stimulants use, demographics, and comorbidities using large real-world health records data. We computed the added risk of MACEs when using prescription stimulants for each patient and applied Association Rule Mining approach to characterize the comorbidity profiles of patients with higher added risk, which were further validated with an independent set of data.

3 Hybridized Genetic Algorithm to Solve Large Multi-Model Markov Decision Process Problems for Sepsis Treatment

Erik Rosenstrom[1], Julie Simmons Ivy[2], [1]North Carolina State University, Raleigh, NC, [2]University of Michigan, Ann Arbor, MI, Contact: erosens@ncsu.edu

The multi-model Markov decision process (MMDP) extends the traditional Markov decision process (MDP) to account for uncertainty. This combinatorial optimization problem is NP-hard. Most existing solution methods are exact and thus do not scale well to large problems. The success of a local search heuristic (LSH) motivates the exploration of other metaheuristic methods to solve large instances. We adapted the genetic algorithm (GA) to solve infinite horizon MMDP problems. Additionally, we hybridize the GA and the LSH. Experiments are conducted comparing the metaheuristics' performance with the extensive form MILP solver, the local search heuristic and random search. Study of the computation time indicates that metaheuristics become more computationally efficient than LSH as the number of actions or states increases without degradation in performance.

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TE19

CC-North 127C
International Healthcare
Community Committee Choice Session
Session Chair: Kraig Delana, University of Oregon, Eugene, OR

1 Cost-Effectiveness of Seroprevalence Based Covid-19 Vaccination Strategies in India

Sripad K. Devalkar[1], Sarang Deo[1], Abhishek Reddy[1], Nimalan Arinaminpathy[2], Sandip Mandal[3], Hiral Shah[4], [1]Indian School of Business, Hyderabad, India; [2]Imperial College London, London, United Kingdom; [3]ICMR, New Delhi, India; [4]GSK, London, United Kingdom. Contact: sripad_devalkar@isb.edu

Identifying and prioritising vaccination strategies based on cost-effectiveness evidence can aid in understanding how to allocate limited supply and resources in the face of heterogeneity and uncertainty in the transmission of a pandemic. In this work, we use COVID-19 as the context to determine the cost-effectiveness of seroprevalence-based vaccination strategies by combining epidemiological and supply chain modeling. We develop a supply chain model based on the resources available to support COVID-19 vaccination and determine the appropriate allocation of these resources to support differentseroprevalence-based vaccination strategies to estimate the cost of vaccine administration. We use an epidemiological model of transmission dynamics to determine health outcomes for the vaccination strategies and estimate their cost-effectiveness.

2 International Vaccine Allocation: An Optimization Framework

Michael H. Veatch[1], Susan E. Martonosi[2], [1]Gordon College, Wenham, MA, [2]Harvey Mudd College, Claremont, CA

In addition to the moral issues, vaccine nationalism during a pandemic could contribute to new variants of the virus. Assuming that variants are more likely to emerge among the unvaccinated in low-income countries, we identify scenarios where donating vaccines before distributing them locally can reduce donor country deaths. An epidemiological model based on COVID-19 is embedded in an optimization framework. We find that vaccine distribution is not a zero-sum game between donor and nondonor countries: changing the objective function can achieve dramatic reduction in total deaths with only a small increase in donor-country deaths.

3 Last-Mile Strategies for Delivery of Health Interventions in Sub-Saharan Africa

Robert Montgomery, Baris Ata, University of Chicago, Chicago, IL, Contact: rmontgo0@chicagobooth.edu

We study the inventory management of medical products in two settings. We examine the last-mile supply chain for malaria vector controls in villages in the Democratic Republic of the Congo, and the distribution of Integrated Community Case Management (iCCM) medications between central locations and community care providers in Liberia. Our models attempt to minimize system costs by strategically distributing treatments between health facilities and households while accounting for the frequent disruptions encountered while operating in these unstable contexts.

4 Multichannel Delivery in Healthcare: The Impact of Telemedicine Centers in Southern India

Kraig Delana[1], Sarang Deo[2], Kamalini Ramdas[3], Ganesh-Babu Subburaman[4], Thulasiraj Ravilla[4], [1]IE Business School, Madrid, Spain; [2]Indian School of Business, Hyderabad, India; [3]London Business School, London, United Kingdom; [4]Aravind Eye Care System, Madurai, India

We empirically study the impact of rural telemedicine centers on patients' access, outcomes, and costs at the Aravind Eye Care System in Southern India. Using a quazi-experimental difference-in-differences approach, we find that telemedicine centers increase visit rates 30%, of which 60% is driven by new patients, demonstrating improved patient access. Telemedicine centers also increase the prescription rate for glasses by 18.5% while decreasing travel costs for patients by 30%. The findings show telemedicine centers are effective in providing healthcare to rural communities of developing countries.

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TE20

CC-North 128A

Optimal Resource Allocation in Healthcare Operations

Community Committee Choice Session

Session Chair: Vahid Sarhangian, University of Toronto, Toronto, ON, Canada

1 Implementation of Interpretable Placement Decision Support in Community Corrections

Xiaoquan Gao, Griffin Carter, Pengyi Shi, Nicole Adams, Purdue University, West Lafayette, IN, Contact: shi178@purdue.edu

The incarceration population in the U.S. has grown significantly over the past three decades, and there is a pressing need to resolve the overcrowding issue. One viable approach is to divert individuals from jail to community corrections (CC). However, simply sending all eligible individuals to CC may shift the crowding from jail to CC and cause negative societal consequences. Therefore, analytics-informed decision support is essential to help determine the priority on whom to divert to CC while taking into account various system- and individual-level factors that are balanced against intricate tradeoffs. We collaborate with our community partner to co-develop and implement an interpretable analytics-enabled decision support tool that combines theoretical advancement with tangible impact.

2 Location-Allocation of Emergency Service Systems in Light Traffic: Application to Lift-Trap Rescue

Xin Wang[1], Weiliang Liu[2], Zhisheng Ye[2], [1]National University of Singapore, Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore. Contact: xinwang99@u.nus.edu

This study investigates the location-allocation problem for emergency service systems (ESSs) in light traffic conditions. Given the time sensitivity, the performance metric for an ESS location-allocation problem is usually a function of response time for emergency calls. The complex response time distribution for queued emergency calls makes computing performance metrics challenging, resulting in intractable optimization. To address this, we examine the asymptotic behavior of spatial queuing systems and derive a closed-form approximation for performance metrics under light traffic.

We then apply this approximation to two ESS schemes, demonstrating significant reductions in coverage loss using real lift-trap rescue data from Singapore.

3 Vaccination for Endemic Diseases: Optimal Allocation of Initial and Booster Vaccine Doses

Isabelle Jueli Rao, Margaret L. Brandeau, Stanford University, Stanford, CA, Contact: isarao@stanford.edu

For some communicable endemic diseases such as COVID-19, vaccination is an effective means of control but must be augmented with booster doses due to waning immunity from vaccination. We consider an SIS model with interacting population groups, an allocation over time of limited vaccines (initial and booster doses), and four objectives: minimize new infections, deaths, life years lost, and quality-adjusted life years lost due to death. We develop intuitive analytical solutions by approximating epidemic dynamics. We then extend the analysis to the case of an SEIS model. In both cases vaccines are allocated as much as possible to groups in order of priority until no vaccines remain. Numerical simulations show that our method achieves near-optimal results and outperforms simple allocation rules. Our unique model provides interpretability while still being accurate.

4 Individualized Dynamic Patient Monitoring Under Alarm Fatigue

Hossein Piri[1], Tim Huh[2], Steven Shechter[3], Darren Hudson[4], [1]Haskayen School of Business-University of Calgary, Calgary, AB, Canada; [2]University of British Columbia, Vancovuer, BC, Canada; [3]University of British Columbia, Vancouver, BC, Canada; [4]Department of Critical Care Medicine, University of Alberta, Edmonton, AB, Canada. Contact: hossein.piri@ucalgary.ca

Hospitals are rife with alarms, many of which are false. This leads to alarm fatigue, in which clinicians become desensitized and may inadvertently ignore real threats. We develop a partially observable Markov decision process model for recommending dynamic, patient-specific alarms in which we incorporate a cry-wolf feedback loop of repeated false alarms. Our model takes into account patient heterogeneity in safety limits for vital signs and learns a patient's safety limits by performing Bayesian updates during a patient's hospital stay. We develop structural results of the optimal policy and perform a numerical case study based on clinical data from an intensive care unit.We find that compared with current approaches of setting patients' alarms, our dynamic patient-centered model significantly reduces the risk of patient harm.

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TE21

CC-North 128B

Innovations in Healthcare Operations for Improved Patient Outcomes

Community Committee Choice Session

Session Chair: Kejia Hu, Vanderbilt University

Session Chair: Zhenzhen Jia, Shanghai, China

1 Will Centralized Procurement of Drugs Reduce the Innovation Investment of Enterprises? Observations from the Chinese Pharmaceutical Industry

Kang Sun[1], Kejia Hu[2], Hongmin Li[3], Xiande Zhao[4], [1]Shanghai Jiao Tong University, Shanghai, China; [2]Vanderbilt University, Nashville, TN, [3]Arizona State University, Tempe, AZ, [4]China Europe International Business School, Shanghai, China

OM-public-policy is a cutting-edge area of operations management research. Major public policies of-ten have a significant impact on business operations. Yet there is a lack of focused research in this area. We hand-curated a database of 500 pharmaceutical companies against the backdrop of the Centralized Procurement of Drugs policy being implemented in China's pharmaceutical industry. Based on this, we analyze the impact of the Centralized Procurement of Drugs policy on firms' R&D investment and the moderating effects of organizational slack and generic R&D intensity. Based on new institutional theory, it is proposed that the Centralized Procurement of Drugs policy can act as a market-based coercive pressure from the government. Our study finds that the Centralized Procurement of Drugs policy does not have a significant effect on firms' R&D investment in generic drugs and R&D investment in innovative drugs. We also find that the effect of the Centralized Procurement of Drugs policy on firms' R&D investment is moderated by organizational slackness and generic R&D intensity. Specifically, firms with higher organization slackness have no significant impact on generic R&D investment after centralized procurement, and R&D investment in innovative drugs decreases. Firms with stronger generic R&D intensity will see an increase in generic R&D investment and an increase in innovative R&D investment after centralized procurement. The Centralized Procurement of Drugs policy does not have a significant impact on firms' R&D investment in general. This is because firms' behavioral choices in the face of market-based coercive pressures are multiple, creating a neutralizing effect in the aggregate. The heterogeneous effects of centralized drug purchasing policies through organizational slack and generic R&D intensity can provide insights into the different response behaviors of firms in the face of market-based coercive pressures, which are moderated by the resource base of the organization.

2 Simultaneous Imputation and Prediction with High-Dimensional Data (SIP-HD): A Deep Learning Model for Disease Diagnosis

Zhenzhen Jia[1], Jianqiang Hu[1], Kejia Hu[2], Qingchen Wang[3], Ning Zhang[4], [1]Fudan University, Shanghai, China; [2]Vanderbilt University, Nashville, TN, [3]Opendoor, New York, NY, [4]Shanghai Jiao Tong University, Shanghai, China. Contact: 18110690011@fudan.edu.cn

Advanced medical tests can be financially costly or infeasible for some patients, leading to limitations in doctors' diagnostic accuracy. To address this, we propose SIP-HD, a deep learning model that simultaneously performs imputation and prediction with high-dimensional data. Our one-step approach reduces errors compared to two-step models, with imputation serving the goal of better prediction. Our meaningful graph construction enhances the model's capacity to handle high-dimensional data, resulting in superior performance compared to similar one-step approaches. Evaluations demonstrate that our model outperforms two-step models, one-step models, and doctors' preliminary diagnoses in ACC, AUC, and F1 score. We recommend our model to healthcare institutions where advanced tests may not be available to improve doctors' diagnostic practices.

3 Shortening Emergency Medical Response Time with Unmanned Aerial Vehicle-Ambulance Joint Operations

Xiaoquan Gao[1], Nan Kong[1], Paul Griffin[2], [1]Purdue University, West Lafayette, IN, [2]The Pennsylvania State University, University Park, PA, Contact: nkong@purdue.edu

Unmanned aerial vehicles (UAVs) can improve emergency medical service (EMS) logistics by quickly delivering medical interventions with the help of bystanders. We formulate a large-scale MDP model to jointly optimize the dispatching and redeployment of UAVs and ambulances in real time. To tackle the curse of dimensionality, we adopt an approximate dynamic programming (ADP) approach with neural network-based value function approximations. We construct a set of basis functions based on queueing and geographic properties of the UAV-augmented EMS system to design the approximation. Our approach outperforms existing benchmarks and provides guidance for effectively incorporating UAVs into EMS operations. By highlighting the potential advantages of using UAVs, we hope to encourage their wider adoption in the EMS field.

4 Performance Tradeoff Under Vbp Program Structure

Xin Ding, Rutgers University, Neward, NJ

In this study, I examine how hospitals trade off various performance metrics under the ongoing value-based purchasing program structure. The longitudinal study supports performance tradeoffs and also suggests that the tradeoff effect varies by different types of hospitals and is also subject to market conditions.

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TE22

CC-North 129A

Healthcare in Supply Chains

Community Committee Choice Session

Session Chair: Junghee Lee, University of Notre Dame, Notre Dame, IN

1 The Generic Competition Paradox in the Prescription Drug Market

Qinquan Cui, Kenan Arifoglu, Dongyuan Zhan, UCL School of Management, University College London, London, United Kingdom. Contact: qinquan.cui.21@ucl.ac.uk

The generic competition paradox (GCP) is the increase in the price of a branded drug when the competition emerges by introducing a new generic drug to the market. To explain the GCP, we build a game-theoretic model with signalling where the brand-name firm (incumbent) and the generic firm (entrant) have asymmetric information on consumers' relative price sensitivity to the branded drug. We show that the brand-name firm uses limit pricing to deter the entry of the generic firm and the limit pricing can be another rationale behind GCP. Also, we show that GCP can benefit consumers and the limit pricing may increase or decrease the social welfare.

2 Promoting Generics: Effects on Pharmaceutical Quality

In Joon Noh[1], Hessam Bavafa[2], Christian Blanco[3], [1]Pennsylvania State University, University Park, PA, [2]Wisconsin School of Business, Madison, WI, [3]Ohio State University, Columbus, OH, Contact: ikn5003@psu.edu

Generic drugs are a cornerstone of affordable healthcare. In this study, we empirically examine the pharmaceutical quality effects of Generic Drug User Fee Amendments (GDUFA), a hallmark legislation enacted by Congress in 2012 that armed the FDA with resources to improve the timeliness of generic drug application reviews. While GDUFA succeeded in shortening total application review times, its impact on drug quality, as measured by drug recalls, has not been considered. This study bridges this gap.

3 Time to Recover Market Share: Lasting Effects of Supply Chain Disruptions on Firm Performance

Minje Park[1], Anita Carson[2], Rena Conti[2], [1]Columbia Business School, New York, NY, [2]Boston University, Boston, MA, Contact: minje.park@columbia.edu

This study investigates the enduring effects of supply chain disruptions on firms' market share. Specifically, we examine the impact of supply-side disruptions on pharmaceutical products, measuring the extent to which lost market share persists even after the product has resumed production. Our results indicate that market share loss due to supply chain disruptions is not entirely recovered even after production has been restored. These findings underscore the significance of investing in supply chain resilience and prompt recovery as a means of mitigating the long-term effects of supply chain disruptions on market share.

4 From Black to Grey: Improving Access to Antimalarial Drugs in the Presence of Counterfeits

Jiatao Ding[1], Michael Freeman[1], Sasa Zorc[2], [1]INSEAD, Singapore, Singapore; [2]University of Virginia, Darden School of Business, Charlottesville, VA, Contact: jiatao.ding@insead.edu

In malaria-endemic countries, the limited availability of affordable antimalarial medication has contributed to the widespread distribution of inferior counterfeit drugs. We study such markets to determine how philanthropic donors can best allocate limited funds to subsidize the purchase or sales of antimalarial drugs via private-sector distribution channels. We also evaluate five strategies that have been employed to combat counterfeit drugs (improving consumer awareness, increasing the cost of sourcing counterfeits, adopting traceability technology, cracking down on the supply, and imposing price controls) and identify the conditions under which these approaches can either improve or worsen outcomes. Our paper provides guidance as to how to improve outcomes in the presence of counterfeit drugs.

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TE23

CC-North 129B

Supply Chain Digitization and Sustainability

Community Committee Choice Session

Session Chair: Li Chen, Cornell University, Ithaca, NY
Session Chair: Shiqing Yao, Monash University, Melbourne, Australia

1 Waste Not Want Not? the Environmental Implications of Quick Response and Upcycling

Xiaoyang Long[1], Luyi Gui[2], [1]University of Wisconsin-Madison, Madison, WI, [2]The Paul Merage School of Business, UC Irvine, Irvine, CA, Contact: luyig@uci.edu

Overproduction is often cited as the fashion industry's biggest environmental issue, as textile production is notoriously resource intensive and pollutive, and much of the textile produced may end up as "deadstock" fabric or finished products that do not sell. In this paper, we study two major approaches commonly adopted by the fashion industry to address this issue: quick response, whereby finished product inventory is replenished on demand, and upcycling, whereby deadstock fabric is reused to make new clothes.

2 Distrust and Dishonesty: An Application to the Ethical Goods Market

Sytske Wijnsma, UC Berkeley, Berkeley, CA

An important issue for the production and sale of ethical goods is that consumers are not able to assess whether a good promoted as ethical has indeed those attributes, even after consumption. This credence attribute may incentivize the seller to cheat on the consumer and sell a mere traditional good promoted as ethical for a premium. This paper sets out to uncover the effects of dishonesty and distrust on market outcomes.

3 Impact of Social Learning on Consumer Subsidies and Supplier Capacity for Green Technology Adoption

Hang Ren[1], Tingliang Huang[2], Georgia Perakis[3], [1]George Mason University, Fairfax, VA, [2]The University of Tennessee-Knoxville, Knoxville, TN, [3]Massachusetts Institute of Technology, Cambridge, MA, Contact: thuang7@utk.edu

Due to the innovative nature of green-technology products (e.g., electric vehicles and solar panels), customers are usually a priori uncertain about their purchasing benefits and typically consult user experiences via online product reviews and word-of-mouth communications. Despite the critical role of this social learning behavior for customers' adoption decisions, its implications for consumer subsidies aimed at facilitating adoption are not well-understood. In this paper, we investigate how social learning affects the government's optimal consumer subsidies considering a supplier's capacity decision and examine the welfare impact overall.

4 Ultra-Fresh Fashion: Creating Demand with Freshness and Agility

Li Chen[1], Hau Leung Lee[2], Shiqing Yao[3], [1]Cornell University, Ithaca, NY, [2]Stanford University, Stanford, CA, [3]Monash University, Melbourne, Australia. Contact: shiqing.yao@monash.edu

Using agile supply chains, fast fashion companies have been viewed as best-practice examples in industries. Prior research has focused on how agility can equip such companies with strong "sense and respond" capabilities to identify and fulfill unpredictable customer demands. There is another powerful dimension of agility—the ability to create new products frequently—that has enabled recent market success of companies such as Shein. We seek to model this dimension of agility as an operational strategy for demand creation. Our model enables us to explore the impacts through the lens of profit to the firm, consumer surplus, and environmental performances.

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TE24

CC-North 130

Multi-channel Retail Operations Strategy

Community Committee Choice Session

Session Chair: Yimin Wang, Arizona State University, Tempe, AZ

Session Chair: Rui Yin, Arizona State University, Kowloon

1 Inventory and Supply Chain Management Withauto-Delivery Subscription

Junfei Lei, University of Washington, WA

Auto-delivery is a subscription model widely employed in supply chains, whereby a supplier delivers products to a buyer (or multiple buyers) according to the buyer's choice of a constant shipping quantity to be delivered at prescheduled dates. The buyer enjoys discounts on auto-delivery orders and other benefits, including free subscription and cancellation. Because these benefits seem to all accrue to the buyer at the supplier's expense, the rationale for the supplier's decision to offer auto-delivery and its impact on the profitability of both parties is an intriguing concern. We develop models that consist of a supplier and a single buyer (multiple buyers), whereby the supplier offers a discount for the auto-delivery orders, and the buyer chooses the auto-delivery quantity with the flexibility of canceling the subscription.

2 When Persuasion is Too Persuasive: An Empirical Analysis of Product Returns in Livestream E-commerce

Xiaojing Feng[1], Ying Rong[2], Xin Tian[3], Mengmeng Wang[2], Oliver Yao[4], [1]Southwestern University of Finance and Economics, Chengdu, China; [2]Shanghai Jiao Tong University, Shanghai, China; [3]University of Chinese Academy of Sciences, Beijing, China; [4]Lehigh University, bethlehem, PA, Contact: yrong@sjtu.edu.cn

Livestream e-commerce features live social interactions that enable real-time, face-to-text communications among a streamer and many customers. We posit such live social interactions generate persuasion effect that eventually leads to higher product returns. Using data from a leading livestream e-commerce firm, we compare the product returns between live sessions with rerun sessions where the only difference is the presence of live social interactions in live sessions but not in rerun sessions, and develop econometric models to estimate the effect of live social interaction intensity on product returns. We find that product returns are higher for the live sessions than for the rerun sessions, and that the magnitude of the effect increases with live social interaction intensity, confirming the adverse persuasion effect in livestream e-commerce.

3 Two-Sided Dynamic Pricing for an Online Used-Car Platform

Meichun Lin[1], Tim Huh[2], Harish Krishnan[1], [1]University of British Columbia, Vancouver, BC, Canada; [2]University of British Columbia, Vancovuer, BC, Canada. Contact: meichun.lin@sauder.ubc.ca

We consider an online platform that sets prices for buying and selling used cars. The platform adjusts purchase and selling prices to match supply with demand and maximize total profit. We show that a fixed price policy is asymptotically optimal as the time horizon grows to infinity. When the supply and demand functions are unknown *a priori*, the platform needs to learn from the purchase and sales data, and dynamic pricing is necessary. This leads to the classical learning and earning trade-off. We propose a pricing policy to achieve this goal.

4 Donation and Pricing Decisions for a Socially Responsible Firm with Prosocial Customers

Xinyue Cai[1], Yongbo Xiao[1], Tony Haitao Cui[2], Chen Hu[3], [1]Tsinghua University, Beijing, China; [2]University of

Minnesota, Minneapolis, MN, [3]Xi'an Jiaotong-liverpool University, Jiangsu, China. Contact: caixy21@mails.tsinghua.edu.cn

In the context of widely advocated ESG concept, we study a business that concerns both its profit and customer welfare. The firm conducts donations to boost customers' wellbeing. In return, donation amount affects the desire of socially conscious customers to purchase. We examine the firm's decision on selling price and donation amount in the case where donations are prioritized to high-value and empty-handed customers. The result is contrasted with the benchmark model where no donation is made. In addition, we examine three extensions, where the firm donates randomly, the firm has exogenous capacity, and the firm's objective function includes the so-called ``warm glow effect," respectively. Our study uncovers some intriguing managerial insights for socially responsible firms in balancing their profits and customer welfare in the presence of prosocial customers.

5 The Interaction Between CSR Labeling and Realized Quality of a CSR Product

Hyunsuk Baek[1], Yimin Wang[1], Sanghak Lee[1], Rui Yin[2], [1]Arizona State University, Tempe, AZ, [2]Arizona State University, Kowloon

We conducted a survey on 383 college students to investigate the post-purchase behavior for a CSR product. Given a hypothetically assumed environment, the survey asked three choices in purchase, return, and future purchase. We identify how the realized quality of a CSR product, which is revealed after purchase, interacts with CSR labeling effect, and how it affects the consumer behavior in return and future purchase. We then show the insights on the CSR practice adoption.

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TE25

CC-North 131A

Interpretable Models for Health & Treatment Management and Policy Design

Community Committee Choice Session

Session Chair: Fernanda Bravo, UCLA Anderson School of Management, Los Angeles, CA

1 Test-Retest and Quarantining Policies: A Pomdp Approach

Zack (Ziqian) Zhu[1], Steven Shechter[2], Tim Huh[3], [1]UBC, [2]University of British Columbia, Vancouver, BC, Canada; [3]University of British Columbia, Vancovuer, BC, Canada

Motivated by recent debates on Covid quarantining policies, we model test-retest and quarantining policies as a partially observable Markov decision process. Costs include testing, quarantining, and spreading the virus, while the state of Covid (truly "positive" or "negative") is partially observable. Daily decisions involve whether to test and/or quarantine. We derive structural results of the optimal cost function and optimal testing/quarantining policy under different modeling assumptions. We discuss how individuals, workplaces, and governments may differ in their preferred policies.

2 Predicting Long-Term Opioid use via Interpretable Machine Learning

Jingyuan Hu, Fernanda Bravo, Elisa Frances Long, UCLA Anderson School of Management, Los Angeles, CA, Contact: jingyuan.hu.phd@anderson.ucla.edu

Long-term prescription opioid use (i.e., more than 90 days of opioid use within a 180-day period) can lead to drug abuse, addiction, and overdose. Predicting who is most likely to become a long-term opioid user could provide opportunities for early intervention by the prescribing physician or dispensing pharmacist. In this study, we examine the effectiveness of an opioid patient alert system currently used by the California Department of Justice (DOJ), and develop a novel risk-scoring rule to predict whether a patient will become a long-term opioid user, based on their historical prescription data and other characteristics. The scoring rule's inputs and assigned points are derived using an interpretable machine learning model.

3 Peer Influence and Spread of Opioid Epidemic: A Data Driven Social Network Analysis Approach Using Facebook's Social Connectedness Index

Kushagra Tiwari[1], M. Amin Rahimian[2], Mark S. Roberts[2], Mary G Krauland[2], [1]University of Pittsburgh, Pittsburgh, PA, [2]University of Pittsburgh, Pittsburgh, PA, Contact: kut20@pitt.edu

The Opioid Epidemic (OE) is a major concern in the US causing over 100,000 deaths due to overdose last year. Despite multiple studies that document the role of peer influence in the spread of OE, our current understanding of social network effects in the spatial spread of OE remains limited. We employ Facebook's Social Connectedness Index (SCI) to quantify social network strength across locations. Using Negative Binomial Regression we assess the SCI 's effect on Opioid Overdose Deaths corroborating our results with robustness checks: Linear Regression, Spatial Autocorrelation, Network Autocorrelation and a Two-way Fixed effect model. Our results suggest that peer influence, as captured by SCI, significantly contributes to OE's spread, highlighting the importance of social networks in public health interventions.

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TE26

CC-North 131B

Empirical Research in Service Operations Management

Community Committee Choice Session

Session Chair: Jing Dong, Columbia University, New York, NY

Session Chair: Carri Chan, Columbia Business School, New York, NY

1 Data-driven Decisions in Supply Chains: Contracts, Algorithms and Efficiency

Karan Girotra[1], Xiaoyue Yan[2], Elena Belavina[3], [1]Cornell Tech/Johnson Cornell University, New York, NY, [2]Cornell, Ithaca, NY, [3]Cornell University, New York, NY, Contact: girotra@cornell.edu

We study the performance of revenue sharing and wholesale price contracts in supply chains where firms make data-driven inventory/pricing decisions. In these supply chains, each tier uses historical and contemporaneous data on demand and demand-relevant covariates to directly arrive at their optimal decisions, as opposed to the traditional paradigm where demand estimates are first exogenously specified, followed by a separate optimization stage. We find that when there is a lot of historical data, or there are several covariates that tend to have positive skew and high variance, wholesale-price contracts tend to unexpectedly yield higher supply chain profits than revenue-sharing contracts—a stark contrast with well-known findings in the supply chain literature.

2 Waiting Online Versus In-Person in Outpatient Clinics: An Empirical Study on Visit Incompletion

Jimmy Qin[1], Carri Chan[1], Jing Dong[2], Shunichi Homma[3], Siqin Ye[3], [1]Columbia Business School, New York, NY, [2]Columbia University, New York, NY, [3]Columbia University Irving Medical Center, New York, NY, Contact: qqin23@gsb.columbia.edu

To better manage telemedicine visits and effectively integrate them with in-person visits, we need to better understand patient behaviors under the two modalities of visits. Utilizing data from two large outpatient clinics, we take an empirical approach to study service incompletion for in-person versus telemedicine appointments. Our estimation results show that intra-day delay increases the telemedicine service incompletion rate by 7.40%, but it does not have a significant effect on the in-person service incompletion rate. We conduct counterfactual experiments to optimize the intra-day sequencing rule when having both telemedicine and in-person patients. Our analysis indicates that not correctly differentiating the types of incompletions due to intra-day delays from no-show can lead to highly suboptimal patient sequencing decisions.

3 Analyzing Illegal Psychostimulant Trafficking Networks Using Noisydata

Margret V. Bjarnadottir, Greg Midgette, Siddharth Chandra, University of Maryland, College Park, MD, Contact: mbjarnad@umd.edu

We apply analytical approaches to map illegal psychostimulant (cocaine and methamphetamine) trafficking networks in the US using data from the System to Retrieve Information from Drug Evidence. We adopt a two-step analytical approach: we formulate the data aggregation problem as an optimization problem to maximize learning, then construct an inferred network of connected states. Our network reveals a number of phenomena, some aligning with what is known and some previously unobserved. Our findings show that an optimally aggregated dataset can provide a more accurate picture of an illicit drug network than can suboptimally aggregated data.

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TE27

CC-North 131C

Platform/Policy Design for Social Good

Community Committee Choice Session

Session Chair: Vahideh Manshadi, Yale University, New Haven, CT

1 Farm Equipment Sharing in Emerging Economies

Olufunke Adebola[1], Priyank Arora[2], Can Zhang[3], [1]Hello Tractor, Abuja, Nigeria; [2]University of South Carolina, Columbia, SC, [3]Duke University, Durham, NC, Contact: priyank.arora@moore.sc.edu

In emerging economies, there is a growing number of farm equipment sharing platforms that connect smallholder farmers with tractor owners who fulfill farmers' requests for mechanization services. Due to the small farm sizes and the low digital literacy in rural areas of emerging economies, these platforms often rely on the so-called “booking agents” to collect demand from individual farmers and submit the aggregated demand on the platform. This paper studies how the presence of such booking agents affects the platform’s optimal pricing and wage decisions and the equilibrium outcomes. Our findings also shed light on the effectiveness of government/donor interventions to promote agricultural mechanization, such as increasing the number of tractors on such platforms and reducing booking agent’s cost for aggregating demand.

2 Optimal Timing for Screening Tests to Identify Children with Reading Disabilities

Akshaya Suresh[1], Edward H. Kaplan[1], Edieal J. Pinker[1], Jeffrey R. Gruen[2], [1]Yale School of Management, New Haven, CT, [2]Yale School of Medicine, New Haven, CT

Reading disabilities (RD) affect 10-15% of US students. Untreated RD students struggle in school, falling behind peers and facing long-term issues. Neuropsychological evaluations identify RD students, and instructional interventions help them catch up. Early intervention is vital as benefits decline with age, but costly evaluations strain school budgets. Thus, schools use cheap screening tests to flag at-risk students or rely on parents to request evaluation, creating disparities in treatment. Screening accuracy increases with age, creating a trade-off between screening too early (wasting evaluations) or too late to provide effective intervention. Here we design optimal screening policies to maximize benefit and minimize disparity given budget constraints. We also calibrate our model using data on 1.5 million Florida students to provide managerial insights.

3 Empowering Collective Impact: Introducing the Swap System for Resource Sharing

Weixiao Huang[1], Elise J. Deshusses[1], Jennifer A. Pazour[2], Yunus Telliel[1], Sarah Stanlick[1], Alexander Teytelboym[3], Andrew C. Trapp[1], [1]Worcester Polytechnic Institute, Worcester, MA, [2]Rensselaer Polytechnic Institute, Troy, NY, [3]University of Oxford, Oxford, United Kingdom. Contact: whuang2@wpi.edu

Nonprofit organizations (NPOs) lack resources, hindering their service delivery. At the same time, NPOs have underutilized resources due to the mismatch between their assets and temporally shifting service demands. Motivated by these observations, we propose what we believe to be the first auction-based resource sharing system: SWAP. SWAP facilitates resource exchanges through integer optimization, enabling NPOs to obtain resources by offering their own. Empirical and simulated experiments reveal: 1. SWAP can address temporal resource needs in practice; 2. optimal exchange outcomes can be generated even for large-scale SWAP markets; and 3. solid evidence to inform the progression for future versions of SWAP. SWAP is implemented in Howard County, Maryland, with ongoing enhancements and strong potential for future expansion.

4 Counterbalancing Learning and Strategic Incentives in Allocation Markets

Jamie Kang[1], Faidra Monachou[2], Moran Koren[3], Itai Ashlagi[4], [1]Stanford, Redwood City, CA, [2]Harvard University, Cambridge, MA, [3]Ben gurion University of the Negev, Beer Heva, Israel; [4]Stanford University, Stanford, CA, Contact: korenmor@bgu.ac.il

Motivated by the high discard rate of donated organs in the US, we study an allocation problem in the presence of learning and strategic incentives. A benevolent social planner decides on the allocation of a single indivisible, common value object to a queue of strategic agents. Each agent holds an informative, yet noisy, private signal about the quality. To make a correct allocation decision, the planner must elicit agents’ true signals. Under the sequential offering mechanism, learning is hampered as herding may emerge. This can result in incorrect allocation. We propose a novel class of incentive-compatible mechanisms that involve a batch-by-batch, dynamic voting process using a majority rule. We prove that the proposed voting mechanisms improve the probability of correct allocation. Particularly, we show that such an improvement can be achieved via a greedy algorithm.

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TE28

CC-North 132A

Frontiers in Revenue Management

Community Committee Choice Session

Session Chair: Huanan Zhang, University of Colorado Boulder, Boulder, CO

Session Chair: Chengyi Lyu, 1</sup

1 Online Learning for Pricing in On-Demand Vehicle Sharing Networks

Saif Benjaafar[1], Xiangyu Gao[2], Xiaobing Shen[1], Huanan Zhang[3], [1]University of Minnesota, Minneapolis, MN, [2]The Chinese University of Hong Kong, Hong Kong, Hong Kong; [3]University of Colorado Boulder, Boulder, CO

We consider the pricing decisions for on-demand vehicle sharing networks in an online learning setting. We use a search subroutine to approximately locate the price with a desired demand for each trip and estimate the gradient information at this price point. We develop an ellipsoid based online learning algorithm with provable theoretical performance guarantees.

2 No Algorithmic Collusion in Two-Player Blindfolded Game with Thompson Sampling

Yi Xiong[1], Ningyuan Chen[2], Xuefeng Gao[1], [1]The Chinese University of Hong Kong, Shatin, Hong Kong; [2]University of Toronto, Toronto, ON, Canada

When two players are engaged in a repeated game, they may be completely unaware of the existence of each other and use multi-armed bandit algorithms to choose the actions, which is referred to as the ``blindfolded game'' in this paper. We show that when the players use Thompson sampling, the game dynamics converges to the Nash equilibrium, under a general condition. Therefore, algorithmic collusion doesn't arise in this case despite the fact that the players do not intentionally use competitive strategies.

3 Approximation Schemes for the Joint Inventory Selection and Online Resource Allocation Problem

Jacob Feldman[1], Panos Kouvelis[2], Xingxing Chen[3], Seung Hwan Jung[4], [1]Olin Business School, Saint Louis, MO, [2]Washington University in St. Louis, Saint Louis, MO, [3]University of Richmond, Richmond, VA, [4]Washington University in St. Louis, Brentwood, MO, Contact: chen@richmond.edu

In this paper, we introduce and study the joint inventory selection and online resource allocation problem, which is characterized by two sequential sets of decisions that are irrevocably linked. First, a decision maker must select starting inventory levels for a set of available resources. Subsequently, the decision maker must match arriving customers to available resources in an online fashion so as to maximize expected reward. We first study the problem in its most general form, before focusing on a specific version that arises at ABI. This particular application of our general setting is referred to as the ABI Trailer Problem, and it considers how ABI ships its beer to vendors via third party delivery trucks. In this problem, ABI must select the weights of preloaded trailers of beer, which are then matched in an online fashion to arriving third party delivery trucks.

4 Assortment Optimization with Multi-Item Basket Purchase Under the Multivariate Mnl Model

Chengyi Lyu[1], Stefanus Jasin[2], Sajjad Najafi[3], Huanan Zhang[1], [1]University of Colorado Boulder, Boulder, CO, [2]University of Michigan, Ann Arbor, MI, [3]HEC Paris, VERSAILLES, France

Assortment selection is one of the most important decisions faced by retailers. Most existing papers in the literature assume that customers select at most one item out of the offered assortment. While this is valid in some cases, it contradicts practical observations in many shopping experiences, both in online and brick-and-mortar retail, where customers may buy a basket of products instead of a single item. In this paper, we incorporate customers' multi-item purchase behavior into the assortment optimization problem. We consider both uncapacitated and capacitated assortment problems under the so-called Multivariate MNL (MVMNL) model, which is one of the most popular multivariate choice models used in the marketing and empirical literature.

5 Schedule-Based Revenue Management with Unknown Demand

Zechao Li[1], Anyan Qi[2], Yining Wang[3], [1]Tsinghua University, Beijing, China; [2]The University of Texas at Dallas, Richardson, TX, [3]University of Texas at Dallas, Richardson, TX

We analyze a class of revenue management problems where a firm provides a service over a selling horizon. Any combination of consecutive periods during the horizon is called a schedule and is available to consumers subject to capacity constraints. The firm must learn about the demand for each schedule on the fly. We introduce learning-while-doing algorithms and quantify the performance of our algorithms using regret analysis.

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TE29

CC-North 132B

Advances in Sustainable Operations

Community Committee Choice Session

Session Chair: Vibhuti Dhingra, Schulich School of Business, York University, Toronto, ON, Canada

1 A Model of International Trade in Carbon Mitigation Outcomes: Analyzing the Impact of Article 6 of the Paris Agreement

Manish Tripathy[1], Sanjith Gopalakrishnan[2], Harish Krishnan[1], [1]University of British Columbia, Vancouver, BC, Canada; [2]McGill University, Montreal, QC, Canada

Article 6, of the ParisAgreement, proposes a mechanism, Internationally Transferred MitigationOutcomes (ITMOs), to allow countries to transfer mitigation outcomes, i.e.reduction of emissions in one country can be credited to another.

In thispaper, we present a theoretical and stylized model for the implementation ofITMOs between two countries, one producing a low-carbon fuel and the otherreliant on a high-carbon fuel. Essentially, we show that with trade and ITMOs,countries can reduce global GHG emissions. We also outline the impacts of ITMOson domestic energy prices and the energy consumption mix in the two countries.

2 Toward Stormwater Resilient Cities: Robust Planning Against Extreme Rainfalls

Sheng Liu[1], Wei Qi[2], Aiqi Zhang[1], [1]University of Toronto, Toronto, ON, Canada; [2]Tsinghua University, Beijing, China. Contact: aq.zhang@rotman.utoronto.ca

We are experiencing prolonged and intensified rainfalls in our cities due to climate change. Unfortunately, existing efforts on urban stormwater infrastructure planning, typically based on empirically predetermined rainfall scenarios, fails to capture the worst scenarios that should be planned against. Leveraging robust optimization techniques, this paper identifies the worst-case rainfall scenarios that cause the most severe flooding losses. The use of robust optimization goes beyond existing literature by constructing a new type of uncertainty set using IDF curves directly. Our analysis reveals that cities should be savvy in balancing their investments in green and grey infrastructures. Under a budge constraint, green infrastructures may have to give way to grey ones in exchange for a larger retention capacity to withstand the increasingly severe rainfalls.

3 Beyond Technical Merits:An Analysis of the Perceived Legitimacy of Small Modular Reactors

Goran Calic[1,2], [12]McMaster University, Hamilton, ON, Canada

Small modular reactors (SMRs) are a promising low-carbon energy technology. This study examines audience perceptions of SMRs' legitimacy using media and policy documents, where legitimacy signifies an SMR's right to exist within society. Audiences utilize analogous concepts to understand SMRs and evaluate their merits and demerits. Findings show that people's bounded rationality results in reliance on heuristics when forming legitimacy perceptions. This insight uncovers cognitive processes and highlights practical implications, such as potential miscommunication and unintended outcomes. We stress that "one-size-fits-all" approaches are unsuitable for promoting SMRs as a climate change solution. Grasping legitimacy perceptions is vital for novel technologies, such as SMRs, successful integration into society.

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TE30

CC-North 132C

Emerging Market Retail Operations

Community Committee Choice Session

Session Chair: Jiwen Ge, Institute of Supply Chain Analytics (ISCA), Dongbei University of Finance and Economics, Karlstad, Sweden

1 A Competitive Facility Location Model to Mitigate Food Insecurity in Emerging Markets

Gonzalo Mejia[1], Raul Aranguiz[2], Julian Espejo[3], Daniela Granados[3], Christopher Mejia[4], [1]Universidad de los Andes, Miami, FL, [2]Pontificia Universidad Catolica de Valparaiso, Valparaiso, Chile; [3]Universidad de La Sabana, Chia, Colombia; [4]Massachusetts Institute of Technology, Cambridge, MA, Contact: cmejia@mit.edu

This research explores the sustainability of street markets to grant access to fruits and vegetables, F&Vs, to underserved communities. Specifically, this paper studies the impact of adding street markets to satisfy the demand of consumers. We developed a non-linear mathematical model to establish the location and number of street markets. This variant of the competitive facility location problem includes specific features of street markets (i.e., itinerant nature, dynamic shopping behavior). To feed the model, we collected data from main competitors of the street markets (i.e., nanostores) to investigate their market share and purchasing habits. The results suggest that street markets can provide better access to F&Vs to food-insecure households to some extent. Still, their operational complexity may limit their applicability in the long term.

2 The Differential Impact of Lead Time Uncertainty and Review Period Uncertainty on Nanostore Ordering Behavior

Simone Balvers, Eirini Spiliotopoulou, Jan C. Fransoo, Tilburg University, Tilburg, Netherlands. Contact: s.balvers@tilburguniversity.edu

Nanostores, or mom-and-pop stores, face different forms of supply uncertainty when making ordering decisions. Besides lead time uncertainty, shopkeepers rely on irregular in-person sales visits to place orders. This paper focuses on two forms of supply uncertainty: lead time uncertainty and review period uncertainty (i.e., uncertainty in the time between two sales agent visits). Using an experimental design, we find that subjects order more under lead time uncertainty than under review uncertainty, for both high and low margin products. We identify as an underlying mechanism the tendency of decision makers to underestimate the expected lead time, while this is not necessarily the case for the expected review period.

3 Value of Exclusive Doorstep Delivery in the Last-100-Meter Distribution

Yang Zhan[1,2], Zheng Zhang[3], Jiwen Ge[4], [1]Zhejiang University of Technology, Hangzhou, China; [2]Cainiao Network, Hangzhou, China; [3]Zhejiang University, Hangzhou, China; [4]Dongbei University of Finance & Economics, Dalian, China

This paper investigates the value of the last-100-meter distribution service on e-commerce sales via a natural experiment. In the experiment, the last-100-meter distribution service is organized by self-pickup points, and doorstep delivery is provided exclusively for Alibaba packages. By leveraging difference-in-differences models and using data from more than 1.5 billion packages, we show that the exclusive doorstep delivery service brought significant sales growth (decline) of Alibaba (Non-Alibaba) and reversed sales growth trends. We uncover cross-channel negative and positive spillover effects that are induced by service capacity sharing and shifting. We reveal how self-pickup points with different service-quality metrics affect sales and competitive position. Our results suggest how to customize business efforts to maximize the Alibaba benefit.

4 Nanostore-Supermarket Supply Chain Competition

Jiwen Ge[1], Brian Tomlin[2], [1]Institute of Supply Chain Analytics (ISCA), Dongbei University of Finance and Economics, Dalian, China; [2]Tuck School of Business, Hanover, NH, Contact: mojietuzi@gmail.com

Nanostores are mom-and-pop stores prevalent in emerging markets. We study the competition between a cluster of nanostores and a supermarket located on a circle. We model a manufacturer as the common supplier to both retailers as a Stackelberg leader in the nanostore retail supply chain, while the manufacturer engages in a Nash Bargaining game with the supermarket.

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CC-North 221B

Advances in Vehicle Routing

Contributed Session

Session Chair: Maichel Aguayo, Universidade de Concepcion, Concepcion, Chile

1 Efficient Routing and Cargo Transfer Strategies with Heuristic Algorithm in Two-Truck Vehicle Routing Problem

Hyungjoo Cha, Taesu Cheong, Korea University, Seoul, Korea, Republic of. Contact: hyungjoo_cha@korea.ac.kr

In this talk, we address the optimization of waste collection in a two-truck vehicle routing problem by proposing efficient routing and cargo transfer strategies utilizing a heuristic algorithm. The problem involves two trucks, where a smaller vehicle with higher speed collects waste and transfers it to a larger vehicle with slower speed. Utilizing a heuristic algorithm, the objective is to minimize total collection time by optimizing routes and managing cargo transfer. The algorithm considers varying vehicle speeds, generating routes that minimize distances and ensure timely transfer. Results show significant improvements in waste collection time, offering a promising approach for enhancing efficiency and promoting sustainable waste management practices.

2 A Reinforcement Learning Approach for Vehicle Routing Problem with Drones

Aigerim Bogyrbayeva, Bissenbay Dauletbayev, Meraryslan Meraliyev, Suleyman Demirel University, Almaty, Kazakhstan. Contact: b.dauletbayev@sdu.edu.kz

Many exact algorithms, heuristics, and metaheuristics have been proposed to solve the *Vehicle Routing Problem with Drones* (VRPD), which involves using a fleet of heterogeneous vehicles to fulfill customer orders in last-mile delivery. We formulate this problem using the *Markov Decision Process* (MDP) and propose a *Reinforcement Learning* (RL) model to solve it, aiming to obtain high-quality solutions for both small and large instances. Our RL model is based on an attention-based encoder-decoder architecture, enabling us to capture every action taken by any agent in the environment. This approach enhances coordination, determining which vehicles should visit specific customers and where vehicles can rendezvous to effectively leverage drones and reduce the overall completion time. Our experiments produce competitive results when compared to benchmark algorithms.

3 The Generalized Critical Node Problem

Vaidehi S. Karajgikar[1], Chrysafis Vogiatzis[2], [1]UNIVERSITY OF ILLINOIS, URBANA -CHAMPAIGN, Urbana, IL, [2]University of Illinois at Urbana-Champaign, Contact: vaidehi5@illinois.edu

In this talk, we introduce the Generalized Critical Node Problem (GCNP). Given a simple, undirected, and unweighted graph with disjoint clusters, the objective is to minimize global pairwise connectivity while satisfying a minimum damage requirement for each cluster, subject to a global budget. This problem is motivated by previously proposed generalizations of combinatorial optimization problems like the traveling salesman problem and minimum spanning tree problem among others. Our formulation is based on transitive constraints at the global and cluster level. We propose a reformulation into a main problem and subproblem to separate the global and local connectivity requirements and develop a solution method inspired by Benders decomposition. We finish this talk with a comparison of runtimes between our approach and commercial solvers for random instances.

4 A Two-Index Formulation for the Fixed-Destination Multi-Depot Asymmetric Travelling Salesman Problem and Some Extensions

Maichel Aguayo[1], Francisco Aviles[1], Subhash C. Sarin[2], Hanif Dostmahomed Sherali[3], [1]Universidad San Sebastián, Concepción, Chile; [2]Virginia Polytechnic Institute, Blacksburg, VA, [3]Virginia Polytechnic & State University, Blacksburg, VA, Contact: maichel.aguayo@uss.cl

We introduce a compact formulation for the fixed-destination multi-depot asymmetric travelling salesman problem (FD-mATSP). It consists of severañ salesmen distributed among depots who depart from and return to their respective origins after visiting a set of customers. The proposed model exploits the multi-depot aspect of the problem by labelling the arcs to identify the nodes that belong to the same tour. Our experimental investigation shows that the proposed-two index formulation is versatile and effective in modelling new variations of the FD-mATSP compared with existing formulations.

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TE33

CC-North 221C

Recent Advances in Optimization Methods for Constrained Machine Learning Problems

Community Committee Choice Session

Session Chair: Sen Na, 1</sup

Session Chair: Vivak Patel, 1</sup

1 Stochastic Algorithms with Adaptive Parameters for Solving Constrained Optimization Problems

Frank E. Curtis, Lehigh University, Bethlehem, PA, Contact: frank.e.curtis@gmail.com

I will discuss some challenges that arise in the design and analysis of stochastic algorithms for solving constrained optimization problems. In particular, I will focus on challenges that arise due to the presence of adaptive algorithmic parameters when their updates are based on stochastic gradient information. I will also present some solutions that my collaborators and I have reached for addressing these challenges in the context of sequential quadratic optimization and interior point methodologies.

2 Physics-Constrained Machine Learning with Differentiable Solvers

Aditi Krishnapriyan, UC Berkeley, Berkeley, CA

Machine learning (ML) has achieved success in a wide variety of applications. While there have also been some successes in the scientific domain, many challenges remain. It is often the case that there is limited data in these settings, as well as ML methods that are not explicitly incorporating information about the physical setting. Examples of such information include conservation laws corresponding to the laws of physics that are known to hold true. I will discuss how we can have stronger control over incorporating conservation laws into neural networks through differentiable optimization and via using the implicit function theorem. Using this, we are able to much more accurately and efficiently converge to the right spatiotemporal solutions, while needing minimal training data.

3 Stochastic Optimization with Constraints: Algorithm, Convergence, and Statistical Inference

Sen Na, 1</sup

Constrained stochastic optimization problems appear widely in numerous applications in statistics, machine learning, and engineering. These include constrained maximum likelihood estimation, constrained deep neural networks, physics-informed machine learning, and optimal control. In this talk, I will describe how to design adaptive algorithms for solving constrained stochastic nonlinear optimization problems based on sequential quadratic programming (SQP). The algorithms employ an exact augmented Lagrangian as the merit function and adaptively select suitable merit parameters. Numerical results are provided.

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TE34

CC-North 222A

Advances in Large Scale Optimization

Community Committee Choice Session

Session Chair: Miaolan Xie, Cornell University, Ithaca, NY

1 Online Learning Guided Curvature Approximation: A Quasi-Newton Method with Global Non-Asymptotic Superlinear Convergence

Ruichen Jiang[1], Qiujiang Jin[1], Aryan Mokhtari[2], [1]University of Texas at Austin, Austin, TX, [2]University of Texas at Austin, Austin, TX, Contact: rjiang@utexas.edu

Quasi-Newton methods are among the most popular iterative methods for unconstrained minimization problems due to their favorable superlinear convergence property. However, existing results for these methods are limited, as they provide either an *asymptotic* superlinear convergence rate or a *local* non-asymptotic superlinear rate. In this talk, we present the first globally convergent quasi-Newton method with an explicit non-asymptotic superlinear rate. Unlike classical quasi-Newton methods, we build our algorithm on the hybrid proximal extragradient method and propose a novel online learning framework for updating the Hessian approximation matrices. Specifically, guided by the convergence analysis, we formulate an online learning problem in the space of matrices and relate the bounded regret of the online problem to the superlinear convergence of our method.

2 Extra-Gradient Method with Adaptive Stepsize for Monotone Equations

Yang Luo[1], Michael O'Neill[2], [1]University of North Carolina at Chapel Hill, Chapel Hill, NC, [2]University of North Carolina at Chapel Hill, Chapel Hill, NC

First-order methods with adaptive step size have obtained significant attention over decades due to their auto-tuning properties, including AdaGrad, Adam, RMSProp and so on. Yet, even for very simple convex-concave minimax problems, these single step adaptive gradient methods may fail to converge. In this work, inspired by the auto-tuning properties of these adaptive gradient methods, we would like to incorporate AdaGrad techniques into Extra-gradient framework to propose a new scheme called AdaEG-Norm for solving monotone equations which can cover convex-concave saddle point problems. We technically establish the sub-linear convergence rate on the squared norm of the operator and show its robustness to the choice of hyper-parameters.

3 Understanding Low-Dimensional Representation Learning via Neural Collapse

Peng Wang, University of Michigan, Ann Arbor, MI

In this work, we study the recently discovered neural collapse phenomenon in training over-parameterized deep neural networks for classification tasks. As feature normalization in the last layer becomes a common practice in modern representation learning, we theoretically justify the neural collapse phenomenon with normalized features. Based on an unconstrained feature model, we simplify the empirical loss function in a multi-class classification task and obtain a nonconvex optimization problem over the Riemannian manifold by constraining all features and classifiers over the sphere. In this context, we analyze the nonconvex landscape of the Riemannian optimization problem over the product of spheres. Moreover, we also establish linear convergence of neural collapse based on the error-bound condition.

4 Robustly Learning a Single Neuron via Sharpness

Puqian Wang[1], Nikos Zarifis[2], Ilias Diakonikolas[1], Jelena Diakonikolas[1], [1]University of Wisconsin-Madison, Madison, WI, [2]University of Wisconsin-Madison, Madison, WI

We study the problem of learning a single neuron with respect to the L_2^2-loss in the presence of adversarial label noise. We give an efficient algorithm that, for a broad family of activations including ReLUs, approximates the optimal L_2^2-error within a constant factor. Notably, our algorithm applies under much milder distributional assumptions compared to prior work. The key ingredient enabling our results is a novel connection to local error bounds from optimization theory.

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CC-North 222B

Algorithmic Foundation in Minimax Optimization

Community Committee Choice Session

Session Chair: Jiajin Li, 1</sup

Session Chair: Jiawei Zhang, MIT, Cambridge, MA

1 Decentralized Methods for Composite Nonconvex Strongly-Concave Minimax Problems

Yangyang Xu, Wei Liu, Rensselaer Polytechnic Institute, Troy, NY

Minimax problems arise in several applications that have attracted a lot of research interests. Many efforts have been made on designing algorithms for solving such problems. A majority of existing algorithms are non-distributed or centralized. In this talk, I will first present a deterministic gradient-type method for non-convex strongly-concave

(NCSC) minimax problems, which can include nonsmooth regularizers for both primal and dual variables. Several existing decentralized methods for NCSC minimax problems only applies to smooth cases. In addition, I will present variance-reduction based stochastic gradient methods for stochastic or finite-sum structured minimax problems. Numerical results will also be shown.

2 Oracle Complexity of Single-Loop Switching Subgradient Methods for Non-Smooth Weakly Convex Functional Constrained Optimization

Yankun Huang[1], Qihang Lin[2], [1]Tippie College of Business, The University of Iowa, Iowa City, IA, [2]University of Iowa, Iowa City, IA

We consider a non-convex constrained optimization problem, where the objective function is weakly convex and the constraint function is either convex or weakly convex. To solve this problem, we consider the classical switching subgradient method, which is an intuitive and easily implementable first-order method whose oracle complexity was only known for convex problems. This paper provides the first analysis on the oracle complexity of the switching subgradient method for finding a nearly stationary point of non-convex problems. Our results are derived separately for convex and weakly convex constraints. Compared to existing approaches, especially the double-loop methods, the switching gradient method can be applied to non-smooth problems and achieves the same complexity using only a single loop, which saves the effort on tuning the number of inner iterations.

3 From Halpern's Fixed-point Iterations to Nesterov's Accelerated Interpretations for Root-finding Problems

Quoc Tran-Dinh, The University of North Carolina at Chapel Hill, NC

We derive an equivalent form of Halpern's fixed-point iteration scheme for solving a co-coercive equation (also called a root-finding problem), which can be viewed as a Nesterov's accelerated interpretation. We show that one method is equivalent to another via a simple transformation, leading to a straightforward convergence proof for Nesterov's accelerated scheme. Alternatively, we directly establish convergence rates of Nesterov's accelerated variant, and as a consequence, we obtain a new convergence rate of Halpern's fixed-point iteration. Next, we apply our results to different methods to solve monotone inclusions, where our convergence guarantees are applied. Since the gradient/forward scheme requires the co-coerciveness of the underlying operator, we derive new Nesterov's accelerated variants for both recent extra-anchored gradient and past-extra anchored gradient methods in the literature. These variants alleviate the co-coerciveness condition by only assuming the monotonicity and Lipschitz continuity of the underlying operator. Interestingly, our new Nesterov's accelerated interpretation of the past-extra anchored gradient method involves two past-iterate correction terms. This formulation is expected to guide us developing new Nesterov's accelerated methods for minimax problems and their continuous views without co-coericiveness. We test our theoretical results on two numerical examples, where the actual convergence rates match well the theoretical ones up to a constant factor.

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CC-North 222C

Global Optimization in Robust Decision-making and Optimal Control

Community Committee Choice Session

Session Chair: William Haskell, Purdue University, West Lafayette, IN

1 Supply Chain Contracts in the Small Data Regime

Xuejun Zhao[1], William Haskell[2], Guodong Yu[3], [1]Purdue University, [2]Purdue University, West Lafayette, IN, [3]Shandong University, Shandong, China

We study supply chain contract design under uncertainty. In this problem, the retailer has full information about the demand distribution, while the supplier only has partial information drawn from historical demand realizations and contract terms. The supplier wants to optimize the contract terms, but she only has limited data on the true demand distribution. We show that the classical approach for contract design is fragile in the small data regime, and we combine the historical demand and retailer data to improve the supplier's contract design terms. Our framework sheds light on the value of information from interactions between agents in a game-theoretic setting and suggest that such information should be utilized in data-driven decision-making.

2 Sequential Quadratic Programming for Optimal Transport

Zihe Zhou, Purdue University, West Lafayette, IN, Contact: zhou408@purdue.edu

The Monge optimal transport (OT) problem seeks an optimal measure that transforms a source probability measure to a target, by minimizing a given cost function. Deviating from the growing literature that focuses on the dual, we formulate the Monge problem as a nonlinear functional optimization problem subject to a nonlinear operator constraint, and develop a sequential quadratic programming (SQP) operator recursion for solution. We first show that the Monge problem, under some reasonable regularity conditions, satisfies the conditions of Alt's SQP formulation over Banach spaces, immediately yielding local convergence. We then discuss embedding the structure provided by Brenier's theorem into the SQP, and also globalizing the SQP recursion. To the best of our knowledge this is the first attempt at a globally convergent SQP operator recursion over function spaces.

3 Preference Robust Optimization with Quasi-Concave Choice Functions for Multi-Attribute Prospects

Jian Wu[1], William Haskell[1], Wenjie Huang[2], Huifu Xu[3], [1]Purdue University, West Lafayette, IN, [2]The University of Hong Kong, Hong Kong, Hong Kong; [3]The Chinese University of Hong Kong, Southampton, United Kingdom. Contact: wbhaskell@gmail.com

In stochastic optimization, the decision maker's (DM's) preferences are expressed by a choice function. Preference robust optimization (PRO) is concerned with the situation where DM's preferences are ambiguous and a precise choice function cannot be specified. The current preference robust choice models are mostly single-attribute and are built upon von Neumann-Morgenstern expected utility theory, the theory of convex risk measures, or Yaari's dual theory of choice. In this paper, we extend the PRO approach to the broader class of monotone and quasi-concave multi-attribute choice functions. We show how to efficiently solve our new class of PRO problems by solving a sequence of convex optimization problems. We test our scheme on a single-attribute portfolio optimization problem and a multi-attribute capital allocation problem.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE37

CC-North 223

Understanding Generalization of Optimization Algorithms in Machine Learning

Community Committee Choice Session

Session Chair: Jiawei Zhang, MIT, Cambridge, MA
Session Chair: Kaiqing Zhang, MIT, Cambridge, MA
Session Chair: Asuman Ozdaglar, Massachusetts Institute of Technology, Cambridge, MA

1 An (Empirical) Law of Data Separation in Deep Learning

Weijie Su, Wharton School, University of Pennsylvania, Philadelphia, PA

The law of equi-separation is a pervasive empirical phenomenon that describes how data are separated according to their class membership from the bottom to the top layer in a well-trained neural network. We will show that, through extensive computational experiments, neural networks improve data separation through layers in a simple exponential manner. This law leads to roughly equal ratios of separation that a single layer is able to improve, thereby showing that all layers are created equal. We will conclude the talk by discussing the implications of this law on the interpretation, robustness, and generalization of deep learning, as well as on the inadequacy of some existing approaches toward demystifying deep learning. This is based on joint work with Hangfeng He (arXiv:2210.17020).

2 On the Role of Attention in Prompt-Tuning

Mahdi Soltanolkotabi, [1]</sup

Prompt-tuning is an emerging strategy to adapt large language models (LLM) to downstream tasks by learning a (soft-)prompt parameter from data. Despite its success in LLMs, there is limited theoretical understanding of the power of prompt-tuning and the role of the attention mechanism in prompting. In this talk I will demystify this phenomenon by characterizing the generalization properties of the trajectory of gradient descent for such problems.

3 Optimization and Generalization for Contrastive Self-Supervised Learning

Tianbao Yang, [1]</sup

In this presentation, I will talk about our recent works about contrastive self-supervised learning. I will highlight the challenges for optimization and present our solutions for addressing the challenges. I will then present the generalization results and discuss their limitations and offer potential path for addressing these limitations in future work.

4 Transformers are Support Vector Machines

Samet Oymak, University of Michigan, Ann Arbor, MI

Recent advances in language modeling, such as ChatGPT, have revolutionized our society within a short timeframe. These large language models are based on the transformer architecture which uses the self-attention mechanism as their central component. However, the theoretical principles underlying the attention mechanism are poorly understood, especially its nonconvex optimization dynamics. In this talk, we establish a formal equivalence between the optimization geometry of self-attention and a linear hard-margin SVM problem that separates the optimal input tokens within the input sequence from non-optimal tokens (e.g. selecting the optimally-relevant words within a sentence). Through this, we characterize the inductive bias of 1-layer transformers optimized with gradient descent and prove that optimization of self-attention weights converges in direction to a max-margin token-separator minimizing either nuclear norm or Frobenius norm objective depending on the parameterization. We also highlight that convergence can occur in locally-optimal directions rather than global ones. Our findings apply to general datasets and allow for a final neural-net layer. Finally, we demonstrate the practical validity of our hard-margin SVM equivalence via thorough numerical experiments. These findings on self-attention inspire a new perspective, interpreting multilayer transformers as a hierarchy of SVMs that separates and selects optimal tokens.

Tuesday, October 17, 4:00 PM - 5:15 PM

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CC-North 224A

First-order Methods and Large-scale Optimization

Community Committee Choice Session

Session Chair: Jonathan Eckstein, 1</sup

Session Chair: Mert Gurbuzbalaban, Rutgers University, Piscataway, NJ

1 Stochastic Approximation Methods in the Presence of Biased Oracles

Sam Davanloo, Yin Liu, The Ohio State University, Columbus, OH, Contact: davanloo.1@osu.edu

Motivated by multiple emerging applications, e.g., stochastic composition optimization, we consider a general optimization problem where the gradient of the objective is only available through a biased stochastic oracle where the bias magnitude can be controlled by a parameter; however, lower bias requires higher computation. Without exploiting a specific bias decay structure, we propose a couple of adaptive and nonadaptive stochastic algorithms to solve the underlying problem. We analyze the nonasymptotic performance of the proposed algorithms in the strongly convex and nonconvex regimes. The numerical performance of the proposed methods over two applications on composition optimization and policy optimization for infinite-horizon Markov decision processes will be presented.

2 Dish: A Distributed Hybrid Primal-Dual Optimization Framework to Utilize System Heterogeneity

Xiaochun Niu, Ermin Wei, Northwestern University, Evanston, IL, Contact: xiaochunniu2024@u.northwestern.edu

We consider solving distributed consensus optimization problems over multi-agent networks. Current distributed methods fail to capture the heterogeneity among agents' local computation capacities. We propose DISH as a distributed hybrid primal-dual algorithmic framework to handle and utilize system heterogeneity. Specifically, DISH allows those agents with higher computational capabilities or cheaper computational costs to implement Newton-type updates locally, while other agents can adopt the much simpler gradient-type updates. Theoretically, we show that DISH achieves a linear (Q-linear) convergence rate to the exact optimal solution for strongly convex functions, regardless of agents' choices of gradient-type and Newton-type updates. Finally, we perform numerical studies to demonstrate the efficacy of DISH in practice.

3 Defbal: The ADMM Meets Proximal Gradient Methods

Jonathan Eckstein[1], Felipe Atenas[2], Paulo J. S. Silva[3], [1]Rutgers University, Piscataway, NJ, [2]University of Melbourne, Melbourne, Australia; [3]University of Campinas, Campinas, Brazil

The ADMM algorithm is an application the Douglas-Rachford splitting method for monotone operators. However, a connection also exists between the ADMM and proximal gradient (forward-backward) algorithms. This talk will explain the connection and show how it can be exploited to develop new ADMM-like augmented Lagrangian algorithms for convex optimization.

4 DEFBAL, Part II: Some ADMM-Like Algorithms Derived from Forward-Backward Methods

Chang Yu, Jonathan Eckstein, Rutgers University, Piscataway, NJ, Contact: cy301@business.rutgers.edu

The connection between the proximal gradient (forward-backward) algorithm and the ADMM allows one to derive new ADMM-like methods by substituting related methods such as FISTA for the ordinary proximal gradient procedure. This talk describes some examples of such algorithms and their potential applications.

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CC-North 224B

New Advance in Solving Vehicle Routing Problems Exactly

Community Committee Choice Session

Session Chair: Yu Yang, University of Florida, Gainesville, FL

1 Maximum Throughput Dispatch for Shared Autonomous Vehicles Including Vehicle Rebalancing

Jake Robbennolt, The University of Texas at Austin, Austin, TX

Shared autonomous vehicles (SAVs) provide on demand point-to-point transportation for passengers. This service has been extensively studied using dispatch heuristics and agent-based simulations of large urban areas. However, these approaches make no mathematical guarantees of passenger throughput for the SAV network. This study uses a dynamic queuing model for passengers and includes rebalancing of empty vehicles to regions of high demand. The dispatch policy is proven to maximize throughput. Simulation results show that including rebalancing in the dispatch policy reduces waiting times (between vehicle dispatch and passenger pickup). However, vehicle time traveling empty increases in some scenarios. Simulation results also show that rebalancing reduces passenger waiting times unless many vehicles rebalance at once and are not available for dispatch.

2 A New Exact Algorithm for Single-Commodity Vehicle Routing with Split Pickups and Deliveries

Jiliu Li[1], Zhixing Luo[2], Roberto Baldacci[3], Hu Qin[4], Zhou Xu[5], [1]School of Management, Northwestern Polytechnic University, Xi'an, China; [2]School of Management and Engineering, Nanjing University, Nanjing, China; [3]Hamad Bin Khalifa University, Doha, Qatar; [4]Huazhong University of Science and Technology, Wuhan, China; [5]Department of Logistics and Maritime Studies, Hong Kong Polytechnic University, Hong Kong, Hong Kong. Contact: zhou.xu@polyu.edu.hk

Based on a pattern-based mathematical formulation and a novel label-setting procedure. we develop a new branch-price-and-cut algorithm to solve a vehicle routing problem with split pickups and deliveries. Extensive computational results on different classes of benchmark instances show that our new exact algorithm solves several open instances and significantly outperforms state-of-the-art algorithms.

3 Elementary Branch-Price-And-Cut for Solving Stochastic Vehicle Routing Problems

Alexandre Florio, Amazon, Bellevue, WA

We consider the vehicle routing problem with stochastic demands (VRPSD), a stochastic variant of the VRP in which demands are only revealed upon arrival of the vehicle at each customer. We focus on the VRPSD under the restocking-based perspective, which means that vehicles are allowed to replenish at the depot to guarantee enough capacity to serve all customers. We present a branch-price-and-cut (BP&C) algorithm for the VRPSD under optimal restocking. The distinctive feature of this algorithm is that it operates with elementary routes, that is, it does not apply any route relaxation strategy. We provide intuition as to why the elementary pricing strategy is more efficient for a wide class of stochastic routing problems. Computational experiments show that the BP&C method outperforms previous state-of-the-art algorithms on several sets of literature instances.

4 Deluxing: Deep Lagrangian Underestimate Fixing for Column-Generation-Based Exact Methods

Yu Yang, University of Florida, Gainesville, FL, Contact: yu.yang@ise.ufl.edu

In this paper, we propose an effective variable fixing strategy called deep Lagrangian underestimate fixing (DeLuxing). It is widely applicable to remove unnecessary variables in column-generation-based exact methods for solving various challenging discrete optimization problems. DeLuxing employs a novel LP formulation, which is theoretically guaranteed to yield qualified dual solutions for computing Lagrangian underestimates. We extend the fundamental concept underpinning the new formulation to contexts beyond variable fixing, namely cutting plane addition and variable type relaxation. We demonstrate DeLuxing brings the performance of the state-of-the-art branch-price-and-cut methods to the next level via an extensive numerical study on three important classes of VRPs: the CVRP, VRPTW, and CMTVRPTW.

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CC-North 225A

Collaboration and Cooperation in City Logistics Systems

Community Committee Choice Session

Session Chair: Julia Lange, RPTU Kaiserslautern-Landau, Kaiserslautern, Germany

1 Resource and Cost Allocation in Cooperative Two-Tier City Logistics Systems

Johannes Gückel[1], Pirmin Fontaine[2], Teodor Gabriel Crainic[3], [1]KU Eichstaett-Ingolstadt, Ingolstadt School of Management, Inglstadt, Germany; [2]KU Eichstaett-Ingolstadt, Ingolstadt School of Management, Ingolstadt, Germany; [3]Université du Québec à Montréal, Montréal, QC, Canada

We introduce a new tactical planning problem for the resource and cost allocation of a two-tier city logistics system with cooperative logistics service providers. Therefore, we present a new mathematical formulation that combines a service network design formulation on the first tier with a capacitated vehicle routing problem with release and due dates on the second tier. Our model accommodates different cooperation scenarios, such as full sharing of resources and customers, partial sharing of customers, and exclusive sharing of resources. This model is used in adapted cost allocation methods, including proportional methods and more complex game theoretical methods. To solve larger instances, we propose a problem-specific iterated local search metaheuristic.

2 Machine Learning for Last-Mile Delivery and Third-Party Logistics

Maria Elena Bruni[1], Edoardo Fadda[2], Stanislav Fedorov[3], Guido Perboli[4], [1]University of Calabria, Rende, Italy; [2]Politecnico di Torino, Turin, Italy; [3]Politecnico di Torino, Turin, Italy; [4]Politecnico di Torino, Turin, Italy. Contact: guido.perboli@polito.it

Third-party logistics is an essential component of efficient delivery systems, enabling companies to purchase carrier services instead of an expensive fleet of vehicles. However, carrier contracts must be booked in advance without knowing what orders will be available for dispatch, while reducing the total service costs. This problem becomes more challenging in satellite-based two-tier systems. In this paper, we present a new heuristic algorithm able to do so based on machine learning techniques able to tackle large-sized instances. Several numerical experiments show that the proposed method performs well in a short computational time. In addition, we present an application of the method to a real case study.

3 A Bi-Level Approach for Last-Mile Delivery with Multiple Satellites

Maria Elena Bruni[1], Sara Khodaparasti[2], Guido Perboli[2], [1]University of Calabria, Rende, Italy; [2]Politecnico di Torino, Turin, Italy

Last-mile delivery is regarded as an essential, yet challenging problem in city logistics. One of the most common initiatives, implemented to streamline and support last-mile activities, are satellite depots, intermediate logistics facilities used to decouple last-mile activities from the rest of the distribution chain. In this paper, the interplay and the hierarchical relation between the problem agents are modeled by a bi-level optimization framework. Two mathematical models and an exact solution approach, properly customized for the problem, are presented. To assess the validity of the proposed formulations and the efficiency of the solution approach, we conduct an extensive set of computational experiments on benchmark instances. In addition, we present managerial insights for a case study on parcel delivery in Turin, Italy.

4 Learning Last-Mile Delivery Drivers' Behavior Using Machine Learning and Spatial Tessellation

Hesam Rashidi[1], Mehdi Nourinejad[2], Matthew Roorda[1], [1]University of Toronto, Toronto, ON, Canada; [2]York University, Toronto, ON, Canada. Contact: hesam.rashidi@mail.utoronto.ca

Delivery drivers develop tacit knowledge about their daily operating environment, enabling them to navigate the service region more efficiently over time. For instance, drivers may avoid neighborhoods during peak congestion periods or when parking availability is limited; these factors may be challenging to predict or incorporate into traditional optimization models. This study develops a human-centric optimization formulation for the Traveling Salesman Problem, aiming to incorporate the expertise and familiarity of in-field drivers. The framework integrates a Machine Learning classifier into a mathematical program to generate routes more likely to be taken by delivery drivers.

5 Coalition-Based Urban Delivery Network Design for the Hyperconnected City Logistics

Simon S. Kwon[1], Johan Leveque[2], Walid Klibi[3], Gautier Stauffer[4], Benoit Montreuil[5], [1]Georgia Institute of Technology, Atlanta, GA, [2]La Poste Group, Paris, France; [3]KEDGE Business School, Talence, France; [4]University of Lausanne, Lausanne, Switzerland; [5]Georgia Tech, Atlanta, GA, Contact: skwon82@gatech.edu

Motivated by the hyperconnected city logistics initiatives, this work addresses the design of hyperconnected urban parcel delivery networks engaging multiple independent delivery actors, modeling it as a coalition-formation game. The objective is to design coalition parcel delivery networks among multiple delivery actors such that the actors within the same coalition may cooperatively share resources (e.g., hubs/vehicles) to achieve their service levels (i.e., timely

origin-destination deliveries) robustly and efficiently. We develop a case study of major delivery actors within a major French urban area to understand the impact of coalitional decisions and different cost-allocation methods on the global and individual network design cost.

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CC-North 225B

Applications of Optimization - 2

Contributed Session

Session Chair: Junyao Yang, Auburn University, Auburn, AL

1 Economic Lot Sizing Problem with Tank Scheduling

Mehmet Önal[1], Wilco van den Heuvel[2], Erinç Albey[3], Ihsan Yanikoglu[4], [1]Özyeğin University, İstanbul, Turkey; [2]Erasmus University Rotterdam, Rotterdam, Netherlands; [3]Özyeğin University, istanbul, Turkey; [4]Özyegin University, Alemdag, Turkey. Contact: mehmetonal@gmail.com

We introduce a multiple-item economic lot sizing problem where items are produced through the fermentation of some raw materials. Fermentation takes place in specialized tanks that have finite capacities, and duration of the fermentation process is item dependent. When fermentation starts, the tanks are not available for the duration of the fermentation process. We analyze the complexity of this problem under various assumptions on the number of items and tanks. In particular, we show that several cases of the problem are (strongly) NP-hard, and we propose polynomial time algorithms to some single item cases. In addition, we propose a quick and simple heuristic approach for one of the multiple item cases.

2 Quick Mods: Shelf Space Optimization on the Fly

Mohit Batham[1], Rishi Bhatia[2], Khosro Pichka[3], Navina Kaur Sethi[4], Saipraveen Vabbilisetty[4], Apoorva Modali[3], [1]Walmart, Bangalore, India; [2]Walmart, BENTONVILLE, AR, [3]Walmart, Sunnyvale, CA, [4]Walmart, Dallas, TX

Deciding how to assign products to limited shelf space is one of the most challenging decisions for retailers. This can affect retailers' profit directly and help them to be more competitive. With supply disruptions and change in buyer preferences, merchants need the ability to make minor updates in store. We developed two optimization models to address this problem, for shelf & pegboards/bars. It tries to minimize the modular alterations per merchant's request and maximize the space allocation. The manual modular draw process requires weeks of lead time and engagement from multiple support teams. But this approach is an efficient solution for merchants to remove, add or even update shelf capacity for a number of products in stores. Quick Mods reduces the cost significantly by reducing the lifecycle of an update from 2 weeks to under an hour and bring sales through updates.

3 Network Design Model for Walmart's Omni-Channel Last Mile Delivery

Xinyue Peng, Yao Luo, Walmart, Sunnyvale, CA, Contact: xpeng37@wisc.edu

To support the design of Walmart's last mile delivery network for different types of offerings (scheduled and unscheduled delivery), we developed a scalable optimization model that generates the optimal last mile network configurations, including the location of delivery stations, catchment areas, and fleet mix. A novel aspect is the unified last-mile catchment design for various assets, such as stores, delivery stations, and market fulfillment centers. This integration minimizes total system costs while ensuring operational efficiency. The model adeptly handles different demand channels, promoting spatial optimization and efficient handling of scheduled and unscheduled deliveries.

4 Portfolio Optimization with Probability Estimated CVaR Objective and Return Constraints

Junyao Yang[1], Alexander Vinel[2], [1]Governors State University, University Park, IL, [2]Auburn University, Auburn, AL, Contact: jyang3@govst.edu

Business intelligence analysis for Financial asset management is well-developed with many applications nowadays. Portfolio optimization is traditionally stimulated by adequately modeling the requirements, including risks, returns, and computational efficiency. However, the optimization framework strictly relies on statistical principles and distribution assumptions, which contain no future information. In this work, we propose a three phases predict-then-optimize framework using AI and CVaR optimization. In particular, the approach can be used for maximizing expected predicted returns while minimizing the risk measured by the CVaR objective simultaneously. A case study for the portfolio of multiple US stocks is performed to demonstrate this new technique can be implemented.

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CC-North 226A

Statistical and Algorithmic Foundations of Reinforcement Learning

Community Committee Choice Session

Session Chair: Yuxin Chen, University of Pennsylvania, Philadelphia, PA

1 Policy Finetuning in Reinforcement Learning via Design of Experiments Using Offline Data

Andrea Zanette, UC Berkeley, Berkeley, CA

In some applications of reinforcement learning, a dataset of pre-collected experience is already availablebut it is also possible to acquire some additional online data to help improve the quality of the policy.However, it may be preferable to gather additional data with a single, non-reactive exploration policyand avoid the engineering costs associated with switching policies.

In this paper we propose an algorithm with provable guarantees that can leverage an offline dataset to design a single non-reactive policy for exploration. We theoretically analyze the algorithm and measure the quality of the final policy as a function of the local coverage of the original dataset and the amount of additional data collected.

2 Settling the Sample Complexity of Model-based Offline Reinforcement Learning

Yuting Wei, University of Pennsylvania, Philadelphia, PA

This paper studies multi-agent reinforcement learning in Markov games, with the goal of learning Nash equilibria or coarse correlated equilibria (CCE) sample-optimally. All prior results suffer from at least one of the two obstacles: the curse of multiple agents and the barrier of long horizon, regardless of the sampling protocol in use. We take a step towards settling this problem, assuming access to a flexible sampling mechanism: the generative model. Focusing on non-stationary finite-horizon Markov games, we develop an algorithm that can learn the equilibrium with optimal sample complexity.

3 Reinforcement Learning in Continuous Time: Learning Hamiltonian and Temperature Control

Wenpin Tang, Columbia University, New York, NY, Contact: wt2319@columbia.edu

Reinforcement Learning (RL) has been successfully applied to wide-ranging domains in the past decade. Recent years have witnessed a fast growing body of research that has extended the frontiers of continuous RL such as designing model-free methods and algorithms. In this talk, I will discuss the recently introduced "q-learning" through the lens of distributional control. Various problems such as policy optimization, Boltzmann exploration and temperature control will also be discussed.

4 When is Agnostic Reinforcement Learning Statistically Tractable?

Ayush Sekhari, Massachusetts Institute of Technology

We study the problem of agnostic PAC reinforcement learning (RL): given a policy class Π, how many rounds of interaction with an unknown MDP (with a potentially large state and action space) are required to learn an ϵ-suboptimal policy with respect to \(\Pi\)? Towards that end, we introduce a new complexity measure, called the \emph{spanning capacity}, that depends solely on the set \(\Pi\) and is independent of the MDP dynamics. With a generative model, we show that the spanning capacity characterizes PAC learnability for every policy class Π. However, for online RL, the situation is more subtle. We show there exists a policy class Π with a bounded spanning capacity that requires a superpolynomial number of samples to learn. This reveals a surprising separation for agnostic learnability between generative access and online access models (as well as between deterministic/stochastic MDPs under online access). On the positive side, we identify an additional \textit{sunflower} structure which in conjunction with bounded spanning capacity enables statistically efficient online RL via a new algorithm called POPLER, which takes inspiration from classical importance sampling methods as well as recent developments for reachable-state identification and policy evaluation in reward-free exploration.

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TE43

CC-North 226B

Scheduling & Demand Modeling in Aviation

Community Committee Choice Session

Session Chair: Alex Estes, 1</sup

1 Integrated Network Planning and Schedule Design for a Regional Airline

Alberto Santini[1], Vikrant Vaze[2], [1]University of Bologna, Caltanissetta, Italy; [2]Dartmouth College, Hanover, NH, Contact: vikrant.s.vaze@dartmouth.edu

We propose a new mixed-integer optimization formulation for jointly optimizing frequency planning, timetabling and fleet assignment decisions with endogenous passenger demand for a regional airline carrier. We develop a column generation-based approach for solving this joint optimization problem within reasonable runtime budgets. We also present a heuristic acceleration strategy for generating high quality solutions quickly for larger scale problems. Computational results demonstrate that our approach outperforms existing benchmark approaches, leading to significant gains in solution quality.

2 Airline Alliances and Schedule Convenience - Evidence from the Transatlantic Market

Volodymyr Purdue Bilotkach, 1</sup

3 Impact Assessment of Capacity Reduction Policies at Major Hubs: Network and Societal Implications

Sebastian Birolini, Nicolò Avogadro, Paolo Malighetti, University of Bergamo, Dalmine (BG), Italy. Contact: sebastian.birolini@unibg.it

We develop an airport⍰centric multi-objective flight scheduling and fleet assignment optimization model to assess the impact of capacity reduction initiatives at major hubs, aimed at alleviating congestion and improving their environmental footprint at short notice, possibly at little expense of passenger surplus. We deploy our model to address three main research questions: (i) investigate the impact of capacity reductions on the hub carrier's network connectivity and profitability; (ii) investigate trade⍰offs between airline profits, local passenger surplus, and CO2 emissions; (iii) investigate the impact and policy implications of different policies, i.e., the setting of air transport movements vs. CO2 limits.

4 Nonmonetary Allocation Under Congestion

Alexander Stewart Estes[1], Ankur Mani[2], [1]University of Maryland-College Park, Ellicott City, MD, [2]University of Minnesota - Twin Cities, Minneapolis, MN, Contact: aestes@umd.edu

We study the problem of allocating a finite set of resources to a finite set of agents with unit demand without monetary transfers. Agents may share a resource and bear a congestion cost, so that the utility that an agent derives from a resource is decreasing in the number of agents sharing that resource. One problem exhibiting similar characteristics is that of allocating arrival slots at an airport. We show that there does not exist a nonmonetary mechanism that produces a stable assignment and that incentivizes truthful revelation by all coalitions. We introduce an nonmonetary mechanism similar to an ascending auction, but where a specified level of congestion takes the place of a price. We find that the mechanism produces a stable assignment. In addition, we prove that this mechanism provides the smallest possible incentives for agents to deviate from truthful behavior.

1 Modeling Hub Dynamics in Long-Haul Aviation Markets

Nuno Ribeiro[1], Mingmei Li[1], Sebastian Birolini[2], [1]Singapore University of Technology and Design, Singapore, Singapore; [2]University of Bergamo, Dalmine (BG), Italy

We look at the strategic hub competition problem in long-haul markets at a global scale. We identify itinerary attributes affecting passengers' choices and integrate them into demand generation and allocation models to analyze the sensitivity of competition across airport hubs in the world.

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TE44

CC-North 226C

AI-driven Healthcare Analytics: Opportunities and Challenges

Community Committee Choice Session

Session Chair: Zheng Zeng, Rutgers University, Edison, NJ

1 An Integrated Framework of Multifaceted Machine Learning, Metaheuristics, and Braden Scale to Predict Hospital-Acquired Pressure Injuries (Bedsores)

Odai Dweekat, State University of New York at Binghamton, Binghamton, NY, Contact: odweeka1@binghamton.edu

Hospital-Acquired Pressure Injuries (HAPIs), known as bedsores, are the second most common diagnosis in healthcare system billing records in the US. The Braden Scale, commonly used to identify HAPIs, is limited by the number of factors that a caregiver can reasonably assess during patient care. Moreover, it identifies a large percentage of hospitalized patients as being at risk for developing HAPIs. This research aims to develop an integrated framework of multifaceted machine learning, metaheuristics, and Braden scale to predict if and when HAPI occurs. The proposed research achieves better performance than Braden and reduces the number of patients identified as at-risk. The research outcomes will provide guidance on early target intervention when it is needed most and will help reduce unnecessary burden on patients and care teams when patients are at lower risk.

2 Modeling Semantic Compositions for Clinical Risk Prediction

Weiting Gao, NJ

Clinical notes are valuable resources for clinical risk prediction. In clinical notes, medical terms commonly co-occur with modifiers, thereby providing additional information that indicates the clinical status or imposes specific constraints. Without capturing the modifiers, the model is likely to capture partial information or incorrectly comprehend the note. In order to learn semantics of the clinical notes correctly and comprehensively, the compositions of medical terms and their modifiers, referred to as medical facts, should be considered as important information units when making predictions. In this work, to enhance the models on capturing the *medical terms-modifiers* compositions, we propose a method to learn the representations of semantic compositions for medical facts and model the impact of medical facts on the predictive outcome.

3 How Does Insurance Coverage Affect Unclaimed Prescriptions and Physician's Behavior?

Zheng Zeng[1], Xiaowei Xu[1], Lian Qi[2], [1]Rutgers University, Piscataway, NJ, [2]Rutgers Business School, Piscataway, NJ, Contact: zzeng@business.rutgers.edu

China implements continuous health reforms for a universal health insurance system, improving affordability and accessibility. National Healthcare Security Administration (NHSA) regularly adjusts the insurance coverage rates for various drugs and services on the basic medical insurance list to dynamically and reasonably allocate the budget and offer patients the most needed support.
This study examines the effects of insurance coverage rates on unclaimed prescription rates and physicians' prescribing behaviors based on outpatient data from one of the largest regional hospitals in Liaoning, China. The results can aid NHSA and other decision-makers in adjusting insurance coverage rates for different drugs and services, managing the government medical budget, and optimizing the insurance system.

4 Trading One Evil for Another? - Analyzing Users' Attitude Towards E-Cigarettes

Anindita Bandyopadhyay, University of Iowa, Iowa City, IA

Sentiment analysis on publicly available content from BecomeAnEX, a smoking cessation platform, is used to understand users' perceptions of e-cigarettes. Through the evaluation of blog posts, group discussions, and comments from 2017 to 2022, we assess users' views on e-cigarettes as smoking cessation aids and factors leading to prolonged addiction. Employing a BERT-based multi-stage classifier model for sentiment classification, our research contributes to public health strategies by offering a comprehensive understanding of e-cigarette sentiments. It also aids in designing effective interventions by elucidating users' misconceptions and perspectives about e-cigarette usage, its role in addiction, and its effectiveness/non-effectiveness as a smoking cessation tool.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE45

CC-North 227A

Nonlinear Learning and Optimization

Contributed Session

Session Chair: Mehmet Kolcu, Norfolk Southern Corp., Atlanta, GA

1 A Quadratic Surface Support Vector Machine for Imbalanced Classification

Xinyu Xu[1], Fengming Lin[1], Zheming Gao[2], Shu-Cherng Fang[1], [1]North Carolina State University, Raleigh, NC, [2]Northeastern University, Shenyang, China. Contact: xxu37@ncsu.edu

This paper studies the problem of constructing a robust nonlinear classifier when the data set is imbalanced. Utilizing the hidden moment information embedded in the data points, a distributionally robust chance-constrained kernel-free quadratic surface support vector machine model is proposed. The proposed model is reformulated as a fractional programming problem with second-order cone constraints. Extensive computational experiments using synthetic and public benchmark data support the superior performance of the proposed model over other state-of-the-art models, particularly for classifying the imbalanced datasets. The proposed model also has dominating performance on a real-world application to battery failure prediction with highly imbalanced data.

2 Data-Driven Preference Learning Methods for Multiple Criteria Sorting with Temporal Criteria

Mengzhuo Guo[1], Yijun Li[2], Qingpeng Zhang[3], [1]SiChuan University, Cheng Du, China; [2]City University of Hong Kong, Kowloon Tong, Hong Kong; [3]City University of Hong Kong, Kowloon, Hong Kong. Contact: mengzhguo@outlook.com

This study presents a novel preference learning method for multiple criteria sorting problems with temporal information. Existing methods lack consideration of temporal dynamics.

Our approach utilizes additive piecewise-linear value functions as the basic preference model for each time point, employing a fixed time decay rate to aggregate values over the time series. By formulating the problem as a quadratic programming model, the solution relies on a subset of training samples. To enhance generalization, we incorporate arbitrary time decay rates and introduce a monotonic recurrent neural network (mRNN) to learn preference model parameters. The proposed mRNN ensures monotonicity and automatically adapts the time decay rate for extensive temporal data. We demonstrate the efficacy in evaluating the value of mobile game users, addressing a real-world problem.

3 Column Generation Methods for Solving Lot Sizing and Scheduling Problems with Sequence Dependent Setup Times

Kai-Yi Lin, Sheng-I Chen, National Yang Ming Chiao Tung University, Hsinchu, Taiwan. Contact: t311704038.mg11@nycu.edu.tw

The lot-sizing and scheduling problem with sequence-dependent setup times is a common and challenging problem in manufacturing industries. The problem complexity arises from the exponential number of possible production sequences to be considered and the weak relaxation solutions of its mixed-integer linear programs. This study reformulates the problem based on the Dantzig-Wolfe decomposition. We propose heuristics to obtain columns of production sequence decisions for each machine. Additionally, a compact formulation is used to reduce the number of binary decision variables and constraints in the mathematical programming model. Computational results display our approach performances using benchmarking problem instances.

4 Debugging Nonlinear Optimization Problems with the Dulmage-Mendelsohn Decomposition

Robert Parker[1], Bethany Nicholson[2], John Siirola[2], Lorenz Biegler[3], [1]Los Alamos National Laboratory, Los Alamos, NM, [2]Sandia National Laboratories, Albuquerque, NM, [3]Carnegie Mellon University, Pittsburgh, PA

Modeling a complex, nonlinear process can be a time-consuming and error-prone task. In nonlinear optimization, modeling errors often appear as rank deficiencies, which can violate assumptions made by the optimization solver or the model. The Dulmage-Mendelsohn partition helps debug such modeling errors by identifying unique subsystems of variables and constraints that are structurally over, under, or well-constrained. In this talk, we describe the Dulmage-Mendelsohn partition in the context of nonlinear optimization problems, give several examples of its application to problems from the IDAES process modeling framework, and present implementations for debugging optimization models in the Pyomo and JuMP algebraic modeling languages.

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5 Integrated Learning of Predictive and Prescriptive Tasks

Mehmet Kolcu[1], Alper E. Murat[2], [1]Norfolk Southern Corp., Atlanta, GA, [2]Wayne State University, Detroit, MI, Contact: mehmetkolcu06@hotmail.com

Traditional decision problems rely on constrained optimization, and real-world problems often contain uncertain parameters. In the presence of feature data pairs for uncertain parameters, a decision-maker can make prescriptions by solving the optimization problem with the pre-estimated parameters. This work proposes a two-stage neural network framework integrating predictive and prescriptive tasks to provide high-quality decisions, especially by capturing non-linearity between uncertain parameters and feature data pairs. While the predictive neural network feeds the decisions, the prescriptive neural network evaluates the decisions by minimizing the objective function and satisfying all the constraints. Overall, this work emphasizes the importance of neural networks in improving decision-making in uncertain and competitive environments.

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CC-North 227B

Data-driven Decision-making for Interconnected Systems

Community Committee Choice Session

Session Chair: Andi Wang, Arizona State University, Mesa, AZ

1 Fast Personalization for Heterogeneous Condition Monitoring Signals Using Neural Processes

Seokhyun Chung, Raed Al Kontar, University of Michigan, Ann Arbor, MI, Contact: seokhc@umich.edu

Personalization is crucial in modeling condition monitoring (CM) signals, as it provides personalized analysis for individual units while retaining population-level features. This study presents a neural process-based approach that enables fast personalization. Our method learns a distribution over signals and a mapping between a set of context points and the corresponding signal's distribution. This allows the model to rapidly infer the future evolution of CM signals by using available observations as contexts. Our model builds upon latent representation based on a mixture of Gaussians, parameterized by deep networks, to effectively handle the heterogeneity present in CM signals. Experiments show that our proposed model achieves faster personalization and improves predictive accuracy, particularly in scenarios involving heterogeneous CM signals.

2 Robust Generalized Scalar-On-Tensor Regression

Elif Konyar[1], Mostafa Reisi[1], Ruizhi Zhang[2], [1]University of Florida, Gainesville, FL, [2]University of Georgia, Athens, GA, Contact: elif.konyar@ufl.edu

High-dimensional (HD) data, such as images and profiles, are commonly collected from complex systems and contain significant explanatory information for systems monitoring and control. Therefore, developing accurate and robust predictive models based on HD data is crucial. In literature, various methods including scalar-on-tensor regression are developed to model a complex system based on HD data. However, they ignore the presence of outliers and are prone to biased estimations. This paper proposes a robust scalar-on-tensor regression framework that handles HD input data when the data contain outliers. Our proposed estimation method is constructed using maximum Lq-likelihood estimation instead of the classical maximum likelihood estimation. Several simulations and case studies evaluate the proposed method's efficacy compared to several benchmark methods.

3 Process Monitoring for Covariance Matrices with Latent Structures

Qing Zou[1], Jian Li[2], Dong Ding[3], Fugee Tsung[4], [1]Xi'An Jiaotong University, Xian, CN, China; [2]Xi'an Jiaotong University, Xian, CN, China; [3]Xi'An Polytechnic University, Xian, CN, China; [4]HKUST(GZ), Kowloon, Hong Kong. Contact: zouqing277@stu.xjtu.edu.cn

Principal component analysis (PCA) based monitoring methods are efficient for detecting additive faults. However, as faults occurring in the covariance matrix are not additive, conventional PCA based methods cannot detect them effectively. To this end, this paper aims to develop a series of efficient monitoring statistics for detecting covariance matrices with latent variables and sensor errors. They include two statistics in the principal component and residual subspaces, respectively, as well as a combined one. The proposed indices do not require knowledge of the remaining near-zero eigenvalues of PCA decomposition, and their detectability analyses and theoretical control limits are also provided. Furthermore, simulations have demonstrated their superiority over existing methods for detecting process/sensor covariance faults.

4 Two-Stage Infill Error Compensation for Cloud Printing

Hui Wang[1], An-Tsun Wei[2], [1]Florida A&M University-Florida State University College of Engineering, Tallahassee, FL, [2]Florida A&M University-Florida State University College of Engineering, Tallahassee, FL, Contact: hwang10@fsu.edu

Infill patterns in 3D printed parts crucially affect structure functionality. Yet, quality control can hamper productivity due to calibration and printing speed. This presentation proposes a cloud-based compensation method to maintain infill quality during rapid printing, optimizing productivity. The method adjusts extruder deposition volume at non-uniform printing locations, allowing high-speed printing with localized slower adjustments. The learning process consists of two stages: the pre-trained stage co-learns group patterns of non-uniformity probability and local conditions from cloud printers, and the fine-tune stage shapes individual infill pattern belief based on minimal data, referencing group patterns. This method enhances productivity and print quality for interconnected printers and practitioners with limited experience and data.

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TE47

CC-North 227C

Surrogate Models for Complex Systems

Community Committee Choice Session

Session Chair: Ashif Iquebal, Arizona State University, Tempe, AZ

Session Chair: Bo Shen, New Jersey Institute of Technology, Newark, NJ

1 An Improved Data-Driven Sequential Learning Framework Guided by Surprise Observations in Autonomous Experimentation Platforms

Ahmed Shoyeb Raihan, Imtiaz Ahmed, West Virginia University, Morgantown, WV, Contact: ar00065@mix.wvu.edu

Autonomous experimentation platforms (AEPs) can revolutionize the traditional material discovery process by searching intelligently for optimal material properties. While machine learning (ML) algorithms are great at identifying the complex relationship between the inputs and the target

property, they initially require a large amount of data to be trained. They are not feasible for use in AEPs. Bayesian optimization (BO) with a sequential learning framework, although effective in determining the optimal design points, is more exploitative and performs poorly in approximation tasks. We propose a surprise-guided framework which addresses all these challenges. Driven by the element of surprise, our proposed approach follows a sequential experiment design policy showing superior prediction performance with fewer data when compared to BO and popular ML methods.

2 Community/Committee's Choice Submission

Ridwan Olabiyi, Arizona State university, Tempe, AZ

3 Hierarchical Active Learning for Defect Localization in 3D Systems

Jianxin Xie[1], Bing Yao[2], [1]University of Tennessee, Knoxville, TN, [2]The University of Tennessee Knoxville, Knoxville, TN

Advanced sensing and imaging enable rich information retrieval from complex systems for personalized simulation and defect localization. This paper presents a Hierarchical Gaussian Process (HGPAL) framework for reliable defect localization in 3D systems. It combines advanced sensing and imaging with physics-based simulations to personalize models for detecting internal system defects. The HGPAL framework uses a two-step process: GP regression on 2D geometry embedding for capturing geometric info, and a Hierarchical GP-based active learning approach to account for system heterogeneity and estimate spatial-varying parameters. We evaluate the performance of the proposed HGPAL framework in a 3D body-heart system to identify and localize infarct in the heart. Numerical experiments demonstrate the effectiveness of our HGPAL framework for 3D defect localization.

4 Heterogeneity-Aware Federated Learning for Quality Control in Distributed Additive Manufacturing

Anyi Li[1], Jia Liu[2], [1]Auburn University, Auburn, AL, [2]Auburn University, Auburn, AL, Contact: azl0082@auburn.edu

Federated learning (FL) is a promising technique enabling privacy-preserving, collaborative learning with a network of distributed additive manufacturing (AM) manufacturers. However, the data among manufacturers are often heterogenous (i.e., non-IID) due to distinct machine specifications, hindering the FL deployment of distributed AM quality control. To alleviate this issue, we propose a heterogeneity-aware FL model to examine fabricated parts' quality in distributed AM, which handles non-IID data across distributed AM manufacturers. During training, it regulates and balances the model weights between global FL and local individual manufacturers' models to mitigate the non-IID constraints while maintaining their model performance. This model is evaluated by a simulation and case studies for quality control of the parts built by distributed 3D printers.

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CC-North 228A

Advancements in Spatial-temporal Analytics

Community Committee Choice Session

Session Chair: Fenglian Pan, University of Arizona, Tucson, AZ
Session Chair: Jian Liu, University of Arizona, Tucson, AZ

1 Decomposition Methods for Spatio-Temporal Hotspot Detection

Hao Yan, Arizona State University, Tempe, AZ, Contact: haoyan@asu.edu

Spatiotemporal hotspot detection is important in many applications such as pandemic monitoring, manufacturing process monitoring and video imaging data. In general, the goal for hotspot detection is not only detect when the hotspot happens but also localize the hotspot when it happens. In this talk, I will summarize existing works and some of our recent progress on the data decomposition methods for hotspot detection such as Bayesian extension, tensor extension, handling non-Gaussian data, etc.

2 An Integrated Uncertainty Quantification Model for Longitudinal and Time-To-Event Data

Ye Kwon Huh[1], Minhee Kim[2], Kaibo Liu[3], Shiyu Zhou[1], [1]University of Wisconsin-Madison, Madison, WI, [2]University of Florida, Gainesville, FL, [3]UW-Madison, Madison, WI, Contact: yhuh8@wisc.edu

We present a novel joint prognostic framework for the integrated analysis and uncertainty quantification of longitudinal data and time-to-event data. Specifically, the proposed integrated uncertainty quantification (IUQ) method models longitudinal data using functional principal component analysis, while the time-to-event data is characterized by a Bayesian neural network-based Cox model. The IUQ model achieves the following advantages: 1) Accurate remaining useful life predictions while seamlessly integrating the uncertainties of both sub-models; 2) Great flexibility in modeling both data types; 3) Real-time updates of the RUL distribution of in-service units; 4) Reliable RUL predictions under limited data availability. Numerical evaluations on synthetic and real-world battery data demonstrate the advantages of the IUQ model.

3 Spatter Trajectory Detection Using Tracking Methods in Laser Powder Bed Fusion Process for Quality Purposes

Mehrdad Moradi, Georgia Institute of Technology, Atlanta, GA, Contact: mehrdadmoradi@gatech.edu

Laser powder bed fusion (LPBF) has emerged as a promising additive manufacturing technique. However, its widespread industrial use faces a significant obstacle due to the lack of robust real-time monitoring techniques for detecting defects and anomalies. Recent research has extensively focused on utilizing spatter-related information for this purpose. Building upon this emerging literature, we propose an algorithm based on Kalman filter to track individual spatters in images and extract relevant statistics such as trajectory length, size, velocity, and more. By detecting the initial and landing points of spatters, one might be able to adjust the manufacturing process to prevent spatters from creating defects in the final part. We validate the proposed method using simulation and real data from an LPBF process.

4 Spatial-Temporal Triggering Pattern Recovery Using Large-Scale Recurrent Event Data

Fenglian Pan, Jian Liu, University of Arizona, Tucson, AZ, Contact: fenglianpan@arizona.edu

The triggering pattern embedded in spatial-temporal (ST) recurrent events provides valuable insight of the mechanism underlying event occurrences. It is of significant research value, yet methodological challenge, to accurately estimate such latent patterns from high-dimensional recurrent event data with complex ST structure. To tackle such challenges, this research proposes a ST latent triggering pattern representation by modeling the ST events as a multi-dimensional Hawkes processes. During the estimation procedure, regularization techniques are employed to learn the ST triggering pattern. A modified likelihood-based algorithm which combines techniques of EM and ADMM are proposed. The performance of the proposed model is demonstrated by a real-world case study.

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CC-North 228B

Advanced Data Analytics and Data-driven Sensor-based Modeling, Prediction, and Control for Complex Systems

Community Committee Choice Session

Session Chair: Phat Huynh, University of South Florida, Tampa, FL

Session Chair: Trung Le, University of South Florida, Tampa, FL

1 Noise-Robust Optimal Sampling Strategy for Multi-Scale Complex Systems Using Deep Reinforcement Learning

Phat Huynh[1], Trung Le[2], Dang Nguyen[3], [1]University of South Florida, Tampa, FL, [2]University of South Florida, Tampa, FL, [3]University of South Florida, Tampa, FL, Contact: huynh105@usf.edu

We propose a reinforcement learning framework that integrates multi-scale complex dynamics to define the reward signals for the agent and uses a deep Q-learning agent to determine the optimal data sampling strategy for capturing multi-scale and/or multi-physics dynamics. We employed the sparse identification of nonlinear dynamical systems (SINDy) algorithm for systems dynamics discovery and prediction, and validated the method using three case studies. The proposed method enables data-efficient reinforcement learning for multi-scale complex systems, facilitates the integration of different modeling techniques, and provides a principled approach for optimizing the data sampling strategy for controlling multi-scale systems.

2 Model Preditive Control in Optimal Interventional of the Covid-19 with Mixed Epistemic-Aleatoric Uncertainty

Jinming Wan[1], Changqing Cheng[1], Saeideh Mirghorbani[2], N. Eva Wu[3], [1]Binghamton University, Binghamton, NY, [2]Binghamton University, Binghamton, NY, [3]Binghamton University, Binghamton, NY, Contact: jwan8@ binghamton.edu

Non-pharmaceutical interventions (NPI) have been proven vital in the fight against the COVID-19 pandemic before the massive rollout of vaccinations. Considering the uncertainty of parameters, accurate simulation and modeling of the interplay between the NPI and contagion dynamics is critical to the optimal design of intervention policies. We propose a modified SIRD-MPC model, which combines a modified stochastic Susceptible-Infected-Recovered-Deceased (SIRD) compartment model with mixed epistemic-aleatoric parameters and Model Predictive-Control (MPC), to develop robust NPI control policies in containing the infection of the COVID-19 pandemic with minimum economic impact. The simulation result indicates that our proposed model can significantly decrease the infection rate compared to the practical result under the same initial conditions.

3 Semiparametric Evaluation of First-Passage Distribution for Step-Stress Accelerated Degradation Tests

Hon Keung Tony Ng[1], Lochana Palayangoda[2], Ling Li[3], [1]Bentley University, Waltham, MA, [2]University of Nebraska Omaha, Omaha, NE, [3]Xi'an Microelectronic Technology Institute, Xi'an, China

In reliability engineering, different types of accelerated degradation tests have been used for the reliability evaluation of highly reliable or expensive products. Step-stress accelerated degradation test (SSADT) is an experimental scheme that can be used to save the resources of an experiment. Motivated by the SSADT data for operational amplifiers collected at Xi'an Microelectronic Technology Institute, we propose a semiparametric approach for SSADT data analysis that does not require strict distributional assumptions. Specifically, the empirical saddlepoint approximation method is proposed to estimate the items' lifetime (first-passage time) distribution at both stress levels included and not included in the SSADT experiment. Monte Carlo simulation studies are used to evaluate the performance and illustrate the advantages of the proposed approach.

4 Feature Subspace Selection for High-Dimensional Data

Di Bo, Hoon Hwangbo, Stephanie TerMaath, University of Tennessee, Knoxville, Knoxville, TN, Contact: dbo@vols.utk.edu

This paper presents a novel feature selection approach that can identify important features and interactions in the form of feature subspaces. This identification is challenging as it requires intensive computations and complex model structures. To tackle this problem, the proposed method applies XGBoost that involves random generations of trees (each forming a feature subspace) and integration of significant base learners created for particular feature subspaces. The XGBoost outcomes are further fed into a partially-connected neural network to adjust the linkages within the subspaces and explore more unseen subspaces. Comparative studies demonstrate the advantages of the proposed method in predictions and feature (subspace) selections.

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Regional-scale, Community-informed Models for Electric Power System Resilience to Climate Change

Community Committee Choice Session

Session Chair: Ana Dyreson, Michigan Technological University, Houghton, MI

Session Chair: Mostafa Sahraei-Ardakani, University of Utah, UT

1 Resilience Oriented Optimization of Energy Storage and Solar Energy Sharing Systems in Residential Communities

Farzane Ezzati[1], Sasha Zhijie Dong[2], Qingyang Xiao[1], [1]University of Houston, Houston, TX, [2]University of Houston, Houston, TX, Contact: fezzati@cougarnet.uh.edu

This study proposes optimized energy sharing solutions for solar and energy storage technologies in residential communities to enhance their energy resilience during outages. A conditional value at risk stochastic programming is developed to optimally plan and schedule the devices while capturing normal and contingency uncertainties and ensuring the model robustness. Meanwhile, a multi objective optimization approach is utilized to maintain a balance between various resilience metrics. Lastly, mixed integer programming with scenario decomposition is explored for modeling and solution techniques. The proposed model's efficiency is evaluated using real case studies in Houston and Austin, paving the way for widespread adoption of renewable energy and increased energy resilience in residential areas.

2 Robust and Sustainable Power System Planning: Insights from Mexico and Ghana

Erin Baker, Univ of Massachusetts-Amherst, Amherst, MA

We combine work from Mexico and Ghana to indicate a way forward for community-informed models for electric power system resilience to climate change. We combine multiple Integrated Assessment Models with a single capacity planning model to derive robust climate mitigation pathways. We combine that with Value Focused Thinking to evaluate the sustainability of the pathways.

3 Toward More Energy Resilient Communities in Los Angeles

Kwami Senam A. Sedzro[1], Kapil Duwadi[1], Bryan Palmintier[2], Sherin Ann Abraham[1], Gayathri Krishnamoorthy[1], Greg Bolla[1], Jane Lokshin[1], Patricia Romero-Lankao[1], Nicole Rosner[1], [1]National Renewable

Energy Laboratory, Golden, CO, [2]National Renewable Energy Laboratory, Golden, CO

Equitable community energy resilience has not always been part of energy planning requirements. But as Los Angeles (LA) transitions toward 100% renewables, it is vital to understand and compare how resilient the city's neighborhoods are, to make sure that disadvantaged communities (DACs) are not left behind. Energy resilient communities keep reasonable access to critical services despite low-probability energy service disruptions. We investigate, for selected neighborhoods in LA, the impact of resilience events on access to key services such as electricity, grocery, hospital, shelter, and banking. Preliminary findings indicate that DACs are more vulnerable to energy service disruptions than non-DACs. We also found that resilience profiles vary by event type and that programs such as energy backups and microgrids can enhance equity in community energy resilience.

4 Pathways and Barriers to an Equitable Blue Economy

Jasmine McAdams, University of California, Berkeley, Berkeley, CA

The growth in demand for ocean-based resources such as food, materials, and energy reflect the growing importance of the blue economy in today's society. In particular, increased attention is being paid to marine renewable energy as key solution for mitigating the climate crisis. The equitable integration of marine renewable energy into local economies requires an understanding of the local economic impacts. This presentation will share some preliminary research findings of a marine energy jobs analysis evaluating forecasted workforce needs, the economic impact of new job opportunities, and the implications for frontline communities.

5 Balancing Wildfire Risk and Demand in Power Systems Expansion

Saeed Manshadi, Reza Bayani, San Diego State University, San Diego, CA

This presentation introduces an innovative approach to address the emergency measure of Public Safety Power Shut-off (PSPS) in wildfire-prone areas. We focus on the challenge of balancing wildfire ignition risk with energy supply continuity. We propose a quantified, robust optimization problem for long-term resilient expansion planning of power systems. The model offers a trio of expansion strategies: addition of new lines, modification of existing ones, and installation of Distributed Energy Resources (DERs). It integrates the uncertainties of DERs and wildfire risk, ensuring resilience against adverse events. Our case studies illustrate the model's ability to balance between customer shut-offs, DER installations, and line modifications while mitigating wildfire ignition risk.

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Modeling Aspects Towards Demand Response

Community Committee Choice Session

Session Chair: Victoria C. p. Chen, The University of Texas at Arlington, Arlington, TX

Session Chair: Jie Han, University of Texas at Arlington, Arlington, TX

1 Probabilistic Day-Ahead Electricity Price Forecasting with Transformer-Based Models

Jie Han[1], Shouyi Wang[1], Wei-Jen Lee[1], Jay Michael Rosenberger[2], Victoria Chen[1], [1]University of Texas at Arlington, Arlington, TX, [2]University of Texas-Arlington, Arlington, TX, Contact: jie.han@mavs.uta.edu

Electricity price forecasting is an essential task for market participants to make management decisions for day-ahead and intra-day energy markets. However, electricity price forecasting has become more and more challenging given the increasing penetration of stochastic renewable energy in recent years. In this study, we developed a new probabilistic deep learning model to achieve long-sequence multivariate time series modeling and forecasting. Our model is an integration of quantile regression and a multivariate time series transformer model. The developed probabilistic deep learning model has been applied to the day-ahead energy price forecasting of the Electric Reliability Council of Texas (ERCOT). The proposed method achieved superior forecasting performance compared with the state-of-the-art methods.

2 Demand Response Optimization Using Bi-Level Adaptive Dynamic Programming

Bahareh Nasirian, Victoria C. P. Chen, Jay Michael Rosenberger, The University of Texas at Arlington, Arlington, TX

In this research, we propose a bi-level stochastic dynamic programming model for an electricity market demand response problem in the residential sector. Three types of customers are represented: load serving entity, dynamic pricing customers, and fixed pricing customers. State variables consist of exogenous deterministic, exogenous stochastic, and endogenous stochastic. Additionally, the model incorporates multiple groups of energy sources, namely renewable energy (wind, solar), the grid, battery, and pre-purchased electricity. The objective is to minimize the cost of demand response decisions while satisfying electricity market needs. Due to the high dimensional state space, we utilize the Design and Analysis of Computer Experiments (DACE) based infinite horizon adaptive dynamic programming solution method.

3 Integer Programming for Non-Intrusive Load Monitoring Using Data-Driven Appliance Signatures

Marina Materikina[1], Eshan Singhal[1], Jay Michael Rosenberger[2], Victoria C. P. Chen[1], Wei-Jen Lee[3], [1]The University of Texas at Arlington, Arlington, TX, [2]University of Texas-Arlington, Arlington, TX, [3]The University of Texas at Arlington, Arlington, TX, Contact: marina.materikina@mavs.uta.edu

Rapidly developing renewable energy sources pose new challenges for utility companies' production and demand response (DR) planning. Studying customers' electricity consumption behavior can enhance the effectiveness of DR programs. Non-intrusive load monitoring (NILM) enables the analysis of individual appliance electricity patterns, fostering the connection between customers and energy providers. An integer programming algorithm utilizing data-driven appliance signatures was developed for NILM. The detailed signatures for modern state-based appliances (EV, AC, solar, washer, dryer) were studied using nonlinear programming and piecewise functions that depend on mode shapes. This approach, applied to low-frequency data, significantly improved load detection accuracy during the disaggregation phase.

4 Optimizing a System of Electric Vehicle Charging Stations Using Mixed Integer Linear Programming Computer Experiments

Ukesh Chawal, University of Texas at Arlington, Arlington, TX, Contact: ukesh.chawal@uta.edu

This paper formulates a mixed-integer linear programming model to optimize a system of EV charging stations, locations of EV charging stations, the number of charging slots to be opened, and expected profits from satisfying demand and electricity trading with the power grid. Then, a two-stage framework is considered that integrates the first-stage system design problem and second-stage control problem of the EV charging stations using a design and analysis of computer experiments based system design optimization approach. The first stage specifies the design of the system that maximizes expected profit. This approach generates a meta-model to predict revenue from the control problem using multivariate adaptive regression splines, fitted over a binned Latin hypercube design. Using the revenues from the control problem, the system design problem is then solved.

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Optimization for Efficient and Resilient Operation of Electric Grids

Community Committee Choice Session

Session Chair: Christine Chen, The University of British Columbia, Vancouver, BC, Canada

Session Chair: Antoine Lesage-Landry, Polytechnique Montréal, Montréal, Canada

2 Assessing Network Resilience Under an Optimal Water Pumping Control Strategy to Provide Frequency Regulation

Anna Stuhlmacher, Seth Guikema, Johanna L. Mathieu, University of Michigan, Ann Arbor, MI, Contact: akstuhl@umich.edu

Recent research has proposed optimizing the operation of the drinking water network and power grid jointly. However, it is critical that new operational strategies do not degrade network performance of the coupled power-water system. In this work, we investigate the impact of optimally scheduling and controlling water pumps in the drinking water distribution network to provide frequency regulation services to the bulk transmission system. We evaluate how changes in operational strategy from a traditional rule-based operation to an optimal pump scheduling operation may impact network resilience during and after a hazard event. In a case study, we demonstrate our approach by comparing the resilience metrics of three operational strategies.

3 Measurement-Based Locational Marginal Pricing in Active Distribution Networks

Roohallah Khatami[1], Severin Nowak[2], Christine Chen[3], [1]Southern Illinois University at Carbondale, Carbondale, IL, [2]Lucerne University of Applied Sciences and Arts, Lucerne, Switzerland; [3]The University of British Columbia, Vancouver, BC, Canada. Contact: roohallah.khatami@siu.edu

The use of distribution locational marginal prices (DLMPs) represents a promising solution to establish distribution-level real-time electricity markets. However, calculating DLMPs is more challenging than their transmission-level counterparts due to solving an optimal power flow (OPF) with nonlinear constraints. Further, accurate distribution network models that reflect the up-to-date operating point are often not available. As a solution, we propose a measurement-based method for calculating real-time DLMPs that relies only on online measurements collected at a subset of distribution system buses to estimate a linear sensitivity model mapping bus voltages to injections, which in turn is embedded in the OPF problem as an equality constraint. The proposed method is computationally efficient and obviates the need for an accurate distribution network model.

4 Online Dynamic Submodular Optimization for Power Systems

Antoine Lesage-Landry, Julien Pallage, Polytechnique Montréal, Mila & GERAD, Montréal, QC, Canada

We propose new algorithms with provable performance for online binary optimization subject to general constraints in dynamic settings. We consider submodular objective functions. We propose the online submodular greedy algorithm (OSGA) which solves to optimality an approximation of the previous round loss function to avoid the NP-hardness of the original problem. We extend OSGA to a generic approximation function. We show that OSGA has a dynamic regret bound similar to the tightest bounds in online convex optimization. For instances where no approximation exists or a computationally more efficient implementation is desired, we design the online submodular projected gradient descent by leveraging the Lovász extension. We obtain a regret bound that is akin to the online gradient descent. Finally, we numerically test our algorithms in two power system applications.

5 Topology-Aware Neural Networks for Power Systems

Agnes M. Nakiganda, Spyros Chatzivasileiadis, Technical University of Denmark, Lyngby, Denmark

Presently, most Machine Learning (ML) methods applied to complex power systems problems cannot capture changes in the grid topology. If an ML model has the capability to account for topology changes, it could handle the combinatorial explosion of *N-k* scenarios involved in the security analysis of power networks faster than conventional methods. This work presents physics-informed topology-aware Neural Network (NN) architectures (Graph NN, Guided dropout, One-hot encoded NN) for power flow computation and investigates their generalization capabilities in handling *N-k* security analyses. Furthermore, performance comparisons to the traditional Newton Raphson solver on various grid sizes are discussed. Finally, the interpretability of models based on graph theoretic principles is examined to foster the confidence needed for their adoption in real systems.

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CC-North 231A

Is the Environmental Impact as Primary Moderator of Sustainability?

Community Committee Choice Session

Session Chair: Biswajit Sarkar, [1</sup]

1 A New Moderator for Sustainable Supply Chain Management Towards Environmental Benefits

Rekha Guchhait, Biswajit Sarkar, Yonsei University, Seoul, Korea, Republic of. Contact: bsbiswajitsarkar@gmail.com

Almost every supply chain management sector moves toward a dual-channel policy because of the changing sustainable nature. This study designs a fourth-party logistics managed closed-loop dual-channel supply chain management that manages the product flow of reverse logistics. Fourth-party logistics formulates an integrated structure that takes the order from the manufacturer for recycled spare parts and finally delivers those required spare parts. The fourth-party service provider manages the execution of this entire process of reverse logistics with random demand for both the new products and recycled spare parts. The collected recycled spare parts through the proposed system are found to be more than the expected demand for spare parts. If 4PL can reduce the purchasing cost of used products from the collection center by 50%, the system can gain 55% more profit.

2 A Game Theoretic Approach for Evaluating and Pricing Alternative Business Models for Clean Technology Adoption: Applications to Solar Panels

J. Lemuel Martin[1,2], S. Viswanathan[3], [1]Cambridge CARES, Singapore, Singapore; [2]Nanyang Technological University, Singapore, Singapore; [3]Nanyang Technological University, Singapore, Singapore. Contact: jesuslj.martin@ntu.edu.sg

We model the interaction between a firm that manufactures and/or sells and installs solar panels and its customers under alternative business models from conventional sales to third-party ownership models such as leasing or power-purchasing agreement. Using price and solar panel maintenance level as decision variables, we look at the distinguishing factors that influence business model choice and develop pricing algorithms to account for customer heterogeneity. We also look at leasing models with minimum energy commitments and buyback policies.

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Machine Learning for Optimization

Community Committee Choice Session

Session Chair: Geunyeong Byeon, Arizona State University, Tempe, AZ

1 Learning to Optimize with Stochastic Dominance Constraints

Bo Dai, Georgia Institute of Technology, Atlanta, GA, Contact: bodai@cc.gatech.edu

In real-world decision-making, uncertainty is important yet difficult to handle. Stochastic dominance provides a theoretically sound approach to comparing uncertain quantities, but optimization with stochastic dominance constraints is often computationally expensive, which limits practical applicability. We develop a simple yet efficient approach for the problem, Light Stochastic Dominance Solver (light-SD). We recast the inner optimization in the Lagrangian as a learning problem for surrogate approximation, which bypasses the intractability and leads to tractable updates or even closed-form solutions for gradient calculations. We prove convergence of the algorithm and test it empirically. The proposed light-SD demonstrates superior performance on several representative problems ranging from finance to supply chain management.

2 Learning to Design Circuits

Vinod Nair, Google, Bangalore, India

Designing efficient hardware circuits from specification for modern chips is a challenging discrete optimization problem involving a large number of decision variables, with complex constraints and objectives. In this talk we present a machine learning-based approach to the problem that decomposes it into two sub-problems -- 1) optimizing for correctness with respect to specification, and 2) optimizing for hardware efficiency. Results show that our approach outperforms classical optimization techniques across a broad set of circuit design problems. It also enables better design flexibility by naturally allowing to trade off correctness for efficiency.

3 Accelerating Benders Decomposition via Exploration

Kaiwen Fang, Geunyeong Byeon, Arizona State University, Tempe, AZ, Contact: kfang11@asu.edu

We propose a Benders decomposition method that accelerates its convergence rate empirically through learning via statistical approaches that balance exploration and exploitation. Specifically, we present a novel algorithmic variant that strategically enriches and exploits information exchanged between decomposed problems for acceleration. A computational study on facility location problems demonstrates the computational benefits of the proposed method over state-of-the-art solution approaches.

4 Learning to Generate Columns

Minseok Ryu, Geunyeong Byeon, Arizona State University, Tempe, AZ, Contact: minseok.ryu@asu.edu

We propose an approach for randomized column generation (CG) that maintains the convergence characteristics of the classic CG technique, while simultaneously improving speed by learning from iterative information. To achieve this, we have modified the CG method to enhance information sharing between decomposed problems, which helps to generate effective columns. By conducting a computational analysis on mixed-integer linear problems, we have shown that our proposed method outperforms current solution approaches in terms of computational efficiency.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE55

CC-North 231C

Infrastructure Planning to Address Climate Change

Contributed Session

Session Chair: Ashkan Zare Hadesh, George Mason University, Fairfax, VA

1 The Fuels and Industry Integrated Optimization Model (FINITO)

Merve Olmez Turan, Maxwell Brown, Daniel Steinberg, National Renewable Energy Laboratory, Golden, CO, Contact: merve.olmezturan@nrel.gov

The evolution of the industrial sectors plays a crucial role on mitigating climate change and reaching net-zero emissions targets by 2050 in the United States yet detailed modeling efforts remain sparse. Therefore, discussion on industrial decarbonization strategies should consider economic and environmental objectives as well as relations with fuel and power sectors. In this presentation, we discuss the Fuels and Industry Integrated Optimization Model (FINITO) which is a spatially explicit, long-term capacity expansion model for the industrial and fuel supply sectors. We demonstrate both the methods of and implications on industrial, fuel supply, and power sector evolution by linking with the Regional Energy Deployment System (ReEDS), the National Renewable Energy Laboratory's flagship electricity capacity expansion model.

2 Managing Physical Assets: A Systematic Review and a Sustainable Perspective

Amir-Behzad Samii[1,2], Georgiana Sandu[1], [1]Vlerick Business School, Brussels, Belgium; [2]Zaragoza Logistics Center, Zaragoza, Spain. Contact: behzad.samii@vlerick.com

Physical Asset Management (PAM) has shifted from the negative image of asset failure and expensive maintenance to an enabler of sustainability that creates value from extended lifetime and renewed functions. We follow a systematic reviewing process enabled by text analytics methods to identify the approaches to building a sustainable perspective for PAM. Statistics and critical features extracted from over 2800 journal articles support our key contributions and insights. We particularly emphasize the research footprint and trends of the asset-intensive construction and energy sectors represented as barriers and enablers of sustainable development. We propose a conceptual framework that adopts an asset-within-a-system perspective, recognizes the links between the stakeholders, and holistically integrates the extracted research trends.

3 Sustainability-Aware Asset Investment Optimization

Nianjun Zhou[1], Pavankumar Murali[2], Dzung Phan[2], Anuradha Bhamidipaty[3], [1]IBM, Chappaqua, NY, [2]IBM Research, Yorktown Heights, NY, [3]IBM, Yorktown Heights, NY, Contact: jzhou@us.ibm.com

Sustainability-aware asset replacement has taken a prominent role in Energy & Utilities, supply chain, transportation, and other industries to meet the clean energy and zero emissions targets set by the 2030 Paris Agreement. This talk introduces a novel approach for asset replacement planning using sustainability scores together with asset health metrics. We prioritize assets to be replaced based on failure risk and criticality while aiming for the highest overall sustainability benefits. Our four-step approach includes computing asset sustainability posture, forecasting this posture over a planning horizon, enhancing the asset risk matrix with sustainability scores, and optimizing asset investment planning by incorporating these scores. We demonstrate the application of our methodology to distribution transformers in the Energy & Utilities industry.

4 Optimal Transportation Infrastructure Protection Investment Timing for Climate Change

Ashkan Zare Hadesh[1], Elise Miller-Hooks[2], [1]George Mason University, Fairfax, VA, [2]George Mason University, Fairfax, VA, Contact: azarehad@gmu.edu

Actions to protect transportation infrastructure against uncertain coastal flooding events and other risks from a changing climate involve major capital investments and long-term implementation schedules. Whether these investments will pay off or could be postponed to allow near-term investment in alternative community needs depends on the outcome of low-probability, but high-consequence events and their timing. This talk will describe OR-based methods to determine a best protective investment strategy and implementation timing toward protecting our transportation systems.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE56

CC-North 232A

Models for Energy Supply Chains

Contributed Session

Session Chair: Hyunhong Choi, Kyung Hee University, Yongin, Korea, Republic of

1 A Two-stage Spatiotemporal Predictive Framework to Forecast Mobility Patterns to Gas Stations

Zhiyuan Wei[1], Sayanti Mukherjee[2], [1]University at Buffalo, Buffalo, NY, [2]University at Buffalo - The State University of New York, Buffalo, NY, Contact: zwei7@buffalo.edu

Accurate demand forecasts for gas stations are fundamental to providing essential services to people, yet have received little attention in the literature due to data unavailability and lack of sophisticated predictive tools. Thus, we provide a new perspective for demand forecasts at gas stations leveraging large-scale human mobility data, and propose a novel two-stage data-driven framework mobility prediction. The first stage is to decompose the mobility patterns into spatial and temporal components, whereas the second stage is to model temporal dynamics using multivariate time series analysis. The results show that our model demonstrates the best predictive performance over multiple benchmark models for varying forecast horizons. The stability and reliability of the framework are also investigated through sensitivity analysis and robustness checks.

2 A Nationwide Hydrogen Supply Chain Deployment Plan for a Short-Term Hydrogen Supply Shortage

Seungyeop Lee[1], Hyunjoon Kim[2], Byung-In Kim[1], [1]Pohang University of Science and Technology (POSTECH), Pohang, Korea, Republic of; [2]Gachon University, Seongnam, Korea, Republic of. Contact: sylee1509@postech.ac.kr

A nationwide hydrogen supply chain deployment problem for mobility involves determining the sites and capacities of hydrogen refueling stations (HRSs), considering production, physical state, transportation, refueling, and demand. Short-term solutions entail on-site HRS installation to overcome supply shortages from existing facilities. To tackle this problem, we propose a two-stage optimization approach that includes demand and supply stages using mixed-integer linear programming models. In the demand stage, the optimal locations and capacities of HRSs are determined, along with demand allocation. In the supply stage, the installation of additional on-site production facilities for HRSs to be deployed and the supply allocation are determined. Realistic assumptions and high-resolution data are utilized to evaluate our proposed approach for 2025 and 2030.

3 Investigating Development Trends and Emerging Technological Topics in Hydrogen Sector Using Patent Data

Hyunhong Choi, Kyung Hee University, Yongin, Korea, Republic of. Contact: hongchoi@khu.ac.kr

As a promising alternative for the future energy system, hydrogen technology has been gaining significant attention, particularly recently. This study aims to investigate both the long-term development trends and recent emerging technological topics in the hydrogen technology sector. Specifically, using a structural topic model and patent data collected from the US Patents and Trademarks Office, we examine which topics led the previous key uptakes in the sector and which are likely to drive the next surge in hydrogen technology in the near future. Moreover, we provide a national-level comparison and decision-making tools for policymakers, enabling them to better understand and classify hydrogen technology.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE57

CC-North 232B

Perspectives on Adoption of Emerging Technologies

Contributed Session

Session Chair: Segev Wasserkrug, IBM Research - Israel, Haifa, Israel

1 Pride and Program: How Overconfidence Drives Crypto Asset Adoption

Dominik M. Piehlmaier, Emanuela Stagno, Maria Restuccia, University of Sussex, Brighton, United Kingdom

Despite large and persistent volatility, crypto assets have become an important investment tool over the past decade. However, little is known about the drivers of adoption of such assets and the reasons why some investors choose to bank on crypto assets in an early market with a lack of information and high volatility. We show that overconfident investors drive the expansion of crypto assets by expecting higher returns than mass-market investors. Using data from approximately 2,000 investors, 800 experimental participants, and more than 5.5 million transactions, we show that confidence in investment knowledge significantly increases the chances of investing in an early crypto market. However, objective knowledge has the opposite effect. Furthermore, overconfident early investors overtrade crypto assets and hurt their bottom line with every additional transaction.

2 Straying or Staying: The Impact of Token Incentives on User Defection and Retention

Jian Li[1], Xinyu Zang[2], Xiang(Shawn) Wan[3], Xi Zhao[1], Kenny Cheng[2], [1]Xi'an Jiaotong University, Xi'an, China; [2]University of Florida, Gainesville, FL, [3]Santa Clara University, Santa Clara, CA, Contact: xinyu.zang@warrington.ufl.edu

The prosperity of cryptoeconomics in recent years has highlighted the need for reliable crypto exchange platforms. Due to the significant issues associated with centralized exchanges, decentralized exchanges (DEXs), which are two-sided on-chain platforms without intermediaries, have emerged as a viable alternative. Based on a series of competitive events between two leading DEXs in the blockchain ecosystem, we empirically investigate the impact of tokenized incentives on user defection and retention. Our study provides valuable insights into motivating user engagement for DeFi applications and the broader blockchain community.

3 Leveraging the Internet of Things and an Understanding of Human Behavior in Condition-Based Preventive Maintenance

Mateus J do Rego F. Lima[1], Elliot Bendoly[2], Nathan C. Craig[3], [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, Worthington, OH, [3]Ohio State University, Columbus, OH, Contact: doregoferreiralima.1@osu.edu

We investigate settings where the Internet of Things augments condition-based preventive maintenance. Inspired by field case data and on-site observations, we observe work behaviors that undermine the full potential of this technical benefit and consider mitigation options. We delve into these issues through the use of a multimethod empirical perspective.

4 The Usage of Robotics, AI and Sensor Fusion to Meet Sustainability Goals in Technology Companies

Stavan Dholakia[1], Shivani Shukla[2], [1]Microsoft Corp, Seattle, WA, [2]University of San Francisco, San Francisco, CA

This paper investigates the integration of robotics, AI, sensor fusion and warehouse automation and order fulfillment to achieve sustainable operations. The aim is to drive sustainable practices, reduce resource consumption and enhance environmental performance. AI algorithms contribute to sustainability by optimizing processes and minimizing environmental impact. Metrics such as a 25% decrease in energy consumption, a 20% reduction in carbon emissions, and a 15% improvement in equipment uptime highlight the positive outcomes achieved through accurate demand forecasting, energy management, optimization and predictive maintenance facilitated by AI technologies. We compare the metrics of such an implementation in the context of a real-world application.

5 Who Benefits from Multi-Cloud? A Game Theoretic Analysis

Segev Wasserkrug[1], Shaul Rosner[2], Takayuki Osogami[3], [1]IBM Research - Israel, Haifa, Israel; [2]Reichman University - Israel, Herzeliya, Israel; [3]IBM Research - Tokyo, Tokyo, Japan. Contact: segevw@il.ibm.com

The benefits of cloud computing, along with its limitations such as provider lock in and geographical restrictions on data, are leading to the formation of a new multi-cloud market in which cloud users will be able to distribute their workloads easily and dynamically across different clouds. While this is expected to be beneficial to users, providers' income may reduce from such a move.
In this work, using trading networks, we formally analyze the multi-cloud market and show that, surprisingly, users may also pay more in such a market. Moreover, we show that with a centralized broker, it is almost always possible to create a multi-cloud market beneficial to all when assuming truthful revelation. Finally, we show that it many cases, using automated mechanism design, it is possible to learn mutually beneficial mechanisms where truthful value reporting is the dominant strategy.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE58

CC-North 232C

Network Analytics for Smart and Resilient Urban Systems

Community Committee Choice Session

Session Chair: Jinzhu Yu, 1</sup

1 Networked Systems: Going Beyond Topological Relations

Jürgen Hackl, Princeton University, Princeton, NJ, Contact: hackl@princeton.edu

Network science offers robust techniques for analyzing complex systems like power grids, transportation, communication infrastructures, and social networks. With increased access to data on networks with more than just dyadic relations, we can also understand when, where, and in which order these relations occur. Despite advances in data analytics and machine learning, applying these techniques to real-world data with complex characteristics remains challenging.
Novel approaches in network science are needed to address this challenge. This presentation introduces formal methods in network science for complex dynamic processes in transportation networks and spatially embedded systems. The focus is on space and time-aware network analytic methods that consider both temporal and topological dimensions of complex systems.

2 A Simulation-Based Optimization Approach for Resource Allocation Decisions Considering Organizational Dynamics

Shima Mohebbi, Pavithra Sripathanallur Murali, George Mason University, Fairfax, VA, Contact: psripath@gmu.edu

Traditional resource allocation models focus on centralized approaches, where there is a single decision maker, one set of resources, and one aggregated goal. However, many complex systems such as infrastructure systems are governed by several sectors working together. The collective performance of such systems is affected by various factors such as financial decision-making and communication protocols between sectors. We develop a hybrid simulation-based optimization model for decentralized resource allocations with applications in infrastructure systems. Dynamics of communication and financial decisions at organizational levels are captured by a system dynamics model while maintenance decisions and network performance are captured by an agent-based model. The proposed model is applied to water and transportation networks in the City of Tampa, FL.

3 An Optimal Control Approach for Additive Manufacturing Production with Waste Recycling Process

Shuo Linda Wang[1], Arian Sarrafan[2], [1]UT Arlington, Arlington, TX, [2]UT Arlington, ARLINGTON, TX

Economic damage due to the supply chain turmoil in the past few years has been more severe than the pandemic. The primary cause of such a crisis is that the current supply chain analysis tool, relying heavily on static optimization, is insensitive to non-eligible changes such as policy changes due to the pandemic. In this talk, the primary purpose is to achieve agile sustainability supply chain management through dynamic system modeling and control for such networks' production processes, which involves theoretical and numerical analysis. Several numerical cases are presented to demonstrate the applicability of this developed dynamic system and further discuss the potential optimal production.

4 Reconstructing Sparse Multiplex Networks with Application to Covert Networks

Jinzhu Yu[1], Jianxi Gao[2], Felipe Aros-Vera[3], Gisela Bichler[4], Mincheng Wu[5], [1]UT Arlington, Arlington, TX, [2]RPI, Troy, NY, [3]Ohio University, Athens, OH, [4]California State University, San Bernardino, San Bernardino, CA, [5]Zhejiang University of Technology, Hangzhou, China. Contact: yujinzhu88@gmail.com

The complete structure of real-world networks is often unavailable, thus it is crucial to develop approaches to infer a more complete structure of networks. To this end, we integrate the configuration model for generating random networks into an Expectation-Maximization-Aggregation (EMA) framework to reconstruct the complete structure of multiplex networks. We validate the proposed EMA framework against the Expectation-Maximization (EM) framework and random model on several real-world multiplex networks. It is found that the EMA framework generally outperforms the EM framework and the random model. The inferred multiplex networks can be leveraged to inform the decision-making on monitoring covert networks as well as allocating limited resources for collecting additional information to improve reconstruction accuracy.

5 Revealing Water Distribution Network Robustness to Link Failures Using a Novel Topological-Physical Measure

Xiangnan Zhou, Leonardo Duenas-Osorio, Rice University, Houston, TX, Contact: xz68@rice.edu

The functionality of a water distribution network (WDN) depends on multiple features including topology structure, element profile, and physical constraints. We propose a novel topological-physical measure, the weighted average source-terminal shortest path length ⍰, to approximate a WDN's capability to deliver water from sources to demand nodes. We use variations of ⍰ to estimate the impacts of pipe failures on a WDN's functionality revealing its robustness. We validate this measure with computational experiments, where pipe rankings using our approach are compared to those by hydraulic analysis, on four WDN test cases. A high correlation was identified between ranking results by the two approaches for all WDNs under single-link and two-link failure scenarios. Also, the critical pipe set identified by hydraulic analysis is always a subset of that by our approach.

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CC-West 101A

AHP / ANP and Extensions for a Better World: New Developments and Applications I

Community Committee Choice Session

Session Chair: Birsen Karpak, Youngstown State University, Canfield, OH

Session Chair: Ilker Topcu, Istanbul Technical University, Istanbul, Turkey

1 Rank Voting: The Closest to Voting with Intensity of Preferences

Luis G. Vargas, University of Pittsburgh, Pittsburgh, PA

Voting is the essence of democracy. One person one vote. It is also known that not everybody likes a candidate with the same intensity. So, how do we enter into the voting process the intensity with which we feel our support for a candidate, or our like/dislike for a candidate? In this paper we show using rank voting with an eigenvector method, that when all the candidates running for an election are ranked, as in Australia, the percent of votes captured by the candidates is close to the values one would obtain if each voter were allowed to express how strongly they prefer one candidate versus another. We show though simulations the convergence of both approaches.

2 Best Worst Method and Data Envelopment Analysis

Dariush Khezrimotlagh, Pennsylvania State University - Harrisburg, Middletown, PA

The challenge for decision makers is to choose appropriate weights for criteria despite their personal preferences. To address this issue, this study develops a linear procedure that balances decision makers' preferences with appropriate weights for criteria.

3 Modeling the IoT Adoption Barriers in Indian Micro, Small & Medium Enterprises Using an Integrated BWM-DEMATEL Approach

Sorokhaibam Khaba[1], Dibyajyoti Ghosh[2], [1]Institute of Management Technology, Dubai, United Arab Emirates; [2]Vellore Institute of Technology, Vellore Tamil Nadu, India. Contact: prinskhaba@gmail.com

The purpose of this study is to identify the ranking of the IoT implementation barriers in the Indian MSME industry and to develop the causal relationships among these barriers. The study has identified 19 barriers to IoT implementation in the Indian MSME industry, grouped into 4 main barriers from literature review and expert opinion. An integrated MCDM technique combining the BWM and the DEMATEL is used to evaluate the barriers. The study found that Technical Challenges and Socio-Environmental Challenges are the most important and the least important barriers respectively. The result from the causal relationship implied that 9 sub-barriers come under the cause group while the effect group includes 10 sub-barriers. The findings would give guidance and deeper insights into potential barriers to IoT adoption and take better strategies for successful IoT adoption.

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CC-West 101B

DEI Ambassador Program

Flash Session

Session Chair: Katy Wrenn, The Boeing Company, San Antonio, TX

Session Chair: Daniel Reich, Naval Postgraduate School, Monterey, CA

Session Chair: Banafsheh Behzad, California State University, Long Beach, Long Beach, CA

1 K-12 Outreach: Early Introduction to Operations Research

Afrooz Jalilzadeh, The University of Arizona, Tucson, AZ

There is a lack of awareness among middle and high school students about the benefits of Operations Research (OR) and how it can lead to better decision-making. Our project aims to address this gap by introducing OR to middle and high school students in Tucson, Arizona. Our approach involves a variety of interactive activities, informative presentations on OR applications, career paths, and the significance of diversity in STEM. In this talk, we will summarize our project's progress and share insights gained from our work with Tucson schools.

2 Guided Discussions on How Women Can Thrive

Aineth Torres, Fractal.ai, Austin, TX

This presentation will describe my experience facilitating the series of "Guided discussions on how women can thrive" which main objective is to critically explore within the INFORMS community what science says about the factors that drive women to suceed in their professional career as well as the obstacles they face, especially in STEM fields. A summary of the content exchanged during each session and the points of view shared by the participants will be included, as well as an overall assessment of the experience and potential extensions or future activities.

3 Survey of DEI Perspectives & Values

Andrea Hupman[1], Gul E. Kremer[2], Allison C. Reilly[3], Jun Zhuang[4], Amy Russ[5], Vivian Nwadiaru[6], Mubarak Iddrisu[7], Dayu Wu[8], Anh Phuong Ngo[9], Hamid Arzani[10], [1]University of Missouri - St. Louis, Saint Louis, MO, [2]University of Dayton, Dayton, OH, [3]University of Maryland, College Park, MD, [4]University at Buffalo, Buffalo, NY, [5]Synchrony, Duluth, GA, [6]University of Massachussetts Amherst, Amherst, MA, [7]University of Massachusetts Boston, Boston, MA, [8]University of Wisconsin, Madison, WI, [9]NCAT, Greensboro, NC, [10]Rotman School of Management, University of Toronto, Toronto, ON, Canada

Value focused thinking advocates beginning any decision-making process by carefully specifying values. The Decision Analysis Society (DAS) DEI Subcommittee is endeavoring to begin its efforts by focusing on values. This project teaches five graduate student fellows about value focused thinking. The student fellows and team members have developed and deployed a survey of INFORMS and DAS members' perspectives and values as they relate to activities promoting diversity and improving a sense of inclusion among all members in order to guide future programming activities and efforts. This talk summarizes the survey instrument and its findings.

4 To Future Medical Failures: Racial and Gender Bias in Research

Behshad Lahijanian, Gian-Gabriel P. Garcia, Nicoleta Serban, Georgia Institute of Technology, Atlanta, GA, Contact: blahijanian3@gatech.edu

Diversity, equity, Inclusion (DEI) is an inherently complex issues, and everyone makes their trade-off between perfect equality and dealing with historical inequality. Researchers always suffer from these biases between different genders, races, and under-represented minorities. This gender bias is more critical in human life. What's missing is an in-depth understanding of how women and men of different races respond differently to medications and other therapies, as well as other variables that profoundly influence human health. In this panel discussion, we will discuss these biases in healthcare research.

5 Active Engagement with DEI Students from Data-Related Master's Programs in the INFORMS Data Mining Society and Beyond

Ying Lin[1], Chun-An Chou[2], Nathan B. Gaw[3], [1]University of Houston, Houston, TX, [2]Northeastern University, Boston, MA, [3]Air Force Institute of Technology, Wright-Patterson AFB, OH, Contact: ylin58@uh.edu

Data science (DS) has drawn increasing attention in academia and every conceivable industry. As a result, there is ever-increasing motivation for students of diverse backgrounds to learn data mining and decision analytics (DMDA) skillsets for their future career. However, it brings apparent difficulties and barriers to train and foster students who were not in DS-related majors. As one of largest professional communities dedicated to OR and analytics research, we are responsible to provide a channel to consider diversity, equity, and inclusion (DEI) for students to participate in INFORMS events. This project conducted by the INFORMS Data Mining Society will contribute to furthering DEI of INFORMS within the data-related communities through attracting students from diverse backgrounds to participate in online seminars, workshops/conferences, and data challenges.

6 Well Informed Mentorship Program

Jessye Talley, Morgan State University, Baltimore, MD, Contact: jessye.bemleytalley@morgan.edu

Wellness and self-care are recognized as an essential part of optimal health and well-being. Creative interventions, seminars and the like are being incorporated in every system (corporate, non-profits, private practice and industry) to promote wellness. This movement is slowly being integrated into the academic setting. Wellness should be considered more than the latest trend; it should also be seen as a tool that prevents non-productivity, self- sabotage or conflict with self and others. The need for education, creative interventions and social support in the academy is vital for the success of all college students and professors. In this session we will highlight our DEIC project that showcases the self-care and wellness practices that we cultivated with OR/MS PhD students on the doctoral journey.

7 A Portal for Diverse OM/MS Teaching Resources

Margret Bjarnadottir[1], Jason Acimovic[2], [1]University of Maryland at College Park Robert H Smith School of Business, College Park, MD, [2]Penn State University, State College, PA, Contact: margret@rhsmith.umd.edu

The goal of this project is to make it easy for faculty to search for inclusive classroom materials by systematically collecting information about DEI cases and MS/OM cases with diverse actors and make them available through an online portal.

8 Adding Wings to the "Pride Forum" at INFORMS

Priyank Arora[1], Dwaipayan Roy[2], [1]University of South Carolina, Columbia, SC, [2]University of Virginia Darden School of Business, Charlottesville, VA, Contact: priyank.arora@moore.sc.edu

This project aims to help the new PRIDE Forum at INFORMS take-off and gain momentum ("add wings") in its initial phase. The PRIDE Forum comprises of individuals with self-identified interest in supporting or championing the interests of LGBTQ+ members.

9 Informs High School Outreach Strategic Initiative

Veronica White[1], Carmen Haseltine[2], Mary Ogidigben[3], [1]University of Wisconsin Madison, Madison, WI, [2]University of Wisconsin-Madison, Madison, WI, [3]Penn State University, State College, PA, Contact: vmwhite@wisc.edu

In 2022, we developed a workshop to introduce high school students to the field of Operations Research. The workshop was delivered to 28 students and was designed to increase student awareness, confidence, and contemplation of OR/MS using a motivational example of choosing social media influencers. Building upon the success of last year's project, we established yearly outreach workshops hosted by the UW-Madison and Penn State INFORMS student chapters that engage underrepresented minority students in OR/MS fields. Additionally, we created a comprehensive informational packet for INFORMS Student Chapters that serves as a standalone guide for student chapters to engage in high school outreach consistently. This talk will discuss the workshops held in 2023, the informational packet, and how to access it.

10 Informs DEI Research: How Can Your Research Help to Promote DEI?

Bing Si, State University of New York at Binghamton, Binghamton, NY

This project proposes a Diversity, Equity, and Inclusion Research (DEIR) initiative to showcase and highlight how the OR/MS research can help to promote DEI through the Research Pathway. The proposed DEIR initiative is inspired by the continued contribution on DEI promotion from our INFORMS researchers who have demonstrated that OR/MS research can help promote DEI in society by directly tackling challenges faced by under representative populations. Under this initiative, a DEIR-featured session is organized in the 2023 INFORMS Annual Meeting, jointly listed by Quality, Statistics, and Reliability (QSR) and Data Mining (DM), to recognize and promote the contribution of OR/MS research on addressing real-world challenges in public health and policy to better serve the diverse population of individuals.

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CC-West 101C

Health Delivery Challenges in Low-Income Settings

Community Committee Choice Session

Session Chair: Jérémie Gallien, London Business School, London, United Kingdom

1 Optimal Geographic Assignment Guidelines for Maternity Waiting Homes in Resource-Limited Environments

George Chen[1], Yuhang Du[1], Jérémie Gallien[1], Jody Lori[2], [1]London Business School, London, United Kingdom; [2]University of Michigan, Ann Arbor, MI, Contact: ydu@london.edu

Maternity waiting homes (MWH) constitute an effective intervention for reducing maternal mortality where timely access to a skilled birth attendant is difficult. MWH operations present challenges due to limited accommodation capacity and delivery date uncertainty however. We consider the problem of whether and when a pregnant woman should go to a local MWH with given capacity based on her health profile and living location. We use variational calculus to derive closed-form assignment policies within an MWH catchment area, perform numerical experiments to evaluate the impact of potential associated interventions in the country of Liberia, and develop related recommendations.

2 When Should Fractional-Dose Vaccines be Used?

Naireet Ghosh[1], Jérémie Gallien[1], Francis de Véricourt[2], [1]London Business School, London, United Kingdom; [2]European School of Management and Technology, Berlin, Germany. Contact: nghosh@london.edu

Fractional-dose vaccines constitute a potential epidemic intervention when available vaccine stockpiles are limited. While fractional-dose vaccines help expand coverage, they are less efficacious and hence lead to a slower buildup of population immunity when the speed of vaccine administration is constrained. We use an optimal control model to analyze this tradeoff and derive a simple and easily implementable vaccination policy relying on a combination of full and fractional-dose vaccines. We perform extensive numerical experiments to investigate the population health benefits and risks associated with this policy relative to single-dose alternatives, and develop policy recommendations based on the available stockpile and maximum vaccination speed.

3 Empowering the Frontline Health Workers to Tackle Stock-Outs: Empirical Evidence from Indonesia

Amir Karimi[1], Anant Mishra[2], Karthik V. Natarajan[2], Kingshuk K. Sinha[2], [1]Alvarez College of Business, The University of Texas at San Antonio, San Antonio, TX, [2]Carlson School of Management, University of Minnesota, Minneapolis, MN, Contact: a.karimi@utsa.edu

In low and middle-income countries, frontline health workers are frequently tasked with the non-clinical responsibility of inventory management for which they are not adequately trained. While training programs can improve the skills of frontline health workers in managing inventories, we have a limited understanding of the conditions under which the benefits from such trainings are more or less pronounced. To address this gap, we analyze novel and proprietary field data from a large-scale training program of frontline health workers in Indonesia, comprising more than 2 million observations from nearly 18,000 health facilities.

4 Managing Essential Gatherings During the Pandemic: The Case of Agricultural Procurement During Covid-19 in India

Hemanshu Das[1], Sarang Deo[2], Sripad K. Devalkar[3], Nimalan Arinaminpathy[4], [1]Yale University, New Haven, CT, [2]Indian School of Business, Hyderabad, India; [3]Indian School of Business, Hyderabad, India; [4]Imperial College,

London, United Kingdom. Contact: sarang_deo@isb.edu
Certain multi-day events of social and economic importance must be held during a pandemic despite their transmission risk. Limiting crowding may reduce transmission at these events within a day but may end up prolonging the overall event duration thereby increasing the overall disease transmission due to the growth of the pandemic in the community over this period. We explore this trade-off using a stochastic, compartmental model in the context of agricultural procurement centres in Punjab, India. We find that the impact of event duration depends on the local epidemiological context. Specifically, counter to intuition, shorter duration is preferred if the event is held in the period of rising infections in the surrounding community.

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CC-West 102A

Scheduling Theory and Its Contemporary Applications

Community Committee Choice Session

Session Chair: Zhixin Liu, University of Michigan - Dearborn, MI

1 Scheduling Chains Using Sublinear Time or Sublinear Space

Hairong Zhao, Purdue University Northwest, Hammond, IN

We study the problem of minimizing makespan on identical parallel machines with precedence constraints. We specifically consider precedence graphs composed of chains. Our goal is to develop approximation algorithms for this problem that utilize sublinear space or sublinear time. These algorithms have practical applications in big data modeling. The techniques used in this research can provide insights for developing algorithms for other problems.

2 Human-Machine Collaboration Scheduling with Serial and Parallel Jobs

Gongjie Xu, Jun-Qiang Wang, Chenmin Liu, Northwestern Polytechnical University, Xi'an, China. Contact: pacpos.gjxu@gmail.com

We study a human-machine collaboration scheduling problem with parallel and serial jobs to minimize the makespan. A parallel job is simultaneously processed by a human and a machine. A serial job is first processed by a human and then processed immediately by a machine. For the problem with parallel jobs, we design an approximation algorithm and analyze its performance. For the problem with serial jobs, we design two heuristic algorithms and verify the effectiveness of the algorithms by experiments.

3 Scheduling for Patient-Centered Care and Outcomes for Chronic Conditions: Challenges and Opportunities

Charu Chandra[1], Zhixin Liu[2], [1]Univ of Michigan- Dearborn, Dearborn, MI, [2]University of Michigan-Dearborn, Dearborn, MI, Contact: charu@umich.edu

The Institute of Medicine defines patient-centered care as “Providing care that is respectful of, and responsive to, individual patient preferences, needs and values, and ensuring that patient values all clinical decisions.” A segment of patients requiring this care regime are elderly with chronic conditions, such as Alzheimer, and congestive heart failure. Due to the nature of their care, these patients are frequently treated by a cadre of caregivers, ranging from a PCP, specialists, nurses, nurses' aides, therapists, etc., often with overlapping and/or coordinated schedules. To accommodate these special care needs, a linear schedule is not feasible. We look at what challenges and opportunities exist for such scheduling and investigate a viable multi-tiered, flexible, and dynamic constrained scheduling solution.

4 Research on Optimization of Material Dispensing Path Selection at the Front End of Production Line

Wei Si[1], Jianbin Li[2], [1]Huazhong University of Science & Technology, Wuhan, China; [2]Huazhong University of Science & Technology, Wuhan, China

With the improvement of productivity level, the competition between enterprises is increasing. Meticulous production is gradually becoming the inevitable trend of enterprise survival and development. In such an economic environment, enterprises rely on manual experience. A lack of scientific guidance in decision-making will substantially increase costs while reducing operational efficiency. In order to achieve cost reduction and increase efficiency and improve enterprise competitiveness, this paper considers inventory cost and material backflow, establishes a material distribution path selection model for the front-end material distribution link in intra-enterprise logistics, and uses a two-stage heuristic algorithm based on local search to solve it.

5 Dynamic Seat Assignment with Social Distancing

Zikang Li, Xiangtong Qi, Qian Liu, The Hong Kong University of Science and Technology, Hong Kong, China

This study addresses the dynamic seat assignment problem with social distancing, which arises when groups arrive at a venue and need to be seated together while respecting minimum physical distance requirements. To tackle this challenge, we develop a scenario-based method for generating seat plans and propose a seat assignment policy for accepting or denying arriving groups. We also explore a relaxed setting where seat assignments can be made after the booking period. The results provide insights for policymakers and venue managers on seat utilization rates and offer a practical tool for implementing social distancing measures while optimizing seat assignments and ensuring group safety.

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CC-West 102B

Recent Developments in Digital Platform Operations

Community Committee Choice Session

Session Chair: Dongwook Shin, HKUST Business School, Clear Water Bay, Hong Kong

Session Chair: Bharadwaj Kadiyala, University of Utah, Salt Lake City, UT

1 Sponsored vs. Programmatic: A Theoretical Analysis of Advertising Strategy on Digital Content Platforms

Kun Qian, Southern University of Science and Technology

Advertisers can reach online content audiences through two channels: programmatic advertising, which involves delivering ads through digital bidding for ad spots controlled by the platform (e.g., YouTube), and sponsored advertising, which involves ad directly sponsoring content creators who include paid product placements or endorsements in their content. The platform may lose revenues if advertisers choose to sponsor creators instead of delivering programmatic ads. This paper employs a game-theoretic model to examine the platform's incentives for allowing or disallowing sponsored advertising and the implications of its advertising strategy on online content innovation, profits, and surpluses.

2 Search in Omnichannel Operations via Information Design

Ailing Xu[1], Qiao-Chu He[2], Ying-Ju Chen[3], [1]The Hong Kong University of Science and Technology, HongKong, China; [2]Southern University of Science and Technology, ??, ??, China; [3]The Hong Kong University of Science and Technology, Kowloon, Hong Kong. Contact: axuaj@connect.ust.hk

This paper examines how firms manage consumer search and purchase behaviors in omnichannel operations via information design. We propose a sequential search model, where consumers are allowed to search either channel or both and choose to purchase or leave at any stage of the search process. By fine-tuning information structures, we can synergize both channels to navigate consumer search and coordinate channel competitions. The optimal signal structure is either a two-interval or three-interval policy online, which is shaped by the complementarity effect between two channels and the tension between the persuasion incentive and the attraction incentive. Especially, when product values are perfectly correlated, firms obfuscate extreme (low-end and high-end) match values and mix intermediate match values to differentiate consumer search patterns in two channels.

3 The Value of Customer-Related Information on Service Platforms: Evidence from a Large Field Experiment

Zhiyu Zeng[1], Nicholas Clyde[2], Hengchen Dai[3], Dennis Zhang[4], Zuo-Jun Max Shen[5], [1]Tsinghua University, Beijing, China; [2]Washington University in St. Louis, SAINT LOUIS, MO, [3]UCLA Anderson School of Management, Los Angeles, CA, [4]Washington University in St Louis, ST LOUIS, MO, [5]University of California Berkeley, Berkeley, CA, Contact: nsclyde@wustl.edu

We conducted a field experiment on a live-streaming platform that connects hundreds of millions of viewers with individual broadcasters. When viewers entered shows, we provided viewer-related information to broadcasters who were randomly assigned to the treatment condition (but not to control broadcasters). Our analyses, involving a random subsample of 49,998 broadcasters, demonstrate that relative to control broadcasters, treatment broadcasters expanded service capacity by 12.62% via increasing both show frequency (3.31%) and show length (7.10%), thus earning 10.44% more income, based on our conservative estimate. Moreover, our intervention increased service enjoyment (measured by viewer watch time) by 4.51%. Additional analyses about the field experiment and two surveys involving 1,229 broadcasters shed light on the mechanisms.

4 The Economics of Ghosting

James Siderius[1], Mohamed Mostagir[2], [1]Dartmouth College, Hanover, NH, [2]University of Michigan, Ann Arbor, MI, Contact: jpsiderius@gmail.com

Ghosting is a phenomenon where communication between two parties abruptly stops after one side becomes deliberately unresponsive. This occurs in a variety of settings and applications, but the term entered the mainstream after its usage to describe an important aspect of the online dating experience that, surprisingly, has been sparsely studied. Both online dating platforms and users report that ghosting is one of the primary drivers hurting user experience and preventing good outcomes. We develop a model of ghosting and study the optimal communication policies that platforms can implement. Interestingly, we show that no structure on communication, or alternatively, eliminating ghosting altogether, can both result in lower welfare for users.

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CC-West 102C

Resource Management in Services

Contributed Session

Session Chair: Xi Shan, Bemidji State University, Bemidji, MN

1 Dynamic Resource Sharing in Private 5g Networks with Slicing

Demet Batur[1], Jennifer K. Ryan[2], Mehmet C. Vuran[1], [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska - Lincoln, Lincoln, NE, Contact: dbatur@unl.edu

We propose a Markov Decision Process model to study the decision problem faced by the operator of a private 5G network, known as a private cell, who must allocate available capacity to meet the resource needs of the primary user of the network, but who may also lease excess capacity to external secondary users to generate additional revenue. Private cells are privately-owned, local wireless networks independent of commercial or public 5G networks. Such networks have recently been implemented in factories, warehouses, hospitals, ports, and campuses. Network slice instances are units of demand from the primary user, requiring specific resource combinations, such as spectrum, computation, or storage. We use the model to characterize the optimal real-time admission decisions for the slice instances, and leasing and cancellation decisions for the secondary user demands.

2 Optimizing the Call Center Headcount of the Largest Bank in Perú, BCP

Alvaro Evangelio, Alfonso Barriga, Cynthia Yacel Fuertes, Banco de Crédito de Perú, Lima, Peru. Contact: alvaroevangelio@bcp.com.pe

We combine machine learning and optimization to determine the optimal number of call center operators in a call center of BCP, the largest bank of Peru. We use empirical data to calibrate the service level as a function of the number of operators. We applied these methods and achieved a 10% reduction in the number of call operators combined with an improvement of service level.

3 Satiation and Motivation for the Long Run: What Motivates Physicians in Online Communities?

Panpan Wang[1], Jifeng Luo[2], Zhiyan Wu[3], [1]Zhejiang University of Finance and Economics, Hangzhou, China; [2]Shanghai Jiao Tong University, Shanghai, China; [3]Shanghai University of International Business and Economics, Shanghai, China

A variety of incentives have been adopted to encourage voluntary contributions in online communities. However, the majority of related research either examines the effect of incentives over the short run or ignores the interplay between supply-side contributions and demand-side requests in multisided platforms. From a two-sided perspective, our study investigates the time-varying effects of different incentives on physician contributions in a doctor-patient interaction platform. The main challenge faced when addressing this problem is a simultaneity and reverse causality issue. We adopt simultaneous equation model to cope with this problem. Our results verify the existence of satiation and the time-varying effects of different incentives on the examined physicians' efforts.

4 Consequences Of Long Lead Time - Evidence From The Israeli Court System

Shany Azaria[1], Noam Shamir[2], [1]Tel Aviv University, Tel-Aviv, Israel; [2]Tel Aviv University, Tel Aviv, Israel. Contact: azaria.shany@gmail.com

This paper describes a data-driven approach to study negative consequences of congestion, demonstrated in court system environment. Combining two extensive and unique datasets from the Israeli court system, we aim to econometrically estimate the effect of long lead times, an outcome of congestion, on real demand for judges' effort caused by changes in work content induced by the customers. We propose a rigorous analysis to deal with the empirical challenges of reverse causality between lead time and effort using the two exogenous shocks to lead time as IVs. Our findings suggest that delay causes a significant increase in judges' effort and in the probability of cases ending with judgments on merits, thus increases demand. These findings contribute to understanding judicial system dynamics and offer insights for enhancing efficiency.

5 Vertical Contracting with Information Asymmetry: Do Secret Offers Hurt a Channel?

Xi Shan[1], Lixin Ye[2], Chenglin Zhang[3], [1]Bemidji State University, Bemidji, MN, [2]The Ohio State University, Columbus, OH, [3]Southwestern University of Finance and Economics, Chengdu, China

We consider the issue of contract confidentiality in a decentralized supply chain, where a manufacturer produces for two downstream competing retailers. When the contracts are observed secretly, we follow the vertical contracting literature by assuming that agents hold "passive beliefs" about the other agent's contract terms. Surprisingly, secret contracts may improve channel profit as they can involve either downward or upward distortion, and channel coordination can be achieved under certain conditions. Our analysis highlights the interplay between the distortion caused by the principal's lack of commitment and the distortion resulting from the agents' private information. Additionally, our findings offer an explanation for the importance and prevalence of protecting agents' contract confidentiality in practice.

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CC-West 103A

Managing in Innovative Environments

Community Committee Choice Session

Session Chair: John N. Angelis, University of Lynchburg, Lynchburg, VA

Session Chair: Juliana Hsuan, Copenhagen Business School, Frederiksberg, Denmark

1 Advancing Digital Servitization Strategies for Sustainability

Juliana Hsuan, Copenhagen Business School, Frederiksberg, Denmark. Contact: jh.om@cbs.dk

The ongoing efforts by manufacturing companies to embrace sustainability requirements into their product-service-software offerings entail development of innovative solutions to integrate and share information among the stakeholders in the ecosystem. Potential pitfalls and traps when embarking on digital servitization journey as well as measurement considerations are shared. Opportunities for inter-disciplinary research are proposed.

2 Building Emotion Vectors Using Twitter Data

Nitin Mayande[1], Charles M. Weber[2], [1]Tellagence, Naperville, IL, [2]Portland State University, Portland, OR

Emotion Vectors represents a valuable framework for analyzing and modeling human emotional states. By capturing the multidimensional nature of emotions, these vectors provide a structured and quantitative approach to understanding emotional experiences. In this empirical research, we gathered Twitter data for 8 basic emotions (joy, fear, trust, surprise, sadness, disgust, anger and anticipation). We built multiple Emotion Vectors with varied-time data aggregations (1 week, 2 weeks, 3 weeks,4 weeks, 6 weeks, 8 weeks, and 12 weeks). In this presentation, we present our initial results regarding the viability of varied-time Emotion Vectors in predicting the emotions of future data sets.

3 A Leadership Model for Volatile, Uncertain, Complex, and Ambiguous Organizational Environments

Charles M. Weber, Dahm Hongchai, Portland State University, Portland, OR, Contact: webercm@pdx.edu

The organizational environment of the 21st Century is becoming increasingly volatile, uncertain, complex, and ambiguous (VUCA). This paper shows that successful leadership in a VUCA environment requires approaches that focus on problem solving, relationships, empathy, and motivation (PREM), as well as integrating three traditional perspectives: authentic leadership, servant leadership, and adaptive leadership. This paper presents a model for PREM and a research agenda from which best practices for leadership in technology management in a VUCA world will hopefully emerge.

4 Exploring the Impact of Increased Resources on Preventing Customer Data Breaches

John N. Angelis[1], Rajendran Murthy[2], [1]University of Lynchburg, Lynchburg, VA, [2]Rochester Institute of Technology, Henrietta, NY, Contact: angelis@lynchburg.edu

Data breaches represent a significant threat to consumer privacy and financial well-being. Previous studies have shown that the firm is sometimes better off shifting blame or justifying their actions rather than fully apologizing for the data breach. We explore whether customers would be more concerned about the damage from data breaches if they were more empowered to prevent data breaches. However, we find that cybersecurity education, prior experience, and other improvements did not result in meaningful change to customer behavior as expected. Thus, data breaches would not diminish, and customers are highly susceptible to privacy fatigue.

5 Impact of Industry 4.0 Technologies on Operator Learning Curves: A Comparative Study in a Manufacturing Environment

Flavio Fogliatto, Universidade Federal do Rio Grande do Sul, Brazil

We examine the effect of Industry 4.0 (I4.0) technologies adoption on the learning process of operators modeled by learning curves. Data from the training of twenty new operators in a quality inspection workstation of an auto parts manufacturer was collected under two scenarios: before and after the adoption of I4.0 technologies to support the operation. A 2-parameter hyperbolic model was used to model the learning process. Results indicated that operators supported by I4.0 technologies had a significantly higher learning rate than those without I4.0 support. No significant difference was found in the final performance level between groups.

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CC-West 103B

Behavior-based Data Analytics

Community Committee Choice Session

Session Chair: Yuqian Xu, UNC-Chapel Hill Kenan-Flagler Business School, Chapel Hill, NC

1 Incentivizing Healthy Food Choices Using Add-On Bundling: A Field Experiment

Nymisha Bandi, McGill University

Retailers can use price, convenience, and taste to incentivize customers to make healthier food choices, but these options are often expensive and infrequently promoted. Recent efforts in deploying healthy nudges to incentivize customers toward healthier food choices have been observed. We conducted a field experiment with a global convenience store chain to better understand how different add-on bundle promotions influence healthy food choices. We considered three types of add-on bundles: (i) an unhealthy bundle, (ii) a healthy bundle, and (iii) a choice bundle. In addition to our field experiment, we conducted an online lab study to strengthen the validity of our results.

2 On the Granularity of Wait Time Information: A Large-Scale Field Experiment on a Major Ride-Sharing Platform

Yiming Zhang[1], Qiuping Yu[2], Yong-Pin Zhou[3], [1]Chinese University of Hong Kong, Shenzhen, China; [2]Georgetown University, Washington, DC, [3]University of Washington, Seattle, Seattle, WA, Contact: zhangyiming@cuhk.edu.cn

Collaborating with a ride-sharing platform, we study whether and how the granularity of wait time information (WTI) impacts customers abandonment behavior through a randomized field experiment on our partner platform. In the experiment, we consider a point estimate, a narrow interval, and a wide interval of WTI. To uncover the fundamental mechanism, we propose a structural model to explore the impacts of granularity of WTI on customers' prior beliefs and waiting cost-reward ratios. We also discuss the managerial implication of our findings.

3 Impact of Workload and Task Complexity on Psychological Counsellors in Appointment Scheduling

Yuchen Liang[1],

The growing demand for mental health services, exacerbated by the COVID-19 pandemic, has placed significant strain on psychological counsellors, posing unique challenges for counselling clinic operations. This paper focuses on the impact of mental stress on counsellor performance and clinic operations within the appointment scheduling setting. Utilizing a data-set from a counselling clinic in a Singaporean university, we examine the effects of workload and task complexity on counsellor behavior. Our findings indicate that higher workload and task complexity are associated with increased likelihood of follow-up appointments and longer intervals between sessions. To improve clinic operations, we propose a scheduling policy that integrates workload and task complexity considerations, and develop a discrete-event simulation model to compare the results.

4 A Self- and Mutual-Exciting Model for Discrete-Time Data: Case Study on Online Money Market Fund

Yuqian Xu[1], Lingjiong Zhu[2], Haixu Wang[3], [1]UNC-Chapel Hill Kenan-Flagler Business School, Chapel Hill, NC, [2]Florida State University, Tallahassee, FL, [3]Citi, Tampa, FL, Contact: lz465@nyu.edu

This paper proposes a novel stochastic model in discrete time to capture two essential features of general event data motivated by the practice: the dependence on the past event arrivals and associated sizes (i.e., self-exciting) and the behavioral interdependence between multiple activities (i.e., mutual-exciting). To illustrate the applicability of our model and validate its performance, we calibrate it with a customer deposit and withdrawal data set from one leading online money market fund. We analytically quantify the churn probability and expected activity level of customers as an illustration of performance measures and then compare our model with classic time-series and machine-learning models and show that our model can achieve high prediction accuracy.

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CC-West 104A

Doing Analytics for Good and Good Analytics

Community Committee Choice Session

Session Chair: Joseph Cazier, Arizona State University, Tempe, AZ

1 Expanding Ethical Awareness in Analytics with the INFORMS CAP Ethics Course

Joseph Cazier[1], Bill Griffin[2], Terry Rawls[3], [1]Arizona State University, Tempe, AZ, [2]INFORMS, Catonsville, MD, [3]Vulcan Academics, Durham, NC

This session introduces a new Ethics Course produced at the request of INFORMS recently. It was created to help prepare CAP and aCAP candidates for the Certified Analytics Practitioner designation. The course is part of an effort by INFORMS to ensure that Associate and full CAP candidates have access to ethical training in the official INFORMS Ethics guidelines before beginning their journey as an aCAP/CAP. The course features several prominent INFORMS Subject Matter Experts (SMEs) sharing their wisdom, insight and stories around each of the core INFORMS Ethics Guidelines. This course is scheduled to launch in late spring of 2023. This presentation will share an overview of the course, providing key insights garnered and lessons learned from the production process and the first cohort to complete the program.

2 Improving Analytics Education and Giving Back with the ***Data and Analytics for Good Journal***

Ronald Freeze[1], Joseph Cazier[2], [1]University of Arkansas, Fayetteville, AR, [2]Arizona State University, Tempe, AZ, Contact: rfreeze@walton.uark.edu

Thispresentation introduces the *Data andAnalytics for Good Journal.* The goal of this journal is to collect,document and share data that has value to society by supporting ESG(Environmental, Social and Governance) objectives, as illustrated by the U.N.Sustainable Development Goals. Each dataset will be made freely available to the public to encourage practitioners andlearners of analytics to analyze and use the data and share insights withothers anywhere they can, including in reports in this journal. Each data set is peer reviewed and madeavailable for download and in a state of the art analytics ecosystem allowinganyone, anywhere to use and play with the data. This is a great resource for educators and anyone wishing to give back,but making data with a social purpose available to use, learn from and sharealongside the tools needed to analyze it.

3 Stories and Lessons from Leading Analytics for Good Communities and Initiatives

Beverly Wright, Burtch Works, Atlanta, GA

Many data professionals spend their time, and careers, helping companies improve their financials. Improving market presence, optimizing operations, developing products, and decreasing expenses all help their companies run more effectively and efficiently. Recognizing the value of their skills, data professionals want to contribute these capabilities to the greater good, going beyond improving profit for companies to doing something to contribute to society. Saving and improving lives, reducing societal challenges such as addiction, home insecurity, hunger, human trafficking, and other issues are but some of the contributions that analytics professionals can provide.

Learn what you can do to become a part of a community that leverages data science for social good. This session will share tips and a framework for starting, developing, improving, and really contributing to social good via data science and analytics in a way that helps those in need.

4 Succeeding in Analytics by Leading in Analytics

Joseph Cazier[1], Terry Rawls[2], [1]Arizona State University, Tempe, AZ, [2]Strategic Transitions Group, LLC, Durham, NC

Inspired by the INFORMS ABOK, this presentation focuses on how to succeed in analytics by leading in analytics. Expanding on Karl Kempf's framework of the 5 Manageable Tasks (Ch. 2 of the ABOK), we interviewed dozens of experts to develop best practices of how to do analytics well, ultimately developing a book and companion professional educational course in partnership with INFORMS and the Professional Development Academy. This short presentations highlights the findings and how to learn more.

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CC-West 104B

Decision-making and Machine Learning

Community Committee Choice Session

Session Chair: Michael Lash, University of Kansas, Lawrence, KS

1 Large-Scale Multiple Testing of Composite Null Hypotheses Under Heteroskedasticity

Trambak Banerjee, University of Kansas, Lawrence, KS

For simultaneous testing of composite null hypotheses, the conventional practice of standardizing or re-scaling heteroskedastic test statistics may severely affect the power of the underlying multiple testing procedure. Additionally, when the inferential parameter of interest is correlated with the variance of the test statistic, methods that ignore this dependence may fail to control the type I error at the desired level. We propose a new Heteroskedasticity Adjusted Multiple Testing (HAMT) procedure that avoids data reduction by standardization, and directly incorporates the side information from the variances into the testing procedure. HAMT is asymptotically valid and optimal for FDR control. Simulation results demonstrate that it outperforms existing procedures with substantial power gain across many settings.

2 Mitigating Label Bias via Decoupled Confident Learning

Yunyi Li, The University of Texas at Austin, Austin, TX, Contact: yunyi.li@mccombs.utexas.edu

Algorithmic fairness has received increasing attention, but methodologies to mitigate bias largely assume that observed labels constitute a "ground truth". In reality, bias in labels is a pervasive problem across important domains. While the presence of labeling bias has been discussed conceptually, there is a lack of methodologies to address this problem. We propose decoupled confident learning (DeCoLe), a pruning method specifically designed to mitigate label bias. Theoretically, we present sufficient conditions under which the DeCoLe algorithm accurately identifies corrupted labels and reduces label bias. Empirically, we illustrate the benefits of the proposed approach in the context of hate speech detection.

3 Corporate Probability of Default: A Single-Index Model with Multiple-Link Approach

Shun Dong, University of Kansas School of Business, Lawrence, KS, Contact: shun.dong@ku.edu

Accurately predicting the Probability of Default (PD) for corporations is crucial for effective risk management and precise asset pricing. In this paper, we present a novel approach for PD prediction by constructing a nonparametric single-index model with multiple link functions for binary response variables. Our proposed model can capture the shape of the PD changes in different industries and model the relationship between corporations and PD for various industries based on significant financial characteristics of companies.

4 Modeling the Transition of Human-AI Collaboration

Wensu Li[1], Neil Thompson[1], Kaizhi Qian[2], Maja Svanberg[3], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]IBM (International Business Machines Corporation), Cambridge, MA, [3]MIT, cambridge, MA

Traditionally, job replacement is seen as a threat when AI systems match human capabilities, often assessed without considering AI-human collaboration. However, the transition will be smoother, with AI initially complementing humans. In hybrid modes, AI excels where it's strong, while humans fill in the gaps. To understand this nuanced transition, we propose to better understand the quality metrics like accuracy and cross-entropy loss from computer vision models to map out the progression. Using information theory, we developed a groundbreaking economics model estimating patterns of human-machine collaboration and reliance on AI. By examining confidence scores and their distribution with AI performance, along with survey data on task error tolerance, we evaluate cooperation levels and predict tangible economic benefits from AI performance improvements.

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CC-West 105A

Advances in Modeling and Statistical Methods for Analyzing Complex Networked Systems

Community Committee Choice Session

Session Chair: Babak Ahmadi, University of Florida, Gainesville, FL

Session Chair: Mostafa Reisi, University of Florida, Gainesville, FL

1 Bayesian Semi-Non-Negative Matrix Factorization: A Technique for Estimating Bank Holdings and Systemic Risk

Shawn Mankad, North Carolina State University, Raleigh, NC, Contact: smankad@ncsu.edu

We propose a novel methodology to estimate the portfolio composition of banks as a function of daily stock returns. Building on a model where individual bank balance sheets connect through common holdings, we derive and solve a constrained semi-non-negative matrix factorization problem where the rows (corresponding to banks) of one latent matrix factor are subject to probability constraints. We develop a Markov chain Monte Carlo estimator that resolves the well-known issues of scale and rotational invariance in non-negative matrix factorization models. Our method allows analysts to understand the interconnectedness of banks and measure the risk from contagion and undiversified bank holdings.

2 Recurrence Network Representation Learning for Quality Control of Additive Manufacturing

Yujing Yang[1], Chen Kan[2], [1]The University of Texas at Arlington, Arlington, TX, [2]University of Texas-Arlington, Arlington, TX, Contact: yxy9663@mavs.uta.edu

Additive manufacturing (AM) is widely adopted in the production of mechanical metamaterials with complex geometries. However, geometric defects largely occur during fabricating, which could compromise the mechanical properties of fabricated parts. It is of great interest to characterize the complex geometries and identify defects, where 3D point clouds are increasingly utilized to represent the geometries of AM builds. In this study, first, we develop a recurrence network-based approach to represent the 3D point cloud, which considers both spatial closeness and geometric similarity. Second, a graph-based one-class classification approach is integrated to detect the presence of geometric defects. Experimental results highlight the effectiveness of the developed framework in detecting AM-induced geometric defects in mechanical metamaterials.

3 Efficient Model Fitting and Two Sample Testing for Large Networks via Subsampling

Kaustav Chakraborty, IL

In recent years, large networks are routinely used to represent data from many scientific fields. Statistical analysis of these networks, such as model fitting and hypothesis testing, has received considerable attention. However, most of the methods proposed in the literature are computational expensive for large networks. In this paper, we propose a subsampling-based method to reduce the computational cost of estimation and two-sample hypothesis testing. The idea is to divide the network into smaller subgraphs, draw inference based on each subgraph, and combine the results together. We first develop the subsampling method for random dot product graph models, and establish theoretical consistency of the proposed method. We demonstrate the performance of our methods through simulation experiments and real data analysis.

4 Anomaly Detection in Temporal Multilayer Networks Using GLMs and Tensor Decomposition

Mahya Qorbani, Kamran Paynabar, ISyE Georgia Tech, Atlanta, GA, Contact: mqorbani3@gatech.edu

Our study aims to improve anomaly detection in complex systems by applying a combination of generalized linear models (GLMs) and tensor decomposition to temporal multilayer networks (MLNs). We apply GLMs and space state models to provide one-step ahead prediction for adjacency tensors of MLNs. To improve the accuracy of our predictions, we leverage the EM algorithm and tensor decomposition methods. We validate our method using simulations and a case study. Our proposed approach provides a more effective means of detecting anomalies in complex systems and has the potential to be applied in a wide range of fields such as, transportation, communications, and marketing.

5 Change Detection in Multi-Layer Dynamic Networks

Babak Ahmadi[1], Mostafa Reisi[2], [1]University of Florida, Gainesville, FL, [2]University of Florida, Gainesville, FL, Contact: Babak.Ahmadi@ufl.edu

With the advancement of data collection systems, collecting entity-level data has become highly feasible. Having any kind of relationship between the entities, the data can be modeled as a network. In certain intricate networks, entities exhibit multiple forms of relationships with each other, as seen in the case of multi-layer networks. In this work, each multi-layer network is presented as an adjacency tensor, and using a modified CP decomposition method, the tensor is decomposed to its factor matrices and features over time. Then, using the extracted features from the data, the one-step-ahead features are predicted over time. Then, to detect the change in temporal multi-layer networks, the residuals are monitored over time. Finally, the proposed modeling and monitoring approach is examined through a simulation and a compelling case study, establishing its validity.

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User Behavior in Online Platforms

Community Committee Choice Session

Session Chair: Chenhui Guo, Michigan State University, East Lansing, MI

1 Effects of Exploration and Exploitation on Mobile App Evolution

Qiang Gao, Baruch College, City University of New York, New York, NY

To ensure market success, mobile app developers need to satisfy their user base by incorporating users' reviews and feedback on the one hand and exploring new features and content that allows them to stay competitive on the other. Drawing on the organizational learning and innovation literature, this research studies how these two activities of exploitation and exploration in consequent app updates affect the app's success

2 Promote Safe Driving: Spread Out Promotions on Telematics App

Jiaoping Chen, Li Zhang, Quan Zhang, Michigan State University, East lansing, MI, Contact: chenj107@broad.msu.edu

Monitoring driving behaviors by telematics is shown effective in improving driving safety in usage-based insurance (UBI). However, the use of telematics in non-UBI settings is insufficiently investigated. We fill the gap by empirically studying the effect of a promotion campaign that incentivizes the engagement of a telematics app. First, participants of the promotion campaign drive more safely during the promotion period. Second, the promotion type and sign-up time moderate the effect. Third, promotion participants with high baseline risk improve more, and fatigue has less negative impact among the participants. The findings reveal insights into use of telematics in non-UBI settings and suggest promotion strategies to improve road safety.

3 The Spillover Effect of a No-Tipping Policy on Competitors' Online Reputation

Naveen Kumar[1], Xiahua Wei[2], [1]University of Oklahoma, Norman, OK, [2]University of Washington, Bothell, Bothell, WA

This paper examines the externality of a no-tipping policy by restaurants on their local competitors' online reviews. Using the testing field of a restaurant chain that introduced a no-tipping policy in different locations, we analyze the customer reviews of these locations' local rivals with a panel data model. In our study, a treatment is the introduction of no-tipping at each location of the restaurant with no-tipping, and an outcome is the sentiment of customer reviews for their competitors in the same zip code. We find that no-tipping leads to negative externalities on the customer sentiment of the local, direct competitors in the same cuisine category. Further, this negative spillover effect is heterogenous along several other dimensions of the rivals, including their review influencers, linguistic features of the reviews, and the local competition intensity.

4 Visualizing the Competitive Market Structure: A Dynamic Latent Factor Model for Mapping Products and Brands Using Online Reviews

Yifan Zhang[1], Ning Zhong[2], [1]Kennesaw State University, Kennesaw, GA, [2]Penn State University, University Park, PA

Online reviews have become an essential tool for businesses to learn about consumer perception of their brand and products. In this research, we develop a dynamic latent factor model that generates a joint spatial mapping of products and brands to provide insights into the underlying competitive market structure. The proposed model combines review text with review rating through a topic model and simultaneously performs market segmentation and brand positioning.
We apply our model to car review data and show how the model may be used by managers to identify changes in consumer perception in online platforms and visualize the competitive market structure.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE71

CC-West 105C

Human Centered Machine Learning

Community Committee Choice Session

Session Chair: Paramveer Dhillon, 1</sup

1 Explainable AI Helps Bridge the AI Skills Gap: Evidence from a Large Bank

Jonathan Hersh[1], Selina Carter[2], [1]Chapman University, Orange, CA, [2]CMU, Pittsburgh, PA, Contact: hersh@chapman.edu

This paper examines the 'AI skills gap' in firms, focusing on the role of trust in AI for predicting significant events and the impact of explainable AI (XAI) on this trust. In collaboration with a major bank, we developed AI predictions for loan disbursement delays, incorporated into a dashboard tool, and surveyed 685 employees pre- and post-exposure to the tool. Additionally, some participants received an XAI treatment explaining model decisions and performance.
Our findings reveal: i) XAI enhances perceived usefulness but not understanding of AI predictions; ii) Senior managers and those less familiar with AI are more reluctant to trust

AI predictions; iii) Greater loan complexity fosters more trust in AI predictions; iv) AI-skeptical groups show stronger responses to XAI. These insights inform the design of ML models for more equitable workplace benefits.

2 Conversation and User-To-User Networks for Product Innovation

Kristen Altenburger, Meta, CA

Technological innovations have fundamentally transformed information flow and social behavior. This talk will provide an overview of how we measure online conversations at Meta, new methods for addressing interference in A/B tests on networks, and ongoing work including studying conflict in groups. The talk will conclude with thoughts on the future of studying online conversations and will discuss the unique role of human-centered machine learning in this space.

3 Occupational Skills and AI Exposure: Evidence from 350 Million Online Job Postings

Sebastian Steffen, Boston College, MA

I study how much occupational skill compositions changed over the last decade, how these skill changes relate to recent AI exposure scores, and what the implications for the values of skills are. To do so, I create a novel occupation-level panel of skill compositions based on the detailed skill demands of over 350 million US online job postings since 2010 and calculate how much occupational skill compositions changed. Recent AI exposure scores only weakly correlated with each other, which raises doubts about their insightfulness; the vast majority of skill, wage, and employment changes can also not be explained by AI. Finally, I estimate the impact of technological change on the market returns of skills and identify several skill groups with high and stable returns that may offer feasible future career opportunities for the workers that are most exposed to AI.

4 Community/Committee'S Choice Submission

Seung Jong Lee, Arizona State University, AZ

Tuesday, October 17, 4:00 PM - 5:15 PM

TE72

CC-West 106A

Predictive Analytics and Game Theoretic Techniques for Smart Network Grids

Community Committee Choice Session

Session Chair: Ming Jin, Virginia Tech, Blacksburg, VA
Session Chair: Harshal D. Kaushik, Bayer, St Louis, MO

1 System-Constrained Multi-Agent Reinforcement Learning for Smart Grid Applications

Daniel Tabas[1], Ahmed Zamzam[2], Baosen Zhang[1], [1]University of Washington, Seattle, WA, [2]National Renewable Energy Laboratory, Golden, CO

Constrained multiagent reinforcement learning (C-MARL) is gaining importance as MARL algorithms find new applications in real-world systems. Most C-MARL algorithms use a primal-dual approach to enforce constraints through a penalization approach. In this talk, we discuss the structural effects of the primal-dual approach on the constraints and value function. We discuss the shortcomings of using the constraint evaluation as the penalty, hence, we propose enforcing meaningful probabilistic safety constraints by simple penalty modifications. Then, we exploit the structural effects of primal-dual methods on value functions, leading to improved value estimates. We use simple energy management environments to demonstrate meaningful guarantees of the proposed constraints reformulations, and the improved convergence behavior of the proposed algorithms

2 Pricing and Economic Impact of Convex Relaxations for Power Flow on Electricity Spot Markets

Johannes Knörr[1], Martin Bichler[2], [1]Technical University of Munich, Munich, Germany; [2]Technical University of Munich, Garching B. München, Germany. Contact: knoerr@cit.tum.de

Welfare maximization problems on electricity spot markets should ideally consider constraints that reflect the physics of the power grid. As this leads to an intractable non-convex and non-linear optimization problem, linearized power flow models are currently used in practice. Tighter non-linear convex relaxations have been developed, but most research focuses on their optimality and scalability. We study the impact of different relaxations on prices, required side-payments by the market operator, and redispatch costs, while also considering non-convexities in the preferences of buyers and sellers. Large-scale numerical experiments indicate that currently used linearized models can lead to unjustifiably high prices and biased investment signals, while tighter convex relaxations set better incentives and reflect the physics of the grid more accurately.

3 Enhancing Power Grid Resilience: Co-Optimizing Repair Crew Routing and Network Reconfiguration for Effective Management of Power Outages

Haneul Kim, Myungseok Yoon, Hyungjoo Cha, Dongkyun Kim, Hyeon Woo, Yongju Son, Sungyun Choi, Taesu Cheong, Korea University, Seoul, Korea, Republic of.

Contact: rgs6827@korea.ac.kr
The increasing occurrence of natural disasters necessitates the effective management of power outages in distribution networks. This study focuses on two key tasks: offline repair crew routing and online distribution reconfiguration. The objective is to co-optimize the visit sequence of repair crews and reconfiguration tasks, aiming to maximize the supply loads during power grid recovery. A mixed-integer programming model is proposed for repair crew routing and network reconfiguration in a discrete event system. Furthermore, deep reinforcement learning is used to address potential changes in repair plans based on actual repair time. The proposed methodology is experimentally evaluated using modified IEEE bus distribution systems.

4 Study the Effect of Weather Uncertainty and Future Scenarios on the U.S. Power Grid
Amir Zeighami, North Carolina State University, Raleigh, NC, Contact: mzeigha@ncsu.edu
This talk will examine how multiple sources of uncertainty influence short term operations of bulk power systems. The first part of the talk focuses on how stationary weather uncertainty affects the distribution of power plant air pollution damages among different demographic groups. The second part investigates how grid decarbonization will influence the response of power system and air quality impacts during extreme events (droughts and heat waves). Both aim to identify effective solutions to mitigate the negative effects of air pollution on public health while also addressing issues of social justice.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE73

CC-West 106B

Information Search and Finance

Community Committee Choice Session

Session Chair: Ryan Israelsen, Michigan State University

1 Regulators at the Gate: SEC Visits and Insider Trading
William Gerken[1], Steven Irlbeck[2], Marcus Painter[3], Guangli Zhang[3], [1]University of Kentucky, Lexington, KY, [2]University of New Hampshire, Durham, NH, [3]Saint Louis University, St. Louis, MO, Contact: marc.painter@slu.edu
The Securities and Exchange Commission (SEC) plays a crucial role in maintaining the integrity of financial markets. Yet, the dynamics of how SEC officers meet with firms is little understood, as these meetings have historically been unobservable. We study the dynamics of the Security and Exchange Commission's face-to-face interactions with firms using individually-linked smartphone geolocation data. This data allows us to identify phones that ``ping'' regularly in SEC offices and in firm headquarters. We characterize the nature of SEC visits, finding these regulator-devices visit firms located both near to and far from SEC offices. On average, insiders are less likely to trade in the week surrounding an SEC-device visit. However, insiders that do sell before a visit outperform the market significantly.

2 Do Mutual Funds Walk the Talk? Evidence from Fund Risk Disclosure
Jinfei Sheng[1], Lu Zheng[2], Nan Xu[3], [1]University of California, Irvine, Irvine, CA, [2]University of California, Irvine, Irvine, CA, [3]Nankai University, Tianjin, China. Contact: jinfei.sheng@uci.edu
Do risk disclosures by mutual funds reflect funds' actual investment risks? In this paper, we examine the quality of risk disclosures in funds' summary prospectus. We first document what types of risk are disclosed by mutual funds and how the disclosed risks relate to academic risk factors, such as size and value. We then develop fund-level measures to evaluate the relevance, conciseness and order of the risk disclosures. We find that disclosed risks explain about 50% of variations in fund returns; funds tend to overdisclose by reporting insignificant risks; the order of disclosure does not imply importance. We also find that funds improve their disclosure relevance after receiving SEC comment letters concerning their prospectus. Furthermore, we explore the implications of risk disclosure for fund flow, risk taking and performance.

3 Community/Committee'S Choice Submission
Huseyin Gulen, Purdue University, West Lafayette, IN
Eye movements reflect biases inherent in decision-making. We conduct an eye-tracking experiment to measure how subjects allocate attention over a price chart while predicting future stock returns. We confirm that the attention allocation reflects how subjects form expectations from past price information. The measure of expectation based on eye-tracking quantitatively fits the actual forecasts submitted by subjects. Easily recognizable patterns in data receive disproportionately more attention: Subjects spend much more time reading recent as well as extreme trends and price levels. Such heuristics in information acquisition are heterogeneous across subjects and lead to inferior forecast precision. Overall, the results provide direct evidence for investor beliefs hypothesized by theories of return extrapolation.

4 All in a Day's Work: What Do We Learn from Analysts' Bloomberg Usage?

Ryan Israelsen[1], Azi Ben-Rephael[2], Zhi Da[3], Bruce Carlin[4], [1]Michigan State University, East Lansing, MI, [2]Rutgers University, Newark, NJ, [3]University of Notre Dame, Notre Dame, IN, [4]Rice University, Houston, TX, Contact: israels4@broad.msu.edu

We use minute-by-minute Bloomberg online status data to characterize two important dimensions of sell-side equity analysts' work habits: we estimate the average workday length (AWL) to proxy for analysts' general effort provision and we use the percentage away day (PAD) to proxy for their soft information production. Controlling for coverage, AWL is positively related to the quantity and the timeliness of analyst forecasts, while PAD is negatively related to quantity. Both are positively related to forecast accuracy. COVID lockdown provides further causal evidence. Traveling analysts experience a significant reduction in forecast accuracy during the lockdown. Using pre-COVID analyst commute time to instrument increased AWL during the lockdown, we find a higher AWL to significantly increase output and improve the accuracy of the forecasts

Tuesday, October 17, 4:00 PM - 5:15 PM

TE74

CC-West 106C

Maintenance Planning

Contributed Session

Session Chair: Mehdi Dadfarnia, National Institute of Standards & Technology, Bethesda, MD

1 Deep Reinforcement Learning for Optimal Planning of Multi-Assembly Line Maintenance with Resource Constraints

Michael Geurtsen, Eindhoven University Of Technology, Arnhem, Netherlands

Discovering the optimal maintenance planning strategy can have a massive impact on production efficiency, yet this aspect is often overlooked in favor of production planning. Our study emphasizes the significance of maintenance planning in the dynamic context of an assembly fab consisting of multiple assembly lines. By maximizing the average production rate and considering factors such buffer contents, machine production states, planning windows and scarce resources, we address a unique problem involving the planning of maintenance on the final machine of multiple serial assembly lines. We employ novel average-reward deep reinforcement learning techniques and compare them to generic dispatching methods. Through experiments using a digital twin with real-world data, we demonstrate the immense potential of this new deep reinforcement learning technique.

2 Maintenance Optimization of Inland Waterway Transportation System via Simulation and Machine Learning

Maryam Aghamohammadghasem[1], Jose Azucena[2], Haitao Liao[3], Shengfan Zhang[3], Heather Nachtmann[3], [1]University of Arkansas, Faytteville, AR, [2]University of Arkansas-IE Department, Fayetteville, AR, [3]University of Arkansas, Fayetteville, AR, Contact: maghamoh@uark.edu

Maintenance optimization is critical in minimizing the negative impact of natural and man-made disruptions on inland waterway transportation systems. This research takes advantage of agent-based simulation and machine learning to enable efficient maintenance for the continued operation of inland waterway transportation systems.

3 Estimation of Remaining Useful Life of Complex Systems Based on Bayesian Autoencoder Latent Variable Extraction

Sun Geu Chae[1], Suk Joo Bae[2], [1]Hanyang University, Seoul, Korea, Republic of; [2]Hanyang University, Seoul, Korea, Republic of

Data-driven approaches are progressively employed in state-based maintenance due to the limitations of physically-based models. Nonetheless, constructing models with minimal failure data poses a significant challenge. Advancements in sensor technology necessitate the management of considerable data and variables, thus highlighting the importance of autoencoders for dimensionality reduction. In this research, we propose a Bayesian Autoencoder for uncertainty quantification-based Virtual Health Index (VHI) development to estimate time-dependent deterioration in complex systems. This approach addresses the need to capture degradation over time in the presence of scarce failure data. Lastly, we validate the proposed methodology using a turbofan degradation dataset, demonstrating its potential for real-world applications.

4 Simulation Manufacturing Operations and Condition-Based Maintenance Policies to Support Condition Monitoring Tool Adoption

Mehdi Dadfarnia, National Institute of Standards & Technology, Gaithersburg, MD, Contact: mehdi.dadfarnia@nist.gov

Condition Monitoring Systems (CMSs) can improve manufacturing performance by helping maintenance detect and diagnose product faults and machine failures. However, measuring CMS impact on manufacturing can be difficult. Though CMS abilities can be assessed using detection or diagnosis metrics and compared to manufacturing performance indicators, manufacturing performance also depends on the configuration of machinery and the implemented maintenance policy. We developed a simulator to analyze manufacturing scenarios across various machinery configurations and maintenance policies, emphasizing CMS-enabled policies. We observe CMS impact on manufacturing performance and consider how machinery configuration and maintenance policy limits or facilitates CMS impact. We also discuss aligning CMS-level metrics and manufacturing performance indicators.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE75

Session.Location:CC-West 208A

Drone Delivery Systems

Contributed Session

Session Chair: Ahmed Ghoniem, Isenberg School of Management, UMass Amherst, Amherst, MA

1 Equitable Flight Path Planning for Drone Delivery

Ahmed Ghoniem[1], Amro M. El-Adle[2], [1]Isenberg School of Management, UMass Amherst, Amherst, MA, [2]Old Dominion University, Norfolk, VA, Contact: aeladle@odu.edu

Using delivery data over an extended planning horizon, we investigate how stakeholders may make use of alternative flight paths to mitigate the impact of persistent drone flights on neighborhoods.

2 The Multi-Period Traveling Salesman Problem with Drones and Parcel Consolidation

Semih Boz[1], Ahmed Ghoniem[2], Amro El-Adle[3], [1]Isenberg School of Management, UMass Amherst, Amherst, MA, [2]Isenberg School of Management, UMass Amherst, Amherst, MA, [3]Old Dominion University, Norfolk, VA, Contact: sboz@umass.edu

We examine parcel consolidation in a last-mile delivery problem by vehicle and drone over a multi-period planning horizon. We develop a mixed-integer program along with a companion heuristic, which we test over large-scale instances involving networks of residences in Amherst, MA.

3 Vehicle-Drone Routing: A (More?) Practical Approach

Ahmed Ghoniem[1], Amro El-Adle[2], [1]Isenberg School of Management, Amherst, MA, [2]Old Dominion University, Norfolk, VA

We propose an optimization model and a companion heuristic for a vehicle-routing problem with drones that incorporate data and solution features of practical relevance to decision-makers.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE76

Session.Location:CC-West 208B

New Topics in Grocery Retailing

Contributed Session

Session Chair: Haoran Yu, Syracuse University, Syracuse, NY

1 Understanding the Relationship Between Customers' Segments and Their Short-Term Goals: A Bayesian Approach

Xiexin Liu[1], Xinwei Chen[2], [1]the Pennsylvania State University - Abington, Abington, PA, [2]Bucknell University, Lewisburg, PA, Contact: xpl5357@psu.edu

Analyzing customers' grocery shopping baskets has long been a critical topic research topic. The abundance of data makes it challenging to extract useful insights, and customers' complex purchasing behaviors make it hard to identify their preferences. This research develops a hierarchical Bayesian model to summarize customers' decision-making processes, where it assumes that a customer tends to wait for a period before shopping again in any specific segment. We use customers' product purchases to derive the probability distribution of their short-term shopping goals, and then further infer the long-term segment distribution. We use real data analysis to demonstrate that the proposed model 1) can be used to understand customer heterogeneity and facilitate personalized recommendations, and 2) predict customers' purchases and assist with product stock management.

2 Title: Order-Picking Strategies and Efficiency Models for the Fulfillment of Multi-Line Ecommerce Grocery Orders

Zijia Wang, Sanchoy Das, New Jersey Institute of Technology, Newark, NJ

The fulfillment process for Buy Online Pickup from Store grocery orders (BOPS-Grocery) is challenging, given the large item count per order and the low-profit margins. This research investigates the BOPS-Grocery model and pursues the following objectives: (i) Defining and specifying the grocery order picking problem. Identifying performance objectives and characterizing the problem variance and resource utilization function. Three classes or sections of grocery ordering picking, straight aisle, Island stocking and counter service; (ii) Modeling and developing of order picking algorithms specific to the straight aisle section. Formulated as an order batching problem with picker movement minimization and no order splitting. Simulation results will be presented.

3 Why Fruit Salads Complicate Ordering: Building Grocery Pipelines for Handling In-Store Transformations

Andrew S. Chen, Afresh Technologies, San Francisco, CA, Contact: andy@afresh.com

Grocery stores are seeing a growing demand for items prepared in store, including fruit bowls, salads, cut meats, ready-to-eat meals, and more. These transformations pose challenges for inventory management solutions, as they significantly change the perishability of the items. For example, cutting a ribeye might drop its shelf life from 30-90 days to 3-4 days. We present a full ML-to-OR pipeline for ordering the ingredients for these in-store transformations. We discuss the modeling decisions and tradeoffs when evaluating data quality, forecasting consumer demand, and ultimately recommending order decisions.

4 Retailing Strategies of Imperfect Produce and the Battle Against Food Waste

Haoran Yu[1], Burak Kazaz[1], Fasheng Xu[2], [1]Syracuse University, Syracuse, NY, [2]Syracuse University, Long Island City, NY, Contact: hyu143@syr.edu

Edible but cosmetically substandard produce is often not sold in stores, leading to substantial food waste. This study investigates how a grocery retailer should choose from three popular retailing strategies: discarding imperfect produce, bunching with perfect produce, and selling perfect and imperfect produce separately at different prices. We first derive conditions under which each retailing strategy is optimal and show that increasing consumers' valuation of imperfect produce can actually lead to more food waste. Next, we investigate the implications of the full-shelf ordering policy where retailers simply order up to their available shelf space, and show that this policy might not necessarily increase food waste. Lastly, we show that our main results remain valid when the imperfect proportion is random.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE77

Session.Location:CC-West Lecture Hall

AI for Healthcare

Contributed Session

Session Chair: Maxim Terekhov, University Of Florida, Gainesville, FL

1 Interpretable Treatment Effect Prediction Using Optimal Trees

Jack Dunn, Interpretable AI, Cambridge, MA

Policy trees are a recent approach that combine interpretable machine learning and causal inference techniques to generate interpretable prescription policies from observational data. However, this approach is designed with the goal of finding the simplest policy for optimal treatment assignment. In many problem settings, particular in medicine, treatments may have side effects that are difficult to quantify, and so instead of simply prescribing the best treatment, our goal is to understand and predict personalized treatment effects in an interpretable way. We propose an approach that combines causal inference techniques with Optimal Regression Trees to generate interpretable treatment effect predictions. This new approach has many applications, including medical scenarios where over-treatment issues are suspected.

2 A Hybrid Approach to Veterinary Clinical Decision Support Systems

DoHoon KIM[1,2], Sangyong Lee[2], [1]Yonsei University, Seoul, Korea, Republic of; [2]Okestro, Seoul, Korea, Republic of

Veterinary CDSSs are crucial for high-quality animal care. A key challenge is unstructured medical records and no direct animal communication. We present a novel method combining rule-based models and LLMs for record insights and use XAI for decision clarity. Evaluations with dog kidney disease data suggest our approach might outdo traditional CDSSs in accuracy and transparency. Integrating cloud SaaS could harness data from multiple veterinary hospitals, fast-tracking training and boosting accuracy. Adopting SaaS enhances performance, emphasizing its broad benefits for the veterinary field.

3 Predicting Cervical Cancer with Machine Learning Algorithms: A Study on the Effectiveness of Sampling Methods

Noreliz Alorico, ANAS HOURANI, Fort Hays State

University, Hays, KS, Contact: naalorico@mail.fhsu.edu
Machine learning algorithms have been studied to predict the likelihood of cervical cancer. The dataset was analyzed with under-sampling, over-sampling, and no-sampling. Logistic regression, SVM, and random forest were built to compare the prediction performance of four targets (biopsy, cytology, Hinselmann, and Schiller) with and without sampling techniques. The data has been preprocessed. The results showed that over-sampling had the best prediction performance, and no sampling and under-sampling need improvement. The machine learning models were capable of predicting the likelihood of cervical cancer in the future.

4 Study of Health Outcomes in a Technology Enabled Virtual Setting

Maxim Terekhov, University Of Florida, Gainesville, FL
This paper presents an empirical analysis of health insurance claims data to explore telemedicine outcomes. Specifically, I utilize causal forests and a retrospective matched case control study design to demonstrate statistically significant changes in costs, utilization, and medication adherence of telehealth users.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE78

Session.Location:CC-West 211A

Topics in Finance - 2

Contributed Session

Session Chair: John Crosby, Old Dominion University, Strome School of Business, College Park, MD

1 A Heuristic Approach to Liquidity Management at Ant Group's Global Currency Network

Xinyue Zhong[1], Zewei Dong[1], Ang Li[2], [1]Ant Group, Hangzhou, China; [2]Ant Group, Shanghai, China. Contact: xinyue.zhong@antgroup.com
Ant's International Business Group (IBG) currently manages a global foreign exchange (FX) and liquidity network to support its cross-border payment and money transfer businesses. The network consists of a hub-and-spoke structure, where certain main accounts are connected to and fulfill cashflow requests arising from their respective peripheral accounts. Based on forecasts, the network needs to make daily decisions on fund re-balancing in each country-level account, as well as route-picking in real time for each request, where different options may carry distinct levels of timeliness, failure rate and cost. This talk briefly describes our pioneer solution to this problem with heuristics. A few future work directions are discussed.

2 Strategic Liquidity Provision in Uniswap V3

Zhou Fan[1], Francisco J. Marmolejo-Cossío[1], Daniel Moroz[2], Michael Neuder[3], David C. Parkes[4], Rithvik Rao[5], [1]Harvard University, Cambridge, MA, [2]Chainlink Labs, New York, NY, [3]Ethereum Foundation, New York, NY, [4]Harvard University, Boston, MA, [5]Jump Crypto, New York, NY, Contact: fjmarmol@seas.harvard.edu
Uniswap is the largest decentralized exchange for digital currencies. In Uniswap v3, liquidity providers (LPs) can selectively allocate liquidity to trades that occur within specific price intervals. While prices remain in that interval, LPs earn fee rewards proportionally to the amount of liquidity allocated. This induces the problem of strategic liquidity provision: smaller intervals result in higher concentration of liquidity and larger rewards when prices remain in the interval, but with higher risk as prices may exit intervals where liquidity is allocated and thus fail to earn rewards. Dynamically re-allocating liquidity can mitigate these losses, but at a cost, as traders must expend gas fees to do so. We formalize the dynamic liquidity provision problem and provide an optimization framework to maximize LP earnings for a general class of LP strategies.

3 Selective Hedging Policies & Commodity Firms: Models and Evidence

Kamal Smimou, Ontario Tech University, Oshawa, ON, Canada. Contact: kamal.smimou@ontariotechu.ca
Commodity firms and their hedging activities are a prominent topic of interest in financial economics. Adding to the current wave of attention, this study advances two theoretical optimization models guided by *market depth* (as a proxy for hedging demand) and *liquidity* to (1) detect and select the most genuinely related and viable commodity futures pertinent to the price movement of commodity companies traded in the stock market, and (2) elucidate *when* and *how* these optimal search strategies can enhance and affect hedging positions of investors. Likewise, we empirically document the joint dynamic behavior of these groups of assets while assessing the effects of including an *optimal* number of hedging instruments. Our insights are valuable for corporate hedging; and this work carries worthwhile implications for portfolio management undertaken by institutional investors.

4 Factor Glut in Asset Pricing and Dodging a Zillion Regressions

John Crosby[1], Gurdip Bakshi[2], Tim Christensen[3], Xiaohui

Gao[2], [1]Old Dominion University, Strome School of Business, Norfolk, VA, [2]Temple University Fox School of Business, Philadelphia, PA, [3]New York University, New York, NY

The issue of the "zoo of factors" has garnered much attention in recent years (eg., Cochrane (2011, JF)) because of the proliferation of proposed factors for explaining asset (especially stock) returns. The principal question that we answer is: Even when the number of potential test factors is large, can we identify the best factors that enter the stochastic discount factor. We develop asset pricing and econometric approaches with three desirable features. First, the realities of bid-ask spreads in prices as well as short-sale constraints are accommodated. Second, stochastic discount factors are strictly positive. Third, the approach is disciplined by the absence of unreasonably high rewards-for-risk. We identify which (in addition to a constant factor) is the best one factor, the best two factors, the best three factors, ..., the best ten factors, etc.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE79

Session.Location:CC-West 211B

Application of Discrete Optimization

Contributed Session

Session Chair: Fabian Torres, EPFL-ENAC-TRANSP-OR, Lausanne, Switzerland

1 Generating Robust Task Allocations by Distributing the Risk Among Agents

Raunak Sengupta[1], Rakesh Nagi[2], Ramavarapu S. Sreenivas[1], [1]University of Illinois, Urbana Champaign, Champaign, IL, [2]Industrial Enterprise Systems University of Illinois, Urbana, IL, Contact: raunaks2@illinois.edu

We address the problem of generating robust solutions for the makespan minimization problem on identical parallel machines. While there are various concepts of robustness in the literature, we show through pathological examples that they do not capture all the desirable properties. We make the simple observation that an allocation that balances the worst-case loads and uncertainties simultaneously can generate extremely robust allocations. This reduces the problem of finding a robust allocation to a two-dimensional load balancing problem. We introduce an efficient algorithm that guarantees an approximation factor of 2 on both dimensions simultaneously along with fair allocation properties. We substantiate our claims with interesting structural and existential results. Finally, we prove the efficacy of our approach using detailed numerical results.

2 Evaluation of Manual Assembly Line Balancing Problem in Flexible Manufacturing and Uncertain Operator Performance

Liam J. Cahalane[1], Thomas A. Mazzuchi[2], Shahram Sarkani[3], [1]The George Washington University, Charleston, SC, [2]George Washington University, Washington, DC, [3]The George Washington University, Washington, DC, Contact: lcahala@gwmail.gwu.edu

Uncertainty in manual assembly operations can significantly impact manufacturing processes, resulting in late deliveries and potential loss of revenue. This research addresses the challenge of optimizing uncertain task durations of a manual assembly line in flexible manufacturing to minimize lateness and maximize revenue. We propose an approach to assigning operators to assembly tasks, without prior knowledge of their performance, which is periodically reevaluated to ensure optimal assignment and balance of the assembly line. Our approach considers the uncertain and variable nature of manual assembly operations, and leverages the Assembly Line Balancing Problem framework to achieve optimal efficiency. We demonstrate the effectiveness of our approach through numerical simulations and provide recommendations for implementation in manufacturing processes.

3 Branch-And-Price for Static Elevator Dispatching

Fabian Torres, Michel Bierlaire, EPFL, Lausanne, Switzerland. Contact: fabian.torres@epfl.ch

The elevator dispatching problem (EDP) is a vertical transportation problem where passengers are transported to their desired floors. In a destination control system, destination floors are known the moment passengers make a call for elevators. We consider the static EDP where complete information about passenger arrivals is known. Solving the static EDP provides a lower bound on the dynamic EDP and gives insights about the value of complete information. We consider 3 common objectives, to minimize the average waiting and journey time of passengers and the total energy consumption of elevators. We present the first branch-and-price algorithm to solve this problem, adapt the dominance rules of the pricing algorithm to each objective and show that we can solve instances with up to 60 passengers, a 5-fold improvement from the network flow formulation.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE80

Session.Location:CC-West 212A

Supply Chain Models for Ecommerce

Contributed Session

Session Chair: Sambit Rath, XLRI, Jhajjhar, India

1 Third-Party Providers in Food and Grocery Delivery Service

Jingran Zhang, Marshall University, Huntington, WV, Contact: zhangjin@marshall.edu

E-commerce has grown rapidly. During the Pandemic, consumers increasingly turned to e-commerce for all their needs, including food and grocery. Leading retailers has changed the traditional retailing models, along with the remarkable growth, to achieve fast fulfillment and delivery. Omni-channel retailers provide different ways to process and fulfill consumer orders, but one of the biggest challenges and expenses is last mile, or final mile delivery. A strategic decision model between self-own delivery or third-party providers is established by forecasting demand and the expense of delivery and quick response to customer orders to optimize cost-cut of retailers and order fulfillment performance.

2 Scattered Storage Assignment to Minimize Picking Travel Distances for Large Order Lines

Mauricio Gámez, Trijntje Cornelissens, Kenneth Sörensen, University of Antwerp, Antwerp, Belgium. Contact: mauricio.gamezalban@uantwerpen.be

E-commerce is changing the way people consume. Usually, only a few items are demanded in small quantities in these online stores. For this reason, many warehouses use the policy of scattered storage to place items in close proximity and speed up the picking process. However, the question is whether scattered storage is also a good strategy for an atypical order that involves large order lines, as in the omnichannel strategy where individual customers and physical stores need to be served from the same warehouse. The idea is to figure out up to what ratio of large order lines scattered storage is still a promising strategy. To enable storage of large quantities, an adaptation of scattered storage with pairwise minimization of distances (SSA-SPD) is presented. Picking routing results show that SSA-SPD is a good storage policy compared to traditional storage policies.

3 Compete or Cooperate: Analysis of Financing and Private Label Decisions in Online Retailing

Sambit Brata Rath[1], Preetam Basu[2], Prasenjit Mandal[3], [1]XLRI – Xavier School of Management, jhajjhar, India; [2]Kent Business School, Canterbury, United Kingdom; [3]NEOMA Business School Reims Campus, Reims, France

Online third-party (3P) retailers face a shortage of working capital and mainly depend on bank financing (BF) for loans. Online platforms such as Amazon and Alibaba have recently started cooperating with retailers by funding them through platform financing (PF). At the same time, they directly compete with the sellers by introducing a competing private label (PB). This study focuses on this fascinating coopetition scenario and jointly analyses the players' financing and operational decisions. We find that the retailer should not always choose BF, even in the presence of PB products (e.g., low referral fee products). The platform should not introduce PB if the product quality is perceived as low. Furthermore, we show with an increase in risk, the retailer prefers PF more, and the platform can introduce lower-quality PB. We also develop a product-based equilibrium strategy.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE81

Session.Location:CC-West 212B

Digital Platform Applications

Contributed Session

Session Chair: Moonwon Chung, Cleveland State University, Cleveland, OH

1 Illegal Content and Monitoring Strategies on Digital Platforms

Tarun Jain[1], Jishnu Hazra[1], T.C.E. Cheng[2], [1]Indian Institute of Management Bangalore, Bangalore, India; [2]The Hong Kong Polytechnic University, Hong Kong, Hong Kong. Contact: hazra@iimb.ac.in

In this talk, we consider a scenario where a subscription-based legal content has to compete with free but illegal content on the same digital platform. In both these scenarios, the digital platform generates revenue for itself. We analyze different content monitoring strategies and identify conditions under which it is beneficial for the platform to exert higher monitoring efforts than the content provider. We also find content monitoring strategies that generate higher payoffs for the digital platform and the content provider.

2 Exploring the Role of Regret and Envy in Crowdfunding Investment Decisions: A Study on Aspiring Entrepreneurs and Funding Efficiency

Giovanni Visentin, Elena Fumagalli, INCAE Business School, Alajuela, Costa Rica

The democratization of new venture funding has created a tension between capital allocation efficiency and inclusivity. To address this, we propose better profiling of entrepreneurs and backers. Our study tests the hypothesis that many crowdfunders are aspiring entrepreneurs who struggle with regret and envy when making backing decisions. We are currently collecting data from prospective entrepreneurs to determine the significance of these mechanisms. Our findings can inform crowdfunding platforms on how to better match the needs of their diverse user base.

3 Cross-Platform Value Co-Creation and Co-Destruction: The Case of Information and Exploit Videos on Youtube

Moonwon Chung[1], Kyungmin Lee[2], Sanghoon Cho[3], Manoj Malhotra[4], [1]Cleveland State University, Cleveland, OH, [2]American University, Washington, DC, [3]Texas Christian University, Dallas, TX, [4]Case Western Reserve University, Cleveland, OH

We study the interactions between two digital platforms, mobile apps and YouTube, to show how content published on YouTube influences users' mobile app engagement and the app's revenue generation. Specifically, we identify two types of videos, information and exploit videos, that leads to value co-creation and co-destruction. We deploy econometric analysis on data collected from the mobile app market and YouTube that contains the longitudinal performance of apps and characteristics of related YouTube videos. Results show that Information videos increase user engagement and revenue streams, while exploit videos decrease revenue streams. Information videos also increase the likes and views of YouTube content creators. In post-hoc analyses, we show the asymmetric impacts on different revenue sources and the antecedents of video creation behavior.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE82

Session.Location:CC-West 212C

Prediction Models for Medication and Health Care

Contributed Session

1 Prediction of Adverse Drug Reactions Using Demographic and Non-Clinical Drug Characteristics in Faers Data

Alireza Farnoush[1], Zahra Sedighi-Maman[2], Behnam Rasoolian[3], [1]University of South Carolina, Columbia, SC, [2]Adelphi University, Garden City, NY, [3]Auburn University, Auburn, AL, Contact: alireza.farnoush@moore.sc.edu

The presence of adverse drug reactions (ADRs) is a significant public health concern. However, current studies on ADR prediction primarily focus on non-clinical data, neglecting the potential of leveraging both demographic and non-clinical information. Additionally, the importance of individual features in ADR prediction remains unexplored. This study aims to fill these gaps by developing an ADR prediction model that incorporates demographic and non-clinical data, identifying the most influential factors. The deep learning and random forest models were used and evaluated using the area under the receiver operating characteristic curve and the mean average precision. Results showed that our random forest model with only the top 20 most important features offers similar ADR prediction performance compared to feature-rich model consisting of all features.

2 Identifying High Risk States and Medications in T2DM Patients Using Dead-Ends

Chanyoung Park[1], Ga Eun Nam[2], Hyo Kyung Lee[1], [1]Korea University, Seoul, Korea, Republic of; [2]Korea University Guro Hospital, Seoul, Korea, Republic of. Contact: chanyoungpark@korea.ac.kr

Patients with type 2 diabetes often require complex medication regimens and are likely to develop irreversible complications which significantly worsen their quality of life. We formulate diabetes medication management problem as a reinforcement learning framework by representing T2DM patient's diabetic status and its transition across a sequence of visit records. Dead-ends Discovery approach is used to identify high-risk patient conditions and medications to avoid that likely lead to dead-ends from which negative outcomes are unavoidable. We set negative outcomes for diabetes patients as developing diabetic complications and aim to identify health conditions from which diabetes complications are highly likely to develop and pinpoint medications that should be avoided.

3 Personalized Statin Treatment Plan Using Counterfactual Prediction and Optimization

Yue Liang[1], Chih-Lin Chi[2], Pui Ying Yew[3], [1]University of Minnesota, Twin Cities, Minneapolis, MN, [2]U of Minnesota, Minneapolis, MN, [3]University of Minnesota, Minneapolis, MN

Statins are a class of drugs that lower cholesterol levels in the blood. High cholesterol levels can cause Atherosclerotic Cardiovascular Disease (ASCVD). Statins can reduce the risk of ASCVD events while they might be associated with symptoms such as muscle pain, etc. This leads to a strong reason to discontinue statin therapy, which increase the risk of cardiovascular events and mortality. To solve this problem, we proposed a framework to produce a proactive strategy, called a personalized statin treatment plan (PSTP) using Overlap Weighting counterfactual prediction, to minimize the risks of statin-associative symptoms (SAS) and risk of discontinuation, and maximizing LDL-C reduction.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE83

Session.Location:CC-West 213A

Supply Chains and Related Topics

Contributed Session

Session Chair: Tuure Tuunanen, University of Jyväskylä, Jyväskylä, Finland

1 Judicial Centralization and Firms' In-House Production: Quasi-Experimental Evidence from China

Hua Cheng[1], Liangfei Qiu[2], [1]University of Texas at Austin, Austin, TX, [2]University of Florida, Gainesville, FL

Firm decisons regarding in-house production or outsourcing is a key source of economic growth but involve significant risk of hold-up and imperfect enforcement of contracts, which makes a sound judicial system highly important. Using a staggered difference-in-differences design, we find the introduction of the circuit tribunals in China, which alleviates local intervention on the judicial system, reduces firms' in-house production sharply. Judicial centralization has much stronger effects on small firms, private firms, and high-growth firms. Finally, we find that judicial centralization indeed increases firms' confidence in the judicial system as seen in an increase in both the number of firm-initiated lawsuits and the claimed amount of funds in the treated areas.

2 Chief Intellectual Property Officers: An Exploratory Analysis of Their Emergence and Effects

Masayo Kani[1], Yoichiro Nishimura[2], [1]Meijo University, Nagoya, Japan; [2]Chuo University, Tokyo, Japan

With the growing importance of intellectual property (IP) management in corporate strategy, Chief Intellectual Property Officers (CIPOs), senior management positions responsible for intellectual property activities, have been appointed. This paper examines the relationship between IP strategy and top management structures, using the Japanese firms' data that can identify the position responsible for IP management. Based on the Contingency Theory and the Institutional Theory, we analyze which factors influence the appointment of the CIPO and how the CIPO affects the strategic divergence in IP management, which is divided into protection and utilization strategies. We evaluate how the indicators of divergence for each type of strategy are affected by the appointment of the CIPO and show the effects of the CIPO with concurrent work status and prior work experience.

3 Modeling the Distribution and Transshipment of Refined Oil Products

Walid Matar, KAPSARC, Riyadh, Saudi Arabia. Contact: walid.matar@kapsarc.org

I have developed an optimization model to characterize long-term planning for the distribution of oil products after the refining stage. The model ensures that the demand for any group of refined oil products is simultaneously met while minimizing the social costs associated with the distribution system. The distribution system moves products from oil refineries or import terminals to petroleum bulk plants using multiple modes of transport. Then, the products are moved from bulk plants to customers via trucking or pipeline transport. The model features:•transport fuel by pipeline, truck or ship by minimizing costs.•capacity constraints for storage and loading and unloading trucks at bulk plants and pipelines across the network.•investments.•geographical coordinates of the locations of all the elements within the distribution system.

4 Supply Chain Model for Three-Echelon Supply Chain for Deteriorating Items

Sarbjit Singh, Institute of Management Technology Nagpur, Nagpur, India. Contact: sarbjitoberoi@gmail.com

This paper proposed three echelon supply chain models. In this study, we have considered that after production, the manufacturer supplies the perishable items to the supplier. Then the retailer receives the product from the supplier for sale to the customers. The retailer assumes the customer's seasonal demand and the supplier's uncertain lead time. In this model, the product expiration date is also considered. The model helps the complete supply stakeholders to optimize their profits by managing optimal inventory. The convexity of the model has been checked, and numerical illustrations have aided the model's suitability.

5 Cocova: A Digital Service Design Method for Continuously Co-Creating Value

Tuure Tuunanen[1], Juuli Lumivalo[1], Alexander Mädche[2], [1]University of Jyvaskyla, Jyvaskyla, Finland; [2]Karlsruhe Institute of Technology, Karlsruhe, Germany. Contact: tuure@tuunanen.fi

This paper scrutinizes the differences between digital service design (DSD) and traditional systems analysis and design (SAD). Whereas SAD methods emphasize gathering or discovering users' requirements for an information system, digital service design utilizes understandings of customers and service providers, their context, and social practices for designing services. However, what is largely absent in the literature is methodological guidance on how to support value co-creation with customers and mitigate potential suboptimal digital service experiences. Thus, we argue that incorporating the value co-creation/co-destruction perspective into a DSD method is essential. Our study aims to fill this research gap by developing the DSD method CoCoVa in a design science research study in collaboration with research clients from both the industry and public sector.

Tuesday, October 17, 4:00 PM - 5:15 PM

TE84

Session.Location:CC-West 213B

Supply Chain Optimization and Resiliency

Contributed Session

Session Chair: Ana Muriel, University of Massachusetts, Amherst, MA

1 Static and Dynamic Optimization for the Joint Replenishment Problem

Miguel Chastre, Albert Schrotenboer, Christina Imdahl, Tom Van Woensel, Eindhoven University of Technology, Eindhoven, Netherlands. Contact: m.chastre@tue.nl

Organizations frequently face Stochastic Sequential Decision Problems and must come up with decision policies. Those problems can be divided into static (made once, e.g. capacity, delivery schedule) and dynamic decisions (made frequently, e.g. replenishment, routing). The static decision is often made in isolation, not considering the future impact on the dynamic policy.

Our research revolves around combining static and dynamic problem-solving methods (Mathematical Programming, Approximate Dynamic Programming, Reinforcement Learning) and applying them on use-cases from retail operations and/or transportation. In this work, we aim to find the best delivery schedule in a Joint Replenishment Problem, one-warehouse-multiple-retailers setting.

2 A Comparison of Stock-Out Scenarios Considering the Risk Attitude of the Retailer

Doran Wood, Sila Cetinkaya, SMU, Dallas, TX, Contact: doranw@smu.edu

We evaluate two practically-common approaches for handling excess demand through the lens of a retailer (newsvendor) whose risk-attitude (risk-neutral vs. risk-averse) is modeled, explicitly. The differing stock-out policies are investigated for both types of risk attitudes utilizing the corresponding expected-profit-based and conditional value-at-risk-based methodologies. Depending on the risk attitude and particular cost parameter relationships, we explore settings that reveal the superior way for handling stock-out scenarios and present practical insights regarding the profitability of each scenario.

3 A Digital Twin Framework for Production Planning Optimization

Ana Muriel[1], Ron Mallach[2], Vivek Saxena[3], William Marrujo[3], [1]University of Massachusetts, Amherst, MA, [2]University of Massachusetts, Amherst, MA, [3]Advisory Aerospace OSC, Minnetonka, MN, Contact: muriel@umass.edu

We develop a Digital Twin framework that allows for practical testing, evaluation, and implementation of new production optimization approaches. The ultimate goal is to facilitate industry adoption of these techniques by bridging theory and practice. To illustrate the approach in collaboration with a software and data analytics firm supporting manufacturers in the aerospace supply chain, we build 1) a factory generator accurately representing large-scale production facilities; 2) a Multi-Level Capacitated Lot Sizing Problem (MLCLSP) approach to generate a production plan for an extended planning horizon with full traceability of customer sales orders; 3) heuristics capable of translating production plans into executable schedules; and 4) advanced analytics and visualizations for evaluating the resulting scenarios and schedules.

4 Smart Contract on Mitigating Returns Risk

Ao Zhuo, Wanshan Zhu, Renmin University of China, Beijing, China. Contact: zhuoao@ruc.edu.cn

A smart contract can be executed automatically based on predetermined terms in supply chain transactions. It has potential to reduce a retailer's returns risk due to a supplier's speculative behavior under a buyback contract. The returns risk occurs when the supplier incurs losses in speculative investment and thus does not have sufficient funds to buy back the retailer's leftover inventory returns. A smart contract specifies a part of the supplier's fund to be stored in the smart contract account only for buyback use. Thus, it may mitigate the returns risk. Our theoretical study shows that when the supplier's speculative investment has high uncertainty, the returns risk is high but can be eliminated by a properly designed smart contract. We extend the model to price-dependent newsvendor and price postponement to show the results are robust.

Tuesday, October 17, 5:25 PM - 6:15 PM

TK01

CC-West 301BC

Advanced Air Mobility: Are We There Yet?

Keynote Session

1 Advanced Air Mobility: Are We There Yet?

Hamsa Balakrishnan, Massachusetts Institute of Technology, Cambridge, MA

Advanced Air Mobility (AAM)—characterized by electric and hybrid aircraft, and highly-automated operations—has the potential to dramatically transform the way in which we transport people and goods, as well as our ability to sense our world from the sky. The excitement around these vehicles and the services they could enable has led to the investment of billions of dollars in their development. However, the deployment of such new aircraft and fleet operators will increase competition for limited airspace resources. Furthermore, in contrast to conventional air traffic that is managed by centralized Air Navigation Service Providers like the FAA, AAM operations are expected to be managed by third-party service providers. In this talk, I will discuss some of the key traffic management challenges to realizing the promise of AAM, and our initial work in overcoming them.

Tuesday, October 17, 5:25 PM - 6:15 PM

TK02

CC-West 301A

Operations Research Methods in National Security

Keynote Session

1 Operations Research Methods in National Security

Les Servi, The MITRE Corporation, Lincoln, MA

Wednesday, October 18, 8:00 AM - 9:15 AM

WA04

CC-North 121A

Sequential Decision Making

Community Committee Choice Session

Session Chair: Azarakhsh Malekian, University of Toronto Joseph L Rotman School of Management, Toronto, ON, Canada

1 Opening Pandora’s Box: The Correlated Case

Evangelia Gergatsouli, University of Wisconsin Madison, Madison, WI, Contact: gergatsouli@wisc.edu

The Pandora’s Box problem and its variants capture sequential decision making settings with stochastic input. The algorithm given a set of random variables with known distributions, has to select one, after obtaining information about their instantiation by paying an “exploration” cost. The goal is to select a good enough variable while not paying too much in exploration cost. All previous work on this class of problems makes the, somewhat unrealistic, assumption that the random variables’ distributions are independent. What happens when we remove this assumption? We summarize the recent solutions given to this problem and some of the techniques used.

2 Pandora’s Problem with Nonobligatory Inspection: Optimal Structure and a Ptas

Hedyeh Beyhaghi, Carnegie Mellon University, Pittsburgh, PA

Weitzman’s “Pandora’s problem” furnishes the mathematical basis for optimal search theory in economics. Nearly 40 years later, Doval introduced a version of the problem in which the searcher is not obligated to pay the cost of inspecting an alternative’s value before selecting it. Unlike the original Pandora’s problem, the optimal solution to the nonobligatory inspection variant is proved to require adaptivity in inspecting the search alternatives and is shown to be NP-hard. Our first main result is a structural characterization of the optimal policy: We show there exists an optimal policy that follows only two different pre-determined orders of inspection, and transitions from one to the other at most once. Our second main result is a polynomial time approximation scheme (PTAS).
Based on joint papers with Linda Cai (STOC 2023) and Robert Kleinberg (EC 2019).

3 Multi-Player Zero-Sum Markov Games with Networked Local Interactions

Chanwoo Park, Massachusetts Institute of Technology, Cambridge, MA, Contact: cpark97@mit.edu

We introduce a new class of Markov Games (MG), the Multi-player Zero-sum Markov Games with networked local interactions (MZNMG), where the Q value of each stage game is represented by a multi-player zero-sum game with local interaction (MZNG). We first identify the necessary and sufficient conditions under which an MG can be classified as an MZNMG, and provide that the set of CCE collapse to the set of NE. Next, we proved that finding stationary Markov approximate coarse correlated equilibria (CCE) in gamma-discounted infinite-horizon MZNMGs is PPAD-hard unless the underlying network is a star shape. For finding nonstationary Markov approximate CCE, we provide an algorithm that uses optimistic multiplicative weight updates. Lastly, we examine the classical learning dynamics of fictitious play in MZNMGs converge to a NE when the interaction structure assumes a star shape.

4 Near-Optimal Prior-Independent Online Algorithms and the Ski-Rental Problem

Jason Hartline, Aleck Johnsen, Anant Shah, Northwestern University, Evanston, IL, Contact: AnantShah2026@u.northwestern.edu

The prior-independent setting of robust algorithms aims to identify an algorithm with expected performance close to optimal in worst case over a family of distributions. This paper gives a fully polynomial time approximation scheme (FPTAS) for the prior-independent optimization of a family of online algorithms problems. Prior-independent approximation can be viewed as a zero sum game. The FPTAS framework then identifies conditions under which the equilibria of this game, which give robust algorithms, can be solved for in polynomial time. A key step is a reduction to online learning. The paper applies the framework to the paradigmatic ski renter problem.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA05

CC-North 121B

Recent Advances in Choice Models and Pricing Analytics

Community Committee Choice Session

Session Chair: Zhenzhen Yan, Nanyang Technological University, Singapore, Singapore

1 Screening with Limited Information

Zhi Chen[1], Zhenyu Hu[2], Ruiqin Wang[3], [1]CUHK Business School, The Chinese University of Hong Kong, Shatin, Hong Kong; [2]NUS Business School, National University of Singapore, Singapore, Singapore; [3]National University of Singapore, Singapore, Singapore

A seller seeks a selling mechanism to maximize the worst-case revenue obtained from a buyer whose valuation distribution lies in a certain ambiguity set. For a generic convex ambiguity set, we show via the minimax theorem that strong duality holds between the problem of finding the optimal robust mechanism and a minimax pricing problem where the adversary first chooses a worst-case distribution and then the seller decides the best posted price mechanism. The duality result connects prior literature that separately studies the primal (robust mechanism design) and problems related to the dual (e.g., robust pricing, buyer-optimal pricing and personalized pricing). We further provide a geometric approach to analytically solving the minimax pricing problem for several important ambiguity sets.The solutions are then used to construct the optimal robust mechanism.

2 Fare Price Ladder Optimization: Airlines in Volatile Environment

Changchun Liu, Hong Ming Tan, Chung Piaw Teo, Yan Chen, Tim Lee, National University of Singapore, Singapore, Singapore

A fare price ladder is a pricing strategy used by airlines to maximize revenue. While the price ladder is often determined using historical sales data, the COVID-19 pandemic has significantly impacted the airline industry and altered the traveling behavior of passengers, prompting a need for airlines to re-evaluate their pricing strategies in a much more volatile environment. This paper proposes an adaptive fare price ladder recommendation model for airlines that employs novel techniques for detecting anomalies in revenue management, which are integrated into existing business processes for forecasting sales and estimating demand elasticity in volatile environments. A field experiment is conducted across ten markets to evaluate the effectiveness of the proposed approach. The results show that the approach improves revenue by 9.4% compared to the control group.

3 Community/Committee’S Choice Submission

Binghan Kou, 1</sup

Wednesday, October 18, 8:00 AM - 9:15 AM

WA06

CC-North 121C

Platforms and Regulation

Community Committee Choice Session

Session Chair: Yao Cui, Cornell University, Ithaca, NY
Session Chair: Wee Kiat Lee, Cornell University, Ithaca, NY

1 Reducing Traffic Incidents in Meal Deliveries: Penalize the Platform or Its Independent Drivers?

Wenchang Zhang[1], Chris S. Tang[2], Liu Ming[3], Yue Cheng[4], [1]Indiana University, Bloomington, IN, [2]University of California-Los Angeles, Los Angeles, CA, [3]Chinese University of Hong Kong, Shenzen, Shenzhen, China; [4]Peking University, Shenzhen, China. Contact: ycheng@phbs.pku.edu.cn

Fierce competition among on-demand meal-delivery platforms resulted in meal-delivery-related traffic violations and accidents. To improve public safety, there is an ongoing debate about whether the government should penalize platforms for delivery-related traffic incidents. Our analysis of a three-stage Stackelberg game yields three results regarding government penalties on drivers and the platform. First, imposing a higher incident penalty on drivers will backfire. It will push the platform to offer higher commissions to incentivize drivers to travel faster, resulting in more accidents and lower profit for the platform. Second, imposing a higher incident penalty on the platform will encourage it to lower commissions, which will induce drivers to travel at safer speeds. Third, penalizing only the platform (not the drivers) is a socially optimal policy.

2 Self-Preferencing and Consumer Choice: Evidence from a Field Experiment

Chiara Farronato[1], Andrey Fradkin[2], Alexander MacKay[1], [1]Harvard Business School, Boston, MA, [2]Boston University, Boston, MA

We study whether Amazon engages in self-preferencing on its marketplace by favoring its own brands (e.g., Amazon Basics) in search, and the welfare consequences of this behavior. To address this question, we collect new micro-level consumer search data using a custom browser extension installed by a panel of study participants. Using this methodology, we observe search positions, search behavior, and product characteristics, and alter the availability of Amazon branded products. We find that Amazon branded products are indeed ranked higher than observably similar products in consumer search results. The prominence given to Amazon brands is 30% to 60% of the prominence granted to sponsored products.

3 Do Predictive Scheduling Laws Work?

Wee Kiat Lee[1], Yao Cui[1], Karan Girotra[2], [1]Cornell University, Ithaca, NY, [2]Cornell Tech/Johnson Cornell University, New York, NY, Contact: wl639@cornell.edu

Workers in the service industry tend to have varying work schedules from week to week. Such unpredictable work schedules can be detrimental to their welfare. The advent of the predictive scheduling law in some areas serves to protect these workers from unpredictable work schedules. This law requires the firms to schedule the work in advance or they will be required to compensate the workers. Opponents of the law have argued that such an intervention may be harmful to both the firms and workers. We build a game theoretic model to analyze the effect of this law. We find that while the firm's hiring level may increase with the regulation, the contracted shift hours and social welfare can potentially decrease. We also find empirical evidence for the predictions from our model using data from the state-wide implementation of a predictive scheduling law in Oregon.

4 Subscription vs. Spot Pricing in On-Demand Economy

Ming Hu[1], Taojie Qin[2], Lu Wang[3], Zhoupeng (Jack) Zhang[2], [1]University of Toronto, Minneapolis, MN, [2]Rotman School of Management, University of Toronto, Toronto, ON, Canada; [3]Shanghai University of Finance and Economics, Shanghai, China. Contact: taojie.qin@mail.utoronto.ca

In this research, we comparatively study the implications of two practically grounded pricing schemes in an on-demand service platform, the subscription and spot pricing. We develop a game-theoretic queueing framework to model the matching process between consumers and workers on a platform. When consumers' valuations for the services are homogeneous, we show that the subscription always yields a lower profit than the spot pricing for the platform operator; yet if the market size is not very high relative to the labor pool size, we find that the ratio of the subscription profit to the spot pricing profit is bounded below by certain constant. In addition, the transaction volume can be higher under the subscription than the spot pricing. The operational implications of these two pricing schemes change dramatically when consumers' valuations become heterogeneous ex post.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA07

CC-North 122A

Algorithms with Predictions and Beyond

Community Committee Choice Session

Session Chair: Billy Jin, Cornell University, Ithaca, NY
Session Chair: Will Ma, Columbia University, New York, NY

1 Algorithms with Prediction Portfolios
Michael Dinitz[1], Sungjin Im[2], Thomas Lavastida[3], Benjamin Moseley[4], Sergei Vassilvitskii[5], [1]Johns Hopkins University, Baltimore, MD, [2]University of California, Merced, Merced, CA, [3]University of Texas at Dallas, Richardson, TX, [4]Carnegie Mellon University, Pittsburgh, PA, [5]Google Research, New York, NY
The research area of algorithms with predictions has seen recent success showing how to incorporate ML predictions into algorithm design to improve performance when the predictions are correct, while retaining worst-case guarantees when they are not. Previous work typically assumes that the algorithm has access to a single prediction. In this work we consider scenarios where multiple predictions are available to the algorithm and the question is how to best utilize them. We study the use of multiple predictions for the fundamental problems of weighted matching, online load balancing, and non-clairvoyant scheduling, which have been studied in the single predictor setting. For each of these problems we introduce algorithms that take advantage of multiple predictions and prove bounds on their performance.

2 Energy-Efficient Scheduling with Predictions
Eric Balkanski, Noemie Perivier, Cifford Stein, Hao-Ting Wei, Columbia University, New York, NY
In this paper, we consider a general setting for energy-efficient scheduling and provide a flexible learning-augmented algorithmic framework that takes as input an offline and an online algorithm for the desired energy-efficient scheduling problem. We show that, when the prediction error is small, this framework gives improved competitive ratios for many different energy-efficient scheduling problems, including energy minimization with deadlines, while also maintaining a bounded competitive ratio regardless of the prediction error. Finally, we empirically demonstrate that this framework achieves an improved performance on real and synthetic datasets.

3 Two-Stage Bipartite Matching with Advice
Billy Jin[1], Will Ma[2], [1]Cornell University, Ithaca, NY, [2]Columbia University, New York, NY, Contact: bzj3@cornell.edu
We study the two-stage vertex-weighted bipartite matching problem (Feng, Niazadeh, and Saberi (SODA '21)) in a setting where the algorithm has access to a suggested matching that is recommended in the first stage. We evaluate an algorithm by its robustness, which is its performance relative to that of the optimal offline matching, and its consistency, which is its performance relative to that of the advice. We characterize the tight robustness-consistency tradeoff for this problem.

4 Fully Dynamic Correlation Clustering in Sublinear Total Update Time
Andreas Maggiori[1,2], [1]EPFL, Lausanne, Switzerland; [2]EPFL, Lausanne, Switzerland
We consider the classic correlation clustering objective in fully dynamic vertex streams: At each time a new vertex is added to or deleted from the stream and the goal is to maintain a solution to correlation clustering, i.e.: a partition of the vertex set. Each vertex is connected to each other vertex with either a + or - edge and the goal is to maintain a partition of the vertices that minimizes the number of + edges across clusters plus the number of - edges within clusters, at each time throughout the update sequence. We show that one can maintain an O(1)-approximation with $\polylog n$ amortized update time in the sublinear regime (where we can make +-degree queries and sample + neighbors in O(1) time).

Wednesday, October 18, 8:00 AM - 9:15 AM

WA08

CC-North 122B
Pricing Innovations at Amazon
Community Committee Choice Session
Session Chair: Shima Nassiri, Amazon, San Bruno, CA

1 Estimating the Distribution of Customers' Willingness to Pay for Delivery Speed
Pau Pereira, Amazon, Seattle, WA
We propose a model of customers' shopping behavior with which we can estimate customer-level parameters that describe the distribution of preferences about different attributes of an offer. We use the model to calculate the distribution of customers' willingness to pay for delivery speed, which we then use to solve the problem of what Retail prices to set on SKUs with long-ship speed competitors that have very long delivery speeds and very low prices. To estimate the model, we use data on consumer search to construct consideration sets for each shopping session. We then model customer choices of which offer to buy using a hierarchical Bayesian multinomial logit model which we approximate the posterior distribution using Mean-Field Variational Inference.

2 Sigmoid Demand Function: An Alternative to Constant Elasticity Demand Function
Hyungjun Lee[1], Pau Pereira[2], [1]Amazon, Cupertino, CA, [2]Amazon, Seattle, WA, Contact: hleehlee@amazon.com

We present the Sigmoid demand function, an alternative to the constant elasticity demand function that is bounded in both price- and quantity-axes. The Sigmoid demand function can be made arbitrarily close to the constant elasticity demand function but does not diverge to infinity when price approaches zero or remain greater than zero when price approach infinity. The conservative demand assumptions at extreme prices lead to more stable price optimization outputs.

3 Choosing an Objective Function for Price Optimization

Joe Cooprider, Amazon, Seattle, WA

When optimally setting Amazon online prices for business to consumer products, we should not only consider the short-term profit, but also the long-term impact of price changes. We study a price optimization setting that aims to balance the short vs long-term impact of retail pricing strategies. Some of the components consider in this optimization setting are: 1) the effect of seeing a price on customers' future purchase behavior, 2) the effect of purchasing the product on customers' future purchase behavior, 3) the effect of additional sales on supply side factors, and 4) the spillover from additional sales on other customers and products.

4 Balancing Bias and Variance in Amazon's Pricing Experiments

Yigit Okar[1], Shima Nassiri[2], Mohsen Bayati[3], [1]University of Washington, Seattle, WA, [2]Amazon, San Bruno, CA, [3]Stanford University, Stanford, CA, Contact: yokar@uw.edu

One of the main challenges faced by Amazon's pricing experimentation platform is the spillover effect in the product-randomized experiments. Spillover effects, when one product's pricing impacts demand for similar products, can bias treatment effect estimation. To mitigate this, we cluster products with correlated demands. This, however, reduces the effective sample size and statistical power. We will present a novel technique optimizing cluster selection and treatment decisions over time, balancing bias and variance for accurate treatment effect estimation.

5 Post Launch Evaluation of Pricing Policies

Shima Nassiri[1], Mohsen Bayati[2], [1]Amazon, San Francisco, CA, [2]Stanford University, Stanford, CA, Contact: shmnas@amazon.com

Running experiments on all policies that have already been launched on a continuous basis is not feasible given that 1) a good control group is not available post launch, and 2) policies can potentially interfere and hence a limited number of initiatives can be tested simultaneously. In this study, we propose a robust way of assessing the performance of launched pricing initiatives at Amazon.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA09

CC-North 122C

Causal Reinforcement Learning

Community Committee Choice Session

Session Chair: Anish Agarwal, Amazon, Newton, MA

1 Did We Personalize? Assessing Personalization by an Online Reinforcement Learning Algorithm Using Resampling

Raaz Dwivedi, Harvard and MIT, Cambridge, MA

There is a growing interest in using reinforcement learning (RL) to personalize sequences of treatments in digital health to support users in adopting healthier behaviors. However, the inclusion of an RL algorithm in an ``optimized'' intervention for real-world deployment, requires data evidence indicating that the RL algorithm is actually personalizing the treatments to its users. Due to the stochasticity in the RL algorithm, one may get a false impression that the RL is learning to provide specific treatments in certain states. We introduce a resampling-based methodology for investigating whether the personalization exhibited by the RL algorithm is an artifact of the RL algorithm stochasticity. We demonstrate how our approach enhances data-driven truth-in-advertising via a case study with data from a physical activity clinical trial, HeartSteps.

2 A Finite-Sample Analysis of Multi-Step Temporal Difference Estimates

Yaqi Duan, MIT, Cambridge, MA

We consider the problem of estimating the value function of an infinite-horizon ⍰-discounted Markov reward process (MRP). We establish non-asymptotic guarantees for a general family of multi-step temporal difference (TD) estimates, including canonical K-step look-ahead TD for $K = 1, 2, \ldots$ and the TD(⍰) family for ⍰ [0,1) as special cases. Our bounds capture the dependence of these estimates on both the variance as defined by Bellman fluctuations, and the bias arising from possible model mis-specification. Our results reveal that the variance component shows limited sensitivity to the choice of look-ahead defining the estimator itself, while increasing the look-ahead can reduce the bias term. This highlights the benefit of using a larger look-ahead: it reduces bias but need not increase the variance.

3 Adaptive Principal Component Regression: Applications to Panel Data

Justin Whitehouse, CMU, Pittsburgh, PA

Principal component regression (PCR) is a popular technique for fixed-design error-in-variables regression, a generalization of linear regression where covariates are corrupted with noise. We provide the first time-uniform finite sample guarantees for PCR whenever data is collected adaptively. The techniques used to obtain bounds for PCR in the fixed design setting don't readily extend to the online setting. Instead, our results rely on applying self-normalized martingale concentration to the error-in-variables setting. As an application, we provide a framework for counterfactual estimation of unit-specific treatment effects in panel data settings when interventions are assigned adaptively. Our framework may be thought of as a generalization of the synthetic interventions framework where data is collected via an adaptive intervention assignment policy.

4 Bayesian Ensembling Methods for Contextual Bandit Models

Joseph Lawson, Duke University, Durham, NC

Contextual bandit models are a primary tool for sequential decision making with applications ranging from clinical trials to e-commerce. While there are numerous bandit algorithms which achieve optimal regret bounds and show strong performance on benchmark problems, algorithm selection and tuning in any given application remains a major open problem. We propose the Bayesian Basket of Bandits (B3), a meta-learning algorithm which automatically ensembles a set (basket) of candidate algorithms to produce an algorithm which dominates all those in the basket. The method works by treating the evolution of a bandit algorithm as a Markov decision process in which the states are posterior distributions over model parameters and subsequently applying approximate Bayesian dynamic programming to learn an optimal ensemble. We derive both Bayesian and frequentist convergence results for the cumulative discounted utility. In simulation experiments, the proposed method provides lower regret than state-of-the-art algorithms including Thompson Sampling, upper confidence bound methods, and Information-Directed sampling.

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WA10

CC-North 123

Experimentation

Community Committee Choice Session

Session Chair: Hannah Li, MIT, Cambridge, MA

Session Chair: Hongseok Namkoong, Columbia University, New York, NY

1 Community/Committee'S Choice Submission

Sergey Gitlin, Uber

2 Experimentation for Scaling Healthcare Service Interventions

Hannah Li[1], Justin J. Boutilier[2], Jonas Oddur Jonasson[3], [1]Columbia, New York, NY, [2]University of Wisconsin - Madison, Madison, WI, [3]MIT Sloan School of Management, Cambridge, MA

A concern about service interventions, commonly found in domains like public health, education, and vocational training, is that promising interventions at the randomized controlled trial (RCT) stage may not perform well at scale. Although many factors contribute to these difficulty in scaling, in this work we highlight and isolate the effects of one such factor: capacity constraints. We consider a case study of a mobile health platform designed to improve patients' adherence to treatment protocols. We model the dynamics as a queueing system and investigate patient adherence. Due to capacity constraints on the system, the effect observed in an RCT may diminish when servicing a larger population. We show that this has counterintuitive implications for the typical power analysis and that a joint power and capacity analysis should be implemented.

3 Treatment Effect Heterogeneity: What It Means for Your Study

Elizabeth Tipton, Northwestern University, Evanston, IL, Contact: tipton@northwestern.edu

Randomized control trials (RCTs) offer the ability to determine unambiguously if an intervention causes outcomes to change; these changes are summarized in terms of the average causal effect (ACE). But interventions may not improve outcomes to the same degree for every unit. Thus, when treatment effects vary, the ACE estimated in one sample or population may not generalize to another. Furthermore, the ACE may not be the parameter of interest; e.g., we may instead be in interested in understanding 'for whom' and 'under what conditions' such an intervention is effective. But what does this mean for how we plan studies? In this paper, I focus on how to best design RCTs when treatment effect heterogeneity is likely. I show that the optimal study designs for estimating average effects, subgroups effects, and unit specific effects can differ substantially.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA11

CC-North 124A
Data-driven Decision Making
Community Committee Choice Session
Session Chair: Qiaomin Xie, University of Wisconsin-Madison, Madison, WI

1 Concentration of Contractive Stochastic Approximation: Additive and Multiplicative Noise
Zaiwei Chen[1], Siva Theja Maguluri[2], Martin Zubeldia[3], [1]California Institute of Technology, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA, [3]University of Minnesota, Minneapolis, MN, Contact: zubeldia@umn.edu
In this talk, we look at the concentration behavior of a stochastic approximation (SA) algorithm under a contractive operator with respect to an arbitrary norm. We consider two settings where the iterates are potentially unbounded: bounded multiplicative noise, and additive sub-Gaussian noise. We obtain maximal concentration inequalities on the convergence errors, and show that these errors have sub-Gaussian tails in the additive noise setting, and super-polynomial tails (faster than polynomial decay) in the multiplicative noise setting. In addition, we provide an impossibility result showing that it is in general not possible to achieve sub-exponential tails for SA with multiplicative noise.
To demonstrate the applicability of our theoretical results, we use them to provide maximal concentration bounds for a large class of reinforcement learning algorithms.

2 Bayesian Learning of Optimal Policies in Markov Decision Processes with Countably Infinite State-Space
Saghar Adler, Vijay Subramanian, University of Michigan, Ann Arbor, MI
Models of many real-life applications-queuing models of communication networks or computing systems-have a countably infinite state-space. Learning procedures to find optimal policies mainly focus on finite-state models. We study the problem of optimal control of a family of discrete-time countable state-space Markov Decision Processes (MDPs) on $\X=\mathbb{Z}_+^d$ with finite action space A, and an unbounded cost function, governed by an unknown parameter $\theta\in\Theta$. The random unknown parameter $\boldsymbol{\theta}^*$ is generated via a given fixed prior. To optimally control the unknown MDP, we propose an a Thompson sampling algorithm with dynamically-sized episodes. Ergodicity assumptions ensure stability of controls. The Bayesian regret is bounded as $\tilde O(\sqrt{|A|T})$.

3 New Improved Regret Bounds for Model-Free Reinforcement Learning
Priyank Agrawal, Shipra Agrawal, Columbia University, New York, NY
Model-free reinforcement learning (RL) algorithms have been established to be simpler to implement in various practical scenarios than their model-based counterparts. This work presents a new algorithm design and regret analysis for model-free RL, mainly focusing on the average reward setting.

4 Measurized Markov Decision Processes
Alba V Victoria Olivares Olivares Nadal[1], Daniel Adelman[2], [1]University of New South Wales, Sydney, Australia; [2]University of Chicago, Booth School of Business, Chicago, IL
We build a framework that facilitates the analysis of infinite horizon Markov Decision Processes (MDP's) by visualizing them as deterministic processes where the states are probability measures on the original state space, and the actions are stochastic kernels on the original action space. We call this to "measurize" the original stochastic MDP, and show that measured MDP's are in fact a generalization of stochastic MDP's. We demonstrate that this framework offers various advantages.

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WA12

CC-North 124B
A Few High-dimensional Inference Problems
Community Committee Choice Session
Session Chair: Dana Yang, Cornell University, Ithaca, NY

1 Test of Significance for High-Dimensional Thresholds with Application to Individualized Minimal Clinically Important Difference
Jingyi Duan[1], Huijie Feng[1], Yang Ning[1], Jiwei Zhao[2], [1]Cornell Univeristy, Ithaca, NY, [2]University of Wisconsin-

Madison, Madison, WI, Contact: jd2222@cornell.edu
This work is motivated by learning the individualized minimal clinically important difference, a vital concept in biomedical studies. We formulate the scientific question into a high-dimensional statistical problem where the parameter of interest lies in a linear threshold. The goal is to develop a hypothesis testing procedure for a single element in this parameter. The difficulty dues to the high-dimensional nuisance, and also the fact that this high-dimensional threshold model is non-regular. To deal with these challenges, we construct a test statistic via a new bias-corrected smoothed decorrelated score approach, and establish its asymptotic distributions under both null and local alternative hypotheses. We propose a double-smoothing approach to select the optimal bandwidth in our test statistic and provide theoretical guarantees for the selected bandwidth.

2 Detection of Dense Subhypergraphs by Low-Degree Polynomials

Abhishek Dhawan, Georgia Institute of Technology, Atlanta, GA, Contact: abhishekdhawan@gatech.edu
Detection of a planted dense subgraph in a random graph is a fundamental statistical and computational problem that has been extensively studied in recent years. We study a hypergraph version of the problem. Let $G^r(n,p)$ denote the r-uniform Erdos-Renyi hypergraph model with n vertices and edge density p. We consider detecting the presence of a planted $G^r(n^{\square}, n^{-\square})$ subhypergraph in a $G^r(n, n^{-\square})$ hypergraph, where $0< \square < \square < r-1$ and $0 < \square < 1$. Focusing on tests that are degree-$n^{o(1)}$ polynomials of the entries of the adjacency tensor, we determine the threshold between the easy and hard regimes for the detection problem.

3 Nearly-Linear Time and Streaming Algorithms for Outlier-Robust Pca

Thanasis Pittas, UW-Madison, Madison, WI, Contact: pittas@wisc.edu
We study principal component analysis (PCA), where given a dataset in R^d from a distribution, the task is to find a unit vector v that approximately maximizes the variance of the distribution after being projected along v. Despite being a classical task, standard estimators fail drastically if the data contains even a small fraction of outliers, motivating the problem of robust PCA. Recent work has developed computationally-efficient algorithms for robust PCA that either take super-linear time or have sub-optimal error guarantees. Our main contribution is to develop a nearly linear time algorithm for robust PCA with near-optimal error guarantees. We also develop a single-pass streaming algorithm for robust PCA with memory usage nearly-linear in the dimension.

4 Entry-Specific Bounds for Low-Rank Matrix Completion Under Highly Non-Uniform Sampling

Xumei Xi[1], Christina Lee Yu[1], Yudong Chen[2], [1]Cornell University, Ithaca, NY, [2]University of Wisconsin, Madison, Madison, WI, Contact: xx269@cornell.edu
Low-rank matrix completion concerns the problem of estimating unobserved entries in a matrix using a sparse set of observed entries. We consider the non-uniform setting where the observed entries are sampled with highly varying probabilities, potentially with different asymptotic scalings. We show that under structured sampling probabilities, it is often better and sometimes optimal to run estimation algorithms on a smaller submatrix rather than the entire matrix. In particular, we prove error upper bounds customized to each entry, which match the minimax lower bounds under certain conditions. Our bounds characterize the hardness of estimating each entry as a function of the localized sampling probabilities. We provide numerical experiments that confirm our theoretical findings.

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WA13

CC-North 125A

VoI, Pandemic Decision Making, and Disaster Response

Community Committee Choice Session

Session Chair: Ali E. Abbas, University of Southern California, Los Angeles, CA

1 Developing Optimal Testing Strategies with Decision Programming

Ahti Salo, Topias Terho, Fabricio Oliveira, Aalto University, Espoo, Finland. Contact: ahti.salo@aalto.fi
By converting influence diagrams into mixed-integer linear programming (MILP) problems, Decision Programming (Salo et al., EJOR 299/2, 2022) makes it possible to eliminate the usual ‘no-forgetting’ assumption and to handle many kinds of logical, resource, and resource constraints. In order to improve the computational performance of these MILP problems, we propose novel formulations for modeling information decisions that govern what information is obtained to support further decisions. Technically, information decisions are represented through binary variables that act as constraints on other decisions. We illustrate the approach with numerical examples on the development of testing strategies.

2 Optimal Strategies for Asset Maintenance with Decision Programming

Leevi Olander, Aalto University, Helsinki, Finland

Condition-based optimal maintenance strategies are needed to maximize the performance of assets such as transportation infrastructures while minimizing the costs of maintenance and the risks of disruptions due to external loads. In this talk, we explore the use of Decision Programming (Salo et al., EJOR 299/2, 2022) in determining efficient maintenance strategies with regard to the level of performance associated with different asset conditions, the risk of disruptions, and the costs and impacts of alternative maintenance actions. The results indicate that Decision Programming is computationally viable for developing risk-informed maintenance strategies, as illustrated by stylized examples for the Finnish Transport Infrastructure Agency.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA14

CC-North 125B

OM Problems with Social Interactions

Community Committee Choice Session

Session Chair: Dongwook Shin, HKUST Business School, Clear Water Bay, Hong Kong

1 Online Combinatorial Optimization with Group Fairness Constraints

Negin Golrezaei[1], Rad Niazadeh[2], Kumar Kshitij Patel[3], Fransisca Susan[4], [1]Massachusetts Institute of Technology, Lexington, MA, [2]Chicago Booth School of Business, CHICAGO, IL, [3]Toyota Technological Institute at Chicago, Chicago, IL, [4]Massachusetts Institute of Technology, Cambridge, MA, Contact: kkpatel@ttic.edu

Online marketplaces are increasingly under pressure to cultivate and sustain a fair ecosystem for all their users. An essential aspect of this challenge involves incorporating group fairness constraints into these platforms' decision-making processes. These processes often must solve NP-complete problems with exponentially large decision spaces, such as sub-modular maximization. We provide a general framework to address this challenge by casting this problem as a max-min game between a primal player aiming to maximize the platform's objective and a dual player in charge of group fairness constraints. With this view, we present fair algorithms for offline and online settings to maximize the platform's objective. We provide theoretical guarantees for our method and empirically evaluate our approach on the MovieLens dataset, demonstrating its effectiveness.

2 Dynamic Expansions of Social Followings with Lotteries and Give-Aways

Jingtong Zhao, Renmin University of China, Beijing, China

We study a practice common on popular microblogging platforms such as Twitter of influencers' expanding their followings by running lotteries and giveaways. We are interested in how the lottery size and the seeding decisions will influence the information propagation process and the final reward for such a campaign. We construct an information-diffusion model based on a random graph, and show that the market demand curve of the lottery reward via the promotion of the social network is "S"-shaped. Second, we observe that 1) the propagation may slow down quickly and 2) with a fixed seeding budget, seeding at two fixed occasions is always better than seeding once at the beginning. These observations motivate us to further study the joint optimization of lottery size and adaptive seeding. We show that the adaptive seeding problem is solvable by modelingit as a tractable MDP.

3 Quality Design for Multi-Attribute Product in the Presence of Social Learning

Eunjee Kim[1], Sang Won Kim[2], Dongwook Shin[3], [1]University of Wisconsin-Madison, Madison, WI, [2]KAIST College of Business, Seoul, Korea, Republic of; [3]HKUST Business School, Clear Water Bay, Hong Kong. Contact: catalanumber@gmail.com

This paper studies a monopolist firm's choices of product quality and price. The product quality is a priori unknown, but customers can infer it from customer-generated reviews using Bayesian updating. This problem is studied using two different review systems: a multi-dimensional (MD) review system, where customers report their experience on multiple features of a product; and a single-dimensional (SD) review system, where customers only provide an overall rating. Our analysis yields two main insights. First, we find that the learning is successful with MD reviews, whereas SD reviews may obfuscate the learning. Second, we find that MD reviews relatively improve the product quality when customers' prior belief is sufficiently negative.

4 Social Learning with Polarized Preferences on Content Platforms

Dongwook Shin[1], Bharadwaj Kadiyala[2], [1]HKUST Business School, Clear Water Bay, Hong Kong; [2]University of Utah, Salt Lake City, UT

The focus of this research is to explore how polarized preferences affect content consumption and production on a digital platform that utilizes popularity metrics to facilitate social learning. Our analysis yields three main insights. First, we find that social learning under polarized preferences can mislead consumers into incorrectly perceiving low-quality content as higher-quality content; consequently, content providers may lower the content quality. Second, despite the negative effects of polarization, social learning improves content quality unless the polarization level is extreme. Third, our research suggests several levers that platforms can use to improve content quality, including implementing two-part compensation plans, suppressing content recommendation, censoring misinformation, and providing viewership information.

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WA15

CC-North 126A

Pricing and Its Effects

Contributed Session

Session Chair: Banafsheh Behzad, California State University, Long Beach, Long Beach, CA

1 Free Freight or Not? Retail Platform Operations Under Reference Price Effect

Qiang Wang[1], Jie Wu[1], Xiang Ji[1], Nenggui Zhao[2], [1]University of Science and Technology of China, Hefei, China; [2]Hefei University of Technology, Hefei, China

We incorporate reference price effect into a Hotelling model to characterize the pricing and freight decisions of two competitive retail platforms. Our results find retail platforms prefer sequential pricing over simultaneous pricing, and free freight will not affect the platforms' operational decisions if the reference price effect is ignored.

2 Dynamic Pricing with Experimentation and Fairness Concerns

Ariit Sengupta[1], Himanshu Rathore[2], [1]Indian Institute of Management, Lucknow, Lucknow, India; [2]Indian Institute of Management Lucknow, Lucknow, India. Contact: ariitsengupta@gmail.com

Research on Dynamic Pricing with demand learning is increasingly gaining traction because of shortening product life cycles. This work subscribes to experimentation in demand learning and proposes a pricing policy that quantifies the impact of fairness concerns on customers. The proposed pricing policy incurs a regret of O(log^m(T)) and performs better than the proposed bounds of Kleinberg and Leighton (2003).

3 Dynamic Pricing with Procedural and Substantive Fairness

Jianyu Xu, Qiao Dan, Yu-Xiang Wang, University of California, Santa Barbara, Santa Barbara, CA, Contact: xu_jy15@ucsb.edu

We study the problem of online dynamic pricing with two types of fairness constraints: a procedural fairness which requires the *proposed* prices to be equal and a substantive fairness which requires the *accepted* prices to be equal in expectation among different groups. A policy that is simultaneously procedural and substantive fair is referred to as doubly fair. We show that a doubly fair policy must be random to have higher revenue than the best fixed-price policy. In a two-group setting, we propose an online learning algorithm for two groups that achieves $O(\sqrt{T})$ regret, zero procedural unfairness and $O(\sqrt{T})$ substantive unfairness over T rounds. We also prove its optimality with two matching lower bounds. To the best of our knowledge, this is the first dynamic pricing algorithm that learns to price while satisfying two fairness constraints at the same time.

4 Managing Presales with Two Payments and Return Policy when Consumers are Time-Inconsistent

Yunjuan Kuang, Li Jiang, The Hong Kong Polytechnic University, Hong Kong, China. Contact: yunjuan.kuang@connect.polyu.hk

We consider a firm using presales with two payments (an upfront deposit and a postponed arrear) to sell a product to time-inconsistent consumers under various return policies. With the passage of time, consumers decide whether to preorder the product by paying the deposit, whether to settle the balance by paying the arrear by the due date, and (when returns are allowed) whether to return a fully paid product for a refund after its fitness is revealed. Consumers exhibit time-inconsistency when making purchasing decisions. We characterize the firm's optimal pricing strategy and return policy.

5 Optimal Three Part Tariff Pricing

Jianqing Fisher Wu[1], Banafsheh Behzad[2], [1]California State University, Long Beach, Long Beach, CA, [2]California State University, Long Beach, Long Beach, CA, Contact: banafsheh.behzad@csulb.edu

We study the pricing of three-part tariffs (3PTs), where service providers charge a fixed fee with an allowance of free units, and a per-unit fee for additional units above the allowance. This is a pricing strategy that has been widely used in a variety of industries, including telecommunications and internet services. Many papers study the properties of the optimal solution of 3PTs. However, the existing solution approaches proposed in prior papers can only be used to solve 3PT problems under certain restricted conditions. This study expands the solution approach to more general cases.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA16

CC-North 126B

Fairness in Real-world Systems

Community Committee Choice Session

Session Chair: Nikhil Garg, Cornell Tech, New York, NY

Session Chair: Zhi Liu, Cornell Tech, New York, NY

1 Online Fair Allocation of Perishable Resources

Sean Sinclair[1], Chamsi Hssaine[2], Sid Banerjee[3], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Amazon / Marshall School of Business, University of Southern California, Ithaca, NY, [3]Cornell University, Ithaca, NY

We consider a variant of the online fair allocation problem: a decision-maker has a budget of resources to allocate over a fixed number of rounds. Each round sees a random number of arrivals, and the decision-maker must commit to an allocation for these individuals before moving on to the next round. In contrast to prior work, we consider a setting in which resources are perishable and individuals' utilities are potentially non-linear (e.g., goods exhibit complementarities). The goal is to construct a sequence of allocations that is envy-free and efficient. We design an algorithm which takes as input a prediction of the perishing order, and a desired bound on envy. The algorithm uses forecasts of future demand and perishing to adaptively choose one of two carefully constructed guardrail quantities to achieve the optimal envy-efficiency Pareto frontier.

2 Redesigning Service Level Agreements: Equity and Efficiency in City Government Operations

Zhi Liu, Nikhil Garg, Cornell Tech, New York, NY, Contact: zl724@cornell.edu

We consider government service allocation -- how the government allocates resources over time. It is important to make these decisions efficiently, equitably, and transparently. In particular, we consider the design of Service Level Agreements (SLA). We model the problem of designing a set of SLAs as a tractable optimization problem with different equity and efficiency objectives under a queuing network framework, with two allocation levers for the city. We empirically apply our framework to calibrated simulations motivated by SLA design in New York City, and find that: (a) status quo budgets are highly inefficient and inequitable, and (b) in practice, the equity-efficiency tradeoff is not substantial: generally, budget and scheduling policies tend to be either both efficient and equitable, or neither efficient nor equitable.

3 Generative Social Choice

Paul Gölz, Simons Laufer Mathematical Sciences Institute, Berkeley, CA

Social choice theory offers group decision processes with mathematical fairness guarantees, but their applicability is limited to choices among few alternatives, not to richer outcome domains like selecting a text statement. We propose *generative social choice*, a framework that combines the mathematical rigor of social choice theory with large language models' capacities to generate text and extrapolate preferences. Our framework breaks down the design of AI-augmented democratic processes into two modules: (1) proving that the process satisfies representation guarantees when given access to oracle queries; and (2) empirically validating that these queries can be approximately implemented with a large language model. We demonstrate this framework for the task of aggregating representative statements in a real-world deliberation on AI governance.

4 Decision-Aware Learning for Global Health Supply Chains

Angel Tsai-Hsuan Chung[1], Vahid Rostami[2], Hamsa Sridhar Bastani[1], Osbert Bastani[3], [1]Wharton School, Philadelphia, PA, [2]Pendulum, Seattle, WA, [3]University of Pennsylvania, Shenzhen, China

Integrating ML and optimization is challenging due to the need to align the ML loss function with the decision loss of the downstream optimization. Current solutions show limits in flexibility and scalability. We present a decision-aware learning algorithm that uses a Taylor expansion of optimal decision loss for efficient learning and decision-making. It only requires re-weighting of training data and can be integrated into modern data science pipelines. We leverage random forests with meta-learning and apply our decision-aware approach to the distribution of essential medicines in Sierra Leone. Our approach significantly reduced unmet demand in over 1000 health facilities.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA17

CC-North 127A

Topics on Information and Behaviors in Service Operations and Management

Flash Session

Session Chair: Jose Pius Nedumkallel, Clemson University, Clemson, SC

1 Improve Engagement in Multi-Tasking Social Referral Programs: The Framing Effect of Rewards

Xu Li[1], Kanliang Wang[2], Hongwei Wang[1], [1]Tongji University, Shanghai, China; [2]Renmin University of China, Beijing, China. Contact: xu.li.edu@hotmail.com

The goal of social referral reward programs is to incentivize existing customers to recommend a product to others. We divide social referrals into single-tasking and multi-tasking social referrals (SSR vs. MSR) based on the reward threshold (i.e., the number of respondents). This paper focuses on the task progress and time in MSR, and explores how to design an effective reward mechanism to improve referral intentions. Based on loss aversion theory, we first elucidate when downgrade- versus gain-framed rewards are most effective in influencing engagement by examining the moderating role of task completion progress. We propose that the above effects will be further moderated by the temporal distance (i.e., the remaining time). Two experiments are designed to test the three hypotheses. This study will provide important implications for designing reward mechanisms in MSR.

2 The Warranty Policy And The Contingent Consumable Products

Jiung Lee, Korea Advanced Institute of Science and Technology (KAIST), Seoul, Korea, Republic of. Contact: leejiung@kaist.ac.kr

The razor-blade pricing strategy involves selling equipment at a low price and charging high prices for related supplies. However, with the entry of low-cost compatible products in the market, firms are no longer able to benefit from deploying the razor-blade strategy. In response, some firms offer warranties that only apply to customers using their OEM supplies. This paper examines the impact of warranty-void policies on a firm's pricing strategy in a competitive environment. We find that implementing a warranty-void policy allows the firm set higher prices for both equipment and supplies, and furthermore, the firm can generate higher profits even after accounting for the cost of the warranty compared to the monopoly case.

3 App Developers' Complaint Response Strategies and Impacts

Jose Pius Nedumkallel, Zhihong Ke, William J. Kettinger, Clemson University, Clemson, SC, Contact: jpiusne@g.clemson.edu

Online reviews greatly influence consumer perceptions and decisions. Ineffective complaint responses can leave customers dissatisfied and negatively impact app adoption. We investigate the complaint response strategies employed by app developers and their impacts on app adoption. Analyzing 1.2 million apps on the Google Play Store from August 2022 to February 2023 using machine learning techniques, we identify two complaint categories: process and outcome failures. App developers use response types: initiation, promises, and resolution. Through fixed-effect panel data analysis, we demonstrate the significant impact of these response types on future app downloads. Our findings provide valuable insights for app developers to enhance their complaint response strategies, fostering positive user experiences and improving app adoption rates.

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WA18

CC-North 127B

Stochastic Approaches to Healthcare Analytics

Community Committee Choice Session

Session Chair: Anil Aswani, UC Berkeley, Berkeley, CA
Session Chair: Ilgin Dogan, University of California, Berkeley, Berkeley, CA

1 Community/Committee'S Choice Submission

Alexander Ioannidis, Stanford University, CA

2 Detection of Early-stage Lung Cancer by DNA Methylation with Simple and Effective Machine Learning Techniques

Xin Guo, University of California-Berkeley, Piedmont, CA

The low abundance of circulating tumour DNA (ctDNA) in plasma samples makes the analysis of ctDNA biomarkers for the detection or monitoring of early-stage cancers (e.g., lung cancer) challenging. We show that deep methylation sequencing aided by a machine-learning classifier of methylation patterns enables the detection of tumour-derived signals at dilution factors as low as 1 in 10000. The low amounts of ctDNA permitted by machine-learning-aided deep methylation sequencing could provide advantages in cancer screening and the assessment of treatment efficacy.

Based on the work ``Ultrasensitive detection of circulating tumour DNA via deep methylation sequencing aided by machine learning'', Nature BME, 2021.

3 Miwaves: Rl Algorithm Design for Digital Health Interventions

Yongyi Guo, Harvard University, Cambridge, MA

MiWaves is a digital intervention aimed at reducing cannabis use among emerging adults using smartphone prompts. Given that excessive prompts can lead to user disengagement and habituation, we are developing an RL algorithm to personalize the timing of prompt delivery. The main theoretical challenge is to strike a balance between efficient learning and personalizing with respect to each user, while ensuring stability in an online low-data setting (with limited users). To achieve this goal, we propose a generalized Thompson-Sampling bandit algorithm with a mixed-effects-based reward model, which automatically adjusts the degree of personalization for each user based on previously available data. We also discuss the computational aspects of the algorithm and our simulation results.

4 Incentive, Lockdown and Testing

Thibaut Mastrolia, IEOR UC Berkeley, Berkeley, CA

In this work, we provide a general mathematical formalism to study the optimal control of an epidemic, such as the COVID-19 pandemic, via incentives to lockdown and testing. In particular, we model the interplay between the government and the population as a principal-agent problem with moral hazard, while an epidemic is spreading according to dynamics given by compartmental stochastic SIS or SIR models. Numerical results confirm that if a tax/incentive policy is implemented, the population is encouraged to significantly reduce its interactions. If the government also adjusts its testing policy, less effort is required on the population side, individuals can interact almost as usual, and the epidemic is largely contained by the targeted isolation of positively-tested individuals

Wednesday, October 18, 8:00 AM - 9:15 AM

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CC-North 127C

Empirical Research in Healthcare

Community Committee Choice Session

Session Chair: Sriram Venkataraman, University of South Carolina, Columbia, SC

1 The Role of Surgical Consumable Standardization in Healthcare: An Empirical Study on Orthopedic Surgery

Ting Wang[1], Ding Xin[2], Kejia Hu[3], Yun Fong Lim[4], Vikram Tiwari[5], [1]University of Science and Technology of China, Hefei, China; [2]Rutgers Business School, New Jersey, NJ, [3]Vanderbilt University, Nashville, TN, [4]Singapore Management University, Singapore, Singapore; [5]Vanderbilt University Medical Center, Nashville, TN

We investigate how surgical consumable standardization (SCS) impacts the performance of healthcare service. To answer this question, we utilize point-of-usage data of over 17,000 orthopedic surgeries and focus on SCS's impact on three healthcare service outcomes: service quality, service efficiency, and service cost. We find that SCS promotes quality patient care at a cost-effective price. Our results provide important implications for (1) surgeons to reshape their understanding of SCS, (2) administrators to establish business cases for SCS initiatives at the hospital or system level, and (3) the healthcare industry to align SCS with ongoing supply chain operations (e.g., volume-based procurement programs) and financial reforms (e.g., from fee-for-service to bundled payments).

2 Impact of Clinical Focus on Patient Outcomes Through Ultra-Early Admissions

Aman Goswami[1], Xin Ding[2], David Dreyfus[3], [1]Rutgers Business School, Newark, NJ, [2]Rutgers University, Newark, NJ, [3]Rutgers University, Newark, NJ, Contact: ag77in@gmail.com

We present research examining the impact of clinical focus on patient outcomes through ultra-early procedures. A theoretical and empirical framework is developed to understand how and why clinical focus impacts patient outcomes. We generate and validate critical hypotheses linking patient outcomes to clinical focus and show how ultra-early procedures mediate this relationship. The results provide a new direction to the research of clinical focus and the applicability of speed, delivery of care, and ultra-early procedures in healthcare settings.

3 The Double-edged Sword Effect Of Corporate Venture Capital On Startup Innovation: Evidence From The Medical Device Industry

Moyan Li[1], George Ball[2], Haizhen Lin[1], [1]Indiana University, Bloomington, IN, [2]Operations and Decision Technologies, Kelley School of Business, Indiana University, Bloomington, IN, Contact: moyli@iu.edu

Venture capital is one of the most important external funding sources for startups. Unlike independent venture capital firms (IVC), corporate venture capital (CVC) not only brings funding but also specialized industry knowledge, comprehensive experience of product life cycle, and perhaps, negative established-industry practices that may lead to quality issues. Using difference-in-difference models and instrument variable strategy, we compare the causal effect of CVC versus IVC on innovation successes of U.S. medical device startup firms. CVCs foster innovation of startups more efficiently than IVCs. Moreover, CVC-backed innovations appear to suffer from more product quality failures than IVC-backed ones, indicating a potential double-edged sword to the innovation benefit of CVCs.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA20

CC-North 128A

Incentive Design and Game Theory in Healthcare

Community Committee Choice Session

Session Chair: Saumya Sinha, University of Minnesota, Minneapolis, MN

1 Incentives and Decentralization for Enhancing Coordination in Consolidated Hospital Systems

Shima Mohebbi, George Mason University, Fairfax, VA

The integration of healthcare systems has been a solution to enhance the quality of care and reduce costs for more than a decade. This study investigates the collaboration of hospitals, consolidated for healthcare service delivery, in the patient's referral process. Cooperative game theory, coupled with optimization techniques, is utilized to model the interaction of main players (physicians, hospitals managers, and the central referral system) and devise an incentive scheme. The feasibility of the approach is examined via a case study. In this setting, a prototype decentralized patients assignment system will be presented which highlights the importance of interoperability and consensus among healthcare players in the decision-making process.

2 Optimal Integration of Screening Strategies and Incentive Mechanisms for the Effective Mitigation of Covid-19

Marie Jeanne Rabil[1], Sait Tunc[1], Douglas R. Bish[2], Ebru Korular Bish[2], [1]Virginia Tech, Blacksburg, VA, [2]University of Alabama, Tuscaloosa, AL, Contact: mariejeanne@vt.edu

Integrating protective and preventative interventions including screening and vaccination is essential for managing infectious disease outbreaks, as COVID-19 demonstrates. Although the vaccination resources became abundant in the later stages of the pandemic, not all universities (or other closed communities) can mandate vaccination, let alone require individuals to report their vaccination status, thus it is important to create mechanisms that will increase voluntary compliance. We propose a novel approach to infection control on university campuses, and study strategies that integrate routine screening and nudge mechanisms (e.g., monetary incentive, or exemption from routine screening, for all vaccinated individuals) under limited resources, considering behavioral issues of the campus population and an imperfect information on vaccination status.

3 Incentives to Improve Participant Retention in Clinical Studies

Xueze Song[1], Mili Mehrotra[2], Tharanga Kumudini Rajapakshe[3], [1]Universityof Illinois-Urbana-Champaign, Champaign, IL, [2]University Of Illinois Urbana Champaign, Champaign, IL, [3]University of Florida, Gainesville, FL, Contact: tharanga@ufl.edu

Participant retention is a significant issue in clinical studies. It is estimated that on average more than 40% of the participants of a clinical study drop out before the conclusion of the study. We analyze mechanisms to improve participant retention. Specifically, we focus on the characteristics of a clinical study, the clinical study team, and the participants, to design incentives and compensations, for the participants and providers, respectively, to achieve a targeted retention level.

4 Hybrid Telehealth Service with Heterogeneous Community Patients

Xiang Zhong[1], Yongpei Guan[2], Tan Yu[3], [1]Univ. of Florida, Gainesville, FL, [2]University of Florida, Gainesville, FL, [3]University of Florida, Gainesville, FL, Contact: oliver040525@gmail.com

We consider a medical institution with one central care facility serving a broad catchment area including multiple communities. We follow the strategic queueing model conventions and conceptualize the care delivery system as an unobservable queue where the customers (patients) do not observe the queue prior to their actions. Two service options are provided, telehealth and in-person visits. Customers belonging to each community can have distinct service values and time costs, based on their proximity to the central care facility. We explore how the equilibrium patient flow looks like with two service options and what factors decide the market size of telehealth, and, how the revenue-maximizing stakeholder behaves differently from the social welfare-maximizing stakeholders with and without the telehealth option.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA21

CC-North 128B

Data-driven Decision Making in Healthcare II

Community Committee Choice Session

Session Chair: Jin Qi, Hong Kong University of Science and Technology, Hong Kong, Hong Kong
Session Chair: Yi Chen, Hong Kong University of Science and Technology, Hong Kong, Hong Kong
Session Chair: Kai Sun, University of Texas-San Antonio, San Antonio, TX

1 Optimizing Early Discharge: Trade-Offs Between Capacity and Re-Admissions

Zhiyuan Lou[1], Gar Goei Loke[2], Jingui Xie[1], Taozeng Zhu[3], [1]Technical University of Munich, Heilbronn, Germany; [2]Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands; [3]Dongbei University of Finance and Economics, Dalian, China. Contact: louzy0803@gmail.com

In this work, we consider the ward capacity management problem where the decision-maker seeks to optimize elective schedule and an early discharge policy, so as to minimize the chance of bed shortages in the ward. In particular, the decision-maker needs to balance the trade-off between the immediate capacity freed up by early discharges and the increased chance of re-admissions. The presence of such re-entry makes it difficult to model this problem via traditional methods. We appeal to the Pipeline Queues (Bandi 2018) framework, and propose an optimization model where the early discharge policy is expressed as a linear state-dependent decision rule. The model has a reformulation, which can be solved as a sequence of convex program with asymptotically linear constraints. We numerically examine the conditions under which early discharge is favoured.

2 Model-Assisted Uniformly Honest Inference for Optimal Treatment Regimes in High Dimension

Yunan Wu, University of Texas at Dallas, Richardson, TX

We develop new tools to quantify uncertainty in optimal decision making and to gain insight into which variables one should collect information about given the potential cost of measuring a large number of variables. We investigate simultaneous inference to determine if a group of variables is relevant for estimating an optimal decision rule in a high-dimensional semiparametric framework. We first establish that a local restricted strong convexity condition holds with high probability and that any feasible local sparse solution of the estimation problem can achieve the near-oracle estimation error bound. We further rigorously verify that a wild bootstrap procedure based on a debiased version of the local solution can provide asymptotically honest uniform inference for the effect of a group of variables on optimal decision making.

3 Distributionally Robust Group Testing with Correlation Information

Daniel Zhuoyu Long[1], Jin Qi[2], Yu SUN[3], Aiqi Zhang[4], [1]The Chinese University of Hong Kong, Shatin, Hong Kong; [2]Hong Kong University of Science and Technology, Hong Kong, Hong Kong; [3]The Chinese University of Hong Kong, Shatin, China; [4]Rotman School of Management, University of Toronto, Toronto, ON, Canada. Contact: jinqi@ust.hk

In this work, we consider a group testing problem where the infection of subjects has a correlation. In such a setting, the joint distribution cannot be exactly characterized; hence, we use a distributionally robust framework. Given the marginal distribution and the correlation information, we evaluate the performance under the worst-case distribution and minimize the expected number of tests and misclassifications (false positive and false negative) to find an optimal partition. Specifically, we consider the pairwise and partial correlation: for the pairwise case, we show the optimality of common group size and derive the optimal partition in a few steps; for the partial case, we generalize the worst-case analysis and provide managerial insights. We also conduct numerical studies to show that the consideration of correlation information is significant.

4 Equitable Anesthesiologist Scheduling Under Demand Uncertainty Using Multiobjective Programming

Kai Sun[1], Minghe Sun[2], Deepak Agrawal[3], Ronald Dravenstott[4], Frank Rosinia[5], Arkajyoti Roy[6], [1]University of Texas at San Antonio, San Antonio, TX, [2]University of Texas-San Antonio, San Antonio, TX, [3]Meta, Fort Worth, TX, [4]UNT Health Science Center, Fort Worth, TX, [5]University of Texas Health Science Center at San Antonio, San Antonio, TX, [6]The University of Texas at San Antonio, San Antonio, TX, Contact: kai.sun@utsa.edu

This work addresses an anesthesiologist scheduling (AS) problem under uncertainty. The goal is to plan and deploy providers to meet clinical demand and institutional protocols. A data-driven two-step sequential AS framework is developed using a mixed-integer multi-objective program. Step 1 designs shifts to minimize excessive clinical time using conditional value-at-risk constraints to account for demand uncertainty. Step 2 assigns shifts to providers considering optimal and equitable workload distribution and the number of required providers. An ⍰-constraint solution method is applied for multi-objective optimization, and an iterative solution method is developed to improve workload equity in clinical applications. Two case studies, the budget and hiring planning and the monthly AS, are addressed in a large anesthesiology department via the AS framework.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA22

CC-North 129A

The Pharma Industry

Flash Session

Session Chair: Nektarios Oraiopoulos, Cambridge University, Cambridge, United Kingdom

Session Chair: Lidia Betcheva, Cambridge Judge Business School, Cambridge, United Kingdom

1 Flash Paper Submission (5-Minute Presentation)

Feryal Erhun[1], Lidia Betcheva[2], Nektarios Oraiopoulos[3], [1]University of Cambridge, Cambridge, United Kingdom; [2]Cambridge Judge Business School, Cambridge, United Kingdom; [3]Cambridge University, Cambridge, United Kingdom. Contact: f.erhun@jbs.cam.ac.uk

This paper provides an overview of decentralized clinical trials (DCTs), emphasizing how they fit into and alter the current clinical development landscape. We propose a conceptual framework that employs systems thinking to evaluate the impact of trial decentralization on key stakeholders through a reiterative assessment of pain points.

2 Flash Paper Submission (5-Minute Presentation)

Hossein Nikpayam[1], Moritz Fleischmann[2], Jochen Schlapp[3], [1]ESMT, Berlin, Germany; [2]University of Mannheim, Mannheim, Germany; [3]Frankfurt School of Finance & Management gGmbH, Frankfurt Am Main, Germany. Contact: hossein.nikpayam@esmt.org

When composing their innovation portfolios, firms can rely on their internal R&D units and invest in projects that are promoted internally; or they can acquire projects that originated outside their boundaries. We ask: How should a firm allocate its scarce resources across the different sources? We investigate this decision by designing a stylized game-theoretic model, and we identify the firm's optimal resource allocation policy.

3 High-Impact Life Sciences Research from Fellows of Indiana Univ Kelley School Center for the Business of Life Sciences

Jonathan Eugene Helm[1], George P. Ball[2], Ozge Yapar[3], [1]Indiana University, Bloomington, IN, [2]Kelley School of Business, Indiana University, Bloomington, IN, [3]Indiana University, Kelley School of Business, Bloomington, IN

In this talk I will provide an overview of the exciting, problem driven research being done at Indiana University Kelley School of Business Center for the Business of Life Sciences (CBLS). CBLS consists of executives from life sciences companies (>15), faculty fellows (>20) who collaborate with these organizations on high-impact life sciences research, and students who learn and prepare for careers in the life sciences. The goal of the center is to match top researchers with innovative managers to engage in academia-industry collaborations, which this talk will highlight. I will also discuss an exciting new opportunity to meet our executives in a small conference setting to share research and generate new research ideas and collaborations jointly with major life sciences companies in April 2024.

4 Flash Paper Submission (5-Minute Presentation)

Carter Dredge, Stefan Scholtes, University of Cambridge, Cambridge, United Kingdom

This paper focuses on the generic drug supply chain's failure to supply essential medicines reliably at low cost. In a novel response, multiple US health systems founded a novel not-for-profit drug manufacturer, Civica Rx, to address the issue. Civica utilizes a new business model known as a *health care utility* that prioritizes access over profit. The company has scaled rapidly and now provides over 75 essential medications that are most at risk of shortages to over 55 health systems in the US. This paper provides first empirical evidence of Civica's effect on security and cost of supply for one of its member health systems, by utilizing internal supply chain, pharmacy, and external market data between 2016 and 2022. Results show that Civica was able to substantially improve essential access on a cohort of medicines plagued by shortages for years at a comparable cost structure.

5 Make It Personal: Standardization And Prosocial Behavior

Rob Glew[1], Claire Senot[2], [1]McGill University, Montreal, QC, Canada; [2]Tulane University, New Orleans, LA, Contact: rob.glew@mcgill.ca

We examined customisation in prosocial healthcare settings. Using a regression discontinuity in time identification method, we analysed a natural experiment in a healthcare programme, with over 300,000 observations of participation decisions. Participants were pseudo-randomly assigned to varying size groups for viral testing and provided with customised test kits. After nine weeks, test kits were made generic and lacked personal identifiers, resulting in a 20% decline in testing participation.We highlight the importance of customisation in fostering psychological ownership and enhancing prosocial behaviours in healthcare. The removal of customisation from test kits weakened psychological ownership, reducing commitment and motivation. However, this effect was moderated by group social influence, with smaller treatment effects in larger groups.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA23

CC-North 129B

Empirical Research on Socially Responsible Operations

Community Committee Choice Session

Session Chair: Hailong Cui, University of Minnesota, Minneapolis, MN

Session Chair: Dwaipayan Roy, University of Virginia Darden School of Business, Albemarle, VA

1 Hiding Behind Complexity: Supply Chain, Oversight, Race, and the Opioid Crisis

Iman Attari, Jonathan Eugene Helm, Jorge Mejia, Indiana University, Bloomington, IN, Contact: iattari@iu.edu

In this study, we examine the opioid crisis from a supply chain perspective and provide evidence on how complexity of presecription opioid supply chains facilitated the flood of opioids into communites without detection by regulatory authorities. Further, we find new evidence on the greater impact of the complexity in non-White communitites that are typically overlooked in governtmental responses to the opioid crisis.

2 Compassion in Discretion: Leveraging Operations Managers' Guilty Conscience to Mitigate Suffering on the Shop Floor

Emily C. Dickey[1], Prisca Brosi[2], Jan C. Fransoo[3], [1]Kuehne Logistics University, Hamburg, Germany; [2]Kuehne Logistics University, Hamburg, Germany; [3]Tilburg University, Tilburg, Netherlands. Contact: emily.dickey@the-klu.org

Addressing suffering on the shop floor, we investigate the impact of emotions on managerial decision-making regarding the trade-off between decent working hours and traditional operational outcomes. Industry characteristics often force a trade-off between employee well-being and profit or productivity, but managers have discretion in this trade-off. We test whether managers' *emotional* responses to these trade-offs alters their decision-making. Across one survey of operations managers and two vignette experiments, we find that guilty managers who feel low autonomy actually de-prioritize worker well-being. In contrast, compassion fosters employee well-being but only when managers feel decision-making autonomy in the workplace. Thus, by encouraging managerial compassion and discretion, companies can mitigate suffering on the shop floor.

3 The Production Benefits of Personalized Agricultural Advice: A Case Study of Mkrishi

Campbell Clarkson, Necati Tereyagoglu, Sriram Venkataraman, University of South Carolina, Columbia, SC

We investigate the effects of introducing a mobile-based agricultural advisory service on crop production, utilizing the launch of one service in Buland Shahar district of India as a case study. We also examine whether such effects are explained by changes in three key agricultural inputs: cultivated area, chemical fertilizer usage, and irrigated area.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA24

CC-North 130

Emerging Topics in Empirical Operations

Community Committee Choice Session

Session Chair: Hailong Cui, University of Minnesota, Minneapolis, MN

Session Chair: Jiding Zhang, NYU, New York, NY

1 Rankings and Usage on Online B2b Platforms: Does Match Quality Matter?

Rakesh Allu, Vishal Gaur, Cornell University, Ithaca, NY, Contact: aa2688@cornell.edu

Large buyer volumes on online B2B platforms cause search friction, which lowers sellers' usage. To solve this problem, online B2B platforms actively invest in R&D to devise algorithms aimed at improving their match quality, that is, the ability to accurately display buyer requests in the decreasing order of their potential value to the sellers. This raises an important question of whether improving match quality is effective in increasing sellers' usage of the platform. We answer this question using page-rank data of 77 million transactions from an online B2B platform. We develop methods to compute match quality from page-rank data that address endogeneity and censorship in such data. Our results indicate that investments in improving match quality not only increase seller usage, they do so by reducing seller effort, measured as the number of positions viewed.

2 The Impact of the Opportunity Zone Program on Residential Real Estate

Xiaoyan Liu[1], Ron Bekkerman[2], Maxime Cohen[3], John Maiden[2], Dmitry Mitrofanov[4], [1]Santa Clara University, Santa Clara, CA, [2]Cherre Inc, New York, NY, [3]McGill University, Kirkland, QC, Canada; [4]Boston College, Chestnut Hill, MA, Contact: xliu10@scu.edu

Opportunity zones (OZs) are designated census tracts in which real estate investments can gain tax benefits. Introduced by the U.S. Tax Cuts and Jobs Act of 2017, the goal of the OZ program is to foster economic development in distressed neighborhoods. In this paper, we investigate and optimize the OZ selection process, and examine the impact of OZs by exploiting large-scale datasets. We find that the OZ program increased real estate prices by 4.03%-6.13% but do not observe a significant effect on the transaction volume. We also find that investors primarily targeted the high end real estate market, namely exhibiting a cherry-picking behavior. To better fulfill its intended societal and economic goals, we propose an optimization framework with fairness considerations for OZ assignment decisions.

3 Impact of Strategic Shifts and Policy Decisions on Global Supply Chains

Vidya Mani, University of Virginia, Charlottesville, VA

We leverage data from company transactions, trade and shipments, and multi-region input and output information to evaluate the impact of national-level policy decisions and company-level supply chain risk mitigation strategies on global supply chains in the apparel and electronics sectors. We identify how, why, and where these supply chains change, the spillover effects, and highlight the unintended consequences of these decisions.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA26

CC-North 131B

Teaching Firm-Level Operations-Finance Interface Topics in the MBA Classroom

Community Committee Choice Session

Session Chair: Vishal Gaur, Cornell University, Ithaca, NY

1 Using Firm-Level to Study Operational Decisions

Danko Turcic, University of California, Riverside, 900 University Ave., CA

We present two research studies that use data to infer firm-level operational decision-making. The first study shows how data can be used to confirm our theoretical understanding of how a firm might optimally interact with its suppliers. The second study uses data to infer an optimal operational policy that is too complicated to describe with a tractable analytical model.

2 Teaching About Inventory Turnover and Its Relationship to Operations and Finance in the Mba Classroom

Vishal Gaur, Cornell University, Ithaca, NY

Inventory turnover is an important metric for the operational and financial performance of a firm. In this talk, I will summarize lessons from teaching about inventory turnover to MBA students and discuss the tools and resources that I utilize for this purpose. This talk is based on the extensive research done on inventory turnover in the Operations Management literature over the last two decades.

3 Supply Networks in Research and Mba Teaching

Nikolay Osadchiy, Emory University, Atlanta, GA

Supply networks provide a novel lens for studying important operational phenomena including demand risk, inventory productivity and the bullwhip effect. Main research findings and experiences from teaching them in a classroom will be discussed.

4 Global Sourcing Under External Shocks: Product-Level Network Dynamics

Maxi Udenio[1], Shaunak Dabadghao[2], James Zhang[3], [1]KU Leuven, Leuven, Belgium; [2]Eindhoven University of Technology, Eindhoven, Netherlands; [3]Technical University of Eindhoven, Eindhoven, Netherlands. Contact: maxi.udenio@kuleuven.be

We study global sourcing dynamics by analysing how firms responded to recent large-scale shocks, such as tariff regime changes. Based on the current literature in global sourcing strategies, we specifically examine the patterns of global sourcing by (1) investigating time-series of imports to the US aggregated at the firm level, and (2) by constructing a dynamic supply network at the product-level.
Our time series analysis enables us to understand tactical sourcing decisions taken by firms as a reaction to (and in anticipation of) structural changes in the network.Moreover, by analysing changes in the network topology at such a disaggregated level, we are able to distinguish previously unobservable dynamics in the supply network, such as changes in the (single/dual) sourcing strategy.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA27

CC-North 131C

Socially Responsible Operations

Community Committee Choice Session

Session Chair: Xiaoyang Long, University of Wisconsin-Madison, Madison, WI

Session Chair: Dennis Zhang, Washington University in St Louis, St Louis, MO

1 Optimizing Solar-Powered Off-Grid Lights for the Bottom of the Pyramid: Evidence from Field Experiments in Ghana

Bhavani Shanker Uppari[1], Serguei Netessine[2], [1]Singapore Management University, Singapore, Singapore; [2]The Wharton School, Philadelphia, PA, Contact: bhavaniu@smu.edu.sg

A large part of Afrika's population does not have access to the electrical grid, and relies on non-sustainable energy sources. Solar lights have a potential of making impact but it remains unknown what configuration of bulbs/batteries/solar panels would enable fast and cost-effective transition to renewable energy. We conduct field experiments in Ghana to answer this question.

2 Self-Preference on E-Commerce Platforms: Evidence from Jd.Com

Zihan Zhao[1], Renyu Zhang[2], Dennis Zhang[3], [1]Washington University in St. Louis, St. Louis, MO, [2]The Chinese University of Hong Kong, Hong Kong, China; [3]Washington University in St Louis, ST LOUIS, MO, Contact: zihan.zhao@wustl.edu

Dual online e-commerce platforms provide the marketplace service and directly sell products as a retailer (e.g., Amazon and JD.COM). Such platforms may abuse their dominating market power to algorithmically discriminate against their third-party sellers by steering more consumer traffic to the platform-owned sellers even for the otherwise identical products. We develop an integrated modeling and empirical framework to identify the algorithmic discrimination against third-party sellers on an e-commerce platform and uncover the underlying mechanism of algorithmic discrimination.

3 Impact of Import Tariff on Lead Recycling in Bangladesh

Qiong Wang[1], Amrita Kundu[2], Erica Plambeck[3], [1]University of Illinois at Urbana-Champaign, Urbana, IL, [2]McDonough School of Business, Georgetown University, Washington, DC, [3]Stanford University, Stanford, CA, Contact: qwang04@illinois.edu

Millions of electronic three-wheelers in Bangladesh are powered by lead acid batteries. Lead supply for producing new batteries comes from either import or recycling used lead acid batteries (ULABs). Informal recycling of ULABs is causing disastrous lead pollution, and government intervention is urgently needed to stimulate formal recycling that meets environmental standard. We show that to this end, deciding the import tariff on lead becomes a tricky choice. A low tariff makes importing lead more profitable than getting it from formal recycling. A high tariff provides the incentive to monopolize ULAB collection, which squeezes the profit margin of formal recycling. We discuss how relaxing export control of ULABs can help to resolve this dilemma.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA28

CC-North 132A

Emerging Topics in Platform Operations

Community Committee Choice Session

Session Chair: Eryn He, University of Utah, Salt Lake City, UT

1 Machine Learning and Prediction Errors in Causal Inference

Daniel Chen[1], Gad Allon[1], Zhenling Jiang[1], Dennis Zhang[2], [1]University of Pennsylvania, Philadelphia, PA, [2]Washington University in St Louis, ST LOUIS, MO, Contact: zhenling@wharton.upenn.edu

Machine learning is a growing method for causal inference. In machine learning settings, prediction errors are a commonly overlooked problem that can bias results and lead to arbitrarily incorrect parameter estimates. We consider a two-stage model where (1) machine learning is used to predict variables of interest, and (2) these predictions are used in a regression model for causal inference. Even when the model specification is otherwise correct, traditional metrics such as p-values and first-stage model accuracy are not good signals of correct second-stage estimates when prediction error exists. We show that these problems are substantial and persist across simulations and an empirical dataset. We provide consistent corrections for the case where unbiased training data is available for the machine learning dataset.

2 Fostering Long-Tenured Seller Value-Creation: A Field Experiment

Grace Gu, University of Southern California, Los Angeles, CA

As e-commerce platforms mature, new seller entry slows down and platforms cannot take advantage of the cross-side network effect from new seller recruitments. Meanwhile, long-tenured sellers become a major part of the market but some of them lose motivation to actively create value. Therefore, it is important to understand how mature platforms can effectively incentivize long-tenured sellers value creation. We leverage a large-scale randomized control experiment in which the platform displays "long-tenured" tags on customer search results to emphasize sellers' tenure credit. The results show that tagging long-tenured sellers leads to significant increases in customer clicks and purchases, which benefits the platform. The mechanism analysis revealed a reputation spillover effect from the tagged sellers to their long-tail products.

3 Deep Learning in Choice Model

Zhi Wang, Rui Gao, University of Texas at Austin, Austin, TX, Contact: zhi.wang@mccombs.utexas.edu

One key principle in discrete choice model literature is the Random Utility Maximization (RUM), which can characterize many well-known parametric choice models like multinomial logit. Emerging literature demonstrates the powerfulness of neural networks (e.g., RUMnet) to represent RUM models. In this project, we design neural networks that represent a mapping of the choice probability distribution from the utilities by leveraging its convexity property. Such characteristics also inspire us to find the connection between the choice model and the optimal transport problem.

4 "uber" Your Cooking: The Sharing-Economy Operations of a Ghost-Kitchen Platform

Feihong Hu[1], junyu Cao[2], Wei Qi[3], [1]University of Texas at Austin, Austin, TX, [2]The University of Texas at Austin, Austin, TX, [3]Tsinghua University, Beijing, China. Contact: feihong.hu@mccombs.utexas.edu

We study a ghost kitchen platform with multiple home chefs, enabling customers to order from various kitchens. We find the optimal price and number of ghost kitchens on the platform to maximize profit. This is a new business model integrating adoption rate, waiting cost, queuing system, and delivery cost. We propose a queuing system that splits orders into sub-orders assigned to different chefs. Chefs proceed to the next dish after finishing the current sub-order, but the order remains incomplete until all sub-orders are fulfilled. We derive a closed-form solution for waiting time. We find that ghost kitchen platforms can be more profitable than traditional delivery platforms due to multi-dash capability, reduced fixed costs, productivity, and specialization. Multi-dash platforms outperform single-dash platforms with smaller service radius under the same conditions.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA29

CC-North 132B

New Topics in Sustainable and Social Operations

Community Committee Choice Session

Session Chair: Amrita Kundu, McDonough School of Business, Georgetown University, Washington, DC

1 Are Firms Voluntarily Disclosing Emissions Greener

Yilin Shi[1], Christopher S. Tang[2], Jing Wu[3], [1]The Chinese University of Hong Kong, ShaTin, Hong Kong; [2]University of California-Los Angeles, Los Angeles, CA, [3]Chinese University of Hong Kong, Hong Kong, Hong Kong. Contact: ylshi@link.cuhk.edu.hk

Do firms voluntarily disclosing emissions generate less greenhouse gas in their in-house and outsourced operations? We examine this using Scope 1 and 3 emission data reported by firms or estimated by S\&P Trucost from 2002 to 2020. Our empirical results reveal that companies who make voluntary carbon disclosures generate less "internal emissions" (i.e., Scope 1 emissions but more "external emissions" from upstream suppliers (i.e., Scope 3 emissions). The net effect is that disclosing firms generate more emissions in the entire supply chain, implying they ``outsource" emissions to upstream suppliers. We also investigate the implications of mandatory environmental reporting regulations by different governments as encouragements for emission disclosure and find they effectively nudge disclosing firms to reduce total emissions.

2 The Effects of Diversity in Algorithmic Recommendations on Digital Content Consumption: A Field Experiment

Guangying Chen[1], Tat Y. Chan[1], Dennis J. Zhang[1], Senmao Liu[2], Yuxiang Wu[2], [1]Washington University in St. Louis, St. Louis, MO, [2]NetEase Cloud Music, Inc., Hangzhou, China. Contact: guangyingchen@wustl.edu

We conducted a large-scale field experiment on a music streaming platform to study the effects of content diversity in personalized recommendations. We randomly assigned users to receive video recommendations either from the platform's current recommender algorithm or our modified algorithm with 2.33% higher topic diversity. Overall, there is no clear evidence that our new algorithm increased the diversity of consumed content, but it decreased users' consumption level. However, for active users, a 1% increase in recommendation diversity boosted their consumption diversity by 0.55% without hurting consumption level. We show that the accuracy of predicting users' preferences is key for the new algorithm to increase the consumption diversity and, when users also highly value the platform, their consumption level will not be hurt.

3 End-Of-Life Product Collection Strategy and Remanufacturing Technology Portfolio Planning

Ying Cao[1], Guang Li[2], Xianghui Peng[1], [1]Penn State University - Erie, Erie, PA, [2]Queen's University, Kingston, ON, Canada. Contact: yxc673@psu.edu

End-of-Life (EOL) product collection rate is an important input in the closed-loop supply chain, which impacts the remanufacturing technology portfolio selection for a remanufacturer who is exposed to various technology alternatives. And, the remanufacturer's technology portfolio decision in return influences his preference for EOL product collection. In this research, we study remanufacturer's joint decision of EOL product collection pricing and remanufacturing technology portfolio planning in order to maximize the expected profit. We derive the properties of optimal pricing strategy and technology portfolio structure. In addition, we conduct numerical study and develop managerial insights for remanufacturing industry.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA30

CC-North 132C

New Challenges for Retailers and Platforms

Community Committee Choice Session

Session Chair: Lai Wei, Boston College, Chestnut Hill, MA

1 Partnership Between Taxis and On-Demand Ride-Hailing Platforms: How Should It be Regulated?

Liling Lu[1], Guiyun Feng[2], Xin Fang[3], Sergei Savin[4], [1]singapore management university, singapore, Singapore; [2]Singapore Management University, singapore, Singapore; [3]Singapore Management University, Singapore, Singapore; [4]Wharton School, Philadelphia, PA

We consider an on-demand ride hailing platform who potentially collaborates with taxi companies to gain access to taxi drivers. We investigate the government regulation to such partnership and its implications. Taxi drivers and private car drivers differ in service quality. The platform sets ride fee for ride hailing riders and provides wage compensation for participating drivers. The government decides taxi drivers' access level to the platform to maximize social welfare. We find that the partnership may benefit all the parties, but advocating it is not always optimal for the government especially when street-hailing is important.

2 Anti-counterfeiting on E-commerce Platforms

Shuang Qiu[1], Man Yu[2], Ki Ling Cheung[3], [1]Hong Kong University of Science and Technology, Hong Kong, China; [2]Hong Kong University of Science and Technology, Hong Kong, Hong Kong; [3]Hong Kong University of Science & Technology-HKUST, Kowloon, Hong Kong

As e-commerce platforms increasingly rely on third-party sales for profit, the problem of third-party counterfeiting is becoming a major threat to many online marketplaces. This paper explores various levers available to the e-platforms in combating counterfeits.

3 The Impact of Counterfeit Victims in the Victim Marketplace

Karl Aquino[1], Mingyuan Ban[2], Qiang Gong[2], Yi Qian[1], [1]University of British Columbia, Vancouver, BC, Canada; [2]Zhongnan University of Economics and Law, Wuhan, China. Contact: qgongpku@qq.com

The sources of inefficiency and unjust of charity are important to understand yet understudied. Our study aims to fill this void by modeling the victims' market in a collective reputation framework. By analyzing individuals who signal their victim status with different personalities, we derive the honest and dishonest equilibria as well as the mixed equilibrium. We reveal the mechanisms analogous to bank run and lemons market could take place in the victims' market. When charity resources are scarce, more strategic signalers could rush to emit false victim signals and drive the market to the dishonest equilibrium with lower social welfare. The need for screening signalers could drive up the psychological costs of honest victims to the extent that they voluntarily drop out of the market and suffer alone, resulting in misplaced charity funds and severe deadweight losses.

4 Coordinating Inventory Capacity Management for Third-Party Sellers on Online Selling Platforms

Rong Li[1], Weibin Mo[2], Lai Wei[3], [1]Syracuse University, Syracuse, NY, [2]Purdue University, West Lafayette, IN, [3]Boston College, Chestnut Hill, MA, Contact: harrymok@

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Online selling platforms (*e.g.* Amazon) have been offering fulfillment and inventory management services (*e.g.* "Fulfillment by Amazon") for third-party sellers. Sellers could leverage the well-established fulfillment networks of platforms to enhance their service and responsiveness while lowering operational costs. Meanwhile, platforms benefit from higher profitability of their investments in storage and fulfillment facilities as well as stronger customer loyalty to platforms. However, due to time-varying demand uncertainty, platforms have been experiencing increasing tension of their storage capacity, especially during holiday seasons. We develop a capacity management model to study coordination between the platform and one or several third-party sellers.

5 Design of Joint Replenishment and Order Fulfillment Processes for an Omni-Channel Retailer

Sinem Kinay Savaser[1], Opher Baron[2], Andre Augusto Cire[2], [1]Rotman School of Management, Toronto, ON, Canada; [2]University of Toronto, Toronto, ON, Canada. Contact: sinem.savaser@rotman.utoronto.ca

We consider a strategic problem for an omni-channel retailer with a single fulfillment center (FC) and multiple stores. We consider walk-in demand at stores as well as online demand from originating from multiple regions. Given these demand streams, the omni-channel retailer simultaneously makes inventory replenishment decisions and fulfills online orders. We first work on a single-item problem and identify conditions under which the online orders can be shipped from stores instead of the FC. We then extend the analysis to multiple item orders and compare the solutions of models that allow or prevent split deliveries. We introduce an algorithm to solve the overall problem, which is NP-Hard, and provide upper bounds on its performance. We finally perform numerical analysis to observe the performance of the algorithm in practice.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA31

CC-North 221A

Methods for Non-Convex Optimization

Contributed Session

Session Chair: Shangzhe Yang, Rutgers University, Piscataway, NJ

1 Adaptive Algorithms for Stochastic Sequential Quadratic Programming

Michael ONeill, University of North Carolina at Chapel Hill, Chapel Hill, NC

We develop a Sequential Quadratic Programming algorithm for minimizing a stochastic objective function subject to deterministic equality constraints. The method uses an adaptive stepsize rule that is not dependent on a pre-specified sequence and a complexity result is derived. In addition, new procedures are developed for estimating the merit parameter, which are more robust to the stochasticity than those proposed in prior work. Numerical validation of the proposed algorithms is also presented.

2 Novel Algorithms for Nonconvex Second-Order Optimization with Complexity Guarantees

Chuan He, Zhaosong Lu, University of Minnesota, Minneapolis, MN

This research introduces new algorithms with substantial theoretical improvements for seeking a second-order stationary point (SOSP) of two types of nonconvex constrained optimization problems. In our first work, we develop a novel augmented Lagrangian (AL) method for finding an SOSP of a nonconvex equality constrained optimization problem. The proposed AL method improves upon the best-known complexity guarantees. In our second work, we design efficient algorithms to find an SOSP of a general conic constrained nonconvex optimization problem. For the first time, we introduce a notion of an SOSP for general conic constrained optimization and propose efficient algorithms to find it. Numerical results also demonstrate the practical superiority of our proposed methods.

3 Confidence Regions in Stochastic Optimization and Systems of Nonlinear Equations

Yi Chu, Raghu Pasupathy, Purdue University, West Lafayette, IN, Contact: chu199@purdue.edu

We consider the question of constructing asymptotically exact confidence regions in two contexts: (i) stochastic optimization problems with a smooth convex objective f and observable first-order oracle; and (ii) stochastic nonlinear equations observable with a stochastic zeroth-order oracle. Relying on results from M-Estimation, we first show that the solutions to the sample-path problems associated with (i) and (ii) satisfy a strong Bahadur Representation (and hence also a functional CLT and a law of iterated logarithm) We then exploit such strong regularity to devise a simple but computationally intensive resampling technique called batching toward constructing exact confidence regions on the optimal value and solution to (i), and on the solution to (ii).

4 Methods for Nonconvex Conditional Stochastic Optimization

Shangzhe Yang[1], Andrzej Ruszczynski[2], [1]Rutgers University, Piscataway, NJ, [2]Rutgers University, Piscataway, NJ, Contact: shangzhe.yang@rutgers.edu

We propose a specialized single time-scale stochastic subgradient method for nonconvex constrained Conditional Stochastic Optimization problems with a Lipschitz smooth outer function and Norkin generalized differentiable inner function. We approximate the inner conditional expectation with a rich parametric model whose mean squared error satisfies a quadratic growth condition. The main feature of our approach is that unbiased stochastic estimates of the directions used by the method can be generated with one observation of the pair of random variables, which makes it applicable to online settings. We introduce a projected stochastic subgradient method and analyze its convergence, using the scheme of differential inclusions and a designed Lyapunov function. We further derive an $O(N^{-1/2})$ error bound for N iterations of the methods within a fixed stepsize.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA32

CC-North 221B

Supply Chain Learning and Sourcing

Contributed Session

Session Chair: Mummad Zia Ul Haq, Ajman University, Ajman, United Arab Emirates

1 Autocorrelated Price-Sensitive Demand and the Dynamics of Supply Chains

Takamichi Hosoda[1], Stephen M. Disney[2], Gerard Gaalman[3], [1]Aoyama Gakuin University, Tokyo, Japan; [2]University of Exeter Business School, Exeter, United Kingdom; [3]University of Groningen, Groningen, Netherlands. Contact: hosoda@gsim.aoyama.ac.jp

We investigate the dynamics of a supply chain with an autocorrelated, price-sensitive, stochastic, and linear demand model. We assume the exogenous market price follows a first-order autoregressive process. The demand process is a weighted function of the current and previous market prices, the market potential, and the positive demand sensitivity coefficient. We assume that a manufacturer faces five different types of customers in the market: responsive, selective, naive, speculative, and slow customers. A weighting factor determines how customers react to period-to-period price changes. In addition to explaining the basic dynamics with this demand model, we propose new ideas for dual sourcing policies, assuming two suppliers, one offshore and one near shore.

2 Forecasting Capability Level and Consignment Contract Revenue Distribution: A Split Ratio Range Analysis

Seong-Hyun Nan, University of North Dakota, Grand Forks, ND, Contact: snam@business.und.edu

This study develops a model to illustrate the optimization and coordination of a revenue-sharing-based consignment contract in a decentralized supply chain. We investigate how the forecasting capability level set by the manufacturer can affect the revenue share allocations proposed by the retailer and measure whether and how both can achieve economic benefits from the given contractual parameter terms. Based on different combinations of the forecasting level and the split ratio, we determine the upper limit of the ratio range acceptable to the manufacturer and show how the ratio range should be adjusted to reduce risk and maximize the mutual profitability for both.

3 Optimizing Supplier Selection and Order Lot-Sizing Decisions in a TwoStage Supply Chain

Qingyuan Lu[1], Jose Antonio Ventura[2], Zijia Chen[3], [1]Penn State University, State college, PA, [2]Penn State University, University Park, PA, [3]Penn State University, state college, PA, Contact: qfl5079@psu.edu

This paper focuses on the analysis of different lot-sizing policies for the supplier selection and order allocation problem in a twostage supply chain. The supply chain consists of multiple suppliers and single buyer. Our goal is to evaluate two lot-sizing policies and select the one that optimizes the supply chain. A bi-objective mixed-integer nonlinear programming (MOMINLP) model is proposed. The first objective consists a coordination mechanism for supplier selection and order allocation , and the second objective comprises a data envelopment analysis (DEA) approach to evaluate the overall performance of suppliers. Then, the two lot-sizing policies are applied to the MOMINLP model separately to determine the set of selected suppliers well as orders allocated to each selected supplier per replenishment cycle. Numerical examples are provided.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA33

CC-North 221C

Advacing Explanable Machine Learning

Contributed Session

Session Chair: Yifan Yang, The Ohio State University, Columbus, OH

1 Topological Learning for Imbalanced Time Series Analysis

Minh Nguyen, University of Hawaii, Honolulu, HI, Contact: duyminh@hawaii.edu

Topological data analysis (TDA) uses algebraic topological tools to analyze the shape of data. Sublevel set filtration is a widely used tool in TDA that captures homological features of data at multiple scales and summarizes the lifespan of these features in summary diagrams, namely persistence diagrams (PDs). By using sublevel set filtration approach and random persistence diagram generator (RPDG) method, we propose a general pipeline for analyzing the topological features of imbalanced time series data. We then investigate the efficacy of our pipeline using four main stock market indices in the US (Dow Jones, S&P 500, Nasdaq Composite, and Russell 2000) to distinguish between stock indices obtained with recessions and without recessions.

2 Development Of Explainable Anomaly Detection Algorithm For Multivariate Time Series Data Using Deep Learning

Sangyong Lee[1], DoHoon Kim[2], [1]Okestro, seoul, Korea, Republic of; [2]Yonsei University, seoul, Korea, Republic of. Contact: sy.lee@okestro.com

The surge in the Internet of Things (IoT) has amplified automated services potential, with anomaly detection being a key application. Traditional machine learning faces hurdles with intricate multivariate time series data, and while deep learning can navigate these, it frequently lacks decision transparency. This paper presents an Explainable Deep Learning-based Multivariate Anomaly Detection method, incorporating a Deep Embedded Clustering (DEC) algorithm for enhanced anomaly detection performance and explainability via eXplainable AI (XAI) techniques. Experimental results illustrate an improvement in performance compared to existing methods by augmenting the comprehensibility of decision-making via XAI. Furthermore, we evaluated multivariate time series benchmark data, validating its effectiveness in improving decision-making transparency.

3 Improving Knowledge Distillation for Regression Under Data Insufficiency

Myeonginn Kang, Seokho Kang, Sungkyunkwan University, Suwon, Korea, Republic of. Contact: kmi0228@skku.edu

Knowledge distillation (KD) has been successful in compressing a large teacher network into a smaller student network. However, conventional KD methods can suffer from performance degradation when the original training dataset is not fully reusable. We propose a teacher-student matching method to improve KD under data insufficiency for regression. The proposed method enhances an existing KD method by introducing three additional learning objectives to make the student network better emulate the prediction capability of the teacher network: perturbation-based matching, adversarial belief matching, and gradient matching. Through experiments using benchmark regression datasets, we demonstrate that the proposed method can improve the predictive performance of the student network, especially when only a small part of the training dataset is usable.

4 Generalization Error Bounds for Learning Under Censored Feedback

Yifan Yang[1], Ali Payani[2], Parinaz Naghizadeh[3], [1]The Ohio State University, Columbus, OH, [2]Cisco, San Jose, CA, [3]Ohio State University, Columbus, OH, Contact: yang.5483@osu.edu

Generalization error bounds from learning theory provide statistical guarantees on how well an algorithm will perform on previously unseen data. In this paper, we characterize the impacts of training data non-IIDness due to censored feedback on generalization error guarantees in classification tasks. We propose to first split the non-IID training data into IID blocks on which the Dvoretzky-Kiefer-Wolfowitz (DKW) inequality can be used to provide error bounds. We then identify scaling and shifting factors that allow us to reassemble the error bounds on the IID blocks to obtain a full-domain error bound, extending the DKW bound to problems with censored feedback. We further analyze the effectiveness of exploration techniques, proposed in recent literature to alleviate censored feedback, on improving these error bounds.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA34

CC-North 222A

First-order Methods for Constrained Optimization and Minimax Problems

Community Committee Choice Session

Session Chair: Afrooz Jalilzadeh, The University of Arizona, Tucson, AZ

Session Chair: Erfan Yazdandoost Hamedani, University of Arizona, Tucson, AZ

1 A Novel Catalyst Scheme for Stochastic Minimax Optimization

Guanghui Lan[1], Yan Li[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, Contact: george.lan@isye.gatech.edu

Existing accelerated proximal point (aka, catalyst) methods play an important role for minimax optimization to achieve fast rate of convergence. However, these schemes do not extend to the stochastic settings as they yield slower rate of convergence than those based on extragradient methods.We present a novel accelerated proximal point that can achieve optimal convergence for both deterministic and stochastic minimax optimization.

2 Scalable Algorithms for Robust Nonconvex Constrained Optimization

Tianjian Huang[1], Maher Nouiehed[2], Meisam Razaviyayn[1], [1]University of Southern California, Los Angeles, CA, [2]American University of Beirut, Beirut, Lebanon

In this study, we investigate the efficacy of different algorithms for solving (stochastic) constrained nonconvex optimization problems appearing in modern machine learning contexts. While the conventional method employed by the machine learning community is to solve the Lagrangian relaxation problem, we show that this approach may not always succeed in various scenarios. As a result, we turn to optimization literature to explore the effectiveness of a broad spectrum of algorithms, including penalty methods, min-max optimization procedures, and Alternating Direction Method of Multipliers, for addressing practical nonconvex constrained optimization issues. After observing the limitations of these algorithms, we propose novel modifications to them. Our experiments provide empirical evidence of the efficiency of our proposed techniques.

3 Projection-Free Methods for Solving Nonconvex-Concave Saddle Point Problems

Morteza Boroun[1], Erfan Yazdandoost Hamedani[1], Afrooz Jalilzadeh[2], [1]University of Arizona, Tucson, AZ, [2]The University of Arizona, Tucson, AZ, Contact: erfan.yzh@gmail.com

This talk addresses constrained saddle point optimization problems with nonconvex-concave and smooth objective functions, which have applications in machine learning. Existing methods rely on computationally expensive projection onto constraint sets. To fill this gap, we propose efficient single-loop projection-free methods using first-order information. We introduce a primal-dual conditional gradient method utilizing linear minimization oracles, achieving an □-stationary solution in O(□^(-6)) iterations when the maximization problem's constraint set is strongly convex. Additionally, we present a one-sided projection-free method with regularized projected gradient ascent, achieving an □-stationary solution in O(□^(-4)) iterations when the projection is easy to compute.

4 Stochastic Approximation for Estimating the Price of Stability in Stochastic Nash Games

Afrooz Jalilzadeh[1], Farzad Yousefian[2], Mohammadjavad Ebrahimi[2], [1]The University of Arizona, Tucson, AZ, [2]Rutgers University, Piscataway, NJ, Contact: me586@scarletmail.rutgers.edu

The goal in this talk is to approximate the Price of Stability (PoS) for stochastic Nash games using stochastic approximation schemes. Motivated by the absence of efficient methods for computing the PoS, first, we consider stochastic optimization problems with a nonsmooth and merely convex objective function and a merely monotone stochastic variational inequality (SVI) constraint. We develop a randomized block-coordinate stochastic extra-(sub) gradient method where we employ a novel iterative penalization scheme to account for the mapping of the SVI in each of the two gradient updates of the algorithm. Second, we develop an SA-based scheme for approximating the PoS and derive lower and upper bounds on the approximation error. To validate our theoretical findings, we provide some preliminary simulation results on a networked stochastic Nash Cournot competition.

5 Randomized Lagrangian Stochastic Approximation for Large-Scale Constrained Stochastic Nash Games

Zeinab Alizadeh[1], Afrooz Jalilzadeh[2], Farzad Yousefian[3], [1]University of Arizona, Tucson, AZ, [2]The University of Arizona, Tucson, AZ, [3]Rutgers University, Piscataway, NJ, Contact: zalizadeh@email.arizona.edu

In this paper, we consider stochastic monotone Nash games where each player's strategy set is characterized by possibly a large number of explicit convex constraint inequalities. The majority of the existing methods for solving such problems rely on employing projected stochastic approximation (SA) methods. However, the projected SA performs poorly when the constraint set is afflicted by the presence of a large number of possibly nonlinear functional inequalities. We develop a single timescale randomized Lagrangian multiplier stochastic approximation method where in the primal space, we employ an SA scheme, and in the dual space, we employ a randomized block-coordinate scheme where only a randomly selected Lagrangian multiplier is updated. We show convergence rate of O(log(k)/sqrt{k}) for suitably defined suboptimality and infeasibility metrics in a mean sense.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA35

CC-North 222B

Efficient Algorithms for Non-convex Low-rank Matrix Optimization Problems

Community Committee Choice Session

Session Chair: Haixiang Zhang, UC Berkeley, Berkeley, CA

1 Understanding Incremental Learning of Gradient Descent: A Fine-Grained Analysis of Matrix Sensing

Jikai Jin[1], Zhiyuan Li[2], Kaifeng Lyu[3], Simon S. Du[4], Jason D. Lee[5], [1]Stanford University, Palo Alto, CA, [2]Toyota Technological Institute at Chicago, Chicago, IL, [3]Princeton University, Princeton, NJ, [4]University of Washington, Seattle, WA, [5]Princeton University, Princeton, NJ, Contact: jkjin@stanford.edu

It is believed that Gradient Descent (GD) induces an implicit bias towards good generalization in training machine learning models. We analyze the dynamics of GD for the matrix sensing problem, whose goal is to recover a low-rank matrix from near-isotropic linear measurements. We show that GD with small initialization follows an incremental learning procedure: GD sequentially learns solutions with increasing ranks until it recovers the ground truth. Compared to existing works which only analyze the rank-1 learning phase, our result provides characterizations for the whole learning process. Moreover, besides the over-parameterized regime that prior works focused on, our analysis of the incremental learning procedure also applies to the under-parameterized regime. Finally, we conduct numerical experiments to confirm our theoretical findings.

2 Alternating Minimization for Rank One Matrix Sensing: Sharp Predictions from a Random Initialization

Kabir Chandrasekher[1], Mengqi Lou[2], [1]Stanford University, Stanford, CA, [2]Georgia Institute of Technology, Atlanta, GA, Contact: mlou30@gatech.edu

We consider the problem of estimating the factors of a rank-1 matrix with i.i.d. Gaussian, rank-1 measurements that are nonlinearly transformed and corrupted by noise. Considering two prototypical choices for the nonlinearity, we study the convergence properties of a natural alternating update rule for this nonconvex optimization problem starting from a random initialization. We show sharp convergence guarantees for a sample-split version of the algorithm by deriving a deterministic recursion that is accurate even in high-dimensional problems. Our sharp, non-asymptotic analysis also exposes several other fine-grained properties of this problem, including how the nonlinearity and noise level affect convergence behavior.

3 Convergence of the Momentum Method for Semi-Algebraic Functions with Locally Lipschitz Gradients

Cedric Josz[1], Lexiao Lai[2], Xiaopeng Li[2], [1]Columbia University, New York City, NY, [2]Columbia University, New York, NY, Contact: xl3040@columbia.edu

We propose a new length formula that governs the iterates of the momentum method when minimizing differentiable semi-algebraic functions with locally Lipschitz gradients. It enables us to establish local convergence, global convergence, and convergence to local minimizers without assuming global Lipschitz continuity of the gradient, coercivity, and a global growth condition, as is done in the literature. As a result, we provide the first convergence guarantee of the momentum method starting from arbitrary initial points when applied to principal component analysis, matrix sensing, and linear neural networks.

4 The Burer-Monteiro Sdp Method Can Fail Even Above the Barvinok-Pataki Bound

Vaidehi Srinivas, Northwestern University, Evanston, IL

The most widely used technique for solving large-scale semidefinite programs (SDPs) in practice is the non-convex Burer-Monteiro method, which explicitly maintains a low-rank SDP solution for memory efficiency. When the maximum allowed rank p of the SDP solution is above the Barvinok-Pataki bound ($p >= sqrt(2n)$, where a globally optimal solution of rank at most p is guaranteed to exist), a recent line of work established convergence to a global optimum for generic or smoothed instances of the problem. However, it was open whether there exists any instance in this regime where this method fails. We provide a family of instances on n vertices that have spurious local minima even when the rank $p = n/2$. This justifies the use of beyond worst-case paradigms like smoothed analysis to obtain guarantees for the Burer-Monteiro method.

5 Low-Rank Matrix Recovery from Unlabeled Data with Missing Entries

Liangzu Peng, University of Pennsylvania, Philadelphia, PA,

Contact: lpenn@seas.upenn.edu

As an important topic in data science, low-rank matrix recovery is concerned with estimating some ground truth low-rank matrix from certain types of data observations. As commonly seen, the observed data can be linear measurements, or sparsely perturbed, outlier-corrupted, or incomplete versions of the ground truth matrix. In this talk, I consider a recently proposed paradigm where the observed data matrix is a permuted (unlabeled) and incomplete version of the ground truth. After motivating this paradigm, I will present some algebraic-geometric theory that provides conditions under which the ground truth matrix can be recovered (uniquely or finitely). Then I proceed to non-convex optimization procedures to computationally recover the ground truth matrix. Experimental analysis will be given to illustrate the efficiency of the proposed method.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA36

CC-North 222C

Advances in Mixed-Integer Optimization

Community Committee Choice Session

Session Chair: Peijing Liu, University of Southern California, Los Angeles, CA

1 An Adaptive Outer-Approximation Method for Solving Mixed-Integer Convex Programs with Indicators

Linchuan Wei, Northwestern University, Evanston, IL

The mixed-integer quadratic programs with indicator variables (MIQP)find various applications in financial economics, electricity powerproduction, transportation, statistical learning, and causal inference. In this paper, we propose to solve MIQPs using an adaptive outer approximation(OA) approach. Our main contributions are (1) a unifying scheme to derivethe OA formulations for the convex relaxations of MIQPs via decomposition, which also generalizes the OA formulation for the convex boolean relaxation, (2) a comprehensive computational study that showcases the performance of our adaptive OA method on the best subset selection and sparse portfolio selection problem.

2 On Relaxations of the Max K-Cut Problem Formulations

Ramin Fakhimi[1], Hamidreza Validi[2], Illya V. Hicks[3], Tamas Terlaky[1], Luis F. Zuluaga[1], [1]Lehigh University, Bethlehem, PA, [2]Texas Tech University, Lubbock, TX, [3]Rice University, Houston, TX, Contact: hvalidi@ttu.edu

The max k-cut problem is a fundamental combinatorial optimization problem with multiple notorious mixed integer optimization formulations. This talk explores four existing mixed integer optimization formulations of the max k-cut problem. We show that the continuous relaxation of a binary quadratic optimization formulation is: (i) stronger than that of two mixed integer linear optimization formulations and (ii) at least as strong as that of a mixed integer semidefinite optimization formulation. We also conduct a set of experiments on the state-of-the-art solvers to assess the theoretical results in practice. Due to the recent advancements of solvers in handling non-convex optimization formulations, we can run the binary quadratic optimization formulation by Gurobi solver. The computational results support our theoretical findings on multiple sets of instances.

3 Optimizing the Designs and Operations of Water Networks: A Decomposition Approach

Yijiang Li[1], Santanu Dey[2], Nikolaos Sahinidis[1], Naresh Susarla[3], Markus Gustav Drouven[4], [1]Georgia Institute of Technology, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA, [3]National Energy Technology Laboratory, Pittsburgh, PA, [4]U.S. Department of Energy, Pittsburgh, PA, Contact: yijiangli@gatech.edu

Water networks are used to transport water, a crucial resource for residential and industrial usages. The water network problems can be divided into the design and operational problem. The design problems can consider pipe sizing and placements of pump stations while the operation problems are generally multiple time period problems to account for temporal changes in supply and demand and can consider the scheduling of the pump stations and relief valves. In this talk, we focus on the network for the so-called produced water and propose two methods to obtain good primal (feasible) solutions. One method is based on decomposition framework while the other method is based on time decomposition. We conduct computational experiments on a network derived from The Produced Water Optimization Initiative (PARETO) case study.

4 A Feasible Direction Method for Convex Quadratic Optimization Problems with Indicators

Peijing Liu[1], Alper Atamturk[2], Andres Gomez[1], Simge Kucukyavuz[3], [1]University of Southern California, Los Angeles, CA, [2]Berkeley Analytics, Berkeley, CA, [3]Northwestern University, Evanston, IL, Contact: peijingl@usc.edu

We consider the convex quadratic optimization problem with indicator variables when the matrix Q defining the quadratic term is a Stieltjes matrix. According to previous research, a convex hull description of this problem in an extended space can be reduced to describing a polytope in the extended formulation. We propose a set of valid inequalities to approximate this polytope based on the submodularity of individual matrices of matrices, and show that separation can be done by computing a Cholesky decomposition. The resulting relaxation is SDP-representable and requires exponentially many linear constraints to describe. Thus, we propose a tailored algorithm to optimize the relaxation, inspired by feasible direction method. Our computational experiments demonstrate the effectiveness of the proposed method compared to state-of-the-art conic optimization solvers.

5 Inverse Optimization for Imputing Constraint Parameters in Quadratic Programs

Archis Ghate, Siva Ramani, University of Washington, Seattle, WA

The goal in (forward) optimization is to compute decision variables given the values of model parameters. In contrast, the goal in inverse optimization is to impute model parameters using given values of decision variables. We will discuss this problem in the context of quadratic programs wherein the left-hand-side constraint parameters are unknown. The resulting inverse problem is nonconvex. We will describe tailored computational methods designed to tackle this nonconvexity. These methods will be compared via numerical experiments.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA37

CC-North 223

Data-driven Optimization

Community Committee Choice Session

Session Chair: Juan Sebastian Borrero, Oklahoma State University, Stillwater, OK

1 Maximum Likelihood Probability Measures over Sets and Applications to Data-Driven Optimization

Juan S. Borrero[1], Denis Saure[2], [1]Oklahoma State University, Stillwater, OK, [2]Universidad de Chile, Santiago, Chile. Contact: juan.s.borrero@okstate.edu

Motivated by data-driven approaches to sequential decision-making under uncertainty, we study maximum likelihood estimation of a distribution over a general measurable space when realizations are not directly observable but instead are known to lie within observable sets. We show that maximum likelihood estimates concentrate on a collection of maximal intersections (CMI) sets, and can be found by solving a convex optimization problem whose size is linear in the size of the CMI. After studying the efficient computation of the CMI and the maximum likelihood estimate, we characterize convergence properties of the maximum likelihood estimate, and we apply our results to construct ambiguity sets and develop compact formulations in the context of Distributionally Robust, and Greedy and Optimistic Optimization

2 Optimal Sequential Stochastic Shortest Path Interdiction

Juan Sebastian Borrero[1], Denis Saure[2], Natalia Trigo[2], [1]Oklahoma State University, Stillwater, OK, [2]Universidad de Chile, Santiago, Chile

We consider a setting of sequential shortest-path interdiction, where a leader, unaware of the distribution of a sequence of iid cost vectors, must interdict a network periodically. On each period, a follower observes the interdicted network and responds traversing a shortest path. We assume that the leader only observes the path selected by the evader and the costs realizations associated with said path. We model the interaction between the leader and follower using bilevel programming, and the trade-off between exploration and exploitation through the bandit paradigm. We establish a fundamental limit on the performance of any admissible policy, and propose a series of policies inspired from the classic bandit setting.

3 Comparisons Between Bagging and Compromise Decisions

Shuotao Diao[1], Suvrajeet Sen[2], [1]Northwestern University, Evanston, IL, [2]University of Southern California, Los Angeles, CA, Contact: shuotao.diao@northwestern.edu

Bagging is a popular technique in Machine Learning, whereas Compromise Decisions come from using multiple replications in Stochastic Programming (SP). We will discuss the similarities and differences between the two in the context of SP.

4 Effective Scenarios in Distributionally Robust Optimization with Cressie-Read Power Divergence and Wasserstein Distance

Guzin Bayraksan[1], Chennan Zhou[2], [1]The Ohio State University, Columbus, OH, [2]The Ohio State University,

Columbus, OH, Contact: bayraksan.1@osu.edu
Effective scenarios are critical to data-driven Distributionally Robust Optimization (DRO) in the sense that, if removed, the optimal value will be changed. Earlier, effective scenarios were examined for convex DRO with Total Variation distance. In this work, we study them for a class of DRO formed with the Wasserstein distance and Cressie-Read power divergences. We present several properties, discuss how to identify effective scenarios, and illustrate our results numerically.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA38

CC-North 224A

Semiconductur Industry and Batch Production

Contributed Session

Session Chair: Jorge Huertas, Georgia Institute of Technology, ATLANTA, GA

1 An Efficient Mixed-Integer Linear Programming Model of Batch Size and Production Frequency Constraints in Master Production Scheduling

Pei-Yu Lin, Sheng-I Chen, National Yang Ming Chiao Tung University, Hsinchu, Taiwan. Contact: jamie1110.mg11@nycu.edu.tw

Manufacturing firms consider the batch size and production frequency in the master production scheduling in order to aggregate production orders and average resource loading and WIP levels. In this study, we formulate various batch size constraints from real-world applications. Also, we apply compact formulations to reduce the model size of the mixed-integer linear programming. Computational experiments use actual problem instances to evaluate the effectiveness of proposed models. Results show that adding the compact batch-size constraints can fulfill decision-maker requirements and obtain well computational performance.

2 A Decentralized Approach for Rescheduling Semiconductor Assembly Systems with Re-Entrant Flows and Time Window Constraints

Yutong Su[1], Bala Krishnan[2], Husam Dauod[3], Nital Patel[3], Feng Ju[1], [1]Arizona State University, Tempe, AZ, [2]Intel Corporation, Bangalore, India; [3]Intel Corporation, Chandler, AZ, Contact: yutongs1@asu.edu

In semiconductor manufacturing, random disruptions, such as machine failures, may cause delays and time window violations, which make master schedule sub-optimal or even infeasible. Considering the re-entrant flows and time window constraints, the rescheduling problem in face of machine failures is formulated as a decentralized mixed integer programming model. To be able to solve the problem in close to real-time, a genetic algorithm (GA) is proposed based on the system decomposition. The computation results using real world case studies demonstrate the effectiveness of the method.

3 The Impact of Tool Allocation and Dedication on Cycle Time

Marino Arturo, Maryam Anvar, Chris Keith, Applied Materials, Santa Clara, CA, Contact: Marino_Arturo@amat.com

There are hundreds of steps that need to be followed to complete processing of wafers in a front-end wafer fab. Before a wafer runs a particular recipe on a tool, the tool must be qualified to run the recipe. In many situations the process of qualifying the recipe on the tool can be both time consuming and costly in terms of resources required. Therefore, there are many cases that some recipes are not supported by some tools in the fleet. This constraint is referred to as “dedication” which results in having fewer resources to support some process steps. Dedication along with other parameters such as tool allocation and uptime variability could impact the cycle time and responsiveness of the system. In this paper, we study the impact of these parameters on lot cycle time using discrete-event simulation software (AutoSched®).

4 Optimization Proxies in the Supply Chain for Semiconductor Manufacturing

Jorge Huertas[1,2], Ashish Nemani[2], Zhenying Zhao[2], Pascal Van Hentenryck[1], [1]ISyE Georgia Tech, Atlanta, GA, [2]Intel, Chandler, AZ, Contact: huertas.ja@gatech.edu

In the supply chain for semiconductor manufacturing, many processes at various stages and locations transform the silica wafers into multiple components to finally produce chips. To generate the production plan along this supply chain, a master production scheduler tool executes different optimization models sequentially. Hence, performing sensitivity analyses for planning purposes becomes a challenge, as it is necessary to execute the sequential optimization multiple times to quantify the impact of variations in the input parameters. To overcome this challenge, we combine optimization and machine learning to produce an optimization proxy of the sequential optimization, allowing quick sensitivity analyses for planning purposes.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA39

CC-North 224B

Facility Logistics

Community Committee Choice Session

Session Chair: Mehdi Behroozi, Northeastern University, Boston, MA

1 Integrated Multi-Stakeholder Freight Transportation System with Uncertain Demand

Mojtaba Hosseini[1], Gita Taherkhani[2], Ali Hassanzadeh[3], [1]University of Iowa, Iowa City, IA, [2]Loyola University, Chicago, IL, [3]University of Manchester, Manchester, United Kingdom

This study focuses on investigating the tactical planning of an integrated multi-stakeholder system. The system receives time-dependent requests from carriers and shippers and optimizes in time and space the operations and transportation activities through the consolidation of loads of different shippers into the same vehicles. The demand values of shippers are taken under uncertainty. The aim of tactical planning in this system is to build an efficient service network and schedule to satisfy the demand and requirements of shippers by making use of the predicted services and their capacities offered by the carriers. A two-stage stochastic program is presented and an exact decomposition-based algorithm is developed. Extensive computational analysis is performed to evaluate the impact of uncertainty on the solution of the proposed model.

2 Health Care Facility Location Planning With Multi-type Facilities And Staff Sharing

Ozgur Unsal[1,2], Halit Uster[1], [1]Southern Methodist University (SMU), Dallas, TX, [2]Gebze Technical University, Kocaeli, Turkey. Contact: cunsal@smu.edu

Motivated by the design of a health care provider network which offers different combination of services in its branches, we study a variant of capacitated facility location problem in which patients seek for different health care services that are provided by facilities that can be built in candidate locations. In this variant, facilities can also share specialists to provide a specific service in more locations, albeit with a restricted operational capacity. The problem is modelled as a mixed-integer program and effective valid inequalities are provided. For larger instances, a Benders decomposition scheme is developed. Computational results show that the solution approaches that we propose for this formulation can tackle with real world sized instances.

3 Locating Electric Vehicles Charging Stations in a Convex Region

Mehdi Behroozi[1], Dinghao Ma[2], [1]Northeastern University, Boston, MA, [2]Northeastern University, Boston, MA, Contact: m.behroozi@neu.edu

The efforts to reduce greenhouse gas emissions to combat climate change has led to the development and increasing adoption of electric vehicles (EVs) that are considered competitive and in many aspects, better than their internal combustion engine counterparts (ICEVs). However, they still have a long way to go to replace ICEVs. One of the main aspects that EVs still have the lower hand is the accessibility of charging stations, which makes the optimal location of EV charging stations a significant factor in fast and successful adoption of EVs. In this paper, we take a robust partitioning and assignment approach for finding efficient locations for these charging stations.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA40

CC-North 225A

Optimization in Transportation Applications

Community Committee Choice Session

Session Chair: Akhilesh Soni, University of Wisconsin-Madison, Madison, WI

1 Rideshare Routing with Flexible Meeting Points, Uncertain Travel Times and Passenger Cancellations

Zuhayer Mahtab, Maged M. Dessouky, University of Southern California, Los Angeles, CA, Contact: mahtab@usc.edu

Ridesharing has the potential to reduce congestion, pollution, and the need for personal vehicles. We propose a rideshare routing framework that has uncertain travel times and stochastic passenger cancellations. We incorporate flexible pickup/drop-off points, which we call meeting points, that can reduce driver detours and waiting times. We implement a Sample Average Approximation (SAA) and Branch and Price (BP) based solution approach that can solve small to medium-sized instances within reasonable computation time. By considering both sources of uncertainty together, we obtain superior results compared to when each source of uncertainty is considered individually.

2 A Progressive Hedging-Based Solution Approach for Multicommodity Network Design Problems Under Demand Uncertainty

Fatemeh Sarayloo[1], Teodor Gabriel Crainic[2], Walter Rei[3],

[1]University of Illinois at Chicago, Chicago, IL, [2]Université du Québec à Montréal, Montréal, QC, Canada; [3]University of Quebec-Montreal, Saint-Lambert, QC, Canada

In this paper, we propose a solution approach for stochastic network design problems with uncertain demand, which we formulate as a two-stage stochastic program. We rely on the progressive hedging (PH) algorithm of Rockafellar and Wets where the subproblems are defined using scenario groups. Our proposed method, referred to as "Integrated Learning and Progressive Hedging", takes advantage of a specialized learning-based matheuristic that is able to quickly produce high-quality solutions to multi-scenario subproblems. Furthermore, we propose a novel reference point definition, at each aggregation step of the PH algorithm, which leverages subproblem information regarding promising design variables. Extensive computational experiments illustrate the efficiency of the proposed matheuristic in obtaining high-quality solutions.

3 Network Design Using Lagrangian Decomposition

Akhilesh Soni[1], Semih Atakan[2], [1]University of Wisconsin-Madison, Madison, WI, [2]Amazon.com, Seattle, WA

We propose a Lagrangian relaxation-based regional decomposition approach for network design problems that leverages local fulfillment in the network. The parent network is decomposed into regional subnetworks while minimizing cross-regional commodities. The cross-regional variables are duplicated while imposing consistency constraints to ensure that the variables remain the same across subnetworks. The consistency constraints are then dualized, resulting in separable regional subproblems that can be solved in parallel. We employ a cutting-plane algorithm to iteratively solve the Lagrangian problem, using outer approximation on the Lagrangian dual and solving subproblems to improve the relaxed dual function's formulation.

4 Uv Mission Planning Under Uncertainty in Vehicles' Availability

Venkata Sirimuvva Chirala, Wayne State University, Detroit, MI, Contact: go1577@wayne.edu

Unmanned vehicles (UVs) are used in defense and civil applications. We present a two-stage stochastic model for a fuel-constrained UV mission planning problem with multiple refueling stations under uncertainty in availability of UVs. Given a set of points of interests (POI) and refueling stations, and a base station where the UVs are stationed and their availability is random, the objective is to determine route for each UV starting and terminating at the base station such that overall incentives collected by visiting POIs is maximized. We present an outer approximation based decomposition algorithm and the skewed variable neighborhood search heuristic to solve large instances, and perform extensive computational experiments. A data driven simulation study is performed using robot operating system framework to corroborate the use of the stochastic programming.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA41

CC-North 225B

Machine Learning for Operations Problems

Contributed Session

Session Chair: Kiarash Ghasemzadeh, Arizona State University, Tempe, AZ

1 Diesel Engine Defect Prediction Framework Using Quantum Mechanics-Based Neural Network

Eunseo Oh[1], Hyunsoo Lee[2], [1]Kumoh National Institute of Technology, Gumi-si, Korea, Republic of; [2]Kumoh National Institute of Technology, Gumi, Korea, Republic of

Data is collected from sensors attached to process equipment through automation. Companies can improve economics and safety by predicting engine defects in advance using diesel engine defect data, one of the manufacturing process data. Diesel engine defects can be predicted through neural network analysis, which is a representative data analysis technique. However, the data collected from the sensor and the weights of the neural network model contain noise. This adversely affects the accuracy of neural network analysis. Therefore, in this study, a quantum mechanics-based neural network is modeled by considering the uncertainty of data and the weight of the neural network. In addition, the proposed framework proposes a new weight update methodology modeled by stochastic differential equations by reflecting the drift of weight and considering the uncertainty.

2 Solving the Paint Shop Problem Using Reinforcement Learning

Mirko Stappert, Bernhard Lutz, Dirk Neumann, University of Freiburg, Freiburg, Germany. Contact: dirk.neumann@is.uni-freiburg.de

In the paint shop problem, a sequence of cars has to be painted with the objective of minimizing the number of color changes. For this purpose, manufacturers employ a multi-lane buffer system with store and retrieval operations. Prior studies solely focused on retrieval operations and simple solution heuristics. In this study, we propose an integrated reinforcement learning approach that simultaneously learns to perform smart storage and retrieval operations. After proving that greedy retrieval is optimal, we incorporate this fact into the model using action masking. Our evaluation, based on problem instances with 2-8 buffer lanes and 5-15 colors, shows that our approach reduces color changes compared to existing methods by up to 59%.

3 Rl Vaccinator: Leveraging Reinforcement Learning for Optimal Immunization in Contact Networks

Ehsan Ardjmand[1], Alireza Fallahtafti[2], Ehsan Yazdani[3], Anwar Mahmoodi[3], [1]Ohio University, Athens, OH, [2]Case Western Reserve University, Cleveland, OH, [3]University of Kurdistan, Sanandaj, Iran, Islamic Republic of

The effective control of infectious diseases heavily relies on designing efficient vaccination policies. However, the complex nature of human contact networks poses significant challenges in determining the optimum allocation of vaccine resources. This research explores the utilization of reinforcement learning (RL) techniques to address this problem. Specifically, we investigate how RL algorithms can be employed to optimize vaccination policies by considering the dynamics of disease spread over human contact networks while targeting the individuals who are the best immunization candidates. For this purpose, a reinforcement learning approach based on graph neural networks is coupled with a pandemic simulator to estimate the future status of the disease spread. Through simulations and analyses, we demonstrate the efficacy of the proposed method.

4 Developing a Reinforcement Learning Based Water Quality Control System

Kiarash Ghasemzadeh[1], Pitu Mirchandani[1], Treavor Boyer[2], [1]Arizona State University, Tempe, AZ, [2]Arizona State University, Tempe, AZ, Contact: kghasemz@asu.edu

Managing water quality is a complex task, requiring the monitoring of interdependent contaminants and their control using measures such as flushing, filtration, chemical injection, and temperature adjustment. The challenge is amplified by the stagnation and lengthy transit times during the delivery process, along with the intricacies of the hydraulic system and the nonlinearity of water quality functions. This research introduces a reinforcement learning (RL) based system, a novel approach to maintaining optimal water quality in buildings. The RL-based system, adaptable to various structures and capable of handling stochastic demand can regulate these control mechanisms effectively and ensure consistent safe-for-drinking water for the end users, presenting a significant advancement in the field.

5 Data-Driven Portfolio Management for Motion Pictures Industry: A New Data-Driven Optimization Methodology Using Chat Gpt as an Expert

Mohammad Alipour-Vaezi, Kwok-Leung Tsui, Virginia Tech, Blacksburg, VA, Contact: alipourvaezi@vt.edu

Portfolio management is one of the unresponded problems of the Motion Pictures Industry (MPI). To design an optimal portfolio for an MPI investor, it is essential to predict the box office of each project. Moreover, for an accurate box office prediction, it is critical to consider the effect of the celebrities involved in each MPI project which was not possible with any precedent expert-base method. In this paper, firstly, the fame score of the celebrities is determined using Chat GPT. Then to tackle the unbalanced character of MPI's data, projects are classified. Furthermore, the box office prediction is taken place for the projects in each class. Finally, using a hybrid multi-attribute decision-making technique, the preferability of each project for the investor is calculated, and benefitting from a bi-objective optimization model, the optimal portfolio is designed.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA42

CC-North 226A

Improving the Effectiveness of Human-AI Collaboration in Operations

Community Committee Choice Session

Session Chair: Stephanie Kelley, Ivey Business School, The University of Western Ontario, London, ON, Canada

1 Explanation Seeking and Recommendation Adherence in Human-to-Human Versus Human-to-AI Interactions

Tracy Jenkin[1], Stephanie Kelley[2], Anton Ovchinnikov[3], Cecilia Ying[4], [1]Queen's University, Kingston, ON, Canada; [2]Sobey School of Business, Saint Mary's University, Halifax, NS, Canada; [3]Smith School of Business, Queen's University, Kingston, ON, Canada; [4]Queen's University, Markham, ON, Canada

We conduct a lab experiment to examine when and why do explanation seeking and recommendation adherence behaviours differ in human-to-human versus human-to-AI settings, with variances in task abnormality, in the online rental market setting. We explore participant heterogeneity to determine how personality traits such as trust propensity, dispositional trust in automation, and perfect automation schema impact explanation-seeking and recommendation adherence between individuals with human and AI advisors. Our traditional experimental analysis is paired with machine learning topic modelling and emotion classification to further investigate participant heterogeneity.

2 Improving Human-Algorithm Collaboration in the Presence of Outliers

Matt DosSantos DiSorbo, Kris Johnson Ferreira, Harvard Business School, Boston, MA, Contact: mdisorbo@hbs.edu

Algorithms are imperfect. While models may perform well on data that are representative of the training set (inliers), they may exhibit sizable error when extrapolating on non-representative data (outliers). In a lab experiment, we demonstrate that participants are unable to sufficiently differentiate trust in an algorithm when faced with both inliers and outliers. We identify a simple intervention — alerting the participant when the feature values are inside or outside the range of the training set and referencing the potential impact on algorithm error — that significantly improves performance. Our work has implications across the many contexts of human-algorithm collaboration.

3 A Meta-Analysis of Algorithm Aversion

Shuba Srinivasan[1], Ya You[2], Amit Joshi[3], Carey Morewedge[1], Maude Lavanchy[3], [1]Boston University, Boston, MA, [2]Cal State, East Bay, CA, [3]IMD, Lausanne, Switzerland. Contact: ssrini@bu.edu

Algorithms have become ubiquitous, and the output of algorithms directly and indirectly affects users' decisions and actions. Despite the benefits of these systems, research has found that users sometimes exhibit negative attitudes and behavior toward algorithms versus humans delivering "equivalent" offerings, referred to algorithm aversion. This study conducts a meta-analysis of 302 effect sizes across 156 studies from 67 articles to identify key factors that may drive algorithm aversion. The results show that users have a significant overall algorithm aversion. Moreover, algorithm aversion is driven by algorithm characteristics, human characteristics, task characteristics and industry characteristics .

4 Multitask Prompt Learning for Hate Speech Detection

Kyuhan Lee[1], Ram Sudha[2], [1]Korea University Business School, Seoul, Korea, Republic of; [2]University of Arizona, Tucson, AZ, Contact: kyuhanlee@korea.ac.kr

The previous approaches for hate speech detection pose several issues including the inability to capture the nuanced variations within different subtypes of hate speech; the neglect of the findings from the psychology literature regarding personality and hate; and the lack of explanation to inform humans in making the final decision of content moderation. To this end, we propose a multi-task prompt-based few-shot learning architecture different from existing ones in the following aspects: applying the theory of questioning for our prompt generation; suggesting an information-theory-based method for computationally selecting prompts; (iii) proposing a multi-task personality-based fine-tuning architecture to incorporate personality information; and (iv) generating explanation more understandable to and acceptable by humans.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA43

CC-North 226B

Simulation, Modeling, and Optimization for Air Transportation and Emerging Mobility

Community Committee Choice Session

Session Chair: Christopher Chin, Massachusetts Institute of Technology, Cambridge, MA

1 Route Network Planning for Urban Drone Delivery : Network Flow Theory or Graph Search Algorithms

Lishuai Li, Xinyu He, City University of Hong Kong, Kowloon, Hong Kong. Contact: lishuai.li@cityu.edu.hk

Unmanned Aerial Vehicles (UAVs)-based commercial services, exemplified by drone delivery, have captured widespread interest from technology companies. However, to scale up drone delivery in urban environments, air route network design and traffic management are essential, yet it is computationally challenging due to the scale, complexity, and density of the urban airspace. In this study, we compare two streams of methods for planning route networks, the Network Flow Models using mathematical programming and Graph Search Algorithms using heuristics. A set of experiments have been conducted and the results show that graph search will be more suitable for large real-world scenarios due to faster computational time, while the Network Flow Model generates routes with superior optimality but requires significantly more computational time.

2 Distributionally Robust Airport Ground Holding Problem Under Wasserstein Ambiguity Sets

Haochen Wu, University of Michigan, Ann Arbor, MI

The airport ground holding problem seeks to minimize flight delay costs due to reductions in the capacity of airports. However, the critical input of future airport capacities is often difficult to predict. To address the problem of designing airport ground holding policies under distributional uncertainty, we formulate and solve the airport ground holding problem using distributionally robust optimization (DRO). The experiment results show that the DRO model outperforms the stochastic models when there is a significant difference between the empirical airport capacity distribution and the realized airport capacity distribution.

3 On the Air Traffic Flow Management with Airspace Users' Preference

Guglielmo Lulli[1,2], Luigi De Giovanni[3], Carlo Lancia[2], Yuhan Jiang[1], [1]Lancaster University, Lancaster, United Kingdom; [2]Universita' di Milano-Bicocca, Milano, Italy; [3]University of Padua, Padova, Italy

In this talk, we present a novel data-driven optimization approach for trajectory-based air traffic flow management (ATFM). A key aspect of the proposed approach is the inclusion of airspace users' trajectory preferences, which are computed from traffic data using machine learning methods. The methodology has been tested on real instances of the problem. In this talk, we show an analysis of preference aware ATFM solutions, the trade-off between preferences and delays as well as the potential benefits. We expect that the proposed approach may facilitate to find a consensus between the network manager and airspace users.

4 Introducing a Novel Optimized Propulsion System for Enhanced Efficiency and Reduced Fuel Consumption in Aviation

Luis Cadarso, Jorge Saavedra García, Rey Juan Carlos University, Fuenlabrada, Spain. Contact: luis.cadarso@urjc.es

Engines in aviation are nearing maximum efficiency, while growing demand drives fuel consumption and emissions. To reduce them and comply with air traffic legislation which regulates emissions and resource use, a new, more efficient system is needed. Here, a novel optimized propulsion system is introduced, recovering heat from engine exhaust to enhance performance. The heated stream is combined with the bypass stream, while a pressure gain-based re-heater maximizes efficiency and power output. The system dynamics are captured by a nonlinear mathematical model that presents multiple decision variables and an objective function focused on minimizing fuel consumption. The optimized system achieves an 11% reduction in fuel consumption.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA44

CC-North 226C

AI-Driven Cybersecurity

Community Committee Choice Session

Session Chair: Tung Cu, Northeastern Illinois University, Chicago, IL

1 Using Cognitive Agents to Collaborate with Cyber Defenders: Current Work and Major Challenges

Yinuo Du, Cleotilde Gonzalez, Carnegie Mellon University, Pittsburgh, PA, Contact: yinuod@andrew.cmu.edu

Cyber security is a team task but has mostly been studied from an individual defender perspective. Human-AI teaming presents an opportunity to improve Cyber Protection Teams but the coordination and collaboration of activities between humans and AI teammates need to be developed.
In the work, we will first propose a new Collaborative Team Defense Game, where one human defender can defend a network together with an autonomous agent. Then, we will introduce three types of autonomous agents to play the role of teammate. We contextualized a set of metrics to evaluate the collective intelligence of cyber teams of different composition. We conclude with future work on team task refinement and AI teammate design.

2 Digital Transformation of Moocs

Tung Cu, Northeastern Illinois University, Chicago, IL, Contact: tcu@neiu.edu

Massive Open Online Courses (MOOC) have caused disruption among higher education institutions by establishing new markets for learners who may not be served by the traditional university. This research aims to investigate whether the MOOCs growth and popularity amongst different countries may contribute to the country's digital transformation over time. To this end, data is collected and analyzed via multiple sources including MOOC enrollment and digital transformation. The use of predictive analytics is applied to estimate countries' transformation and digitalization over time. The study shows that MOOCs are evolving, and as their adoption continues to improve, new markets for new learners will be established, leading to digital growth and transformation among developing countries.

3 Case Studies of AI and Cybersecurity

Bonnie Holub, Infosys Consulting, Sunfish Lake, MN

This paper will consider several use cases where AI-driven cybersecurity solutions have been applied to real-world industrial problems. Use cases will span banking and financial services, manufacturing, technology, healthcare, and life science examples. Future challenges will be outlined as well as areas for future technology development. We will discuss AI-driven cybersecurity in light of cybersecurity risks, privacy, regulatory compliance, intellectual property, and ESG.

4 Ransomware Attack Preventions Based on Defense-In-Depth Algorithms

Arish Ali, Yi Yang, Tung Cu, Northeastern Illinois University, Chicago, IL

We propose several defense-in-depth algorithms against ransomware attacks, which combine two Moving Target Defense (MTD) approaches: an IP address shuffling algorithm and a file backup algorithm. The IP address shuffling algorithm changes the IP addresses of the network randomly to avoid being located by ransomware attackers. The files backup algorithm periodically creates copies of user files to the backup server to enable fast recovery in case of file encryption. We evaluate our algorithms against several well-known ransomware attack families, such as WannaCry, Cerber, Thanos, Tesla, and Bitlocker. Our experimental results are conducted under virtual machines, and they show that our proposed algorithms outperform existing methods in the literature, because they can effectively protect user files from ransomware attacks with only minimal performance overhead.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA45

CC-North 227A

Machine Learning and Optimization Applications

Contributed Session

Session Chair: Joel Persson, ETH Zurich, Zurich, Switzerland

1 Interactive Optimization With Varying Refinement Actions For Supply Chain Design

Damsara Jayarathne[1], Michelle Zhang[2], Sandipan Mishra[1], John E. Mitchell[2], Jennifer Pazour[3], [1]Rensselaer Polytechnic Institute, Troy, NY, [2]Rensselaer Polytechnic Institute, Troy, NY, [3]Rensselaer Polytechnic Institute, Troy, NY, Contact: jayarj2@rpi.edu

We propose an interactive optimization framework that holistically interacts with a human user to recommend a supply chain design, the design's expected systematic performance and associated confidence intervals. Our framework asks the human user questions based on the math program's current solution, confidence intervals, and auxiliary information (e.g., dual variables) to gain access to more or better quality data, problem domain knowledge, or updated preference weights. The human user's responses are interpreted to make varying refinement actions that improve the solution quality, reduce the reality gap, or improve the confidence in the system performance estimates.

2 A Cost-Effective and Accuracy Sensitive Svm with Step Loss Function

Jing-Rung Yu, Chun-Yu Lin, National Chi-Nan University, Nantou, Taiwan. Contact: s110213512@mail1.ncnu.edu.tw

This study proposes a cost-effective and accuracy-sensitive $\ell 1$-norm support vector machine with step loss function (CEAS_SVM_SL) to handle feature selection cost under accuracy sensitivity. The objectives of the proposed model are to minimize misclassification and maximize the lower bounds of the true positive rate and true negative rate. From the empirical testing results, our model is insensitive to outliers. In addition, it shows that the CEAS_SVM_SL performs higher out-of-sample accuracy than other benchmark models while considering the feature cost. The proposed model can extend to handling individual feature and group structure cost-based feature selection even under feature cost uncertainty, saving more money.

3 Capacity Management and Modelling in the Agri-Food Supply Chain: A Systematic Literature Review

Chenqiang Yue, Dong Li, Dongping Song, University of Liverpool, Liverpool, United Kingdom. Contact: yuecq@liverpool.ac.uk

This paper conducts a systematic literature review of capacity management and modelling in the context of agri-food supply chains. Descriptive and theme-based analysis are presented to reveal how capacity management is modelled under uncertainty and risk preferences from perspectives of optimal decisions, influencing factors, and methodology. We highlight current research status and identify future research opportunities.

4 Off-Policy Learning of Content Promotions: Optimal Curation of Digital Distribution Channels

Joel Persson[1], Stefan Feuerriegel[2], Cristina Kadar[3], [1]ETH Zurich, Zurich, Switzerland; [2]LMU Munich, Munich, Germany; [3]Neue Zürcher Zeitung, Zurich, Switzerland. Contact: jpersson@ethz.ch

We present an off-policy learning framework for optimizing which content a digital publisher shall promote on its distribution channels. Our framework comprises a decision model, an identification and evaluation method, and a causal machine learning procedure. We show theoretically that the optimal policy selects the content with top-ranked conditional average treatment effect per time period, that the estimation procedure is sufficient, necessary and doubly robust, and that our estimation algorithm is computationally efficient. We partner with an international newspaper and, using large-scale internal data, demonstrate that the optimal policy improves upon the status quo and baseline methods by 8.5 percent in terms of the key business metric. Our work contributes to previous research by supporting content publishers in curating their distribution channels.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA46

CC-North 227B

Decision-oriented Data Analytics for Modeling, Prediction, and Inference

Community Committee Choice Session

Session Chair: Minhee Kim, University of Florida, Gainesville, FL

1 Thermal History-Based Quantification and Prediction of Overheating in Laser Powder Bed Fusion

Samar Saleh[1], Yuebin Guo[2], Weihong Grace Guo[1], [1]Rutgers University, New Brunswick, NJ, [2]Rutgers University, New Brunswick, NJ, Contact: shs164@scarletmail.rutgers.edu

Despite its revolutionary influence on industries, metal 3D printing's broader adoption is hindered by challenges, most notably overheating, which endangers part quality, structural integrity, and accuracy. Factors like temperature tracking, material variability, complex geometries, and printing parameters complicate overheating quantification in LPBF, compounded by the absence of standards. We aim to create a method integrating pyrometry, image processing, and machine learning to extract representative features from thermal data for overheating quantification and prediction. By monitoring and minimizing overheating flaws, this method enhances 3D printing's dependability and performance, facilitating its wider adoption across diverse sectors.

2 Convolutional Non-Homogeneous Poisson Process with Application to Wildfire Risk Quantification for Power Delivery Networks

Guanzhou Wei[1], Xiao Liu[1], Feng Qiu[2], [1]University of Arkansas, Fayetteville, AR, [2]Argonne National Laboratory, Lemont, IL, Contact: gwei@uark.edu

This talk presents a new spatio-temporal point process model, Convolutional Non-homogeneous Poisson Process (cNHPP), to quantify wildfire risks for power delivery networks. The proposed model captures both the current short-term and cumulative long-term effects of covariates on wildfire risks, and the spatio-temporal dependency among different segments of the power delivery network.

3 Data Driven Sequential Learning Frameworks to Accelerate Multi-Objective Manufacturing Decisions

Hamed Khosravi[1], Taofeeq Olajire[1], Ahmed Shoyeb Raihan[2], Imtiaz Ahmed[2], [1]West Virginia University, Morgantown, WV, [2]West Virginia University, Morgantown, WV, Contact: hk00024@mix.wvu.edu

Optimizing the selection of data collection points is crucial in manufacturing experiments to minimize costs and time while obtaining a comprehensive understanding of the process. This paper introduces a novel data-driven Bayesian optimization framework for efficiently optimizing complex systems with multiple conflicting objectives. Also, it proposes an epsilon-greedy sequential prediction framework that addresses the exploration-exploitation trade-off by establishing a threshold. A novel metric for evaluating multi-objective data-driven optimization approaches is also presented. This metric considers both the quality of the Pareto front and the amount of data used to generate it. The methods and metric are evaluated on real-world manufacturing datasets, showing their superiority in achieving similar manufacturing decisions with reduced costs and time

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WA47

CC-North 227C

Data Science in Healthcare, Medicine, and Public Health

Community Committee Choice Session

Session Chair: Bing Si, State University of New York at Binghamton, Binghamton, NY

Session Chair: Mingyang Li, University of South

Florida, Tampa, FL

1 Spatial Rank-Based Augmentation for Nonparametric Online Monitoring and Adaptive Sampling of Big Data Streams

Xin Zan[1], Di Wang[2], Xiaochen Xian[3], [1]University of Florida, GAINESVILLE, FL, [2]Shanghai Jiao Tong University, Shanghai, China; [3]University of Florida, Gainesville, FL, Contact: xin.zan@ufl.edu

The monitoring of big data streams remains a challenging task in various practical applications mainly due to their complexity in interrelationships, large volume, and high velocity, which places prohibitive demands on monitoring methodologies and resources. To tackle the challenges, we incorporate spatial rank-based statistics with effective data augmentation techniques to analytically inform the monitoring and sampling decisions for general big data streams with a practical partial observability constraint. Theoretical investigations and simulation studies are conducted to understand the proposed augmentation statistics, and also guarantee the superiority of the sampling performance over existing methods.

2 Stochastic Nursing Home Staffing and Scheduling Under Case-Mix Resident Need

Shujin Jiang[1], Mingyang Li[2], Nan Kong[1], [1]Purdue University, West Lafayette, IN, [2]University of South Florida, Tampa, FL, Contact: jiang557@purdue.edu

Staffing adequately in a cost-effective manner is vital to nursing home management in the United States. In this work, we propose SNHSS, short for stochastic nursing home staffing and scheduler—a staffing and scheduling approach tailored to address the unique challenges and uncertainties of nursing home service. Given probabilistic forecasts of nursing home service needs, SNHSS optimally schedules the caregiver's daily assignment based on nursing home resident acuity. SNHSS is formulated as a two-stage stochastic mixed-integer linear program, which we solve using a scenario-based rolling horizon. Tested on real-world data from the U.S. Indiana's nursing home, SNHSS enables nursing homes to provide appropriate and adequate service considering daily resident acuity and acuity-based care needs.

3 Federated Functional Regression for Telemedicine

Bing Si, State University of New York at Binghamton, Binghamton, NY

Federated Learning (FL) is an emerging computing paradigm that leverages multi-source data without data exchange to collaboratively train Machine Learning models with privacy preservation. Functional Regression (FR) aims at predicting a functional response from other functional variables and receives more and more attention in bio-signal-based telemedicine applications. However, no existing research has studied FL of the FR model to facilitate large-scale computing of high-dimensional functional data. This project contributes a novel federated Functional Regression model integrated with an efficient Gradient Boosting algorithm. Theoretical guarantee of the federated model's convergence is also discussed under certain statistical assumptions. The proposed model is tested in simulation studies and a real-world dataset for telemedicine.

4 A Deep Survival Analysis Approach to Improving Functional Outcomes Prediction of Nursing Home Residents

Yulun Xu[1], Hongdao Meng[2], Nan Kong[3], Kelly Smith[4], Mingyang Li[5], [1]University of South Florida, Tampa, FL, [2]University of South Florida, Tampa, FL, [3]Purdue University, West Lafayette, IN, [4]Q3 Healthcare Consulting LLC, Tampa, FL, [5]University of South Florida, Tampa, FL, Contact: yulun@usf.edu

Accurate prediction of discharge outcomes (i.e., time to community, time to re/hospitalization) of residents in a nursing home (NH) is crucial for maximizing restoration and maintenance of residents' functional status and returning them back to the community (e.g., private home or lower-level care settings). However, this task is challenging due to multiple discharge positions, varied individual characteristics, diseases, and treatment variations. We propose a new approach for individualized discharge outcomes prediction by integrating survival analysis and deep learning. The proposed work jointly considers multiple competing discharge dispositions and different censoring types. Using real-world NH data, we demonstrate the advantages of our proposed model over existing benchmarks, highlighting improved accuracy in discharge outcomes prediction.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA48

CC-North 228A

Advanced Online Process Monitoring of Complex Data in Smart and Connected Systems

Community Committee Choice Session

Session Chair: Ziqian Zheng, University of Wisconsin-Madison, Madison, WI

Session Chair: Kaibo Liu, UW-Madison, Madison, WI

1 Self-Starting Monitoring for High-Dimensional Data Under Sampling Control

Jiahui Zhang[1], Jun Li[2], Kaibo Liu[1], [1]University of Wisconsin-Madison, Madison, WI, [2]University of California, Riverside, CA, Contact: jzhang2584@wisc.edu

Real-time process monitoring on high-dimensional data with limited observation resources is a critical challenge. Practitioners need to form a monitoring procedure based on partially observed data while deciding the sampling layout. Additionally, a lack of in-control reference data before production runs calls for self-starting schemes. In this paper, we propose a novel algorithm for monitoring such data under self-starting schemes with sampling control, based on a quantile-based nonparametric CUSUM procedure with likelihood ratio-based statistics, and the Thompson Sampling algorithm is tailored to handle partially observed data in the self-starting case. Our method is robust for detecting arbitrary deviations and compatible with arbitrary heterogeneous distributions. Advantages of the proposed method are shown in simulation experiments and a case study.

2 A Recurrent Variational Autoencoder for Predictive Monitoring of Continual Learning Processes

Adel Alaeddini, Julian Carvajal Rico, University of Texas at San Antonio, San Antonio, TX

Many intelligent algorithms and in particular deep learning models rely on continual learning to keep up with the dynamics of the environment. However, if not monitored appropriately, continual learning may lead to catastrophic forgetting. Several algorithms have been explored in the literature for incremental learning of classification and/or regression tasks to address problems with continual learning. However, less emphasis has been placed on predictive monitoring and control of the continuous learning processes. Here, we propose a recurrent variational autoencoder paired with an appropriate multivariate control charting scheme to dynamically monitor the latent features of the training data based on new samples, and predict possible changes to the performance of deep learning models. We validate the proposed method using extensive simulation studies.

3 Detecting Duplicated Comments from FCC Net Neutrality Rules Using Deep Learning Methods

Zhicheng Huang, The university of Oklahoma, Norman, OK

As part of the rulemaking process, the Federal Communications Commission (FCC) solicits comments from the American public to understand the impacts of proposed rules. However, duplicate comments, which are identical or similar to other comments already received by the FCC, make it challenging for agencies to identify unique content and learn publics' opinions. To address this challenge, we analyzed duplicate comments on the net neutrality docket and developed measures for their detection using a deep neural network. This study presents an experiment testing our approach and comparing its results to state-of-the-art deep learning models. Experimental results indicate that the proposed model outperformed the baseline Bert-based Bigbird classifier and standard Graph Convolutional Network with Long Short-Term Memory (GCN-LSTM) model.

4 Near-Real-Time Detection Objects from Videos via Spatial-Temporal Tensor Decomposition

Yinwei Zhang, Jian Liu, The University of Arizona, Tucson, AZ

Real-time detection of objects from videos is a challenging task. Existing methods based on supervised learning may fall short when the availability of the labeled data is limited. To overcome the limitation, an unsupervised learning method is proposed. Specifically, it considers a video as a three-dimensional tensor of individual pixel motions, which are estimated as optical flows. The tensor can be decomposed into three layers, i.e., a background layer, an object layer, and a noise layer, each of which is regularized mathematically by considering the corresponding motion patterns. An optimization algorithm is proposed to solve the regularization problem effectively and efficiently. A case study is conducted to validate the proposed method.

Wednesday, October 18, 8:00 AM - 9:15 AM

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CC-North 228B

Prospects and Applications of Data Analytics in Human-Centered Manufacturing

Community Committee Choice Session

Session Chair: Shenghan Guo, Arizona State University, Gilbert, AZ

1 Workforce Efficiency and Safety on Human-Centric Manufacturing

Heejin Jeong, Arizona State University, Mesa, AZ

There is growing recognition in the Industry 5.0 paradigm that manufacturing should prioritize the well-being of human workers by adopting a human-centric approach rather than a system-centric approach driven solely by efficiency, quality improvement, and cost reduction. In this talk, Dr. Jeong will present his projects related to workplace safety and ergonomics within the paradigm. The aim is to promote efficiency in human-robot collaboration and ensure occupational workforce safety in the future of manufacturing. This talk will highlight human-technology interactions, focusing on extended reality, artificial intelligence, and wearable sensing, and discuss future directions pertaining to training and assessing the manufacturing workforce.

2 Interpretable and Reliable Machine Learning for Human-Centered Additive Manufacturing

Azadeh Haghighi, Suyog Ghungrad, Meysam Faegh, University of Illinois Chicago, Chicago, IL, Contact: ahaghi3@uic.edu

The manufacturing industry is undergoing a rapid transformation, and data analytics is playing a crucial role in this evolution, enabling and facilitating human-centered manufacturing. Consequently, innovations in interpretable and reliable artificial intelligence for human operators in advanced manufacturing scenarios are necessary. In this talk, we present a new methodology that fuses additive manufacturing-specific physics into the architecture of neural networks to achieve higher interpretability, reliability, and trustability. This fusion mechanism not only enhances performance but also addresses the challenge of learning with smaller sample sizes, which is particularly relevant for human-centered products and devices requiring a high level of customization.

3 Prediction of Optimal 3d Printing Conditions with Computer Vision

Shenghan Guo, Hasnaa Ouidadi, Boyang Xu, Arizona State University, Tempe, AZ

Artificial intelligence (AI) has been applied to a variety of fields and has proven to be an effective tool for many decision-making tasks like object detection, classification, *etc*. Nevertheless, training a machine learning (ML) model may require labelled data to ensure high performance. This data collection task may necessitate human knowledge. For instance, in 3D printing, decision-making for the printing conditions heavily relies on human expertise. This study leverages human knowledge to obtain the optimal printing parameters of Computer-Aided Design (CAD) models. These parameters along with multi-view images of the model will constitute the labelled data for training ML models and develop an automated computer vision tool for predicting the printing condition of new CAD models. This work fills in the gap for a lack of AI-aided design automation for 3D printing.

4 Computer-Vision-Enabled Worker Video Analysis for Motion Amount Quantification

Hari Iyer, Shenghan Guo, Heejin Jeong, Arizona State University, Mesa, AZ

Workers' motion amount is a highly influential factor in their performance. Monitoring and evaluating the motion amount has been challenging due to the difficulties in motion sensing, tracking, and quantitative evaluation. Recently, in-situ videos have been adopted for real-time sensing of worker behavior, providing vital resources for data-driven motion amount quantification. This study proposed a computer-vision-based worker video analysis framework to track workers' right arm, quantify their motion amount, and alarm situations when the motion amount reaches a warning level. AI object recognition tool is integrated with a Hotelling T2 monitoring statistic built upon the extracted information to quantify and monitor the motion amount. This study will shed light on AI-enabled worker behavioral analysis and future workforce training.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA50

CC-North 229A

Advances in Multisectoral Model Data and Couplings for Complex Human-Earth Systems Analysis

Community Committee Choice Session

Session Chair: Stuart Cohen, National Renewable Energy Laboratory, Golden, CO

1 Calibrating Economy-Wide Energy, Matter, and Money Stocks and Flows in a Multi-Sector Macroeconomic Model of the United States

Carey King, Neeraj Hanumante, The University of Texas at Austin, Austin, TX

To coherently model a transition to a low-carbon economy, a macroeconomic model should be fully consistent in tracking stocks and flows of matter, energy, and money. The Human and Resources with MONEY (HARMONEY) model framework was created to do this via consistency with modern monetary principles (i.e., money issued as private debt by banks as well as spending by central governments) and biophysical principles (i.e., machines and capital are constructed of matter extracted from the environment and require energy input as fuel to operate). This presentation describes the effort to calibrate mass, energy, and monetary data to a multi-sector HARMONEY model of the United States (U.S.)

using databases standardized for many countries (e.g., EXIOBASE3, International Energy Agency) as well as literature and data sets specific to the U.S. (e.g., USGS material flows).

2 Equitably Improving Adaptive Capacity in Response to Health Risks from Air Pollution

Rebecca Saari, University of Waterloo, Waterloo, ON, Canada

We seek to inform policy to equitably improve adaptive capacity by modeling nature-society interactions. Air pollution and COVID-19 were both linked to millions of deaths over the recent pandemic. Current policy for adaptation to outdoor air quality relies on individuals moving to clean indoor environments, to which people experiencing socio-economic hardship and homelessness have limited access. The pandemic shifted where time indoors was spent, and introduced protective mask wearing that reduces air pollution exposure. Here, we assess different adaptation measures (avoidance, masks, improving buildings), and quantify the missed health opportunity by not improving indoor environments in equitably protecting health from air pollution.

3 Climate-Water-Electricity Interactions in the U.S. Under Alternative Decarbonized Futures

Stuart M. Cohen, National Renewable Energy Laboratory, Golden, CO, Contact: stuart.cohen@nrel.gov

The U.S. electric sector is rapidly evolving, with widespread renewable energy deployment, building and transport electrification, and nuanced decarbonization policies. Climate change influences the supply and demand for electricity by altering water resources for cooling and hydropower, thermal plant efficiencies, and heating and cooling demand. This research combines global climate model data, asset-level water and streamflow modeling, and electric sector capacity expansion modeling to study climate-water-electricity interactions across myriad future climate and electricity scenarios that consider electrification and decarbonization using renewable, hydrogen, carbon capture, and nuclear technologies. Multi-model integration leads to insights into power-water sector interactions and their impacts on grid economics and environmental outcomes.

4 A Multi-Model Integrated Workflow for Harmonized Energy System Transitions, Grid Operations, and Power Plant Siting

Kendall Mongird[1], Chris Vernon[1], Jennie Rice[1], Zarrar Khan[2], Kerem Akdemir[3], Konstantinos Oikonomou[1], Jordan Kern[3], [1]Pacific Northwest National Laboratory, Richland, WA, [2]Pacific Northwest National Laboratory, College Park, MD, [3]North Carolina State University, Durham, NC, Contact: kendall.mongird@pnnl.gov

Answering complex questions as to how the US electric grid will evolve under the compounding effects of climate change, energy system transitions, and changes in electricity demand requires the integration of electricity system models that operate at dissimilar temporal and spatial scales. We present a novel multi-model workflow to spatiotemporally link a geospatial power plant siting model (CERF) and a nodal grid operations model (GO) to achieve electricity price-informed power plant siting, and new infrastructure-informed grid operations for alternative energy system transitions developed by an integrated assessment model (GCAM-USA).

5 Pathways for Small Modular Reactor Deployment Serving Industrial Process Heat with Learning and Policy Impacts

Max Vanatta, University of Michigan, Ann Arbor, MI, Contact: mvanatta@umich.edu

Hard to decarbonize industrial emissions are a challenge which small modular nuclear reactors (SMRs) have the potential to satisfy. Current SMR designs are novel and expensive but due to their inherent manufacturability, they could benefit from learning curves. In this study, we evaluate deployment pathways for SMRs serving industrial process heat across the continental US. Defining these pathways are policy, supply chain, and learning rate variations which the nascent SMR industry will need to navigate. Initial results suggest that SMRs do have a significant potential to economically decarbonize, or partially decarbonize, large numbers of industrial facilities in the US though the extent of this is sensitive to policy and learning.

Wednesday, October 18, 8:00 AM - 9:15 AM

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CC-North 229B

Integrating Non-Traditional Resources and Reducing Asset Delivery Risk in Power Systems

Community Committee Choice Session

Session Chair: Richard Paul O’Neill, ARPA-E, Silver Spring, MD

Session Chair: Jon Glass, ARPA-e, Washington, DC

1 Economic and Reliability Outcomes of a Risk-Adjusted Stochastic Day-Ahead Unit Commitment Model

Dalia Patino-Echeverri, Duke University, Durham, NC,

Contact: dalia.patino@duke.edu
This presentation will discuss the cost savings and reliability effects of using a risk-adjusted stochastic day-ahead unit commitment model in a vertically integrated utility and the impact of different methods to generate probabilistic forecasts.

2 Integrating Non-Traditional Resources and Reducing Asset Delivery Risk in Power Systems
Selin Yanikara, Tabors Caramanis Rudkevich, Newton, MA, Contact: syanikara@psopt.com
Extreme weather events, increasing electrification, and integration of weather-dependent resources pose significant risk for common mode failures in the power grid and increasingly threaten its reliable operation. We summarize the theoretical foundation for locational and temporal probabilistic assessment of resource adequacy and present novel adequacy metrics that establish spot pricing for scarcity and help value the contribution of each system asset - generation, transmission, or demand resource - to system adequacy. The Monte Carlo based probabilistic methodology is augmented with a computationally efficient stratified sampling approach to obtain statistical significance and accuracy. The presentation will illustrate the probabilistic methodology and metrics evaluation on a real size US market.

3 Stochastic Market Auction Redesigned Trading System (Smarts) Update: The Value of Virtual Power Plant and Global Market Intelligence
Hung-po Chao, Energy Trading Analytics (ETA), Palo Alto, CA, Contact: hungpo.chao@et-analytics.com
Our aim is to provide an update on the ARPA-E PERFORM project titled “Stochastic Market Auction: Redesigned Trading System (SMARTS).” We will focus on two key areas for risk management in electric power markets. First, we will discuss the game-changing potential of global market intelligence (GMI) by leveraging advanced data analytics and deep market insights to enhance price formation and investment incentives. Traders can improve their market performance, and market designers can test enhanced market features. Second, we will discuss the value of integrating demand flexibility and virtual power plants (VPP) into electric power markets under efficient revenue and energy yield management. In conclusion, the SMARTS project aims to leverage the power of GMI and harness demand flexibility in VPP to revolutionize risk management for future power grids.

4 Flexibility as Optionality: Methods to Value the Flexibility of Distributed Energy Resources
Helyette Geman, Johns Hopkins University, Baltimore, MD
Flexible loads, including smart thermostats, smart water heaters, and electric vehicles, can provide valuable flexibility services, but the capacity of these services is uncertain because it depends on the stochastic and time-varying nature of weather and occupant behavior. Properly valuing this flexibility can reduce the barriers of entry into existing markets and encourage adoption of these technologies. This talk will compare the ideas of energy flexibility and optionality and propose methods for flexible load valuation.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA52

CC-North 230
Planning and Operating Hydropower
Community Committee Choice Session
Session Chair: Feng Pan, Pacific Northwest National Laboratory, Richland, WA

1 Optimization of Pumped Hydro Energy Storage: A Structural Analysis
Harun Avci[1], Ece Cigdem Karakoyun[2], Ayse Selin Kocaman[2], Emre Nadar[2], Parinaz Toufani[2], [1]Northwestern University, Evanston, IL, [2]Bilkent University, Ankara, Turkey. Contact: selin.kocaman@bilkent.edu.tr
We study the energy generation and storage problem for a pumped hydro energy storage facility that consists of two connected reservoirs fed by a natural inflow. The operator decides in real-time how much water to pump or release in order to determine how much energy to buy or sell. We model this problem as a Markov decision process that accounts for the uncertainty in streamflow rates and electricity prices. We establish the optimality of a state-dependent threshold policy when electricity prices are positive.

2 Probabilistic Seasonal Inflow Forecasts and Chance-Constrained Optimization for Cascading Hydro Power Systems
Lei Wu, Xianbang Chen, Stevens Institute of Technology, Hoboken, NJ, Contact: xchen130@stevens.edu
This presentation will discuss a probabilistic seasonal water inflow prediction model for cascading hydropower systems. The Bayesian neural network is used to deliver the water inflow prediction in the form of a Gaussian mixture model (GMM). A chance-constrained programming (CCP) based optimization framework is further developed to evaluate the probabilistic seasonal water inflow prediction framework. By accurately capturing the system’s physical characteristics,

the operation model determined the cascading hydropower systems operation decisions in enabling maximum hydropower generation over the long term. The CCP-based method leverages the uncertainty information provided by GMM-based predictions, to handle the inevitable errors in water inflow predictions.

3 Pumped Storage Hydro Units Optimization in Day-Ahead and Real-Time Market Under Uncertainty

Bing Huang[1], Arezou Ghesmati[1], Yonghong Chen[1], Ross Baldick[2], [1]Midcontinent Independent System Operator (MISO), Carmel, IN, [2]University of Texas at Austin, Austin, TX, Contact: bhuang@misoenergy.org

Pumped storage hydro units (PSHU) are great sources of flexibility which is especially valuable to the modern systems with increasing shares of intermittent renewable resources. However, the flexibility from PSHUs has not been fully explored and utilized in the current system. In this presentation, first, a strategic design of incorporating and fully optimizing PSHUs in the day-ahead (DA) market is presented. The DA computational impact is discussed. Second, to provide a practical solution to the daily operation of a PSHU in a single day look-ahead commitment (LAC) and real-time market, models that only use probabilistic price forecast to incorporate uncertainties and manage risks are presented. Numerical studies in Mid-continent Independent System Operator (MISO) show that market efficiency is improved with moderate impact on the LAC computational performance.

4 Hydropower Operational Strategies For Enhanced Wind Integration

Yiwen Wang[1], Todd Levin[2], Jonghwan Kwon[2], [1]University of Massachusetts - Amherst, Amherst, MA, [2]Argonne National Laboratory, Lemont, IL, Contact: yiwwang@umass.edu

The West Coast has vast hydropower and wind energy potential. Hydropower can be used to compensate for the intermittency of wind energy to provide cleaner and more reliable electricity. However, the operation of a hydro-wind hybrid system requires proper planning and optimization. This project uses the A-LEAF operation model to evaluate how operational strategies and market incentives for hydropower support or inhibit hydropower's ability to help integrate high penetrations of wind resources into the power system.

5 Enhance Day-Ahead Generation with Hydropower and Battery Storage

Feng Pan, Arun Veeramany, Slaven Kincic, Pacific Northwest National Laboratory, Richland, WA, Contact: feng.pan@pnnl.gov

Our objective is to assess the benefits of batteries in a power system with hydroelectric generators. We will introduce a day-ahead unit commitment model with enhanced hydropower representation to capture hydro related conditions on flow rate, hydro-power conversion, limits on flow fluctuation, reservoir operation, and river network. Additional constraints can be used to improve hydro operation by reducing the frequent ramping. Batteries are integrated into the system as co-optimized resource or as hybrids co-located with run-of-river generators. The simulation included several scenarios of battery locations, sizes, and hybridization in a utility-size system with different levels of clean energy penetration, and cost-reduction and clean energy utilization were compared in these settings.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA53

CC-North 231A

Towards Net Zero: Efficient and Sustainable Operations

Community Committee Choice Session

Session Chair: Osman Alp, University of Calgary, Calgary, AB, Canada

1 Applying Energy Surcharges to Increase Supply Chain Energy Efficiency: A Cautionary Tale

Jason Nguyen[1], Karen L. Donohue[2], Mili Mehrotra[3], [1]Ivey Business School, Western University, London, ON, Canada; [2]University of Minnesota, Minneapolis, MN, [3]University Of Illinois Urbana Champaign, Champaign, IL, Contact: jnguyen@ivey.ca

Energy price surcharges are often recommended as an effective countermeasure to account for energy externalities and encourage more Energy Efficiency (EE) investments. However, the resulting higher energy price can cause loss of domestic manufacturing to external competitors. Extant research on the topic often overlooks details at an operational level, including supply chain interactions and the uncertainty in EE saving potential that may have important implications in practice. Our study analyzes how energy price surcharges and its supplemental policies, including surcharge reductions and EE investment subsidies, impact supply chain EE investments, domestic sourcing and overall social welfare while accounting for these factors.

2 Combatting Food Waste via Joint Pricing and Perishable Inventory Optimization

Zichun Liu[1], Sentao Miao[1], Wei Qi[2], [1]McGill University, Montreal, QC, Canada; [2]Tsinghua University, Beijing, China. Contact: zichun.liu@mail.mcgill.ca

We address the simultaneous determination of pricing and inventory control for perishable products to maximize profit. The optimal policy is computationally intractable due to the curse of dimensionality. We show our heuristic policy is asymptotically optimal under several parameter regimes. In addition, we prove the necessity to model perishibility nature, and how it reduces food waste compared with current operations.

3 Path to Energy Sovereignty: Clean and Affordable Solutions for Remote Communities

Serasu Duran[1], Feyza G. Sahinyazan[2], Jayashankar M. Swaminathan[3], [1]Haskayne School of Business, Calgary, AB, Canada; [2]Simon Fraser University, Burnaby, BC, Canada; [3]University of North Carolina Chapel Hill, Chapel Hill, NC, Contact: serasu.duran@haskayne.ucalgary.ca

Remote communities around the globe rely on off-grid installations of stand-alone diesel generators to cover their energy needs which can be cost-inefficient, harmful for the environment and subject to disruptions. Policy makers seek sustainable solutions for these communities to meet the Sustainable Development Goals regarding clean energy and reduced inequalities. Even with the best intentions, ignoring community perspectives can hamper the clean energy transition and energy accessibility goals of remote communities. Our objective in this research is to identify the optimal generation capacity investment decisions from a remote community's perspective and investigate how common policy mechanisms interact with these decisions.

4 Technological and Market Response to Environmental Tax by a Competitive Industry

Anton Ovchinnikov[1], Dmitry Krass[2], [1]Smith School of Business, Queen's University, Kingston, ON, Canada; [2]Rotman School of Management, University of Toronto, Toronto, ON, Canada. Contact: ao37@queensu.ca

We consider a response to environmental taxes by firms producing a commodity good with a polluting by-product. Firms are heterogeneous with respect to production efficiency and pollution control technology. Cournot competition is assumed, with two demand functions: iso-elastic and linear. In this setting, we consider a market response, where firms choose production quantities given their technology choices, and a technology response, where firms also choose among a discrete set of available technologies. We characterize the equilibria and examine using environmental taxes to incentivize "green" technology choices. We also show that results may qualitatively differ depending on the demand function assumed.

5 Optimal Rebate Level, Compensation Rate, and Capacity Investment for Fostering Solar Panel Adoption

Osman Alp[1], Serasu Duran[2], Saman TeymoorianMotlagh[1], [1]University of Calgary, Calgary, AB, Canada; [2]Haskayne School of Business, Calgary, AB, Canada. Contact: osman.alp@ucalgary.ca

Feed-in tariff policies and solar panel rebates incentivize roof-top solar adoption in the society. However, such policies can create stress on the electricity distribution system and non-solar households. By considering government, utility company, solar and non-solar households as four stakeholders, we develop optimal rebate level for solar installations and the feed-in tariff rates for solar generation so that none of the stakeholders are worse-off. Households determine how much to invest in solar energy based on the rebate level and the feed-in tariff rate set by the government as well as their solar intensity, roof top area and budget. Governments anticipate this action of the households and set a rebate level and a feed-in tariff rate so that the utility company's profit does not drop and the cost of electricity does not increase.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA54

CC-North 231B

Use of Universal Quantum Computers and Quantum Annealers to Solve ORMS Problems

Community Committee Choice Session

Session Chair: Stefan Creemers, IESEG, Aarschot, Belgium

1 Discrete Optimization: A Quantum Revolution?

Stefan Creemers[1], Luis Fernando Perez Armas[2], [1]IESEG, Paris, France; [2]IESEG, lille, France

We use Grover's algorithm to build quantum algorithms that can be used to solve discrete optimization problems on a universal quantum computer. We use our quantum algorithms to solve the binary knapsack problem, and highlight a number of challenges that are faced when effectively using Grover's algorithm to solve discrete optimization problems.

2 Solving the Resource-Constrained Project Scheduling Problem (RCPSP) with Quantum Annealing

Luis Fernando Pérez Armas[1], Stefan Creemers[1], Samuel Deleplanque[2], [1]IESEG, Lille, France; [2]Junia Isen, Lille, France. Contact: l.perezarmas@ieseg.fr

Quantum annealing offers a promising approach for solving combinatorial optimization problems like the Resource-Constrained Project Scheduling Problem (RCPSP). We investigated its empirical performance by formulating the RCPSP as QUBO and ISING model. Experimental results are provided using a cutting-edge annealer (D-Wave Advantage) on RCPSP instances from the CV dataset. We conducted a thorough analysis of the solution energy landscape focusing on diversity and quality. Results are compared with classical solvers, shedding light on the potential advantages and limitations of using quantum annealing for RCPSP. Our findings suggest that quantum annealing delivers satisfying solutions for smaller to medium-sized problems. It also offers a high diversity of solutions making it a viable candidate for hybrid approaches to further enhance solution quality.

3 Solving Industry-Relevant Optimization Problems with Neutral Atoms-Based Quantum Computers

Wesley Coelho, PASQAL, Paris, France. Contact: wesley.coelho@pasqal.com

The emergence of quantum devices opens many exciting perspectives in the high-performance computing world. Among other quantum platforms, fully programmable neutral atom devices display unique characteristics and, by better controlling quantum entanglement and superposition, they represent a powerful tool to tackle complex problems and computing challenges. In this talk, Wesley Coelho will show how PASQAL Quantum Computers are used to address complex optimization problems while presenting the last achievements on industry-relevant use cases.

4 Neutral Atom Quantum Computers: The Platform and Applications

Hossein Sadeghi, PASQAL, Vancouver, BC, Canada. Contact: hossein.sadeghi@pasqal.com

PASQAL manufactures neutral atom quantum computers that use lasers to drive transition between atomic states and perform analog and digital operations on qubits.In addition, PASQAL is a full-stack company that provides access to quantum computers through cloud computing, a suite of SDKs that allows users to communicate with the quantum processor using a high-level language, and a suite of algorithms for a wide range of commercial applications.In this talk, I will walk you through an overview of the technology, its capabilities, and examples of real-world applications developed by PASQAL.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA55

CC-North 231C

Planning and Operations of Power Systems

Contributed Session

Session Chair: Todd Levin, Argonne National Laboratory, Lemont, IL

1 Price Pass-Through and Cost Burden Induced by Decarbonization Policies Considering Long-Term Capacity Expansion and Short-Term Grid Operation

Hongyang Zou[1], Huibin Du[1], Gang He[2], Kuishuang Feng[3], [1]Tianjin University, Tianjin, China; [2]Stony Brook University, New York, NY, [3]University of Maryland, Washington, MD

The impact of carbon cost on electricity supply and carbon pass-through requires a simulation that integrate CO_2 emission trading and electricity supply and dispatch into a continuous procedure. This study links agent-based model with SWITCH model that involves electricity supply, transmission and load centers, and estimates the carbon pass-through rates of different regions. The results show that a high carbon pass-through rates is closely related to local electricity supply and interregional power dispatch. The mix scenario that simultaneously considers CO_2 emission trading (CET) and renewable electricity target (RET) shows the synergistic effect of two policies on low-carbon electricity transition. Meanwhile, at low carbon cost, carbon market should be implemented combining with renewable electricity target to achieve the expected policy target.

2 A Data-Driven Model of the European Day-Ahead Electricity Market

Balazs Riskutia, Kenneth Bruninx, TU Delft, Delft, Netherlands. Contact: k.bruninx@tudelft.nl

In Europe’s day-ahead electricity market, flow-based market coupling facilitates electricity trade between market zones. Transmission system operators restrict commercial flows based on expected congestion on inter- and intra-zonal network elements. A lack of transparency on the strategies followed by transmission system operators and the bids/offers challenges studying the market’s performance. We leverage publicly available data sets to reconstruct supply curves and the flow-based domains through inverse optimization. The resulting interpretable model reproduces day-ahead electricity prices, cross-border flows, and flow-based domains with similar accuracy as state-of-the-art black-box tools. In addition, it allows studying the expected impact of structural changes, such as new transmission or generation assets.

3 Transcontinental Power Pools for Low-Carbon Electricity

Haozhe Yang[1], Ranjit Deshmukh[2], Sangwon Suh[1], [1]University of California, Santa Barbara, Santa Barbara, CA, [2]University of California Santa Barbara, Santa Barbara, CA, Contact: haozheyang@ucsb.edu

Transition to low-carbon electricity is crucial for meeting global climate goals. However, given the uneven spatial distribution and temporal variability of renewable resources, it is challenging to balance the supply and demand of electricity when relying heavily on renewables. Here, we use an electricity planning model to examine whether transcontinental power pools help meet global electricity demand by renewables. By utilizing only 10% available sites, renewables are economically infeasible to meet 12% of global demand in 2050 without international electricity trade. Introducing transcontinental power pools, however, renewables are feasible to meet 99% of electricity demand, while reducing the costs by 3-31% across power pools. Our results highlight the potential of expanding regional transmission networks in achieving decarbonization of electricity.

4 Modeling Ramping Constraints for the Statistical Unit Commitment Problem

Carlos Olivos[1,2], Jorge F. Valenzuela[1], [1]Auburn University, Auburn, AL, [2]Universidad Católica del Norte, Antofagasta, Chile. Contact: cro0010@auburn.edu

Over the past decade, stochastic models have gained relevance in the power systems operation field. Due to a growing integration of renewable energy sources, it is essential to incorporate the inherent variability of these sources into optimization models. In this work, we propose a variation of the Stochastic Unit Commitment problem that does not rely on scenario-based methods. Instead, an analytical formulation of the expected dispatch cost is derived from the net-load probability distribution function, considering technical constraints such as startup cost trajectories and ramping constraintsl. The model is tested in the California Independent System Operator (CAISO) power system. Results, algorithms, and conclusions will be presented.

5 The Role of Long Duration Energy Storage in Mitigating the Reliability Impacts of Climate-Driven Extreme Weather Events

Todd Levin, Argonne National Laboratory, Lemont, IL, Contact: tlevin@anl.gov

It is becoming clear that climate change will lead to changes in future weather patterns, including increasingly frequent and impactful periods of extreme operating conditions. We demonstrate the importance of considering future weather conditions in generation expansion planning through a case study analysis of the ERCOT power system, with a specific focus on establishing the role of long duration energy storage in mitigating the associated reliability impacts. We utilize data from three global climate models to generate a range of future scenarios for wind and solar availability and electricity demand, while also considering temperature-dependent generator and transmission infrastructure outage probabilities. We then illustrate how representing projected future weather conditions in a stochastic GEP framework impacts the optimal generation portfolio.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA57

CC-North 232B

Managing Organizations to Boost Productivity

Contributed Session

Session Chair: Olivia Newton, University of Central Florida, Orlando, FL

1 Exploring Managerial Choice Making and Information Boundaries in Global Facility Location Decision Making Process

Debarshee Bhardwaj, Aseem Kinra, Universität Bremen, Bremen, Germany

Global facility location decision-making (GFLD) is a complex process that often prompts managers, particularly in small and medium-sized enterprises (SMEs) to adopt a satisficing approach. However, the optimal amount of information needed from site selection intermediaries regarding location attributes remains unclear, as managers may employ various decision-making and assessment strategies. To address this gap, our paper delves into the choice-making process of managers and investigates the information boundaries within the GFLD process specifically for SMEs. Using quasi-experiments based on verbal protocol analysis, involving 39 students and 50 SME managers, we found that medium information volume led to higher satisfaction, simplifying decision-making, improving outcomes, and generating relevant attributes, albeit with some trade-offs in accuracy.

2 Optimizing Healthcare Staff Efficiency Through Integration of Circadian Rhythms into Work Scheduling

Diana Lopez-Soto[1], Karen Niño[2], [1]North Dakota State University, Fargo, ND, [2]Universidad Militar Nueva Granada, Bogotá, D. C., Colombia. Contact: diana.lopez@ndsu.edu

Extended or rotating shifts in healthcare are practices commonly used to ensure patient care at all times; however, they can disrupt the body's natural circadian rhythm. Approximately 75% of workers face difficulties adapting to night shifts, which increases the risk of injuries, accidents, and chronic diseases, in addition, to impacting mental health. This research explores incorporating circadian rhythm variables into shift work scheduling to facilitate better adaptation for workers. A multi-objective model has been developed to address the problem, focusing on maximizing the allocation of personnel experience while considering the time needed for recovery before another shift and the desired level of performance and risk.

3 Maximizing Healthcare Worker Availability During Infectious Disease Outbreaks: A Novel Mdp Model and Validation Study

Mina Bahadori[1], Tugce Isik[2], [1]Clemson University, Central, SC, [2]Clemson University, Clemson, SC, Contact: mbahado@clemson.edu

Healthcare workers are at increased risk during infectious disease outbreaks, which can impact their ability to provide care. We develop an MDP model to optimize healthcare worker availability during an outbreak. Going beyond the SEIR framework, our model is prescriptive and provides implementable staffing policies. To validate the model, we first conduct a simulation study and demonstrate the alignment of model results with existing literature. We then present a case study using real-world Covid-19 infection and contact data collected on Clemson University campus. These analyses show the credibility of the proposed model and allow us to assess the model's ability to improve healthcare worker availability during an outbreak. We also discuss the potential use of our MDP model to devise optimal schedules for healthcare workers throughout different phases of an outbreak.

4 Modeling the Relationship Between Social Diversity and Organizational Decision Making on Open Collaborations in Information Systems

Olivia B. Newton, Stephen M. Fiore, University of Central Florida, Orlando, FL, Contact: olivia.newton@ucf.edu

Contemporary work is often based on the open collaboration model as observed in software development. Transparency of, and access to, information systems enables widespread participation in the development of software. At the same time, low social diversity in these ecosystems has implications for software and society. Combining data analytics with survey research for a mixed-methods approach, we use systems theory to study open source developers decision making. Our goal is to elucidate the relationship between individual, collective, and societal factors associated with social diversity in software projects maintained by organizations and online groups. We discuss how disparities drive the direction of technological innovations and explore the promises and pitfalls of organizational decisions on achieving social diversity in open information systems.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA59

CC-West 101A

Multiple Criteria Decision Making and Decision Analysis

Community Committee Choice Session

Session Chair: K. Nadia Papamichail, The University of Manchester, Manchester, United Kingdom

1 Survey of Multiobjective Optimization Methods for Business Data Analytics

Pubudu Jayasekara[1], Dilhani Shalika Marasinghe[2], [1]The University of Tennessee at Chattanooga, Chattanooga, TN, [2]University of Tennessee Chattanooga, Chattanooga, TN, Contact: pubudu-jayasekara@utc.edu

We present a review of the use of data analytics in the context of multiobjective optimization. Research in multiobjective optimization aims to develop algorithms and techniques to solve problems having multiple, often conflicting, objectives efficiently, by identifying the Pareto set precisely or approximates as closely as possible. With the increasing availability of data and recent advancements in machine learning and optimization techniques, there has been a growing trend towards utilizing data analytics to address challenges in Management Science. This work provides a review of recent data analytics applications in three major areas of Management Science, namely revenue management, statistics, and supply chain management. Numerical results are included.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA60

CC-West 101B

Creating Environments to Foster Diversity

Contributed Session

1 Uncovering The Network Power Gap:a Deep Learning Approach To Investigating Gender Disparities In The Boardrooms Of Canadian Public Firms

Yuhao (Jet) Zhou[1], Collins Ntim[2], María Óskarsdóttir[3], Matthew Davison[1], Cristian Bravo[4], [1]Western University, London, ON, Canada; [2]University of Southampton, Southampton, United Kingdom; [3]Reykjavík University, Reykjavik, Iceland; [4]University of Western Ontario, London, ON, Canada. Contact: yzho82@uwo.ca

Our study employs a multi-channel deep learning model to investigate factors influencing board appointments in Canadian public firms. We analyzed directors' social networks, career paths, and static features, including education and social engagement. The model demonstrated robust predictive power without gender stratification, providing insights into network channel decomposition. Applying the model separately for male and female directors, we identified significant differences in network power between genders. Our research offers a comprehensive understanding of mechanisms driving board appointments and provides evidence to inform policies aimed at addressing gender disparities, fostering a more inclusive corporate environment.

2 Founder Diversity: The Key to Unlocking a Diverse Tech Firm Workforce

Mi H. Tran, Johan Wiklund, Cristiano Bellavitis, Syracuse University, Syracuse, NY, Contact: mhtran@syr.edu

Our study investigates how founder gender and ethnicity impact high-tech firm hiring preferences regarding candidate gender and ethnicity. We analyzed a dataset of 73,520 job candidates and 1,170 firms from a high-tech networking platform across three stages of the recruitment process: initial contact, candidate response, and successful hire. The results show that firms are more likely to contact and receive responses from female and underrepresented minority (URM) candidates when the founding team has a higher proportion of female or URM founders. Our study highlights the imprinting influence of founder demographics on recruitment outcomes and suggests that creating a foundation for sustained diversity within the high-tech workforce requires providing resources and opportunities for female and URM entrepreneurs right from the onset of the business formation.

3 Remote Work Arrangement and Gender Inequality

Shuang Xia[1], Yuxiao Ye[1], Shenyang Jiang[2], Baofeng Huo[1], [1]College of Management and Economics, Tianjin University, Tianjin, China; [2]Advanced Institute of Business, Tongji University, Shanghai, China. Contact: xiashuang@tju.edu.cn

COVID-19 prompted widespread adoption of remote work arrangements (RWAs), now continued by many companies. This study investigates the impact of RWAs on workplace gender inequality and explores the moderating effects of government wage subsidies and female executives. By analyzing detailed firm-level data from 15,737 companies across 34 countries, our study reveals that RWAs exacerbate gender inequality, leading to a significant decline in the proportion of female employees and consequent reduction in firm performance. However, we find that government wage subsidies during the pandemic and the presence of female executives mitigate the impact on gender inequality. Our research highlights the cascading consequences of this operational decision for companies, while providing insights for businesses and policymakers on mitigating these negative impacts.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA61

CC-West 101C

Humanitarian Operations and Disaster Management II

Community Committee Choice Session

Session Chair: Andrew N. Arnette, Virginia Tech, Blacksburg, VA

Session Chair: Christopher W. Zobel, Virginia Tech, Blacksburg, VA

1 Information Management For Disaster Response: The Role Of Operational Updates And Crew Experience

Alfonso J. Pedraza-Martinez[1], Sebastian Villa[2], Tricia Moravec[3], Eunae Yoo[3], Lu (Lucy) Yan[3], [1]University of Notre Dame, Notre Dame, IN, [2]University of New Mexico, Albuquerque, NM, [3]Indiana University, Bloomington, IN, Contact: apedraz2@nd.edu

We use text analysis, econometrics and online experiments to understand the effect of relief organizations' operational updates on public sentiment during wildfire response.

2 The Impact of Postponement and Stock Sharing Strategies on Prepositioned Relief Stocks

Lamia G. Kasap-Simsek[1], Burcu Balcik[1], Florent Chane[2], [1]Ozyegin University, Istanbul, Turkey; [2]Emergency Supply Pre-positioning Strategy (ESUPS), Bonn, Germany. Contact: lamia.kasap@ozu.edu.tr

We evaluate effects of postponement and stock-sharing practices among humanitarian agencies that preposition supplies in a depot. We develop a Monte Carlo simulation algorithm that involves inventory allocation models for sharing stock among agencies and mobilizing stock from agencies to countries. We test our approach using historical hurricane scenarios from the Caribbean region and data from agencies. We demonstrate significant savings in fill rate, response time, and inventory utilization.

3 Vulnerability-Based Prioritization in Disaster Relief Efforts

Feyza G. Sahinyazan[1], Halenur Sahin[2], Irfan Mahmutogullari[3], [1]Simon Fraser University, Vancouver, BC, Canada; [2]TOBB ETU, Ankara, Turkey; [3]KU Leuven, Leuven, Belgium

Equity, Efficiency and Effectiveness (3E) are commonly used objectives in disaster literature. In this paper, we introduce an alternative measure that prioritizes vulnerable populations during disaster response efforts, and we compared its performance against the 3E measure using Istanbul's population characteristics and earthquake data.

4 Optimizing Water Delivery in Post-Disaster Humanitarian Logistics with Social Costs

Azadeh Sadeghi[1], Felipe Aros-Vera[2], [1]University of Michigan- Flint, Flint, MI, [2]Ohio University, Athens, OH, Contact: sadeghia@umich.edu

This research focuses on the delivery of critical supplies, particularly water, in the aftermath of a disaster. The tradeoffs between using bottled water, which is easily distributed but costly, and bulk water, which is cheaper but requires containers, are explored. To address this, the Social Cost Vehicle Routing Problem is introduced as a mathematical optimization model that determines the best mix of water resources for transportation, routing, and delivery. The model is applied to a case study of post-disaster water distribution in Puerto Rico after Hurricanes Irma and Maria. The results indicate that a combination of bottled and bulk water is the most effective approach for aid delivery while minimizing social costs.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA62

CC-West 102A

Contemporary Scheduling

Community Committee Choice Session

Session Chair: Yumei Huo, City University of New York, College of Staten Island & The Graduate Center, Staten Island, NY

1 A Self-Learning Multi-Population Evolutionary Algorithm for Flexible Job Shop Scheduling

Zhaohong Jia, Anhui University, Heifei, China

Due to the energy crisis and environmental downgrade, manufacturing companies face rising costs. The flexible job shop scheduling problem considering time-of-use pricing (FJSPTOUP) is studied to minimize the maximum completion time and total electricity cost. A new self-learning multi-population evolutionary algorithm (SLMPEA) is proposed to address the static scheduling problem. A self-learning module is designed to acquire knowledge from elite individuals in subpopulations. We present an elite retention and enhancement strategy. Two enhancement operators are developed to elevate the quality of elite individuals, and a selection strategy is designed for the enhancement operators. A time-of-use-based adjustment strategy is proposed to reduce the total electricity costs without increasing the maximum completion time.

2 The Circular Balancing Problem

Kangbok Lee[1], Myungho Lee[2], [1]Pohang University of Science and Technology, Pohang, Korea, Republic of; [2]POSTECH IME, Nam-gu, Pohang-si, Korea, Republic of. Contact: kblee@postech.ac.kr

We propose a balancing problem with a minmax objective in a circular layout. This balancing problem is to arrange an even number of items with weights on a circle to minimize the maximum total weight of the items arranged on a semicircle. Due to its generic structure, it may have applications in fair resource allocation. We show the NP-hardness of the problem and develop polynomial-time algorithms when the number of different weights is a fixed constant. We also propose a tight approximation algorithm that is better than existing ones. This worst-case performance ratio is derived by a linear combination of valid inequalities obtained from the problem definition, the properties of the proposed algorithm, and the optimal circular permutation structure.

3 Sublinear Time Algorithms For Scheduling Problems

Bin Fu, The University of Texas Rio Grande Valley

Sublinear Time Algorithms for Scheduling Problems We present a framework for sublinear time algorithms in the context of scheduling problems. Our focus lies in the classical scheduling problem involving parallel machines, where the precedence graph exhibits bounded depth. The objective entails minimizing the maximum completion time. Our contribution pioneers the development of sublinear time algorithms for this problem. We address scenarios where job processing times differ by no more than a constant factor 'c,' and the number of machines 'm' remains bounded. We introduce the novel concept of a 'scheduling sketch,' which furnishes a blueprint for efficiently scheduling all jobs. Our research demonstrates the feasibility of designing sublinear time algorithms for a substantial range of scheduling problems. This work is joint with Yumei Huo and Hairong Zhao.

4 Streaming Algorithms For Classical Scheduling Problems

Yumei Huo, City University of New York, College of Staten Island & The Graduate Center, Staten Island, NY

In this research, we study the streaming algorithms for the classical scheduling problems. Streaming algorithms are algorithms for processing the input where some or all of the data is not available for random access but rather arrives as a sequence of items and can be examined in only a few passes (typically just one). We consider both the case that the number of jobs and largest processing time are known as priori and the case that no information is given before stream input arrives. We introduce the concept of "sketch of schedule" for the applications where not only an approximate value, but also a schedule associated with the approximate value is needed.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA63

CC-West 102B

Service Research in Supply Chain Management

Community Committee Choice Session

Session Chair: Bernie F. Quiroga, West Virginia University, Morgantown, WV

1 Logistics Service Quality in the Pharmaceutical Supply Chain

Molly Hughes, West Virginia University, Morgantown, WV

Policymakers assume that generic drugs are a substitute for brand name drugs. The FDA states, "You can take a generic medicine as an *equal substitute* for its brand-name counterpart." (FDA 2023). Something that is not taken into consideration is the logistics service quality (LSQ) behind these products. This research asks what risks come from the differentiation in LSQ and how LSQ compares brand and generic suppliers. Through comparison of logistics metrics from 283 brand drug suppliers and 199 generic drug suppliers it was found that brand suppliers outperformed generic suppliers in timeliness, order procedure, order discrepancy, and order quality, generic suppliers outperformed brand suppliers in order accuracy, information quality, and personal contact quality. This research has potential implications for policymakers, managers, and LSQ research.

2 Estimating Inventory Control Parameters for the Continuous Review Policy when Orders Crossover

John Patrick Saldanha[1], Bradley Price[1], Doug Thomas[2], Peter F. Swan[3], [1]West Virginia University, Morgantown, WV, [2]University of Virginia, Charlottesville, VA, [3]Penn State Harrisburg, Middletown, PA, Contact: jpsaldanha@mail.wvu.edu

The majority of the inventory management literature as well as inventory models implemented in ERP systems assume the probability of order crossover is negligible and therefore ignore this phenomenon. We empirically document the presence and effects of order crossover on setting inventory parameters to achieve a target cycle service level (CSL) for the continuous review policy. Employing a modified heuristic and bootstrap algorithm we demonstrate using data obtained from an industry partner that accounting for order crossover can significantly improve reorder point estimation accuracy.

3 Improving Parcel Delivery Operations by Using Autonomous Truck-Based Drones and Intermediate Points

Bo Lan[1], Yoshinori Suzuki[2], [1]West Virginia University, Morgantown, WV, [2]Iowa State University, Ames, IA, Contact: bo.lan@mail.wvu.edu

The current studies about parcel delivery with truck and drone are restricted the drones' launch and/or recovery sites to the customer locations. In practice, parcel carriers are considering the use of intermediate points (IPs) to operate drones. This study investigates if, when, and where the use of IPs can be beneficial for truck-and-drone parcel deliveries. We first theoretically analyze the merit of using IPs and show that IPs have both advantages and disadvantages so that their use does not always give positive cost savings. We then develop a set of hypotheses based on our theoretical findings along with existing theories, and test them empirically using a technique that combines computational experiments and regression analysis. The implications derived in this study may be used as a guideline for implementing the concept of IPs in the field.

4 Replenishing Personal Protective Equipment for Healthcare Systems in Rural America at the Onset of a Pandemic

Bradley Price[1], John Patrick Saldanha[2], Bernardo (Bernie) F. Quiroga[3], Sally L. Hodder[4], [1]West Virginia University, Morgantown, WV, [2]West Virginia University, Morgantown, WV, [3]West Virginia University, Morgantown, WV, [4]West Virginia University, Morgantown, WV, Contact: bernie.quiroga@mail.wvu.edu

In the face of a worldwide shortage of personal protection equipment (PPE) at the onset of the COVID-19 pandemic, we report on our team's challenge of meeting hard-to-forecast PPE demand with supply under challenging replenishment conditions in the state of West Virginia. We implement a novel agent-based epidemiological model for forecasting PPE demand of confirmed and suspected COVID-19 patients, extending popular epidemiological models. We developed nonparametric approaches to set inventory parameters needed by the combination of nonstandard lead-time distributions and autocorrelated demand. Our simulation studies, grounded in the practical need of replenishing PPE stocks for the entire state, demonstrate improvements in both a) forecast accuracy possible, and b) estimation improvement of our nonparametric inventory estimates over existing approaches.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA64

CC-West 102C

Simulation Methods and Applications

Contributed Session

Session Chair: Jeroen Didden, Eindhoven University of Technology, Eindhoven, Netherlands

1 Calibration of Inexact Stochastic Simulation Models via Energy Score

Ziwei Su[1], Matthew Plumlee[2], [1]Northwestern University, Evanston, IL, [2]Northwestern University, Evanston, IL, Contact: ziwei.su@northwestern.edu

Stochastic simulation calibration is the act of using the output-level data from a process to align the stochastic simulation model with the target process by adjusting the parameters. Stochastic simulation calibration is difficult when the model is inexact, meaning there is always a discrepancy between the model and the process. To address this challenge, we propose using the score as the model discrepancy measure. Under the kernelized discrepancies such as the energy score, we introduce the simulated score and the expected simulated score as the loss functions of the simulation model based on the data. In this talk, we delineate different levels of approximation for estimating the optimal model parameter using optimization. We substantiate the estimation procedures with consistency results and numerical experiments.

2 Using Game Engines to Investigate the Cyber-Physical Security of Machines

Madison Evans, Gregory T. Purdy, Auburn University, Auburn, AL, Contact: mle0020@auburn.edu

Since the Stuxnet attack on the Iranian centrifuges, the cyber-physical security of systems has been an area of importance. For manufacturers, the Industry 4.0 revolution allows previously isolated systems to connect to other systems and the internet, creating a new security risk. Researching cyber-physical attacks on manufacturing equipment is a complicated process due to costs. To combat this issue, we have proposed the development of a Cyber-Physical Manufacturing Range, a controlled environment for security testing. One of the critical pieces of the range is the virtual component which acts as a realistic model of the physical system. The game engine platform will host a model driven by data collection. The game engine's platform has the necessary tools to generate an accurate replication.

3 Optimal Selection Of Financial Strategies For Tail Risk Mitigation

Taeho Kim[1], Dohyun Ahn[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]The Chinese University of Hong Kong, Shatin, Hong Kong. Contact: thk5594@gmail.com

This paper addresses the ranking and selection problem with a risk-sensitive objective. We aim to identify the least-likely system whose loss exceeds a given common threshold. If the threshold is sufficiently large, the naive Monte Carlo estimator to estimate the tail probability becomes highly unstable, leading to performance degradation in existing ranking and selection frameworks. To overcome this issue, we propose a new approach by reformulating the objective using a "tail indicator" that governs the tail behavior of the underlying distribution. Based on this quantity, we provide a framework to estimate the tail indicator and develop an efficient sampling scheme for comparing the tail indicators of each system.

4 Optimizing Tool-Path Distance in Drilling Operations

Mohamed Elnoor[1], Ebisa Wollega[2], [1]University of Maryland, College Park, MD, [2]Colorado State University Pueblo, Pueblo, CO, Contact: melnoor@umd.edu

In this paper, we present the use of a genetic algorithm to minimize tool path distance in multi-tool drilling NP-hard problem operations. Most of the research on hole-drilling path optimization focuses on drilling holes of the same diameter, primarily addressing single-tool path planning. However, optimizing drilling paths for multiple hole sizes in a workpiece involving multi-tool path planning has received relatively less attention. This paper presents an improved approach for minimizing the length of tool paths in multi-tool drilling using a genetic algorithm.

5 Design of Virtual Manufacturing Cells: An Approach Based on Aco and Negotiation-Based Mas

Jeroen Didden[1], Vinh Dang[2], Ivo Adan[2], [1]Eindhoven University of Technology, Eindhoven, Netherlands; [2]Eindhoven University of Technology, Eindhoven, Netherlands. Contact: j.b.h.c.didden@tue.nl

Customer profiles have rapidly changed toward high-mix, low-volume, high-complexity products. This research therefore presents a learning-based approach to design virtual manufacturing cells for reconfigurable manufacturing systems. Data from the shop floor is used to dynamically re-allocate machines, tools and fixtures among the cells, according to the current state of the shop floor.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA65

CC-West 103A

Strategies and Insights on Workforce Training

Contributed Session

Session Chair: Emil Palikot, Stanford University, Stanford, CA

1 A Cross-Cultural Comparison of Information-Seeking and Uncertainty Reduction Among Newcomers During Organizational Entry

Michael J. Farzinpour, The University of Arizona, Tucson, AZ, Contact: michaelfarzinpour@gmail.com

National corporations have unique onboarding processes, during which newcomers experience uncertainty because they cannot predict veteran employees' behavior. Newcomers can reduce their uncertainty by engaging in information-seeking behaviors. This study investigates the effects of international and domestic newcomers' information-seeking behaviors in reducing their uncertainty during the entry phase of U.S. national corporations. A survey will be created to capture cross-sectional data addressing the theoretical constructs. 150 newcomers will be recruited, and respond to measures (of information-seeking behaviors, information accessibility, uncertainty reduction, familiarity of organizational culture, and intercultural communication competence) that will employ a Likert-type 5-point scale (1 = strongly disagree to 5 = strongly agree).

2 Understanding Tradeoffs Between Training and Readiness in U.S. Army Aviation

Austin Semmel, US Army, Raleigh, NC, Contact: adsemmel@ncsu.edu

The usage and maintenance of the US Army's AH-64 Apache helicopter are highly scrutinized, with monthly reports detailing flying hours and readiness rates prepared for Commanders on the 15th of every month. Since the publication of Army Regulation 700-138 in 1985, the Army has imposed a 75% readiness requirement on its units. First, an analysis of seven years of AH-64 maintenance data illustrates historical patterns surrounding the decision to fly/not fly an individual aircraft on a given day, the time until phase maintenance, and the unit readiness ratings over time. Analysis includes the presentation of an efficient frontier that captures tradeoffs between readiness and flight hours (training proficiency). Second, a mathematical model identifies relevant factors to provide the Army with decision support tools to maximize readiness subject to a readiness constraint.

3 Impact of Training on Faculty'S Motivation to Adopt the Simulation Pedagogy

Veena Pailwar, Institute of Management Technology, Nagpur, Nagpur, India. Contact: vpailwar@imtnag.ac.in

Simulations are considered to be very effective in teaching pedagogy. The adoption of simulation pedagogy is limited in online classes due to a lack of familiarity with online teaching platforms. This paper makes an assessment of the online training sessions on the faculty's motivation level to adopt the simulation pedagogy. The post-training session feedback from the faculty, which was analyzed using mixed methods, such as bar charts, sentiment analysis, and chi-square, indicated that most were motivated to adopt simulation pedagogy in their classes. The analysis also revealed that demographic characteristics, such as gender, designation, years of experience, and area of expertise, do not affect the sentiments.

4 Automation As Antidotes For Employee Overloaded? An Empirical Analysis In Digital Control Rooms

Changyu Men[1,2], Maud Van den Broeke[1], Marijn Verschelde[1,2], [1]IESEG School of Management, Lille, France; [2]KU Leuven, Leuven, Belgium. Contact: c.men@ieseg.fr

Workload and automation receive increasing attention in light of Industry 5.0. We examine how operators' performance is influenced by their objective workload and how this influence is moderated by their use of automation. Our empirical analysis builds upon a purposefully constructed operational data set in a digital control room setting.

5 Effective and Scalable Programs to Facilitate Labor Market Transitions for Women in Technology

Emil Palikot, Susan Athey, Stanford University, Stanford, CA, Contact: palikot@stanford.edu

We describe the design, implementation, and evaluation of a low-cost and scalable program that supports women in Poland in transitioning into jobs in the IT sector. This program, called "Challenges," helps participants develop portfolios that demonstrate capability for relevant jobs. We conduct two independent evaluations, one focusing on the Challenges program and another on a one-to-one mentoring program. We estimate that the mentoring program increases the probability of finding a job in technology by 13 percentage points (pp) and the Challenges program by 9 pp. Next, we show that treatment effects vary with individual characteristics, and we estimate gains from optimally assigning applicants across the two programs. We find that optimal assignment increases the average probability of finding a job in tech by approximately 13% compared to random assignment.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA66

CC-West 103B

Advances in Data-driven Decision-Making in Operations Management

Community Committee Choice Session

Session Chair: Yonggab Kim, Purdue University, West Lafayette, IN

1 Learning-Based Operations of an Autonomous Mobile Robot System for Material Handling

Byeongmok Kim, Yonggab Kim, Seokcheon Lee, Purdue University, West Lafayette, IN

In a manufacturing environment, autonomous mobile robots (AMRs) operate autonomously and with greater operational flexibility than automated guided vehicles (AGVs), which are controlled by a central system. On the other hand, the inability to find an operationally optimal solution from a global perspective partially offsets the operational efficiency of AMRs. In our study, we propose a new learning framework to achieve both operational efficiency and flexibility of operations of AMRs by learning the operating policies of AMRs based on the optimal solution of a centralized system.

2 Computer Vision and Data Mining Toward the First Large-Scale Power Transmission Network Dataset

Minsoo Choi, Purdue University, West Lafayette, IN, Contact: choi502@purdue.edu

The electric power system infrastructure is a critical part of the reliable operation of modern society, and it has expanded rapidly in the past few decades. This growing infrastructure has also been increasingly exposed to natural and weather disasters due to climate change. It thus comes as no surprise that governments and researchers need to understand and build resilient power systems. However, there is no real or realistic power transmission tower network dataset available for the research community, which means only limited research, using proxy datasets, has been possible. In this study, we propose a method that can effectively and accurately build a country-wide transmission tower network dataset using optical satellite images and deep learning. Our results are the necessary first step for power infrastructure resilience studies to advance.

3 Towards Sustainable Electric Scooter Share System: A Deep Reinforcement Learning Based Model for Charging and Rebalancing

Zhuoli Yin[1], Hua Cai[2], [1]Purdue University, West Lafayette, IN, [2]Purdue University, West Lafayette, IN, Contact: zhuoliyin@purdue.edu

Electric scooter (e-scooter) share systems offer a potentially eco-friendly commuting solution, substituting private cars and mitigating traffic congestion, but their life cycle greenhouse gas (GHG) emissions are comparable to conventional private cars, challenging their sustainability in urban mobility. Existing operational studies primarily focus on profit maximization and customer retention through rebalancing the systems without considering sustainability. This study formulates a sustainability-oriented e-scooter rebalancing model to minimize the GHG emission while meeting customer demand. To solve this model, we propose a deep reinforcement learning based algorithm that learns the optimal strategy for sustainable rebalancing, emphasizing the sustainability consideration into operational practices for micro-mobility solutions.

4 An Explainable AI-Driven Algorithmic Framework for Decision-Making Evidence from Semiconductor Scheduling

Yonggab Kim, Purdue University, West Lafayette, IN

Semiconductor manufacturing is the most complex manufacturing process and requires substantial resources. However, the design of decision-making tools has become cumbersome and slow, making it difficult to apply them to the mega fabrication lines used today. Therefore, identifying the most critical factors that have the greatest impact on business goals and designing decision-making tools capable of handling those factors is essential. Additionally, every decision made in the manufacturing process requires a significant investment, and it is vital to have an explainable and reexamined decision-making process before investing. This study focuses on the design of an OHT dispatching rule that is explainable and scalable to the real world.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA67

CC-West 104A

Large-scale Smooth Optimization

Community Committee Choice Session

Session Chair: Igor Molybog, University of California-Berkeley, Berkeley, CA

1 Personalized Dictionary Learning For Heterogeneous Datasets

Geyu Liang, Naichen Shi, Raed Al Kontar, Salar Fattahi, University of Michigan, Ann Arbor, MI

We introduce a relevant yet challenging problem named Personalized Dictionary Learning (PerDL), where the goal is to learn sparse linear representations from heterogeneous datasets that share some commonality. In PerDL, we model each dataset's shared and unique features as global and local dictionaries. Challenges for PerDL not only are inherited from classical Dictionary Learning (DL), but also arise due to the unknown nature of the shared and unique features. In this talk, we provide a meta-algorithm called Personalized Matching and Averaging (PerMA) that can recover both global and local dictionaries from heterogeneous datasets. PerMA is highly efficient; it converges to the ground truth at a linear rate under suitable conditions. Moreover, it automatically borrows strength from strong learners to improve the prediction of weak learners.

2 Optimizing Product Profile Selection for a Single-Product Firm: A Moment Method and Robust Optimization Approach

Hsin Lu, Northwestern University, Evanston, IL, Contact: hsin.lu@kellogg.northwestern.edu

This paper analyzes a firm's problem of selecting the optimal subset of product profiles to minimize mismatch costs while meeting customer demand. The production process involves uncertainty due to engineering errors, resulting in varying probabilities of product failures. The authors propose a moment method and robust optimization framework to handle high-dimensional correlations and apply it to an actual dataset. The model considers both engineering and operational factors and identifies profiles with lower engineering error probability as generally optimal. However, offering more product profiles may be preferable under certain operational strategies if managerial costs are low relative to mismatch costs. The model provides a framework for firms to make informed decisions based on customer preferences and tradeoffs between various factors.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA68

CC-West 104B

Networks in Machine Learning and Data Science

Community Committee Choice Session

Session Chair: Yu Tian, University of Oxford, Oxford, United Kingdom

1 Curvature-Based Clustering in Mixed-Membership Graphs

Zachary Lubberts, Johns Hopkins University, Baltimore, MD

We study the problem of mixed-membership community detection using curvature-based algorithms, which utilize discrete notions of Ricci curvature to evolve the network edge weights, elucidating community structure. These curvature-based methods are especially effective at detecting edges that act as "bridges" between communities, but in the mixed-membership setting, networks may have nodes acting as bridges rather than edges, obscuring the community boundaries. In this context, the line graph arises as a natural tool, since it takes the edges of the base graph as its vertices and connects two edges whenever they are incident on the same vertex. This transforms the bridge-finding problem into one of identifying edges again. We also investigate the relationship of discrete curvature in the line graph to that of the original graph.

2 Learning Knowledge Networks with Dynamic Latent Space Models

Aaron Schecter, University of Georgia, Athens, GA

In knowledge based organizations, it is important to match tasks to individuals with the correct expertise. This matching often involves routing problems from one individual to another. To optimize routing, accurate knowledge networks - who knows who knows what - are critical. In this paper we model knowledge networks as a latent space model, and use repeated search behaviors to iteratively learn the network structure. We apply the model to an IT service company with over 70,000 routing actions. Implications for system design and performance are discussed.

3 Nonunifrom Sampling in Link Prediction on Real-World Networks

Xie He, Dartmouth College, West Lebanon, NH

Sampling is an important task in link predictions. A good sampling on the real-world networks will result in a better link prediction result and vice versa. However, most of the time, real world network's missing information are not uniformly at random, while the current state of the art link prediction almost always assume missing edges happen uniformly at random without even knowing the reason behind. This work aims to focus on the pattern of missing edges and how the different node, edge, graph based sampling process could affect the results of various types of link prediction algorithms.

4 Robustness to Embedding Dimensions via Classically Boosted Network Embeddings

Joel Nishimura[1], Yunpeng Zhao[2], [1]Arizona State University, Glendale, AZ, [2]Colorado State University, Fort Collins, CO, Contact: joel.nishimura@asu.edu

Network embeddings are a popular and effective preprocessing step for machine learning applied to network data. We demonstrate that standard boosting techniques, AdaBoost and Real AdaBoost can be applied to network embedding techniques to improve performance on link prediction. These approaches produce results competitive with other state-of-the-art embedding approaches when applied to a number of empirical networks. Additionally, we show on simulated data that Real AdaBoost can deaggregate some networks, wherein networks created by two independent latent features can have those separate latent features inferred by different boosted rounds. Further analysis of the performance of these boosted methods shows that they retain the characteristic robustness to over-fitting as boosting methods in classical settings.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA69

CC-West 105A

AI, Text, Image and Video Analytics

Community Committee Choice Session

Session Chair: Hyunsang Son, The University of New Mexico, Albuquerque, NM

1 Predicting User Engagement Using Textual, Image, and Video Data in Instagram: A Transfer Learning Approach

Young Eun Park, Sookmyung Women's University

2 An Interpretable Sec2sec Co-Attention Transformer for Video Emotion Prediction

Mingwei Sun[1], Kunpeng Zhang[2], [1]University of Maryland, College Park, MD, [2]University of Maryland Robert H. Smith School of Business, College Park, MD

Emotion is associated with thoughts, feelings and a degree of pleasure, which can accordingly affect people's decision-making. Two major dimensions of emotion - valence and arousal have been widely studied in the literature. Video-based emotion detection is underexplored and has some challenges. For example, how to represent different modalities (visual and audio) in a video, how to capture their alignment, and how to model the temporal structure can significantly affect the model performance. In this study, we develop a novel LSTM-based network with a transformer co-attention mechanism to predict emotions. Results of experiments show that our proposed model outperforms state-of-the-art baselines. We also investigate the role of different parts of a video in emotion prediction, which has practical implications for video designers.

3 Ai-Enabled Material Tracking System for Extreme Environments in Open-Die Press Forging

Chiseong Kim, Taeju Bak, POSTECH, Pohang, Korea, Republic of. Contact: kimchistar@postech.ac.kr

Open-die press forging involves heating ingots in a furnace and pressing them into the desired product shape. The products are low volume and wide variety, and given the repeated cycles of heating and pressing, precise material flow tracking becomes an essential requirement. Conventional methods such as barcodes or sensors are not adaptable to extreme temperature environments, necessitating manual tracking. This study proposes an AI-enabled material tracking system for extreme environments that involves video data preprocessing using computer vision technology and material tracking utilizing a convolutional neural network based object detection model. The proposed system aims to mitigate the risk of wrong delivery by ensuring accurate and reliable material tracking.

4 Transfer Learning of Effects of ESG Posting on Consumer Engagement on Social Media and Firms' Abnormal Return

Hyunsang Son[1], Young Eun Park[2], [1]The University of New Mexico, Albuquerque, NM, [2]Sookmyung Women's University, Seoul, Korea, Republic of. Contact: hson@unm.edu

Timely and accurate predictions of factors affecting consumers' engagement in social media offer various benefits for managers and advertisers. Yet, modeling textual, image, and video data and their interaction systematically and simultaneously is challenging and complex because of the lack of modeling techniques and dynamics of various features. In this study, we first build a feature set that might influence users' engagement of Interbrand 100 companies' social media posts using Fortune 500 companies' ESG or CSR reports.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA70

CC-West 105B

Empowerment of Data Science and Information Technology in eBusiness World

Community Committee Choice Session

Session Chair: Zihong Huang, University of Minnesota Twin Cities, Minneapolis, MN

1 Love-Hate Tango: The Intriguing Dance Between Long and Short Video Platforms

Yunxuan M. Yang[1], Xingchen Xu[2], Lijia Ma[2], Yong Tan[2], [1]University of Pittsburgh, Pittsburgh, PA, [2]University of Washington, Seattle, WA, Contact: YUY139@pitt.edu

Numerous creators on short video platforms often generate derivative works by utilizing content from long video platforms (e.g., producing summaries of television series). However, an ongoing debate exists concerning the potential infringement of copyrights associated with derivative works and the subsequent impact on long video platforms. Utilizing a natural experiment arising from a strategic collaboration between a long video platform and a short video platform in China, we examine how this partnership influences the exposure of long video content on short video platforms and, subsequently, the consumption patterns of long video platforms. Our research also includes an in-depth exploration of underlying mechanisms and heterogeneity analyses, offering valuable insights for platforms, content creators, and regulatory bodies.

2 A Comprehensive Study of Using ChatGPT for Seeking and Sharing Knowledge

Bahar Javadi Khasraghi, Eric Walden, Texas Tech University, Lubbock, TX, Contact: bahar.javadi@ttu.edu

Individuals adopt varying approaches to acquiring knowledge. With the advent of technology, people are now utilizing advanced techniques such as OpenAI's chatGPT to actively seek and contribute knowledge. ChatGPT is a chatbot powered by OpenAI that utilizes generative AI to respond to user queries using natural language processing (NLP) techniques. Individuals use ChatGPT to answer their questions even when they feel confident in answering questions on their own. They may seek knowledge to share and contribute to the knowledge of others. Our research suggests that users might have different emphasis on ChatGPT use cases when seeking knowledge for themselves, compared to when seeking knowledge for others to contribute to their knowledge and these differences are different enough that will be some difference in some aspects of the user's behavior.

3 The Value of Remote Work in the Post-Covid Era: An Empirical Assessment of Employee Turnover and Wage

Sojung Yoon[1], Jason Chan[1], Jinan Lin[2], Tingting Nian[2], [1]University of Minnesota, Minneapolis, MN, [2]Paul Merage School of Business, UC Irvine, Irvine, CA, Contact: yoon0180@umn.edu

The abrupt closure of offices during the COVID-19 has allowed millions of workers to discover these advantages of remote work. However, the question of whether remote work will become the new normal remains unresolved, as employers are reluctant to bear the costs that accompany remote work. For firms to provide remote work as a permanent working arrangement, it is essential to understand how workers perceive and value remote work. Adopting Herzberg's two-factor theory (1959), we provide empirical evidence of how remote work is valued and to what extent, by examining the causal relationship between firms' decision to offer remote work and workers' job-switching behaviors as well as changes in wages. Given that recruitment and retention are crucial to business success, understanding this relationship would provide valuable insights into the sustainability of remote work.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA71

CC-West 105C

Sponsored Research Projects

Community Committee Choice Session

Session Chair: Xiao Liu, 1</sup

Wednesday, October 18, 8:00 AM - 9:15 AM

WA72

CC-West 106A

Statistical and Data Mining Approaches for Decision Making

Community Committee Choice Session

Session Chair: Sangahn Kim, Siena College, Loudonville, NY

Session Chair: Mehmet Turkoz, William Paterson University, New Brunswick, NJ

1 A New Data-Driven Multivariate Process Capability Index

Sangahn Kim[1], Mehmet Turkoz[2], [1]Siena College, Loudonville, NY, [2]William Paterson University, New Brunswick, NJ, Contact: skim@siena.edu

A process is typically monitored and controlled statistically to achieve high levels of production and quality performance. Along with the philosophy of six sigma, a process is measured by a single index to determine whether a process is capable of producing products and services within the specification, i.e., capable of a certain quality performance presented by producers or customers, so called process capability indices (PCIs). So far, several univariate PCIs and only a few multivariate PCIs have been introduced. Due to the complex nature of multivariate processes, the methods used to assume specific well-known distributions such as a multivariate normal distribution. This work develops a new data-driven multivariate PCI using a support vector data description (SVDD) without the assumption of normality or any known probability distribution for the process data.

2 Spatial Randomness Kullback-Leibler Divergence-Based Approach for Monitoring Local Variations in Multimode Surface Topography

Jaeseung Baek[1], Myong Kee Jeong[2], Elsayed A. Elsayed[3], [1]Northern Michigan University, Marquette, MI, [2]Rutgers University, Piscataway, NJ, [3]Rutgers University, East Brunswick, NJ, Contact: jbaek@nmu.edu

This study presents a novel approach for monitoring local topographic variations in the presence of multimode surface topography. We present a multimode surface binarization model to enhance the representation of the surface to distinguish the defective area where binarized patterns are spatially autocorrelated. To systematically evaluate the spatial randomness of binarized surfaces and utilize it for monitoring the surface, we introduce a new probabilistic distance measure (PDM) that quantifies the similarity between two binary patterns. The proposed PDM takes advantage of identifying local variations by utilizing the order neighbor statistics, which can capture the local property of binary patterns. Experimental results with numerical simulation data and real-life paper surface data are provided to show the effectiveness of the proposed approach.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA75

Session.Location:CC-West 208A

Port Operations and Freight Logistics

Contributed Session

Session Chair: Dilhani Shalika Marasinghe, University of Tennessee Chattanooga, Chattanooga, TN

1 Unleashing the Power of the 4P4C Model: A Novel Approach for Forging a Bridge Between Marketing Analysis and Strategic Business Decision in the Heavy Machinery Industry

Tian Tian, Kai Shu, Sai Zhang, Illinois Institute of

Technology, Chicago, IL, Contact: ttian4@hawk.iit.edu
This article presents a groundbreaking approach, the 4P4C model (Product, Place, Period, Prediction, Company, Chart, Comparison, and Clustering dimensions), to analyze sales data of heavy machinery products in the United States. By embracing a multidimensional perspective, this novel methodology enables a meticulous and all-encompassing examination of the market, unveiling crucial trends and patterns that may elude conventional approaches. Furthermore, through the detailed exploration of essential data collection and analysis aspects such as product, place, period, prediction, company, chart, comparison, and clustering, the model accurately sheds light on areas ripe for data collection and data-driven improvement. This innovative approach offers insights for businesses and organizations, empowering them to make well-informed decisions.

2 Optimizing Nuclear Power Plant'S Environmental Factors Through Functional Design of Experiments

Kangwon Seo, Benjamin Oguejiofor, University of Missouri, Columbia, MO, Contact: seoka@missouri.edu
Nuclear power plants rely on cooling systems to ensure the safe and reliable operation of the nuclear reactor. During operation, the reactor coolant pump (RCP) functions to circulate demineralized light water under pressure through the reactor vessel and loops. The RCP provides forced primary coolant flow to remove and transfer the amount of heat generated in the reactor core. In this study, a sample of continuous vibration signal data from an RCP of a nuclear power plant was analyzed. The continuous signal was acquired approximately every five seconds and visualized in real-time for trending and monitoring. Using wavelet functional analysis, we extract functional principal components (fPCs). Establishing a relationship between fPCs and environmental factors, the vibration signals will be controlled in an optimal shape.

3 Practical Implementations of the Multi-Period Model for a New Facility in a Horizontal Collaborative Network

Dilhani Shalika Marasinghe, Pubudu LW Jayasekara, University of Tennessee Chattanooga, Chattanooga, TN, Contact: dmarasi@g.clemson.edu
This study focuses on a facility type that has high throughput with a primary function of organizing and rerouting freight contained on pallets or pallet-like containers. The key difference with the existing similar facilities is that the freight does not have a predetermined path from origin to destination established before it begins its journey. Different policies have been introduced for enhancing the efficiency of operations in a unit load facility that is part of a horizontal collaborative network. The performance of the policies is evaluated by the total cost obtained by assigning pallets to locations under different conditions.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA76

Session.Location:CC-West 208B

Supply Chain Methods in Practice

Contributed Session

Session Chair: Zuochun Tang, IBM, San Francisco, CA

1 A Strategic Decision-Making Tool for Last Mile Delivery Using Simulation

Raghavan Srinivasan[1], Joseph Gerard Szmerekovsky[2], [1]Ball State University, Muncie, IN, [2]North Dakota State University, Fargo, ND
To determine an aggregate delivery capacity plan for last mile delivery services, we conducted a simulation analysis. This simulation is done considering the use of permanent resources, seasonal resources and utilizing crowdsourcing capacity to meet the demand while aiming to achieve the lowest operational cost. In addition, we also consider the case of resource attrition and missed deliveries being fulfilled the next day. The results from the simulation runs lead to an overall understanding of the capacity needed to meet the desired service level. The use of crowdsourcing capacity can be influential in meeting the demand and lowering operational expenses.

2 Artificial Intelligence Frameworks for Supply Chain Digital Transformation in the Pc Industry

Suri Gurumurthi, Hong Kong University of Science and Technology, Kowloon, Hong Kong
The PC and consumer electronics industry has seen double digit declines in recent years with weakening demand and intensifying competition. This sector is of vital importance to the financial and economic health of several countries. The industry leaders are racing to cut costs and boost profitability in the face of the sharpening decline. We explore digital transformation frameworks that can potentially deliver greater efficiencies for this industry, while enhancing responsiveness. We identify the areas where Artificial Intelligence and Machine Learning tools have the greatest impact, and outline a recent case study based on the efforts of one of the

leading companies in the sector. We highlight some issues in implementation, and suggest some solutions that could accelerate the digital transformation efforts.

3 A Supplier Risk Scoring Framework for Strategic Alignment and Proactive Decision-Making

Zuochun Tang[1], Yihua Li[2], [1]IBM, san francisco, CA, [2]IBM, San Francisco, CA, Contact: ztang@us.ibm.com

Supplier risk scoring is critical for business success in complex supply chains. However, the absence of standardized scoring is a challenge due to diverse risk metrics, supplier diversity, and complex supply chain processes. Our proposed framework tackles these challenges by employing hierarchical categorization and rule-based guidelines. It effectively aligns supplier risk scoring with customer business strategies while utilizing machine learning techniques to address data quality and availability risks. By offering proactive risk warnings and aiding informed decision-making, the framework supports various industries. It considers diverse business data sources, including sustainability and financials, and caters to customer-specific interests.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA78

Session.Location:CC-West 211A

Optimization for Advacing Machine Learning Methods

Contributed Session

Session Chair: Yinsong Wang, Northeastern University, Boston, MA

1 Path of Solutions for Non-Smooth Fused Lasso

Cheng Lu[1], Tor Nitayanont[2], Dorit Simona Hochbaum[2], [1]Apple, Cupertino, CA, [2]University of California-Berkeley, Berkeley, CA, Contact: torpong_nitayanont@berkeley.edu

In a fused lasso problem on a sequence data, the objective consists of two competing terms: the separation term and the deviation term. The two terms are balanced via a tradeoff parameter. Selecting a value for the tradeoff parameter is critical. However, we often do not know the quality of a certain tradeoff value until we obtain the solution. Here, we propose a minimum cut-based method that solves for all tradeoff values at once. This method eliminates the need to pre-specify tradeoff values since it solves the problem for all values that yield different solutions. Moreover, we prove that, for the L1 deviation, the number of solutions across all tradeoff values is at most 2n^3 for n variables. In fact, experimental results show a linear bound. For a general convex deviation function, the bound is 2n^3(U/⍰) where ⍰ is the solution accuracy and U is the range of variables.

2 A New Classification Method Based on Tuning of Hyper-Parameter and Decision Threshold for Imbalance Data

Tai-Jung Chen, Kwok-Leung Tsui, Virginia Tech, Blacksburg, VA, Contact: taijungchen@vt.edu

In many real world two-class classification problems, the data are imbalanced. This sometimes leads to naïve classifiers of predicting all the samples as the majority class and may result into misleading accuracy, poor precision, and confusing conclusions. One of the key reasons for the poor performance is related to the inappropriate decision threshold. Conventionally, the decision threshold of a two-class classification problem is set to 0.5, which may not be the best choice for imbalance data. In this paper, we propose a simultaneous tuning method that tunes the model hyper-parameter along with the decision threshold. We select Cohen's kappa as the tuning metric and re-interpret Cohen's kappa as measuring the improvement over a baseline classifier called p-naïve classifier. Finally, we extend the idea of kappa to other standard classification metrics such as f1 score.

3 Inverse Mixed-Integer Optimization for Learning Interpretable Decision Rules

Rishabh Gupta[1], John Wassick[2], Qi Zhang[1], [1]University of Minnesota, Twin Cities, Minneapolis, MN, [2]Carnegie Mellon University, Pittsburgh, PA

Humans rely on heuristics to simplify the complexity and ambiguity of real-world decision making. We propose a data-driven framework for learning these decision-making rules based on inverse optimization (IO). Our approach leverages the powerful modeling capability of mixed-integer optimization to incorporate domain knowledge and model complex logical relationships between decisions. IO is then used to learn the importance of each decision through its weight in the objective function, which provides interpretable insights into the decision policy of the decision maker. The effectiveness of the proposed framework is demonstrated through supply chain planning-based case studies.

4 Tap: The Attention Patch for Cross-Modal Knowledge Transfer from Unlabeled Modality

Yinsong Wang, Shahin Shahrampour, Northeastern University, Boston, MA, Contact: wang.yinso@northeastern.edu

This paper addresses a cross-modal learning framework, where the objective is to enhance the performance of supervised learning in the primary modality using an unlabeled, unpaired secondary modality. We show that the extra information contained in the secondary modality can be estimated via Nadaraya-Watson (NW) kernel regression, which can further be expressed as a kernelized cross-attention module (under linear transformation). Our results lay the foundations for introducing The Attention Patch (TAP), a simple neural network add-on that allows data-level knowledge transfer from the unlabeled modality. We provide extensive numerical simulations using four real-world datasets to show that TAP can provide statistically significant improvement in generalization across different domains and different neural network architectures.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA79

Session.Location:CC-West 211B

Bin Packing: Algorithms and Applications

Contributed Session

Session Chair: Yanzhi Li, City University of Hong Kong, Hong Kong, Hong Kong

1 Three-Dimensional Container Loading Problem Solved by an Innovative-And-Iterative Algorithm

Yao-Huei Huang, Zi-Hsuan Lin, Fu Jen Catholic University, New Taipei City, Taiwan. Contact: ccc888880@gmail.com

This study addresses a novel method for the three-dimensional container loading problem (3DCLP), which is an NP-hard problem in management science and operations research. To reduce computational complexity and guarantee solution quality, this study designs a 3D relative-positions scheme so that the 3DCLP can be relaxed to a linear programming problem. Solving the relaxed 3DCLP can obtain a feasible solution. Subsequently, an innovative-and-iterative algorithm is designed to enhance the solution quality. Experimental results have shown that the proposed method has higher efficiency and accuracy in dealing with complex three-dimensional container loading problems.

2 Innovative and Iterative Algorithm with Relative-Positions Scheme for the Two-Dimensional Variable Sized Bin Packing Problem

Yao-Huei Huang, Hao-Jing Lin, Fu Jen Catholic University, New Taipei City, Taiwan. Contact: jinlin95040@gmail.com

The two-dimensional variable sized bin packing problem (2DVSBPP) is a classical problem in the field of management science and operations research. This study proposes a novel method that uses a relative-positions scheme to address the relaxed 2DVSBPP linear programming problem. Additionally, an innovative and iterative algorithm is adopted to improve the solution quality iteratively. The proposed algorithm not only obtains optimal solutions for small-scale problems, but also enhances the solution quality for large-scale problems. Numerical experiments also show that the proposed algorithm outperforms state-of-the-art algorithms.

3 Lower Bounds and Heuristics for the Multi-Class Constrained Bin Packing Problem

Baptiste Coutton[1], Dario Pacino[2], Klaus Holst[1], Stefan Guericke[3], Martin Kidd[4], [1]Maersk, Copenhagen, Denmark; [2]DTU, Kobenhavn, Denmark; [3]Hochschule Osnabrück, Osnabrück, Germany; [4]Vatenfall, Copenhagen, Denmark. Contact: bnco@dtu.dk

We study a variant of the Bin Packing Problem where, in addition to a size, items have a set of attributes (classes) for which they can take different values. Each bin has a limited capacity regarding the total size and the number of distinct values per attribute it can accommodate. The aim is to find the cheapest set of bins in which all items can fit. We propose two lower bounds as well as four greedy heuristics and an ALNS metaheuristic to solve the problem, the latter outperforming a commercial solver.

4 Integrated Multi-Level Multi-Item Capacitated Lot-Sizing and 2-Dimensional Packing Problem in Integrated Steel Production

Jeff Young[1,2], Defeng Sun[3], Lixin Tang[1], [1]National Frontiers Science Center for Industrial Intelligence and Systems Optimization, Northeastern University, Shenyang, China; [2]Key Laboratory of Data Analytics and Optimization for Smart Industry (Northeastern University), Ministry of Education, China, Shenyang, China; [3]Liaoning Engineering Laboratory of Data Analytics and Optimization for Smart Industry, Shenyang, China. Contact: yang_jie_fu2013@live.com

Integrated Steel Production (ISP) become the mainstream production in the steel industry. It incorporates multi-stage operations production (casting, rolling, etc.), which involves coupled multi-level multi-item capacitated lot-sizing and 2-dimensional packing problems. As a consequence, planning in ISP become increasingly challenging due to its large scale and interconnectedness. To address the problem, this paper formulates a mixed-integer programming model, which considers the widespread difficulties such as the batching production for orders with similar properties. And then the proposed model is solved by a Branch-Price-Cut algorithm. We apply Lagrangian relaxation and dynamic programming methods to improve the solving process of subproblems. Computational results on different sets of instances show the effectiveness of the new exact algorithm.

5 Anticipatory Packing

Tongwen Wu[1], Z. Max Shen[2], Yanzhi Li[1], [1]City University of Hong Kong, Hong Kong, China; [2]The University of Hong Kong, Hong Kong, China. Contact: yanzhili@cityu.edu.hk

In this paper, we study a novel practice termed anticipatory packing, which is to prepare some packages in non-peak periods to be used for fulfilling orders in the subsequent peak periods. Specifically, the preparation involves the operation of picking some items and putting them in the same customer bin but may not involve actual packaging. For effective anticipatory packing, we develop a sample-average approximation (SAA) model by using the order data of recent days and then design an effective approximation algorithm to solve it. We investigate the effectiveness of anticipatory packing and the SAA model with extensive experiments. On a real data set, we show that anticipatory packing can yield an significant operational cost reduction.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA80

Session.Location:CC-West 212A

Emprical and Experimental Analysis of Online Retailers

Contributed Session

Session Chair: Yunhao Huang, UC Berkeley, Berkeley, CA

1 Do Consumers Return More when They Browse More Alternatives?

Ragip Gurlek[1], Diwas S. KC[2], Paolo Letizia[3], [1]Emory University, Atlanta, GA, [2]Emory University, Atlanta, GA, [3]University of Tennessee, Knoxville, TN, Contact: rgurlek@emory.edu

Although the existing literature establishes a relationship between product variety and purchase behavior, the impact on product returns has been overlooked. To address this gap, we conduct a study using clickstream and transaction data from 4 million unique visitors to a fashion accessories e-retailer. Our investigation utilizes a natural experiment setting, capitalizing on the exogenous variation caused by product model characteristics. The findings reveal that browsing one more SKU not only decreases the likelihood of a consumer visit being converted into an order but also increases the probability of a product return.

2 Ride the Wave or Not? the Spillover Effect of Online Shopping Festivals and Best Timing for Advertising

Yue Wang[1], Xiaobei Shen[2], Xiabing Zheng[2], [1]Hong Kong University of Science and Technology, Hong Kong, Hong Kong; [2]University of Science and Technology of China, Hefei, China. Contact: ywangmk@connect.ust.hk

This work explores the spillover effect of online shopping festivals on short-video advertising through a natural experiment. Online shopping festival has a spillover effect on short-video advertising and the effect changes over time. It is positive in the warm-up and general-promotion periods, and becomes negative in the peak-promotion and post-promotion periods of the festival. We propose three mechanisms to explain the positive effect (i.e., festival's environmental cues) and the negative effects (i.e., diminishing marginal utility and financial constraints of consumers). We conduct a field experiment, several surveys, and use some model-free evidence to verify the existence of these mechanisms. The results suggest firms may ride the wave of exogenous festivals, but shall carefully choose the best timing for their advertising.

3 How Does Offline Store Opening Affect Nearby Consumers' Online Market Baskets?

Youngsoo Kim, Texas Tech University, Lubbock, TX

We empirically examine how an offline store entry affects online consumer's purchase behavior. Our analyses show that online consumers' market baskets substantially change when an offline store opens. We find that different consumer segments respond differently to a store entry, and that the dominant store entry effects are determined by product types. Our results also show that (1) the final direction of store entry effects depends on consumer segments rather than product types; (2) when a pre-existing superstore exists, the number of items purchased online is not affected by a new store entry; (3) the decreased number of items purchased online decreases even after 6 months.

4 Unmasking the Deception: The Interplay Between Fake Reviews, Rating Dispersion, and Consumer Demand

Yunhao Huang, J. Miguel Villas-Boas, Mingduo Zhao, University of California, Berkeley, Berkeley, CA

This study explores the interplay between fake reviews, rating dispersion, and consumer demand. Using rating distribution rounding-induced dispersion changes as an identification strategy, we find that rating dispersion negatively affects sales. Then, we examine the connection between fake reviews and rating dispersion using an observational study. To investigate the underlying mechanism, we conduct an experiment and show that increased rating dispersion raises concerns about fake reviews, impacting consumer demand. We introduce an information treatment warning consumers about fake reviews, an instrumental variable (IV), to determine the impact of consumer suspicion of fake reviews on their demand. Crucially, the treatment has a greater impact on socially disadvantaged groups, indicating its potential to promote equity in the online marketplace.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA81

Session.Location:CC-West 212B

Circular Economy and Sustainability Considerations

Contributed Session

Session Chair: Can Baris Cetin, HEC Montreal, Montreal, QC, Canada

1 Supply Chain Relationship Dependencies and Circular Economy Performance: The Contingency Role of Digitalization Capability

Mingjie Fang[1], Yanling Yu[2], Kwangtae Park[3], Feng Liu[2], Shufeng (Simon) Xiao[4], Yangyan Shi[5], [1]Korea University Business School (KUBS), Seoul, Korea, Republic of; [2]Shandong University, Weihai, China; [3]Korea University Business School (KUBS), Seoul, Korea, Republic of; [4]Sookmyung Women's University, Seoul, Korea, Republic of; [5]Macquarie University, Sydney, Australia. Contact: mj_fang@korea.ac.kr

Drawing on resource dependence theory, we investigated how the degree of dependence of focal firms on suppliers and customers affects their CE performance. Employing hierarchical linear modeling on a panel dataset of listed Chinese manufacturers during 2010-2020, we found that the more dependent a firm is on its major suppliers and customers (the higher the supplier and customer concentrations), the worse its CE performance. In addition, we utilized data mining techniques to capture manufacturers' digitalization capabilities. We examined how digitalization empowers manufacturers to alleviate power imbalances in supply chain dependencies. Our results suggest that the manufacturers' digitalization capability significantly weakens the negative impacts of supplier and customer concentrations on CE performance.

2 From Linear to Circular Economy: A Newsvendor's Perspective

Haokun Chen[1], Stanko Dimitrov[1], Xuan Zhao[2], [1]University of Waterloo, Waterloo, ON, Canada; [2]Wilfrid Laurier University, Waterloo, ON, Canada. Contact: h463chen@uwaterloo.ca

The circular economy promises to reduce waste and enable us to live in a sustainable manner. In this work, we examine the transition from the current linear economy to the circular economy through the lens of a newsvendor model. The insights we provide may be surprising but will inform regulators and firms on the impact of the transition from the linear to the circular economy.

3 Environmental Disclosure in Supply Chains

Jie Lian[1], Yan Dong[1], Sining Song[2], Natalie Ximin Huang[3], [1]University of South Carolina, Columbia, SC, [2]University of Tennessee Knoxville, Knoxville, TN, [3]University of Minnesota, Minneapolis, MN

Firms in supply chains have increasingly adopted environmental disclosure to improve environmental performance. This research studies the spillover effect of a firm in disclosing its environmental performance on its suppliers' decision to do the same. The firm's disclosure creates both a pressure to disclose and an opportunity to freeride. Using panel data and econometric analysis, we investigate the outcome of this tradeoff in supply chains.

4 Strategic Pricing and Investment in Environmental Quality by an Incumbent Facing a Greenwasher Entrant

Can Baris Cetin[1,2], Arka Mukherjee[3], Georges Zaccour[2,1], [1]HEC Montreal, Montreal, QC, Canada; [2]GERAD, Montreal, QC, Canada; [3]Concordia University, Montreal, QC, Canada. Contact: can-baris.cetin@hec.ca

We examine how greenwashing affects the strategies and outcomes of companies and consumers. We develop a two-stage game, where a monopolist sets price and invests in environmental quality in the first stage, and competes with a new entrant in the second stage. The incumbent company is genuinely environmentally friendly, while the new entrant may use deceptive green marketing. We assume that only inexperienced consumers can be influenced by greenwashing, and consider two important dynamic factors, i.e., a change in competitive structure and a learning effect in the market. We investigate the conditions under which greenwashing is profitable for the new entrant, the ways in which the incumbent company responds to it, and the impact of greenwashing on the environment and consumers.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA83

Session.Location:CC-West 213A

On Online Retail Operations

Contributed Session

Session Chair: Pantelis Loupos, University of California, Davis, Davis, CA

1 Selling Format, Advertising Selling And Information Sharing In Online Retailing

Jianyue Wang, Albert Ha, Ki Ling Cheung, The Hong Kong University of Hong Kong, Hong Kong, China. Contact: jwangen@connect.ust.hk

We study the selling format (agency selling versus reselling) and the strategies of seller services (advertising and information sharing) in a supply chain with a supplier and an online retailer. For a game theoretic model with both seller services, we fully characterize its equilibrium and show how each firm's preference of the selling format depends on the model parameters. We also consider two other models with either advertising service only or no seller services. By comparing the models, we show how the offering of more seller services impacts the firms' profits as well as their preference of the selling format.

2 Anti-Counterfeit Strategies over E-Commerce Platforms

Ayesha Arora[1], Tarun Jain[2], [1]Indian Institute of Management Bangalore, Bangalore, India; [2]Indian Institute of Management Bangalore, Bangalore, India. Contact: ayesha.arora19@iimb.ac.in

Online sellers often sell counterfeit products over e-commerce platforms. We compare scenarios where different parties take actions to detect counterfeits and penalize the seller. Our research reveals some interesting managerial insights for the platforms and the regulators.

3 Dynamic Analysis of Language Style and Customer Attrition on Venmo

Pantelis Loupos, University of California, Davis, Davis, CA

We investigate the impact of language style and transactional topics on customer attrition on Venmo. Our study dynamically analyzes Venmo users and their interactions within their communities, and finds that changes in language style, particularly in description comments, can predict attrition. Additionally, the nature of transactions can also have an impact on attrition. Our findings highlight the importance of language style and transactional topics in predicting customer attrition, and suggest that targeted interventions based on these factors can help improve customer retention on Venmo.

Wednesday, October 18, 8:00 AM - 9:15 AM

WA84

Session.Location:CC-West 213B

Inventory Management: Algorithms and Applications

Contributed Session

Session Chair: Zhaoxuan Wei, 1</sup

1 Transportation Asset Acquisition Under a Newsvendor Model with Cutting Stock Restrictions: Approximation and Decomposition Algorithms

Joris Wagenaar, Tilburg University, Tilburg, Netherlands. Contact: j.c.wagenaar_1@uvt.nl

Logistics service providers use transportation assets to offer services to their customers. To cope with demand variability, they may require additional assets on a one-off (spot) basis. The planner's problem is to determine the optimal level of assets acquired upfront such that their cost is minimized. We introduce a two-stage newsvendor model where demand for spot assets is derived through optimal cutting stock patterns. Leveraging results from bin-packing, we propose polynomial algorithms that have worst-case guarantees for upper and lower bounds. Out method finds optimal solutions to instances intractable by commercial solvers.

2 Online Inventory Control with Partial Backorder

Zhaoxuan Wei[1], Andrew Lim[1], Hanqin Zhang[2], [1]National University of Singapore, Singapore, Singapore; [2]National University of Singapore, Singapore, Singapore. Contact: e0546201@u.nus.edu

We consider a single-product inventory model where the unmet demands may be either patient and choose to wait (backorder) or lose their patience and leave (lost sale), which can be taken as the hybrid of the canonical lost-sales and backorder model. With perfect information about the system primitives and perfect observation of the states of the system, we show that the base-stock policy is a uniformly asymptotically optimal policy. We then consider a more practical problem where the system primitives are unknown and only the sales are observed. Compared to the literature, our problem has unique challenges as (a) the state of the system is only partially observable and (b) the sales are mixed by the exogenous demand and the backorder. An UCB-type algorithm is then developed and we prove the regrets of the algorithm are (nearly) tight in the planning horizon T.

Managing Inventory in the Presence of Lead Time and Demand Correlation

Fouad H. Mirzaei[1], Andy A. Tsay[2], [1]University of North Texas, Denton, TX, [2]Santa Clara University, Leavey School of Business, Santa Clara, CA, Contact: fhmirzaei@unt.edu

Numerous studies commonly assume that lead time and daily demand are independent. In this study, we relax the assumption of independence between lead time and demand in a continuous review inventory system. By analyzing the optimal ordering policy, we compare the uncorrelated and correlated cases. Our findings demonstrate that considering the correlation between demand and lead time adds complexity, but it also leads to more generalized and robust recommendations.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB04

CC-North 121A

Big Data Analytics for Higher Education

Community Committee Choice Session

Session Chair: Roger R. Gung, University of Phoenix, Phoenix, AZ

1 Behavior Risk Model and Interaction Optimization

Roger R. Gung, University of Phoenix, Phoenix, AZ

Classroom behavior is the early indicator of student learning outcomes. In online education, classroom behavior is stored in an Hadoop based big data system, that can be used to measure students' quality and risk to learning performance metrics. Using the quality and risk models output, in conjunction with interaction data, the model recommends the optimal interaction topic that would maximize the expected improvement of the quality and risk.

2 Short-term and Long-term Course Starts Forecasting

Jixiang Fang, University of Phoenix, Tempe, AZ

Course starts in adult on-line learning is the key performance indicator of student retention. In this research, we developed recursive survival model based forecasting method to predict each student's probability to take the course on a given course start date. For a given future course start date, all possible scenarios are analyized to measure the probability of starting the course. The method yields accurate forecast for the near future course start dates, as welll as the one-year out course start date.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB05

CC-North 121B

New Models in Revenue Management

Community Committee Choice Session

Session Chair: Zhenyu Hu, Singapore, Singapore

1 learning Mixed Multinomial Logits with Provable Guarantees and Its Applications in Multi-Product Pricing

Yiqun Hu[1], Limeng Liu[2], David Simchi-Levi[3], Zhenzhen Yan[2], [1]Amazon, Chelsea, NY, [2]Nanyang Technological University, Singapore, Singapore; [3]Massachusetts Institute of Technology, Cambridge, MA, Contact: yanzz@ntu.edu.sg

A mixture of multinomial logits (MMNL) is commonly used in modeling market demand to capture consumer heterogeneity. We propose a new algorithm built on the Frank-Wolfe (FW) method that learns both mixture weights and component-specific logit parameters with provable convergence guarantees for an arbitrary number of mixtures. Our algorithm utilizes historical choice data to generate a set of candidate choice probability vectors, each being close to the ground truth with a high probability. We further provide a sample complexity analysis to show that only a polynomial number of samples is required to secure the performance guarantee of our algorithm. Finally, we apply the learned MMNL to data-driven multi-product pricing problems. Numerical studies are conducted to evaluate the performance of the proposed algorithms.

2 Content Rotation in the Presence of Consumer Satiation

Xiao Lei[1], Shixin Wang[2], [1]University of Hong Kong, Hong Kong, Hong Kong; [2]The Chinese University of Hong Kong, Hong Kong, China

Content rotation is a common practice in the service industry to moderate operating costs and avoid customer satiation. However, designing an optimal rotation schedule remains a challenge. In this paper, we investigate how customers interact with rotation schedules, and how the correlation among service products affects the optimal rotation schedule. We also examine the impact of other factors, such as customer strategic behavior and sellers' competition. Our study aims to provide computational methods as well as managerial insights for service providers to make informed decisions about their rotation schedules.

3 Optimal Dynamic Mechanism Under Customer Search

Zhenyu Hu, Yangge Xiao, National University of Singapore, Singapore, Singapore

This paper investigates the seller's revenue-maximizing mechanism in the face of a customer who searches for outside alternatives over a finite horizon. Under a general recall function, we show that the optimal strategy for the seller is to offer a menu of American options consisting of deposits and strike prices. In the case where the customer can only recall a few recent outside alternatives, we further establish that customers with low valuation search for outside alternatives without engaging with the seller, while high-valuation customers exercise the option immediately, effectively turning the option into an exploding offer. Customers with intermediate valuation will only exercise the option, if ever, at the end of the search horizon. The seller's revenue decreases with more alternatives but it may first decrease and then increase as search cost increases.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB06

CC-North 121C

Machine Learning and Analytics in Business Decision Making

Community Committee Choice Session

Session Chair: Heng Zhang, Arizona State University, Tempe, AZ

Session Chair: Dennis Zhang, Washington University in St Louis, ST LOUIS, MO

1 A Learning and Optimization Method for Personalized Product Design

Mengxin Wang[1], Meng Qi[2], Zuo-Jun Max Shen[3], [1]University of California, Berkeley, Berkeley, CA, [2]Cornell University, Ithaca, NY, [3]University of California Berkeley, Berkeley, CA, Contact: mengxin_wang@berkeley.edu

The product design problem aims to select a combination of features for a new product that maximizes the revenue of the releasing company. We developed an estimation and optimization framework that uses customer data to personalize product design. We present a learning method for estimating model parameters from choice-based conjoint data and provide finite sample performance guarantees for our estimation and optimization results. Our results, as far as we know, fill in the gap in the product design literature with the first finite sample performance guarantee. Our theoretical results reveal a missing angle in the literature that the assortment size in conjoint data can affect learning algorithm efficiency and provide insights for collecting conjoint data more efficiently. Numerical results validate our theoretical findings.

2 Estimating Effects of Long-Term Treatments

Shan Huang[1], Chen Wang[2], Yuan Yuan[3], Jinglong Zhao[4], Zhang Jingjing[5], [1]University of Hong Kong, Seattle, WA, [2]The University of Hong Kong, Hong Kong, Hong Kong; [3]Purdue University, West Lafayette, IN, [4]Boston University, Boston, MA, [5]Tencent Inc., Shenzhen, China

One lingering challenge of randomized controlled trials (or A/B tests) is to estimate the effects of long-term treatments. Learning such effects is crucial for management but conducting long-duration experiments is costly. In this paper, we propose a longitudinal surrogate model to estimate the effects of long-term treatments using data collected from short-term experiments and historical observations. We show that under standard assumptions, the effect of long-term treatments can be decomposed into a sequence of functions that depend on the user attributes, their short-term intermediate metrics, and the treatment assignments. We conduct two large-scale long-term experiments on WeChat, an instant messaging platform, and demonstrate the effectiveness of our methods.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB07

CC-North 122A

Topics About E-commerce and Digital Platforms

Community Committee Choice Session

Session Chair: Xu Han, 1</sup

Session Chair: Lin Hao, Fordham University, New York City, NY

1 A Design Framework For Detecting And Understanding Ai-generated Texts: Fusing Transformers And Linguistic Features

Sen Yan, Zhiyi Wang, David Dobolyi, University of Colorado, Boulder - Leeds School of Business, Boulder, CO

AI-based large language models, represented by OpenAI's ChatGPT, have advanced rapidly, prompting the need for reliable detection methods and a systematic understanding of AI-generated content. In this study, we present a novel detector for AI-generated texts leveraging RoBERTa, a transformer-based model, and linguistic feature analysis for accurate and interpretable AI-text detection. The proposed detector exploits RoBERTa for its superior performance in capturing semantic relationships and uses linguistic features for recognizing AI-text patterns. Our study provides insights into AI-generated content detection and a better understanding in terms of the patterns of AI-generated texts. We inspire further research in AI text detection and responsible AI, and offer implications for digital platforms to better screen AI-generated content.

2 Examining the Effects of Firms' Dei Tweets with Deep Learning

Lingshu Hu[1], Weilu Zhang[2], [1]Washington and Lee University, Lexington, VA, [2]University of Kentucky, Lexington, KY, Contact: lhu@wlu.edu

Previous research has demonstrated that firm-generated content on social media plays a significant role in achieving marketing excellence. However, the question of what constitutes the "right content" remains unknown, especially with respect to the impact of Diversity, Equity, and Inclusion (DEI) related content. Therefore, this study uses tweets collected weekly from Fortune 1000 companies and users who mentioned these companies from May 2022 to May 2023 to develop a machine learning pipeline with pre-trained models that identifies various types of tweets discussing DEI topics. The study then analyzes the effects of these tweets on the firms' popularity and likability gains, implements NLP algorithms to investigate public perceptions of these firms on Twitter, and examines how the political orientation of the firms' followers moderates the effects of DEI tweets.

3 Algorithmic Recommendations Change Guys' Patience but Not Gals': Evidence from a Field Experiment

Guangrui(Kayla) Li[1], Zheng Gong[2], Xiaoquan(Michael) Zhang[3], [1]York University, Toronto, ON, Canada; [2]CUHK(SZ), Shenzhen, China; [3]Tsinghua University, Shenzhen, China. Contact: kaylali@schulich.yorku.ca

Algorithmic recommendations are widely used to predict user preferences and suggest relevant content or products. These recommendations can have a lasting impact on us by altering our preferences. One important preference algorithms can influence is patience - the marginal substitution rate between current and future consumption. While traditional video consumption involves active searching, algorithmic recommendations provide instant and continuous content, potentially decreasing users' patience. However, this constant content stream can also enhance happiness and positive moods, potentially increasing users' patience. To explore this, we conducted lab and field experiments. Interestingly, we observed that male users exhibited increased patience after disabling algorithmic recommendations, whereas no significant change was found among female users

4 Tensor Completion on Panel Data: Uncovering the Effect of Smart Vending Machine

Mingrui Zhang, University of Washington- Michael G. Foster School of Business, Seatttle, WA, Contact: mz74@uw.edu

Smart vending machines have revolutionized the retail industry by generating vast amounts of panel data encompassing sales, customer behavior, location of the machine, and operational performance. However, the presence of missing or incomplete data poses a challenge in accurately assessing the effects of these machines. To overcome this limitation, we apply tensor completion techniques to fill in data gaps and uncover the impact of smart vending machines on sales compared to traditional machines. Moreover, we combine the scenario and the region information to construct estimates of the vending machines' demands in different regions across different scenarios. This allows us to gain insights into the variations in demand patterns across other locations and circumstances, providing valuable information for optimizing the placements of vending machines.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB08

CC-North 122B

Pricing and Inventory Estimation

Contributed Session

Session Chair: Fatemeh Nosrat, Rice University, Houston, TX

1 Probabilistic Inventory Estimation in Grocery with Inaccurate Records

Clement Micol, Aaron Stern, Afresh, San Francisco, CA, Contact: aaron.stern@afreshtechnologies.com

Inventory management is important in industries such as grocery and retail, but taking inventory can be tedious and time-consuming. Perpetual inventory methods are often used to estimate inventory, but these methods are sensitive to inventory record inaccuracy (IRI) and perishability. To improve inventory estimate accuracy, we present a probabilistic generative model (InvHMM) that explicitly models IRI and perishability. We use a particle filter to infer the posterior inventory, as well as a novel particle smoothing algorithm to estimate past inventory retrospectively. On a dataset from a major US grocery chain, InvHMM improves inventory estimate accuracy over a simply perpetual inventory by >40% and gives well-calibrated confidence bounds.

2 Willingness-to-Pay Estimation and Pricing Optimization for Airline Seat Assignment and Branded Fares

Sajad Aliakbari Sani[1], Adam Bockelie[1], Tianjiao Liu[1], Alan Regis[1], Yury Sambale[1], Cindy Yao[1], Alvarez Aldair[2], Dan Teodora[3], Carl Perreault-Lafleur[2], Emma Frejinger[4], Andrea Lodi[5], Guillaume Rabusseau[3], [1]Air Canada, Montreal, QC, Canada; [2]IVADO Labs, Montreal, QC, Canada; [3]IVADO LABS, Montreal, QC, Canada; [4]Université de Montreal, Montreal, QC, Canada; [5]IVADO labs, Montréal, QC, Canada

In response to different customer needs and preferences, airlines provide branded fares, a set of offers that bundle flights with other travel ancillaries and privileges like seat assignment, checked baggage, and flexibility for rescheduling or cancellation, etc. Decision makers are faced with the challenge of setting the markup price, the increment or decrement amount relative to a base fare brand, in such a way that maximizes total revenue. There are not many branded fare price optimization models presented in the literature that can be applied in practical settings. We present a machine learning willingness-to-pay estimation model and a price optimization model for branded fares that we designed and deployed at a major airline.

3 Risk-Averse Network Revenue Management

Christiane Barz[1], Martin Glanzer[2], [1]University of Zurich, Ermatingen, Switzerland; [2]University of Mannheim, Mannheim, Germany. Contact: christiane.barz@uzh.ch

We consider the network capacity control problem from the perspective of a risk-averse expected exponential utility maximizing revenue manager. To overcome the curse of dimensionality of the corresponding risk-sensitive Markov decision process, we build on a mathematical programming based ADP approach with a new multiplicative (monomial) value function approximation. Reformulating the resulting nonconvex approximate model as a signomial program and reducing the problem analytically, we present an algorithm that determines risk-averse acceptance policies. Policies generated by our algorithm resemble the popular structure of bid price controls and can decrease the revenue risk substantially in return for sacrificing only little expected revenue, as we illustrate with numerical examples.

4 Assortment Planning Problems with Network Effects Under Mixed Multinomial Logit Choice Models

Fatemeh Nosrat[1], William L. Cooper[2], [1]Rice University, Houston, TX, [2]University of Minnesota, Twin Cities, Minneapolis, MN, Contact: fn12@rice.edu

A product displays non-negative network effects if each customer's valuation for the product increases in its overall sales. In the case of multiple products, strategic firms must decide which subset of products to offer to customers to maximize their revenue. The problem of selecting the optimal assortment of products is known as assortment planning. We aim to identify the best assortment of products given network effects and multiple customer segments, using a mixed multinomial logit choice model as the base demand. Since the problem is NP-hard, we provide a method for constructing upper bounds on the optimal expected revenue. We demonstrate that well-known policies, such as revenue-ordered and quasi-revenue-ordered assortments, are not generally optimal. Instead, we introduce a new, tractable set of policies called k-quasi-revenue-ordered assortments.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB09

CC-North 122C

Optimization over Probability Distributions: New Developments

Community Committee Choice Session

Session Chair: Daniel Alabi, Columbia University, New York, NY

1 Near-Optimal Fitting of Ellipsoids to Random Points

Prayaag Venkat, Harvard University

Given n independent standard Gaussian points in dimension d, for what values of (n, d) does there exist with high probability an origin-symmetric ellipsoid that simultaneously passes through all of the points? This basic problem of fitting an ellipsoid to random points has connections to low-rank matrix decompositions, independent component analysis, and principal component analysis. Based on strong numerical evidence, Saunderson, Parrilo, and Willsky (2011) conjectured that the ellipsoid fitting problem transitions from feasible to infeasible as the number of points n increases, with a sharp threshold at $n \sim d^2/4$. We resolve this conjecture up to logarithmic factors by constructing a fitting ellipsoid for some $n = d^2/\text{polylog}\}(d)$.

2 Leveraging Reviews: Learning to Price with Buyer and Seller Uncertainty

Wenshuo Guo[1], Nika Haghtalab[1], Kirthevasan Kandasamy[2], Ellen Vitercik[3], [1]University of California, Berkeley, Berkeley, CA, [2]University of Wisconsin, Madison, Madison, WA, [3]Stanford University, Stanford, CA, Contact: vitercik@stanford.edu

On online marketplaces, customers have access to hundreds of reviews for a single product. Buyers often use reviews from other customers that share their personal attributes—such as height for clothing or skin type for skincare products—to estimate their values, which they may not know a priori. Customers with few relevant reviews may hesitate to buy a product except at a low price, so for the seller, there is a tension between setting high prices and ensuring that there are enough reviews that buyers can confidently estimate their values. Simultaneously, sellers may use reviews to gauge the demand for items they wish to sell. In this talk, we formulate this pricing problem through the lens of online learning and provide a no-regret learning algorithm. Our matching regret upper and lower bounds show that our algorithm is minimax optimal up to lower order terms.

3 Out-Of-Distribution Generalization in Kernel Regression

Abdulkadir Canatar[1], Blake Bordelon[2], Cengiz Pehlevan[2], [1]Flatiron Institute, Simons Foundation, New York, NY, [2]Harvard University, Cambridge, MA, Contact: acanatar@flatironinstitute.org

Training distributions for machine learning models often differ from the test distribution. Under such distributional shifts, we study generalization in kernel regression using methods from statistical physics. We derive an analytical formula for the out-of-distribution generalization error applicable to any kernel and real datasets. The mismatch between distributions are quantified by an overlap matrix as a key determinant of generalization performance under distribution shift. We analyze and elucidate various generalization phenomena including possible improvement in generalization when there is a mismatch. We develop procedures for optimizing training and test distributions for a given data budget to find best and worst case generalizations under the shift. We present applications of our theory to real and synthetic datasets and for many kernels.

4 Crowdsourcing with Hard and Easy Tasks

Srikant Rayadurgam, UIUC

5 Degree Distribution Identifiability of Stochastic Kronecker Graphs

Daniel Alabi, Columbia University, New York, NY

Many network or graph generation algorithms rely on the Kronecker multiplication primitive. Seshadhri, Pinar, and Kolda (J. ACM, 2013) proved that stochastic Kronecker graph (SKG) models cannot generate graphs with degree distribution that follows a power-law or lognormal distribution. As a result, variants of the SKG model have been proposed to generate graphs which approximately follow degree distributions, without any significant oscillations. However, all existing solutions either require significant additional parameterization or have no provable guarantees on the degree distribution. In this work, we propose criteria, based on statistical and computational identifiability, that can be used to establish the usability and utility of SKG models.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB10

CC-North 123

Causal Inference in the Presence of Interference

Community Committee Choice Session

Session Chair: Shuangning Li, Harvard University, Cambridge, MA

1 Modeling Interference Using Experiment Roll-Out

Ariel Boyarsky[1], Hongseok Namkoong[1], Jean Pouget-Abadie[2], [1]Columbia University, New York, NY, [2]Google Research, New York, NY, Contact: a.boyarsky@columbia.edu

Experiments on online marketplaces and social networks suffer from interference, where the outcome of a unit is impacted by the treatment status of other units. We propose a framework for modeling interference using staggered roll-out designs, which slowly increase the fraction of units exposed to the treatment to mitigate any unanticipated adverse side effects. Our main idea leverages temporal variations in treatment assignments introduced by roll-outs to model the interference structure. We first present identification conditions under which the estimation of common estimands is possible and show how these conditions are aided by roll-out designs. Since there are often multiple competing models of interference in practice, we develop a model selection method that evaluates models based on their ability to explain outcome variation observed along the roll-out.

2 Low-Degree Outcomes and Clustered Designs: A Combined Approach for Causal Inference Under Interference

Matthew Eichhorn[1], Samir Khan[2], Johan Ugander[2], Christina Lee Yu[1], [1]Cornell University, Ithaca, NY, [2]Stanford University, Palo Alto, CA, Contact: cleeyu@cornell.edu

Existing literature on estimating causal effects under network interference falls under two primary approaches: leveraging assumptions on the interference to inform the experimental design or leveraging assumptions on the potential outcomes to inform the choice of estimator. These strategies have traditionally been considered in isolation; our work aims to understand and quantify their synergy. We present a general pseudoinverse estimator for causal effects under low-degree outcome models that works for arbitrary experimental designs. Next, we analyze the bias and variance of this estimator both for arbitrary designs and more specifically in the case of cluster randomized designs. Throughout, we see that the combination of cluster randomized designs and low-degree outcome models leads to more favorable properties than either strategy ensures on its own.

3 Optimal Individualized Treatment Rules Under Cluster Network Interference

Yi Zhang, Kosuke Imai, Harvard University, Cambridge, MA, Contact: yi_zhang@fas.harvard.edu

Most existing work on policy learning has assumed that the treatment assignment of one unit does not affect the outcome of another unit. We consider the problem of learning an optimal individualized treatment rule (ITR) under partial interference where clusters of units are sampled from a population and units may influence one another within each cluster. Unlike previous methods that impose restrictive interference structures, our method only assumes a semi-parametric model of interference, assuming that the cluster-level average outcome is an additive function of unit-level treatments within the cluster, where the proposed estimator for evaluating an ITR achieves better performance than the standard IPW estimator. We establish the regret bound for the learned ITR and illustrate its value in utilizing network information through simulation and empirical studies.

4 Model-Based Regression Adjustment with Model-Free Covariates for Network Interference

Kevin Han, Stanford University, Stanford, CA, Contact: kevinwh@stanford.edu

In this work, we introduce a sequential procedure to generate and select graph- and treatment-based covariates for GATE estimation under regression adjustment. We show that it is possible to simultaneously achieve low bias and considerably reduce variance with such a procedure. To tackle inferential complications caused by our feature generation and selection process, we introduce a way to construct confidence intervals based on a block bootstrap. We illustrate that our selection procedure and subsequent estimator can achieve good performance in terms of root mean squared error in several semi-synthetic experiments with Bernoulli designs. We apply our method to a real world experimental dataset with strong evidence of interference and demonstrate that it can estimate the GATE reasonably well without knowing the interference process a priori.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB11

CC-North 124A

Inventory Management: Theory and Practice

Community Committee Choice Session

1 The Benefits of Delay to Online Decision-Making

Yaqi Xie[1], Will Ma[2], Linwei Xin[1], [1]University of Chicago, Chicago, IL, [2]Columbia University, New York, NY

Real-time decisions are usually irrevocable in many contexts of online decision-making. One common practice is delaying real-time decisions so that the decision-maker can gather more information to make better decisions. However, decisions cannot be delayed forever. In this paper, we study this fundamental trade-off and aim to theoretically characterize the benefits of delaying real-time decisions. We provide a theoretical foundation for a broad family of online decision-making problems by proving that the gap between the proposed online algorithm with delay and the offline optimal policy decays exponentially fast in the length of delay. We also conduct extensive numerical experiments on the benefits of delay, using both synthetic and real data. Both our theoretical and empirical results demonstrate an important managerial insight: a little delay is all we need.

2 Dynamic Commodities for Large Scale Fulfillment Optimization

Ioannis Spantidakis, Tolga Cezik, Amazon.com, Seattle, WA, Contact: spanioan@amazon.com

The fulfillment execution system of Amazon needs to optimize the fulfillment method for tens of millions of customer orders per day over hundreds of thousands of potential transportation paths. The goal is to evaluate all fulfillment methods per order and dynamically choose one that minimizes the fulfillment cost while reserving capacity for future demand. This requires frequent solving of an extremely large-scale problem, which does not scale at an individual order level. To reduce both the impact of demand forecast errors as well as the dimension of the problem, we cluster orders with similar characteristics into commodities. We give a formal definition of a commodity and study how different levels of granularity affect the tradeoff between optimization speed and fulfillment cost in the Amazon network.

Session Chair: Linwei Xin, University of Chicago, Chicago, IL

3 Multi-Period Multi-Secretary Problem

Zi Ling[1], Linwei Xin[2], Yuan Zhong[3], [1]University of Chicago, Chicago, IL, [2]University of Chicago, Chicago, IL, [3]University of Chicago / Booth School of Business, Chicago, IL, Contact: zling@chicagobooth.edu

Replenishment usually plays a crucial role in various online decision-making contexts (for example, replenishment after online order fulfillment in online retailing). In this paper, we mainly study the real-time decision problem with replenishment. To address this problem, we present a family of offline optimal hindsight policies, specifically when the offline optimal policy cannot be determined due to the complexities of replenishment. Subsequently, we propose a corresponding online policy tailored for real-time decision-making in such scenarios. To analyze the performance of the proposed algorithms, we provide a theoretical analysis that establishes performance bounds. This analysis serves as a foundation for understanding the effectiveness of the online policy in the absence of an optimal offline policy.

4 Sample Complexity of Policy Gradient Method and Applications in Inventory Models

Minda Zhao, Xin Chen, Georgia Institute of Technology, Atlanta, GA, Contact: mindazhao@gatech.edu

Policy gradient methods for Markov Decision Processes (MDPs) do not converge to global optimal solutions in general due to the non-convexity of the objectives. In this work, we show that for a class of MDPs in which the optimal policies described by a finite number of parameters and the cost-to-go functions are convex, the objectives of the policy gradient satisfy the gradient dominance conditions. Using this, we develop policy gradient-based algorithms and establish their sample complexities required to attain ϵ-global optimal solutions. Our results find applications in a host of inventory models including multi-period newsvendor model and multi-echelon inventory model. In particular, the policy gradient method achieves an $O(\epsilon^{-2})$ sample complexity for the capacitated inventory control models, matching the result of sample average approximation in the literature.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB12

CC-North 124B

Learning, Experimental Design, and Societal Considerations

Community Committee Choice Session

Session Chair: Yunzong Xu, Massachusetts Institute of Technology, Cambridge, MA

1 On Differentially Private Federated Linear Contextual Bandits

Xingyu Zhou, Wayne State University, Detroit, MI

We consider differentially private cross-silo federated linear contextual bandit (LCB) problem. We identify three issues in the state-of-the-art: (i) failure of claimed privacy protection and (ii) incorrect regret bound due to noise miscalculation and (iii) ungrounded communication cost. We first design an algorithmic framework consisting of a generic federated LCB algorithm and flexible privacy protocols. Then, we establish privacy and regret guarantees under silo-level local differential privacy, which fix the issues present in state-of-the-art algorithm. To further improve the regret performance, we next consider shuffle model of differential privacy, under which we show that our algorithm can achieve nearly "optimal" regret without a trusted server.

2 Optimizer's Information Criterion: Dissecting and Correcting Bias in Data-Driven Optimization

Garud Iyengar, Henry Lam, Tianyu Wang, Columbia University, New York, NY, Contact: tw2837@columbia.edu

In data-driven optimization, the sample performance of the obtained decision typically incurs an optimistic bias known as the Optimizer's Curse. Common techniques to correct this bias, such as cross-validation, require repeatedly solving additional optimization problems and are computationally expensive. We develop a general bias correction approach, building on what we call *Optimizer's Information Criterion (OIC)*, that directly approximates the first-order bias and does *not* require solving any additional optimization problems. OIC evaluates the objective performance in data-driven optimization, which involves not only model fitting but also its interplay with the downstream optimization. We apply our approach to various formulations comprising empirical and parametric models, their regularized counterparts, and furthermore contextual optimization.

3 Switchback Experiments in a Reactive Environment

Hongyu Chen[1], David Simchi-Levi[2], [1]MIT, cambridge, MA, [2]Massachusetts Institute of Technology, Cambridge, MA, Contact: chenhy@mit.edu

In this paper, we consider the problem of estimating the treatment effect of a new policy by conducting switchback experiments in a reactive environment, where the system's response fully captures the potential temporal interference. We propose an estimator based on importance sampling and discuss an experimental design that has a near-optimal worst-case guarantee. For performing inferences, we develop the central limit theorem for the estimator and construct a corresponding conservative confidence interval. We show by numerical experiments that the proposed estimator along with the experimental design achieves smaller risk compared to the traditional inverse propensity score estimator.

4 Offline Reinforcement Learning: Fundamental Barriers for Value Function Approximation

Yunzong Xu, Massachusetts Institute of Technology, Cambridge, MA

We consider the offline reinforcement learning problem, where the aim is to learn a decision making policy from logged data. Offline RL -- particularly when coupled with (value) function approximation to allow for generalization in large or continuous state spaces -- is becoming increasingly relevant in practice, because it avoids costly and time-consuming online data collection and is well suited to safety-critical domains. We discuss some recent advances on the hardness of offline reinforcement learning and provide insights on algorithm design.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB14

CC-North 125B

Data-driven Research with Social Impacts

Community Committee Choice Session

Session Chair: Masoud Kamalahmadi, University of Miami, Miami, FL

1 Admission Decisions Under Imperfect Classification: An Application to Criminal Justice

Zhiqiang Zhang[1], Pengyi Shi[2], Amy R. Ward[1], [1]The University of Chicago Booth School of Business, Chicago, IL, [2]Purdue University, West Lafayette, IN, Contact: zqzhang0@chicagobooth.edu

We study the decision of admitting individuals eligible for probation to incarceration diversion treatment programs, whose aim is to reduce the chance an individual re-offends. The admission decisions are made based on the outcome of a machine learning (ML) algorithm. We model the diversion program as a queueing loss model with reneging during service, and calibrate the model using data from Illinois. Using fluid optimization, we show that the optimal policy has a simple prioritization scheme when the ML algorithm's prediction is sufficiently accurate, but is suboptimal otherwise. We propose guidelines for when to follow the ML-based recommendation and when to involve human judgement. Finally, we investigate the fairness issues among different subpopulations and discuss the impact of various fairness criteria on the ML algorithm and admission decisions.

2 How Do Drug Shortages Affect Fda Inspections? an Empirical Study

Archie Zhuang[1], In Joon Noh[2], Hui Zhao[3], [1]Penn State University, State College, PA, [2]Penn State University, University Park, PA, [3]The Pennsylvania State University, University Park, PA, Contact: zpz5187@psu.edu

Drug shortages have been a significant and persistent challenge in the U.S. Some drug manufacturers blame FDA for the production delay and resultant shortages, claiming that FDA's inspections tend to be unnecessarily stringent. Given these anecdotes, we conduct a large-scale empirical study to investigate the impact of drug shortages on FDA inspections.

3 Communication Breakdown: A Study of Recall Effectiveness in the United States Automobile Industry

Ramin Sepehrirad[1], Kevin Mayo[2], George Ball[3], [1]Washington State University, Pullman, WA, [2]Washington State University, Pullman, WA, [3]Operations and Decision Technologies, Kelley School of Business, Indiana University,

Bloomington, IN, Contact: ramin.sepehrirad@wsu.edu
While significant research explores recall causes and effects, little is understood about recall effectiveness; how well the firm performs in repairing or replacing faulty products. Anecdotal reports indicate that firms are relatively ineffective in this endeavor, leading to millions of recalled products remaining in the market, unaddressed. We investigate communication strategies of recalling firms to raise customer awareness and encourage compliance with remedial procedures. Increasing recall effectiveness directly lowers the risk of harm to consumers, thereby meaningfully contributing to societal well-being. We leverage text analyses to explore the content and channels of manufacturer communications with dealers and affected customers in the United States automobile industry.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB16

CC-North 126B

On the Fairness for Optimization and Learning

Contributed Session

Session Chair: Parian Haghighat, University of Illinois at Chicago, Chicago, IL
Session Chair: Hadis Anahideh, University of Illinois Chicago, Chicago, IL

1 Geometric Envy-Free Pricing of Seats in Planetariums: Maximizing Revenue and Welfare

Freija M. E. van Lent[1], Alexander Grigoriev[1], Julian A. P. Golak[2], [1]Maastricht University, Maastricht, Netherlands; [2]Hamburg University of Technology, Hamburg, Germany. Contact: f.vanlent@maastrichtuniversity.nl
We study a geometric envy-free pricing problem with a single item demand. The aim of the seller is to maximize the revenue by assigning prices to points in the plane and by allocating customers to these points in an envy-free manner, i.e., every allocated customer receives a point of her highest possible utility, and all non-allocated customers cannot afford any point. Next to this continuous problem, we consider a discrete version where customers purchase the tiles of a regular tessellation of the plane, e.g., grid squares or honeycomb hexagons. For a special case of the continuous version of the problem, where all customers have the same preferred point, we introduce a dynamic programming algorithm solving the problem in polynomial time. For the discrete version of the problem, we extend the dynamic programming algorithm to the quasi-polynomial time approximation scheme.

2 Existence and Computation of Epistemic EFX Allocations

Ioannis Caragiannis[1], Jugal Garg[2], Nidhi Rathi[1], Eklavya Sharma[2], Giovanna Varricchio[3], [1]Aarhus University, Aarhus, Denmark; [2]University of Illinois at Urbana-Champaign, Urbana, IL, [3]Goethe University Frankfurt, Frankfurt, Germany
For the problem of fairly dividing a set of indivisible items among agents, envy-freeness up to any item (EFX) and maximin fairness (MMS) are arguably the most compelling fairness concepts proposed till now. Unfortunately, despite significant efforts over the past few years, whether EFX allocations always exist is still an enigmatic open problem. Furthermore, we know that MMS allocations are not guaranteed to exist. These facts weaken the usefulness of both EFX and MMS despite their appealing conceptual characteristics. We propose an alternative fairness concept called epistemic EFX (EEFX) that is inspired by EFX and MMS. We explore its relationship to well-studied fairness notions and prove that for additive valuations, EEFX allocations always exist and can be computed efficiently. Our results justify that EEFX can be an excellent alternative to EFX and MMS.

3 Should I Stop or Should I Go: Early Stopping with Heterogeneous Populations

Hammaad Adam[1], Mary Hu[2], Fan Yin[3], Neil Tenenholtz[4], Lorin Crawford[4], Lester Mackey[4], Allison Koenecke[5], [1]Massachusetts Institute of Technology, Cambridge, MA, [2]Microsoft, Redmond, WA, [3]Amazon, Seattle, WA, [4]Microsoft Research, Cambridge, MA, [5]Cornell University, Ithaca, NY, Contact: hadam@mit.edu
Randomized experiments often need to be stopped prematurely due to the treatment having an unintended harmful effect. Existing methods that determine when to stop an experiment early are typically applied to the data in aggregate and do not account for treatment effect heterogeneity. In this paper, we study the early stopping of experiments for harm on heterogeneous populations. We first establish that current methods often fail to stop experiments when the treatment harms a minority group of participants. We then use causal machine learning to develop CLASH, the first broadly-applicable method for heterogeneous early stopping. We demonstrate CLASH’s performance on simulated and real data and show that it yields effective early stopping for both clinical trials and A/B tests.

4 Fairpilot: An Explorative System for Hyperparameter Tuning Through the Lens of Fairness

Francesco Di Carlo, Nazanin Nezami, Hadis Anahideh, Abolfazl Asudeh, University of Illinois Chicago, Chicago, IL, Contact: hadis@uic.edu

Despite the potential benefits of machine learning (ML) in high-risk decision-making domains, the deployment of ML is not accessible to practitioners, and there is a risk of discrimination. To establish trust and acceptance of ML in such domains, democratizing ML tools and fairness consideration are crucial. In this paper, we introduce FairPilot, an interactive system designed to promote the responsible development of ML models by exploring a combination of various models, different hyperparameters, and a wide range of fairness definitions. We emphasize the challenge of selecting the ``best" ML model and demonstrate how FairPilot allows users to select a set of evaluation criteria and then displays the Pareto frontier of models and hyperparameters. FairPilot offers a unique opportunity for users to responsibly choose their model.

5 Unleashing the Potential of Predictive Analytics with Fair Mars: A Statistical Model that Prioritizes Equity and Transparency

Parian Haghighat[1], Hadis Anahideh[1], Lulu Kang[2], [1]University of Illinois at Chicago, Chicago, IL, [2]Illinois Institute of Technology, Chicago, IL

This project aims to develop a fair Multivariate Adaptive Regression Splines (MARS) model that reduces bias towards sensitive attributes like race or gender across achieving more equitable outcomes. MARS is a non-parametric regression model with a built-in feature-selection step. Our fair MARS model prioritizes fairness as well as accuracy via pre-processing (decorrelating sensitive and non-sensitive attributes) and in-processing (incorporating fairness constraints during knot optimization). Adding the fairness component to the training process not only produces less biased predictions but also generates a fair set of decision rules based on the splitting criteria for the selected variables. By developing and sharing this model, we offer a more interpretable and accessible prediction model, enhancing the utility of predictive analytics in practice.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB18

CC-North 127B

Data Informed Methodologies to Improve Patient Access to Healthcare Services

Community Committee Choice Session

Session Chair: Esma S. Gel, University of Nebraska-Lincoln, Lincoln, NE

Session Chair: Santiago Romero Brufau, Mayo Clinic, Rochester, MN

1 Improving the Compassionate Dialysis Process via Patient Routing and Prioritization Schemes

Olga Bountali[1], Farnaz Nourbakhsh[2], Sila Cetinkaya[3], [1]Rotman School Of Management, University of Toronto, Toronto, ON, Canada; [2]United Parcel Service, Elkridge, MD, [3]SMU, Dallas, TX, Contact: olga.bountali@utoronto.ca

Uninsured patients suffering from End Stage Renal Disease (ESRD) have access to treatment under EMTALA (a federal law) after being evaluated as in an 'life-threatening' condition. This practice, a.k.a. *compassionate dialysis,* routes these patients through the ER, blends them with non-ESRD patients, and assesses their condition factoring both medical 'emergency' criteria and existing available capacity. Compassionate dialysis has been proved to be inefficient for both hospital and patient outcomes. Informed by our analysis of real-life data from a hospital offering compassionate dialysis, we analyze alternative service protocols that rely on patient flow re-routing and prioritization schemes with the goal of informing medical personnel and government decision makers.

2 Community/Committee'S Choice Submission

Thomas Kingsley, Mayo Clinic, Rochester, MN

3 Statistical Characterization of Patient Response to Offered Access Delays Using Healthcare Transactional Data

Derya Kilinc[1], Esma S. Gel[2], Mustafa Y. Sir[3], Kalyan Pasupathy[4], [1]Socure Inc, Phoenix, AZ, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]Amazon, Redmond, WA, [4]University of Illinois at Chicago, Chicago, IL

We present a novel framework to characterize the probability that an appointment will be booked and attended by a patient. We refer to this probability as the probability of realization' and demonstrate how empirical characterization of this measure can be used to identify policies for managing patient demand and enabling the use of care resources. We consider the estimation problem in the context of new patients looking to establish care at a clinic, and offer a model of patient responses during appointment scheduling. We first demonstrate the accuracy of estimations using simulated data, and then highlight behavioral differences between different patient groups using real-life transactional data. Finally, we demonstrate a practical use case for the obtained probabilities by showing that they can be reliably used as input to a patient prioritization mechanism.

4 Ai Translation Advisory Board: Support the Process from Data to Clinical Impact

Lu Zheng, Mayo Clinic, Rochester, MN

In this session we will discuss the AI Translation Advisory Board, a Board within Mayo Clinic to accelerate the translation of AI projects into clinical practice at Mayo Clinic by providing comprehensive assessment and support for projects. We will describe the board's multi-background team and the streamlined process by going through an example of a project to implement ML-based models and process optimization to improve inadequate bowel preparation prior to colonoscopy.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB19

CC-North 127C

OR Applications in Neuroscience

Community Committee Choice Session

Session Chair: Taghi Khaniyev, Bilkent University, Ankara, Turkey

1 Optimizing Concussion Assessment: A Mixed-Integer Optimization Approach with Time Constraints

Himadri S. Pandey, Gian-Gabriel P. Garcia, Georgia Institute of Technology, Atlanta, GA, Contact: hpandey30@gatech.edu

Concussion is a common type of brain injury in sports and recreation, with 1.6-4 million cases yearly, half of which go unreported or undetected. Prompt and precise diagnosis is vital to manage the injury and reduce the risk of severe short-term and long-term effects, such as cognitive impairment, depression, and neurodegenerative disorders. However, identifying appropriate concussion assessment tools in time-constrained settings like athletic competitions is still challenging. We are proposing a novel approach to optimize the accuracy of a concussion assessment battery under time constraints. Specifically, we formulate the problem as a mixed-integer optimization problem with chance constraints. Our findings demonstrate that we can create precise assessment batteries even for short timeframes, resulting in better outcomes in time-constrained settings.

2 Optimal State-Space Reconstruction of Complex Systems for Pattern Discovery of Brain Disorders

Chun-An Chou[1], Haidong Gu[1], Shaodi Qian[1], Huiyu Huang[2], [1]Northeastern University, Boston, MA, [2]Northeastern University, Brookline, MA, Contact: ch.chou@northeastern.edu

Human brain is considered as one of most complex systems. In theory, the dynamics of a complex system exists and follows an evolution rule. However, its behavior is not easily observed and analyzed. To this end, we formulate an optimization problem for identifying an intrinsic space of brain system, where the dynamics can be discovered in a reconstructed state space. Then, we present a complex measure to represent brain behaviors. We demonstrate the effectiveness of our proposed approach in neuroscience applications of seizure detection and schizophrenia classification using multi-variate EED signals.

3 Optimal Personalized Brain Parcellation

Taghi Khaniyev[1], Beyza Bakir[1], Sahin Hanalioglu[2], [1]Bilkent University, Ankara, Turkey; [2]Hacettepe University, Ankara, Turkey. Contact: taghi.khaniyev@bilkent.edu.tr

Recent advances in imaging technologies allowed researchers probe the human brain in high resolution. One of biggest challenges of analyzing the intricate nature of the human brain is to process the data emanating from high-resolution imaging. To tackle this challenge, neuroscientists typically conduct their analyses on brain area level rather than voxel level. Division of the brain cortex into distinct areas is called parcellation. Traditional parcellation approaches typically offer a universal atlas which ignores the large amount of inter-individual variability. We propose a novel mathematical optimization model for personalized parcellation. In this formulation, the objective is to assign each voxel to a brain region for each individual in such a way that the dissimilarity of the resulting connectivity network from an archetypical brain network is minimized.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB20

CC-North 128A

Hospital's Surgical and Inpatient Operations

Community Committee Choice Session

Session Chair: Vikram Tiwari, Vanderbilt University Medical Center, Nashville, TN

1 Optimizing Intra-Hospital Patient Transport Services

Christopher Sun[1], Martin Copenhaver[2], A. Cecilia Zenteno[3], Retsef Levi[4], [1]University of Ottawa; University of Ottawa Heart Institute, Ottawa, ON, Canada; [2]Massachusetts General Hospital & Harvard Medical School, Boston, MA, [3]Massachusetts General Hospital, Boston, MA, [4]MIT, Cambridge, MA, Contact: sun@telfer.uottawa.ca

Intra-hospital patient transportation services are an integral part of daily logistic activities in a hospital, facilitating patient flow between inpatient units on stretchers, wheelchairs, and beds. Delays stemming from suboptimal transport practices can significantly impact operations of procedural areas and test sites, potentially compromising quality of care. In this project, we identified the primary drivers of patient transport delays at Massachusetts General Hospital, and propose analytical frameworks to address these issues.

2 A Pareto Improvement Bumping-Rescheduling Policy for Operating Room Scheduling

Hung Do[1], David C. Novak[2], Mitchell H. Tsai[3], [1]University of Vermont, Burlington, VT, [2]University of Vermont, Burlington, VT, [3]University of Vermont Medical Center, South Burlington, VT, Contact: Hung.Do@uvm.edu

For hospitals using shared operating rooms for scheduled and emergent cases, a bumping policy is needed to facilitate emergent cases when they arrive, but it often operates with competing objectives. The current bumping policies do not offer efficient access to capacity (i.e., Operating Rooms) as well as any mechanism for collaboration. We introduce, model and analyze a bumping policy called First-In-First-Out (FIFO) Bump Policy in the context of Operating Room Scheduling that facilitates more efficient use of capacity with pooling effects and offers a collaborative mechanism with potential positive behavioral effects to speedup service rates.

3 Data-Driven Approach to the Surgical Block Auto-Release Decision

Sandeep Rath[1], Moe R. Lim[2], [1]University of North Carolina at Chapel Hill - Kenan Flagler, Chapel Hill, NC, [2]University of North Carolina at Chapel Hill, Chapel Hill, NC, Contact: sandeep_rath@kenan-flagler.unc.edu

Surgical block allocation involves reserving block time in operating rooms (OR) for surgeon scheduling. This gives the surgeons independence to manage their own schedules predictably and ensures fair distribution of OR capacity across departments. However, unused block time can result in idle time, leading to lower OR utilization. To improve utilization and total case volume, unused blocks are auto-released for open access several days before surgery. The decision on how far in advance to automatically release unfilled block time is a trade-off between predictable surgeon scheduling and OR utilization. We develop a data-driven approach for surgical block auto-release, using historical data of surgical case bookings from a large academic medical center. Our model improves OR utilization without compromising predictable surgeon scheduling.

4 A Multi-Treatment Forest Approach for Analyzing the Heterogeneous Effects of Team Familiarity

Minmin Zhang[1], Guihua Wang[2], Wallace J. Hopp[3], Michael Mathis[4], [1]The University of Texas at Dallas, Richardson, TX, [2]The University of Texas at Dallas, RICHARDSON, TX, [3]University of Michigan, Ann Arbor, MI, [4]University of Michigan Medical School, Ann Arbor, MI

Extensive research has revealed that prior collaborative experiences among team members (called “team familiarity”) enhance outcomes of group work in many different environments. In this study, we examine the effect of team familiarity on surgery duration and extend the literature on team dynamics by examining whether the effect of team familiarity is heterogeneous across patients. We find (1) an increase in team familiarity score, especially the anesthesiologist-nurse and surgeon-anesthesiologist familiarity scores, significantly reduces surgery duration, and (2) the effect of team familiarity is heterogeneous across patients with different features. Finally, we develop an optimization model to assess the value of leveraging the heterogeneous effects of team familiarity to better match surgical teams with patients.

5 Community/Committee’S Choice Submission

Seung-Yup Lee, 1</sup

Wednesday, October 18, 9:30 AM - 10:45 AM

WB21

CC-North 128B

Recent Development in Healthcare Analytics

Community Committee Choice Session

Session Chair: Susan F. Lu, Purdue University, West Lafayette, IN

Session Chair: Zhenzhen Yan, Nanyang Technological University, Singapore, Singapore

1 Got (Optimal) Milk? Pooling Donations in Human Milk Banks with Machine Learning and Optimization

Rachel K. Wong[1], Timothy C. Y. Chan[2], Rafid Mahmood[3], Ian Y. Zhu[2], Sharon Unger[4], Debbie Stone[4], Deborah O'Connor[5], [1]University of Toronto, Toronto, ON, Canada; [2]University of Toronto, Toronto, ON, Canada; [3]Telfer School of Management, Ottawa, ON, Canada; [4]Sinai Health System, Toronto, ON, Canada; [5]University of Toronto, Toronto, ON, Canada. Contact: rache.wong@mail.utoronto.ca

Human donor milk provides critical nutrition for the millions of infants that are born preterm each year. While the macronutrients in donor milk are critical to infant development, they vary by donation. In collaboration with Rogers Hixon Ontario Human Milk Bank, we developed a data-driven framework to pool multiple donations using machine learning and optimization. Over a one-year trial, our implementation yielded significantly higher macronutrient content than current pooling practices, with the proportion of pools meeting clinical fat and protein targets increasing by approximately 31%, with a 60% decrease in recipe creation time.

2 Treatment Planning of Victims with Heterogeneous Time-Sensitivities in Mass Casualty Incidents

Yunting Shi[1], Nan Liu[2], Guohua Wan[1], [1]Shanghai Jiao Tong University, Shanghai, China; [2]Boston College, Chestnut Hill, MA, Contact: sherryshi@sjtu.edu.cn

Mass casualty incidents (MCIs) lead to a sudden jump in patient demand, making it inevitable to ration medical resources. Informed by a unique timestamps dataset collected during a large-scale earthquake, we develop data-driven approaches to aid treatment planning for MCIs . A distinguishing feature of our modeling framework is to simultaneously consider victim health deterioration and wait-dependent service times in making decisions. We identify conditions under which victims with a less critical initial condition have higher or lower priority than their counterparts in an optimal schedule—the priority order depends on victim deterioration trajectories and the resource (i.e., treatment time) availability.

3 Joint Prediction and Stopping in Treatment of Aortic Aneurysms

Huan Yu[1], Qingxia (Cynthia) Kong[2], Gar Goei Loke[2], Merieke Stevens[2], Merel Verhagen[3], Jan van Schaik[3], [1]University of Southampton, Southampton, United Kingdom; [2]Erasmus University, Rotterdam, Netherlands; [3]Leiden University Medical Center, Leiden, Netherlands. Contact: huan.yu@soton.ac.uk

In this paper, we consider the problem of finding the optimal treatment time for aortic aneurysm patients in a cardiac clinic. Treatment decisions depend on the trade-off between sudden mortality from aortic rupture and long-term chance and costs of complications. We propose a decision support tool that provides recommendations on the treatment time, that uses a survival model as inputs for estimating the risks of complications and mortality. We propose a novel robust optimization model to control for errors in the estimation of the hazard function, and to jointly form predictions and treatment time decisions. We illustrate our model on a data set of aortic patients in the Leiden University Medical Centre. Our model has the potential to open the door to preventive medicine as it forms individualized treatment decisions for patients based on their unique characteristics.

4 Test

Mabel Chou, National University of Singapore

5 Elective Surgery Sequencing and Scheduling Under Uncertainty

Xiaojin Fu[1], Jin Qi[2], Chen Yang[1], Han Ye[3], [1]Hong Kong University of Science and Technology, Hong Kong, Hong Kong; [2]Hong Kong University of Science and Technology, Hong Kong, Hong Kong; [3]Lehigh University, Bethlehem, PA, Contact: cyangap@connect.ust.hk

We consider a surgery sequencing and scheduling problem with uncertain surgical durations. Our goal is to balance the risk of delay and idle time, so the Punctuality Index is proposed. We derive exact solutions based on Benders Decomposition. The framework can also accommodate a robust optimization setting. For practical use, we propose two effective heuristics based on the variance and the forward-backward deviations. With comparison, we demonstrate that our framework is significantly good. The robust setting can effectively lessen the risk of large delay and idle time, and the heuristics are efficient with only little performance sacrificed.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB22

CC-North 129A

Healthcare Products and Services Operations

Community Committee Choice Session

Session Chair: Jun Li, Ross School of Business, University of Michigan, Ann Arbor, MI

Session Chair: Xinyu Shirley Liang, 1</sup

1 The Impact of Workload on Racial Disparities in Healthcare

Alison Murphy[1], Rachna Shah[2], [1]University of Minnesota-Twin Cities, Minneapolis, MN, [2]University of Minnesota, Minneapolis, MN, Contact: murp1888@umn.edu

A growing stream of literature has shown how service rate and quality are impacted by workload. Increasing workload also increases cognitive load, which increases the likelihood that individuals will act on implicit biases. We explore how provider workload contributes to inequities in healthcare delivery and disparities in outcomes based on patient race in the context of maternal health. Overall, Black women are less likely to receive epidurals and are more likely to experience severe morbidities than White women. We show that the patterns of inequities and disparities vary with provider workload.

2 Generic Drug Effectiveness-An Empirical Study on Health Service Utilization and Clinical Outcomes

Xinyu Liang[1], Jun Li[2], Ravi Anupindi[1], [1]University of Michigan, Ann Arbor, MI, [2]Ross School of Business, University of Michigan, Ann Arbor, MI, Contact: xinyul@umich.edu

Close to 90% of drugs consumed in the US are generics, saving over 2.4 trillion dollars over the past decade. While the cost savings are evident, effectiveness of generic drugs have been the subject of debate. In this paper, we estimate the effect of generic drug usage on health outcomes and address the potential endogeneity using instrumental variables. We find that generic drug usage leads to significantly more hospital visits. Generics also appear to be less clinically effective in reducing low-density lipoprotein cholesterol levels and preventing hospitalizations. In particular, the effect of generic drug usage is more prominent among older patients and patients with high prior healthcare expenses. Furthermore, we find that the effectiveness varies across generics from different manufacturers, particularly between authorized generic manufacturers and others.

3 Optimizing Equitable Resource Allocation in Parallel Any-Scale Queues with Service Abandonment and Its Application to Liver Transplant

Shukai Li, Sanjay Mehrotra, Northwestern University, Evanston, IL

We study the problem of equitably and efficiently allocating resources, modeled as service rates, to multiple queues with abandonment. The problem is motivated by the national liver allocation system, which includes numerous small-scale patient waitlists in terms of arrival intensities, with the possibility of patients abandoning (death) until the required service is completed (matched donor livers arrive). We model each waitlist as a GI/MI/1+GI queue. To evaluate the queue performance, we develop a finite approximation method, which is further used within an optimization model. We find that increasing the proportion of livers allocated to waitlists with small scales or high abandonment (death) risks improves allocation equity. This suggests a proportionately greater allocation of organs to smaller transplant centers and those with more vulnerable populations.

4 Studying the Effect of Team Familiarity in Surgical Teams

Gulin Tuzcuoglu[1], Daniel Adelman[2], Cagla Keceli[1], Kiran Turaga[3], Hunter Witmer[1], Frederick Godley[1], Josh Morris-Levenson[1], [1]University of Chicago, Chicago, IL, [2]University of Chicago, Booth School of Business, Chicago, IL, [3]Yale University, New Haven, CT, Contact: gulin@uchicago.edu

We study the effect of team familiarity in surgical teams to maximize team performance. Our approach takes the team members' individual and collaborative experiences into account, which we quantify using a novel metric. We report on results based on data from a high-volume academic medical center.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB23

CC-North 129B

Decision making in sustainable supply chains

Community Committee Choice Session

Session Chair: Mirel Yavuz, University of California Los Angeles, Los Angeles, CA

Session Chair: Charles J. Corbett, University of California-Los Angeles, Los Angeles, CA

1 Interactive Optimization with Unknown Value Function: Illustrative Application to Sustainable Sourcing in the Apparel Industry

Mirel Yavuz, Charles J. Corbett, University of California Los Angeles, Los Angeles, CA, Contact: mirel.yavuz.phd@anderson.ucla.edu

Optimization in sustainability is inherently multi-criteria and the underlying value function used to indicate preferences is usually unknown and difficult to elicit. In this work, we consider the example of sustainable sourcing in the apparel industry and assume the economic and environmental preferences of a consistent and rational decision maker

(DM) are based on an unknown implicit value function. We propose a new interactive optimization approach that asks pairwise comparison questions to the DM to determine the sourcing mix that is most aligned with her preferences. Our interactive algorithm has a great potential in replacing/reducing the current ad-hoc approaches typically used in sustainable decision making.

2 The Impact of Extreme Weather Events on Firm Activity

Suvrat Dhanorkar[1], Suresh Muthulingam[2], [1]Pennsylvania State University, University Park, PA, [2]The Pennsylvania State University, University Park, PA, Contact: ssd14@psu.edu

Severe weather has been increasingly disrupting operations and supply chains. We examine the impact of extreme weather events on firm operations and outcomes.

3 Incentivizing Recycling to Improve Sustainability: Evidence from Field Experiments

Dayton T. Steele[1], Atalay Atasu[2], Saravanan Kesavan[3], [1]University of Minnesota, Carlson School, Minneapolis, MN, [2]INSEAD, Fontainebleau, France; [3]University of North Carolina-Chapel Hill, Chapel Hill, NC

The growing focus on sustainability initiatives for businesses has increased the need to understand how to encourage customers to participate. Through a partnership with a consumer electronics company, we conduct a set of field experiments to understand how its customers respond to incentives to return products to be recycled.

4 Promoting Circularity in Repair Operations with Incentives

Nail Tahirov[1], Tarkan Tan[2], Gizem Sagol Mullaoglu[3], [1]University of Zurich, Schaffhausen, Switzerland; [2]University of Zurich, Zurich, -, Switzerland; [3]ASML, Eindhoven, Netherlands

As sustainability becomes increasingly important, many manufacturers are switching their business model from the traditional "linear" approach to a "circular" paradigm. However, it is not easy for a company to realize it without the involvement of its suppliers. For a successful circular business model companies should induce their suppliers to invest in more circularity by producing durable materials and increasing reprocessing capabilities. We investigate a case presented by our industry partner, who seeks to enhance their circular economy by fostering collaboration with their suppliers in repairing spare parts. The willingness of suppliers to engage in joint initiatives with the manufacturer for circular economy improvement may vary depending on their preferences. Hence, this study addresses incentivization mechanisms aimed at benefiting both parties.

5 Remanufacturing of Consumer Returns by a Retailer: Implications for Supply Chains

Narendra Singh, Nazarbayev University, Astana, Kazakhstan. Contact: narendra.singh@nu.edu.kz

I analyze a supply chain where a manufacturer sells new products to consumers through a retailer and consumers return new products that are defective. I examine how strategic interactions among the manufacturer, the retailer, and consumers affect the supply chain profits in the presence of remanufacturing of consumer returns.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB24

CC-North 130

AI and decision making in operations management

Community Committee Choice Session

1 Scalable Optimal Multiway-Split Decision Trees

Shivaram Subramanian, Wei Sun, IBM T. J. Watson Research Center, Yorktown Heights, NY, Contact: subshiva@us.ibm.com

There has been a surge of interest in learning optimal decision trees using mixed-integer programs (MIP) as heuristic-based methods do not guarantee optimality and find it challenging to incorporate practical operational constraints. Existing MIP methods rely on an arc-based binary-tree formulations that are limited to datasets having a few thousand samples, sample-level constraints, and linear metrics. We propose a novel path-based MIP model that can be solved using a scalable column generation framework to produce a multiway-split tree that is more interpretable due to its shorter rules. Our method can optimize nonlinear metrics like F1 score and satisfy a broader class of constraints. We demonstrate its efficacy with extensive experiments including a million-sample dataset and report up to a 24X reduction in runtime compared to the state-of-art MIP-based methods.

2 Reducing Food Waste Through a Reservation System

Retsef Levi[1], Georgia Perakis[2], Emily Zhang[3], [1]MIT, Cambridge, MA, [2]Massachusetts Institute of Technology,

Cambridge, MA, [3]Massachusetts Institute of Technology, Cambridge, MA, Contact: eyzhang@mit.edu
With over one-third of all food produced going to waste, food waste is a critical issue that contributes to climate change and has adverse social and economic effects. We propose a grocery reservation system that aims to reduce food waste in grocery stores. Under this system, consumers can make advanced reservations for items at a reduced price or purchase them at the full price in-store. By providing the store with additional information about the customers' preferences, the reservation system can help to reduce demand variability, resulting in fewer unsold items going to waste. We identify conditions under which the reservation system can improve both profits and waste reduction, and our computational analysis shows that the reservation system can reduce expected waste by over 10% while increasing expected revenue by more than 5%.

3 Staffing Planning for Last Mile Delivery Drivers
Tolga Cezik[1], Tamar Cohen-Hillel[2], Liron Yedidsion[3], [1]Amazon.com, Seattle, WA, [2]UBC Sauder School of Business, Vancouver, BC, Canada; [3]Amazon, Redmond, WA
Staffing planning for last-mile delivery drivers is the process of planning the number of drivers required each week to deliver all the expected volume for a pre-determined time horizon, with the ability to adjust the decisions over time under guardrail restrictions. We formulate the problem as a multi-dimensional stochastic dynamic program with a newsvendor-based cost function. We propose an approximation algorithm to solve the problem near optimality in tractable time.
Session Chair: Pavithra Harsha, IBM Research, Pleasantville, NY

4 An Optimistic-Robust Approach for Omnichannel Inventory Management
Pavithra Harsha[1], Shivaram Subramanian[2], Ali Koc[1], Mahesh Ramakrishna[1], Brian Quanz[1], Dhruv Shah[1], Chandra Narayanaswami[1], [1]IBM Research, Yorktown Heights, NY, [2]IBM, Frisco, TX, Contact: pharsha@us.ibm.com
In this paper, we introduce a data-driven optimistic-robust bimodal inventory optimization (BIO) policy to allocate inventory across a retail chain to meet time-varying omnichannel demand. While prior Robust optimization (RO) methods emphasize the downside, i.e., worst-case adversarial demand, BIO also considers the upside to remain resilient like RO while also reaping the rewards of improved average-case performance. We provide structural insights about the BIO solution and how it can be tuned. Our experiments show significant benefits rethinking traditional approaches to inventory management that are siloed by channel and location, and additionally projects a 15% profitability gain for BIO over RO on real-world data from a mid-sized American retailer.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB25

CC-North 131A
Pricing and Risk Management in New Business Practices
Community Committee Choice Session
Session Chair: Soudipta Chakraborty, University of Kansas, Lawrence

1 Insuring Autonomous Vehicles: Perspectives from Operations Management
Amin Abbasi Pooya, Nagarajan Sethuraman, Suman Mallik, University of Kansas, Lawrence, KS, Contact: a.abbasipooya@ku.edu
The objective of our study is to model issues related to the insurance of autonomous vehicles. We use optimization and game theory to generate insights about monopolistic and competitive markets. Our models allow us to characterize equilibrium, analyze its properties, and provide useful insights.

2 Retail Category Management with Slotting Fees
Yasin Alan[1], Mumin Kurtulus[2], Alper Nakkas[3], [1]Vanderbilt University - Owen Graduate School of Management, Nashville, TN, [2]Vanderbilt University, Nashville, TN, [3]University of Texas at Arlington, Arlington, TX, Contact: yasin.alan@vanderbilt.edu
Slotting fees are lump-sum payments manufacturers make to retailers to secure slots for their products in retailers' assortments. We study the role of slotting fees in a retailer's category management decisions and strategic interactions with national brand manufacturers.

3 Is Your Price Personalized? Alleviating Customer Concerns with Inventory Availability Information
Qian Kenneth Zhang[1], Arian Aflaki[2], [1]University of Pittsburgh, Pittsburgh, PA, [2]University of Pittsburgh, Pittsburgh, PA, Contact: qiz91@pitt.edu
Research has shown that personalized pricing(PP), i.e., the practice of customizing prices for individual customers, can benefit firm and some customers. However, customer concerns about being targeted by such practices, especially those who pay higher prices. Using a Bayesian persuasion

framework, we study whether and under what conditions price can signal such PP implementation to customers. We also investigate whether disclosing inventory availability information can alleviate customer concerns and benefit the firm and customers.

4 Persuading Skeptics and Fans in the Presence of Additional Information

Tamer Boyaci[1], Soudipta Chakraborty[2], Huseyin Gurkan[3], [1]ESMT Berlin GmbH, Berlin, Germany; [2]University of Kansas, Lawrence, KS, [3]ESMT GmbH, Berlin, Germany. Contact: soudipta.c@ku.edu

Motivated by the practice of firms selectively soliciting reviews from experts, we study the information design problem of a demand-maximizing firm launching a product of unknown quality to a polarized market consisting of customers who have heterogeneous prior beliefs about quality and can acquire additional information from outside sources.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB26

CC-North 131B

Emerging topics in FinTech and novel financing schemes

Community Committee Choice Session

Session Chair: Jie Ning, Case Western Reserve University, Cleveland, OH

1 Quality Signaling Through Crowdfunding Pricing

Ehsan Bolandifar[1], Zhong Chen[2], Panos Kouvelis[3], Weihua Zhou[4], [1]HSBC Business School, Peking University, Shenzhen, China; [2]East China Normal University, Shanghai, China; [3]Washington University in St. Louis, St. Louis, MO, [4]Zhejiang University, Hangzhou, China. Contact: zchen@aebs.ecnu.edu.cn

This paper studies an entrepreneur's pricing strategy in a reward-based crowdfunding campaign under asymmetric product quality information. We develop a stylized game-theoretic signaling model with funding and regular selling periods, propose two signaling mechanisms and investigate how entrepreneurs can leverage their pricing strategy to signal a high-quality project. We show that the distinct feature of crowdfunding, that is, the probabilistic nature of crowdfunding, plays different roles in one- and two-price signaling. It is the driving force for the separating equilibrium in one-price signaling, and in two-price signaling, it affects how the entrepreneur should manipulate his funding and regular selling prices to reduce signaling cost.

2 Bargaining, Investment, and Trade Credit

Leon Chu[1], S. Alex Yang[2], Jin Yao[3], [1]Cheung Kong Graduate School of Business, Beijing, China; [2]London Business School, London, United Kingdom; [3]The University of Hong Kong, Hong Kong, Hong Kong

We propose a new theory that explains the prevalent usage of trade credit by even financially unconstrained firms. Using an alternative-offer bargaining model, we study the impact of trade credit on bilateral supply chain relationships and capacity investment. Under this bargaining framework, trade credit alters how the total payoff is shared between the two parties. This in turn alleviate holdup problem and boost supply chain capacity investment. Specifically, with trade credit, the market boost investment and profits of two parties in the supply chain are higher than those under the trade credit being not allowed.

3 Automating Supply Chain Contracts in the Presence of Demand Shifts and Contract Execution Lag

Xiaohang Yue, University of Wisconsin-Milwaukee, Milwaukee, WI

We develop an analytical model in which a supply chain can adopt either a conventional non-automated (long-term) contract or an automated contract in response to a potential demand shift. Under the automated contract, the wholesale prices are dynamically updated based on embedded Bayesian detection of the demand shift. A higher automation level means a smaller lag in executing the updated wholesale prices. A fully automated contract is known as a smart contract. We find that the magnitude and timing uncertainty of the demand shift are positive factors that favor the adoption of the automated contract in a supply chain. We also extend the model and explore the effect of supply chain competition on the adoption of automated contracts when two supply chains have Cournot competition.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB28

CC-North 132A

Recent topics in inventory and supply chain management

Flash Session

1 Economic Policy Uncertainty and Inventory Holdings: Global Evidence

Rajeev A[1], Vishnu K Ramesh[2], Athira A[3], [1]IIM Raipur, Raipur, India; [2]IIM Rohtak, Rohtak, India; [3]IIM Bangalore, Bangalore, India

Using economic policy uncertainty (EPU) as a proxy to measure country-level policy uncertainty, we study how policy shocks impact inventory levels. We also investigate how the association between EPU and inventories varies with respect to leanness, industry type, and country-development status. We find that higher policy uncertainty leads to an overall reduction in inventory holding. In our subsequent analysis, we find that amid rising EPU, firms increase their proportion of raw materials and reduce work-in-progress inventory and finished goods. Further, we find that the negative effect of policy uncertainty on inventory is less pronounced for lean and non-manufacturing firms. We also document that the negative association between EPU and inventory is more severe amongst firms in emerging firms.

2 A Model for Planning the Production of Multi-Product Orders in Flexible Deadlines Settings

Cristian D. Palma, Universidad del Desarrollo, Concepcion, Chile. Contact: cristianpalma@udd.cl

Most of the time, customers place production orders that include different products. Current optimization models for production planning aggregate different orders and translate them into product demand constraints to be met in specific periods according to the order deadlines. We show a model that explicitly considers production orders instead of products, and provides the flexibility of completing orders before their deadlines, allowing a more flexible use of resources. The model is used to plan the production in a sawmill, and both the model formulation and its benefits are presented.

3 Supply Chain Resilience:The Intervening Roles of Autonomy and Heteronomy

Jiuh-Biing Sheu[1], Vivi Kuo[2], [1]National Taiwan University, Taipei, Taiwan; [2]National Chin-yi University of Technology, Taichung, Taiwan

This paper investigates the moderating effects of autonomy and heteronomy on strategic procurement planning and customers' panic buying to influence supply chain resilience amid the beginning of the Covid-19 pandemic. Meanwhile, resilience restoration will have reciprocal causality on the buyers and end customers. Drawing on hyperbolic discounting theory and supply chain risk management research, we create a conceptual model that autonomy and heteronomy(Name-based rationing system, NBRS) considered separately are treated as two critical moderators on the effect of strategic procurement planning and consumers' panic buying on supply chain resilience.

4 Assessing Supply Chain Disruption Severity and Occurrence with a Competing Risk Model Using Random Survival Forests

Amin Keramati, Afrooz Moatari-Kazerouni, Widener University, Chester, PA, Contact: akeramati@widener.edu

Supply chain disruptions can significantly impact business operations, leading to increased costs and revenue loss. Previous research focused on predicting disruption occurrence or severity, but this study introduces a competing risk model to assess both aspects simultaneously. The authors utilize Random Survival Forest, a machine learning algorithm effective in handling high-dimensional data. The findings offer businesses and decision-makers an improved understanding of the simultaneous effects of disruption causes on severity and occurrence likelihood, enabling better preparation and management of potential disruptions.

5 Building a Resilient Supply Chain to Face Disruption: An Empirical Study

Subarna Haque[1], Mehmet Bayram Yildirim[1], Mehmet Barut[2], [1]Wichita State University, Wichita, KS, [2]Wichita State University, Wichita, KS, Contact: sxhaque@shockers.wichita.edu

Most organizations were not prepared for the disruptions caused by the COVID-19 pandemic. As a result, this pandemic impacted every aspect of the supply chain. Therefore, in this empirical study we have focused on the effect of risk mitigation strategies and supply chain operational efficiency to build supply chain resiliency. The result of this empirical study indicates that the proactive risk mitigation strategies have a positive impact on the supply chain operational efficiency; supply chain operational efficiency has a positive impact on the supply chain resilience; there is no significant moderating impact of the post risk mitigation strategies on the relationship between supply chain operational efficiency and supply chain resiliency.

6 Online Marketplace Channel Introduction Strategies Of Logistics Service Supply Chain

Jing Xu[1], Nengmin Wang[2], [1]Xi'an Jiaotong University, Xi'an, China; [2]Xi'an Jiaotong university, Xi'an, China. Contact: xujing@stu.xjtu.edu.cn

This study investigates the online marketplace channel introduction and information transparency investment strategies in a logistics service supply chain (LSSC) comprising a service integrator (LSI) and a service provider (LSP). We compare three models in centralized and decentralized supply chains: the reselling model, the dual-channel model, and the marketplace model. We find that the competition in dual-channel presents a bright side on information transparency investment in some cases, and in a centralized supply chain, the dual-channel model is always a dominant strategy. However, the case in which the LSI and LSP reach a consensus is limited in a decentralized supply chain, and a sufficient low commission rate and high investment efficiency are not favorable for LSP and LSI, respectively.

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WB29

CC-North 132B

Socially Responsible Supply Chains

Community Committee Choice Session

Session Chair: Leon Valdes, University of Pittsburgh, Pittsburgh, PA

1 Transparency into Sustainability Initiatives: A Field Experiment

Neslihan Ozlu[1], Basak Kalkanci[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, Contact: neslihan.ozlu@scheller.gatech.edu

As customers become more aware of the importance of sustainable supply chains, companies are being prompted to be transparent about their environmental and social responsibility initiatives and communicate them to customers. We collaborate with an apparel company that is active in both internal and external responsibility initiatives. Through our field experiments, we use audio and video displays to inform customers about these initiatives. By conducting these experiments in developing countries, we can analyze the effect of these initiatives on customers' purchasing behavior, and compare them with findings in the develop world.

2 Sustainability Implications of Supply Chain Responsiveness

Robert Swinney, Ali Kaan Tuna, Duke University, Durham, NC, Contact: alikaan.tuna@duke.edu

We study the environmental implications of a critical decision made by many firms: whether to adopt a responsive supply chain (prioritizing speed) or an efficient supply chain (prioritizing cost). We analyze a model wherein responsiveness increases marginal costs, decreases leadtimes, and changes the per-unit environmental impact of production and distribution. We consider three pathways to achieve responsiveness: offshoring uses expedited production and transportation methods; nearshoring reduces the physical distance between source and destination; and hybrid nearshoring is a mix of efficient production and nearshoring. We show that responsiveness is likely to both maximize firm profit and minimize environmental impact when demand variability is high and unsatisfied customers substitute with a product that generates high environmental impact.

3 Mitigating Shortages Of Generic Drug Supply: The Role Of Risk Certification

Robert Swinney, Xiaoyu Wu, Can Zhang, Duke University, Durham, NC, Contact: xiaoyu.wu@duke.edu

Generic drugs play a vital role in the U.S. healthcare system. However, generic drugs have experienced severe shortages due to supply disruptions, caused by a number of factors including low profit margins that lead manufacturers to underinvest in supply reliability. The U.S. Food and Drug Administration has recently proposed to implement a certification system that assesses the reliability of generic drug manufacturers. We propose a game-theoretic model that captures the effects of such a reliability certification. We characterize mandatory and voluntary certification schemes and discuss the impact of subsidizing reliable suppliers in the certification system. Interestingly, certification may motivate suppliers to invest more in reliability; however, this may increase the likelihood of a shortage once the buyer adjusts its sourcing strategy in response.

4 Behavioral Biases in Social Audits: An Experiment

Gabriel Pensamiento[1], Leon Valdes[2], [1]Katz Business School, University of Pittsburgh, Pittsburgh, PA, [2]University of Pittsburgh, Pittsburgh, PA, Contact: gap75@pitt.edu

Companies often rely on third-party audits to assess the social and environmental practices of their suppliers. However, empirical evidence suggests that these audits may be too lenient and that poor practices can go undetected or unreported. We designed an incentivized lab experiment to investigate some of the causes and mechanisms behind this behavior. Specifically, we examine how the supplier choosing and/or paying the auditor affects the leniency of audit reports. In addition, we explore whether and to what extent these effects are impacted by what received information suggests is the supplier's true type, auditors' biased beliefs (stemming from motivated reasoning), and reciprocity towards the audited firm.

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WB30

CC-North 132C

Behavioral Revenue Management

Community Committee Choice Session

Session Chair: Haokun Du, The University of Texas at Dallas, Richardson, TX

Session Chair: Na Zhang, Warrington College of Business, University of Florida, Gainesville, FL

1 Bargaining for Advance Purchase Discount

Haokun Du, Minmin Zhang, Elena Katok, The University of Texas at Dallas, Richardson, TX

Traditional newsvendor model concerns a highly structured one-shot game. In this paper, we consider two extensions to the traditional model: the supplier could produce more than what the retailer orders and the retailer could order additionally after demand realization, and (some of) the terms of transfer are negotiated in an unstructured manner. Our theory builds upon Nash bargaining framework and utilizes backward induction to derive normative predictions. We consider four different schemes and propose to test the theories with experiments. Preliminary results suggest that the theory fails to capture behavioral regularities and we discuss some of the implications.

2 Sharing Economy Platforms with Reference-Dependent Gig Workers

Na Zhang[1], Anand Paul[2], Liangfei Qiu[3], [1]Warrington College of Business, University of Florida, Gainesville, FL, [2]University of Florida, Gainesville, FL, [3]University of Florida Warrington College of Business Administration, Gainesville, FL

The sharing economy and gig workers have become a major feature in modern economies. The empirical literature shows that gig workers have reference-dependent, loss-averse preferences toward wage. To fill the gap between prior theoretical work, we initiate a theoretical study of gig worker's reference-dependent, loss-averse preferences in sharing economy platforms.

3 Community/Committee'S Choice Submission

Qiuxia Chen, The University of Texas at Dallas, Richardson, TX

4 Behavior-Based Personalization with Endogenous Consumer Preferences

Dawei Jian, University of Wisconsin - Milwaukee, Milwaukee, WI

Behavior-based personalization allows firms to improve product match, build long-term relationships, capitalize on CLV. We study a new class of personalization problems, where a consumer's past behavior reveals her current preference, and influences her future valuation. A challenge is how to simultaneously learn and shape the consumer's evolving preferences through service offerings. The optimal solution serves the purposes to prevent cannibalization, exploit consumer habituation, and extract surplus. The solution deploys a novel mechanism of homogenization to reduce future valuation heterogeneity. Our study helps explain the popularity of behavior-based personalization: it can help firms to leverage consumer uncertainty, relax self-selection constraints, and internalize surplus gain. As such, it can improve social welfare and produce Pareto outcomes.

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CC-North 221A

Network Optimization Applications

Contributed Session

Session Chair: Dung Nguyen, Colorado State University, Fort Collins, CO

1 Boosting Efficiency in Power System State Estimation Leveraging Attention Mechanism

SangWoo Park, New Jersey Institute of Technology (NJIT), North Bergen, NJ, Contact: sangwoo.park@njit.edu

Ensuring stability in power systems requires accurate state estimation, which is challenging due to the presence of noise in measurements, nonlinearity of power flow equations and potential false data injections. We introduce the Graph Attention Estimation Network (GAEN) model for power system state estimation, which leverages the graph structure of power grids for efficient information exchange, distributed architecture, and resilience to cyber-attacks. Using Graph Convolutional Neural Networks (GCNNs) and attention mechanisms, we address the limitations of previous architectures. Empirical results show superior performance, scalability, and heightened efficacy compared to traditional techniques. This work advances the integration of learning architectures in power system state estimation, fostering reliable and secure power networks.

2 Production Networks Resilience: Cascading Failures, Power Laws and Optimal Interventions

Marios Papachristou[1], M. Amin Rahimian[2], [1]Cornell

University, Ithaca, NY, [2]University of Pittsburgh, Pittsburgh, PA, Contact: rahimian@pitt.edu

We propose a node percolation process on production networks that model product suppliers failing independently due to exogenous, systemic shocks and causing other products to fail when production requirements are unmet. We first show that the size of the cascading failures follows a power law in random directed acyclic graphs, whose topology encodes the natural ordering of products from simple raw materials to complex products. This motivates the need for a resilience metric, which we define as the maximum magnitude shock the production network can withstand with only a small fraction of products failing. We study the resilience of several architectures and classify them as resilient or fragile depending on their topological attributes. Finally we offer optimal interventions for improving resilience, empirically evaluate the resilience metrics and interventions.

3 A Benders-Decomposition Approach for Network Topology Optimization with Port Selection

Linxin Yang[1], Yuan Wang[2], Akang Wang[2], Xiaodong Luo[2], [1]The Chinese University of Hong Kong, Shenzhen, Shenzhen, China; [2]Shenzhen Research Institute of Big Data, Shenzhen, China. Contact: linxinyang@link.cuhk.edu.cn

The network topology optimization problem with port selection aims to identify routes for data streams and data-port assignments in wireless networks such that the total operational cost is minimized. We formulate this problem as a mixed-integer linear program and then tackle it via a Benders-decomposition approach. The master problem determines data flow routes while the subproblem assigns ports to each data stream. Since the subproblem entails discrete decision-making, we resort to scaled cuts for convexification. We conduct extensive computational experiments, and the results demonstrate that our proposed approach significantly outperforms off-the-shelf general-purpose optimization solvers.

4 Improved Airline Network Topologies for Building Resilient & Robust Aviation Infrastructures

Ashwini Ravindran, Sergiy Butenko, Texas A&M University, College Station, TX

We propose new mathematical models to generate network connectivity patterns for airline networks in order to provide cost-effective solutions for enhanced operational efficiency and airport connectivity with improved tolerance to node disruptions. The objective is to enable the creation of a modeling and optimization framework for the design and development of commercial airline networks and analyze them from a graph theoretic perspective. We compare these newly developed theoretically optimal network topologies with the existing airline networks to evaluate its performance with regard to connectivity, robustness, resilience and tolerance to targeted attacks.

5 A Scalable Optimization Model to Prioritize Landscape Fuel-Break Investment for Effective Wildfire Management

Dung Nguyen[1], Yu Wei[1], Erin Belval[2], Matthew Thompson[3], Benjamin Gannon[4], Jesse Young[5], David Calkin[5], [1]Colorado State University, Fort Collins, CO, [2]Rocky Mountain Research Station, USDA Forest Service, Fort Collins, CO, [3]USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO, [4]USDA Forest Service, National Office, Fire and Aviation Management, Fort Collins, CO, [5]USDA Forest Service, Rocky Mountain Research Station, Missoula, MT, Contact: dung.nguyen@colostate.edu

Optimization modeling for wildfire management has been a challenge due to the need for exact methods to handle vast datasets and large landscape scales. We introduce an exact optimization model based on mixed integer linear programming to prioritize investment in a landscape's fuel-break network and maximize protection against wildfires. We demonstrate the model's scalability through its implementation in a large Southern California landscape, with several hundred thousand simulated wildfires being used to find optimal fuel-break locations under different budget scenarios. Sensitivity analysis confirms the effectiveness and robustness of our model, making it a powerful tool to leverage data and improve decision-making in wildfire management.

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CC-North 221B

Facility Management and Network Design

Contributed Session

Session Chair: Lingyun He, Pennsylvania State University, State College, PA

1 A Beautiful Shock? Exploring the Impact of Pandemic Shocks on the Accuracy of Ai Forecasting in the Beauty Care Industry

Ilya Jackson, MIT, Cambridge, MA, Contact: ilyajack@mit.edu

This research focuses on the profound impact of the shocks caused by the COVID-19 pandemic on the accuracy of AI-based demand forecasting in the beauty care industry. It aims to understand the key factors that led to decreased forecasting accuracy during the pandemic and employs causal mediation analysis to systematically investigate this complex issue. The empirical analysis is conducted using extensive order data from a major beauty care product manufacturer and distributor, covering the pre-pandemic, pandemic, and post-pandemic periods. The findings reveal that it is primarily the increase in demand volatility, and not the surge in sales volume, that has led to an increase in forecasting errors. This research provides crucial insights into the nuanced effects of macroeconomic shocks and consumer behavior changes on AI-based forecasting within the beauty care industry. Furthermore, it highlights the importance of understanding the underlying mechanisms that drive forecasting errors, paving the way for more resilient and robust demand forecasting systems in the future.

2 Pickup and Delivery Problem with Time Window and Ride-Time Constraints

Xinbo Zhang, City University of Hong Kong, Hong Kong, Hong Kong. Contact: xinbzhang3-c@my.cityu.edu.hk

The PDPTW-RD is an important generalization of VRP and a basic distribution management problem that can be modeled for real-world problems and which consists of designing a set of minimum cost routes, originating and terminating at a central depot, for vehicles that service a set of customers with known demands. The customers must be assigned exactly once to vehicles such that the vehicle capacities are not exceeded. The service to a customer must begin within the time window when the customer permits the start of service. This paper proposes a path-based set-partitioned-liked formulation that derives the lower bounds. We propose the exact cut-and-column generation to find the optimal routes. Computational experiments show that our proposed algorithm can solve instances optimally up to around 50 requests.

3 Integrated Optimization of Train Path Selection and Rolling Stock Planning in Freight Transportation: A Column Generation Approach

Louis Fourcade[1,2], Stéphane Dauzère-Pérès[3], Juliette Pouzet[1], [1]SNCF SA, Saint-Denis, France; [2]Ecole Des Mines de Saint-Etienne, Gardanne, France; [3]Ecole Des Mines de Saint-Etienne, Gardanne, France

The optimal use of critical resources, in particular train paths, rolling stock and drivers, is crucial for railway companies to improve their operational efficiency and to reduce their costs. In this work, we explore the design and solutions through column generation of optimization models for the integrated planning of train paths and rolling stock for freight transport. We consider various constraints such as maximum load, maximum length, delivery time and rolling stock availability. Real-world data on the French railway network is used to validate the proposed approach, and good solutions are obtained in reasonable computational times. Our integrated approach is also compared with a sequential approach.

4 Capacity Pooling for Network Revenue Management

Asrar Ahmed[1], Milind Sohoni[2], Sumit Kunnumkal[3], Raja Gopalakrishnan[4], [1]ISB Hyderabad, Hyderabad, India; [2]Indian School of Business, Hyderabad, India; [3]ISB, India, India; [4]Indian Railways, New Delhi, India. Contact: asrar_ahmed@isb.edu

Motivated by the resource allocation rule used by a large passenger rail operator, we consider a novel variant of the classical network revenue management. In our setting, the firm, along with carrying dedicated capacities for its products, sets aside some of its capacity that is common for all products. The firm's decision problem is to determine the optimal partitioned and common pooled capacities. We model the above problem as a dynamic program and provide insights into simple conditions under which only-pooling or only-pooling is optimal. To address the large state space of the dynamic program, we develop a Lagrange relaxation-based solution, benchmark it against the deterministic linear program and find the Lagrange relaxation provides tighter upper bounds. Finally, we evaluate our solution on synthetic and real-world data sets.

5 Using Machine Learning/Regression Analysis to Solve the Equilibrium Network Design Problem

Lingyun (Iris) He, Terry Lee Friesz, Pennsylvania State University, State College, PA, Contact: lbh5479@psu.edu

For applications of realistic size, the continuous equilibrium network design problem is often too computationally intensive to be solved. To fill this gap, we developed machine learning models to predict the relationship between the equilibrium traffic flow and capacity improvement. We created a data set by fixing capacity improvements and solving for the corresponding equilibrium traffic flow using standard methods. These data were used to derive relationships between arc flows and capacity using a variety of regression schemes. Such relationships are used to reduce the problem to a conventional mathematical program whose solution is relatively easy and produces new local optima superior to those discovered historically using an MPEC formulation.

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WB33

CC-North 221C

Optimization for Deep Learning: Modern Perspectives

Community Committee Choice Session

Session Chair: Kayhan Behdin, Massachusetts Institute of Technology, Cambridge, MA

1 A Theory for Overparameterization

Jianhao Ma, University of Michigan, Ann Arbor, MI

Overparameterization plays an extremely important role in modern machine learning. However, it is still unclear whether overparameterization affects underlining optimization. In this work, we identify some sufficient and necessary conditions under which overparameterization can benefit the optimization.

2 How Does Sharpness-Aware Minimization Minimize Sharpness?

Zhiyuan Li, Toyota Technological Institute at Chicago, Chicago, IL

Sharpness-Aware Minimization (SAM) is a highly effective regularization technique for improving the generalization of neural networks. However, the underlying working of SAM remains elusive. SAM intends to penalize a notion of sharpness of the model but implements a computationally efficient variant; moreover, a third notion of sharpness was used for proving generalization guarantees. his paper rigorously nails down the exact sharpness notion that SAM regularizes and clarifies the underlying mechanism. We also show that the two steps of approximations in the original motivation of SAM individually lead to inaccurate local conclusions, but their combination accidentally reveals the correct effect, when full-batch gradients are applied. Furthermore, we also prove that the stochastic version of SAM in fact regularizes the third notion of sharpness mentioned above.

3 On First-Order Meta-Reinforcement Learning with Moreau Envelopes

Mohammad Taha Toghani[1], Sebastian Perez-Salazar[2], Cesar A. Uribe[3], [1]Rice University, HOUSTON, TX, [2]Rice University, HOUSTON, TX, [3]Rice University, Houston, TX, Contact: mttoghani@rice.edu

We study the Meta-Reinforcement Learning (MRL) problem under the policy gradient formulation, where we propose a novel algorithm that uses Moreau Envelope surrogate regularizers to jointly learn a meta-policy that is adjustable to the environment of each individual task. Our algorithm, Moreau Envelope Meta-Reinforcement Learning (MEMRL), learns a meta-policy that can adapt to a distribution of tasks by efficiently updating the policy parameters using a combination of gradient-based optimization and Moreau Envelope regularization. We provide a detailed analysis of the MEMRL algorithm, where we show a sublinear convergence rate to a first-order stationary point for non-convex policy gradient optimization. We finally show the effectiveness of MEMRL on a multi-task 2D-navigation problem.

4 The Dynamics of Neural Network Training: Edge of Stability

Jeremy Cohen, Carnegie Mellon University, Pittsburgh, PA, Contact: jeremycohen@cmu.edu

According to classical optimization theory, gradient descent converges because its step size is set small relative to the curvature of the objective function. Yet recent studies have demonstrated that this is not how deep learning works. Instead, in deep learning, gradient descent *automatically* remains in low-curvature regions via an in-built negative feedback mechanism that was only discovered recently. The mechanism is: if the curvature is high, gradient descent oscillates, yet these oscillations implicitly trigger a movement into lower-curvature regions - an effect revealed by a cubic Taylor approximation (rather than the usual quadratic one). Rigorous mathematical analysis of this behavior is needed, and could even conceivably lead to improved algorithms for training neural networks.

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CC-North 222A

First-Order Methods for Challenging Constrained Optimization Problems

Community Committee Choice Session

Session Chair: Paul Grigas, UC Berkeley, Berkeley, CA

1 Nonconvex Functional Constrained Optimization with Applications in Risk Aversion and Sparsity Control

Yi Cheng, Amazon LLC, Bellevue, WA

Risk and sparsity are essential in many applications, e.g., portfolio optimization, assortment planning, and healthcare treatment planning. Effectively balancing these requirements involves nonconvex functional constrained formulation and the creation of projection-free methods. In this talk, we introduce Level Inexact Proximal Point (LIPP) and Direct Nonconvex Conditional Gradient (DNCG) for solving challenging nonconvex functional constrained problems by generating sparse solution trajectory with risk aversion. LIPP leverages a convex oracle to solve a series of subproblems while DNCG is a single-loop algorithm directly accessing the conditional gradient step. Effectiveness of LIPP and DNCG is demonstrated by two risk averse sparse applications: (1) cardinality-constrained portfolio selection, (2) radiation therapy treatment planning.

2 Some Primal-Dual Theory for Subgradient Methods for Strongly Convex Optimization

Benjamin Grimmer, Danlin Li, Johns Hopkins University, Baltimore, MD, Contact: grimmer@jhu.edu

We consider (stochastic) subgradient methods for strongly convex but potentially nonsmooth non-Lipschitz optimization. We provide new equivalent dual descriptions (in the style of dual averaging) for the classic subgradient method, the proximal subgradient method, and the switching subgradient method. These equivalences enable optimal convergence guarantees for both a classic primal gap and a not previously analyzed dual gap. Consequently, our theory provides these classic methods with simple, optimal stopping criteria and optimality certificates at no added computational cost. Our results apply under nearly any stepsize selection and for a range of non-Lipschitz ill-conditioned problems where the early iterations of the subgradient method may diverge exponentially quickly (a phenomenon which, to the best of our knowledge, no prior works address).

3 Splitting Conditional Gradient Algorithms

Zev Woodstock, Zuse Institute Berlin (ZIB), Berlin, Germany

Classical Conditional Gradient minimization algorithms enforce a single closed convex constraint using its linear minimization oracle (LMO). We develop and analyze a method for minimization over an intersection of multiple sets without computing the LMO of their intersection (which is often computationally expensive) - instead, we use LMOs for the individual sets.

4 Stochastic First-Order Algorithms for Constrained Distributionally Robust Optimization

Hyungki Im[1], Paul Grigas[2], [1]UC, Berkeley, Berkeley, CA, [2]UC Berkeley, Berkeley, CA

We consider distributionally robust optimization (DRO) problems with multiple expectation constraints. We propose a generic stochastic first-order meta-algorithm, wherein the decision variables and uncertain distribution parameters are each updated separately by applying stochastic first-order methods. We then specialize our results when using particular versions of stochastic mirror descent to update both sets of variables. In this case, we demonstrate that the per iteration cost to update the decision variables is almost independent of the dimension of the distribution parameters. When the ambiguity sets are □^{2}-divergence sets, we additionally show that the update cost of the distribution parameters is almost independent of the dimension of the distribution parameters.

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CC-North 222B

Geometry and Optimization Methods

Community Committee Choice Session

Session Chair: Dogyoon Song, 1</sup

Session Chair: Diego Cifuentes, Georgia Institute of Technology, Atlanta, GA

1 Geometry of Regularizing Norms and Structured M-Estimation

Dogyoon Song[1], Venkat Chandrasekaran[2], [1]University of Michigan, Ann Arbor, MI, [2]California Institute of Technology Division of Engineering and Applied Science, Pasadena, CA, Contact: dogyoons@umich.edu

Regularization is a fundamental technique in optimization with numerous applications. In this talk, we discuss the geometric properties of the solution of regularized optimization problems --- particularly the minimizer of the objective function consisting of a loss and a regularizing norm. We introduce a novel concept of "structure" induced by the regularizer in terms of geometric properties of the associated convex body. Further, we identify the class of regularizers that induce such a structure. Additionally, we examine the geometry of regularized M-estimators, presenting a condition for successful structure-consistent estimation. Our findings offer advancements in the analysis of graphical Lasso and low-rank matrix estimation, among others. Overall, these results provided enhanced insights into the role of regularization and its potential applications.

2 A Superlinearly Convergent Subgradient Method for Sharp Semismooth Problems

Vasileios Charisopoulos, Cornell University, Ithaca, NY
Standard first-order methods for nonsmooth optimization can be slow for "poorly conditioned" problems. In this talk, I will present a locally accelerated first-order method that is less sensitive to conditioning and achieves superlinear convergence near solutions for a broad class of sharp semismooth problems and discuss its stochastic extensions. The algorithm is inspired by Newton's method for solving nonlinear equations.
Joint work with Damek Davis.

3 Outlier-Robust Second-Order Nonconvex Optimization and Its Application to Low-Rank Matrix Sensing
Shuyao Li[1], Yu Cheng[2], Ilias Diakonikolas[1], Jelena Diakonikolas[1], Rong Ge[3], Stephen Wright[1], [1]University of Wisconsin-Madison, Madison, WI, [2]Brown University, Providence, RI, [3]Duke University, Durham, NC, Contact: shuyao.li@wisc.edu
Finding an approximate second-order stationary point (SOSP) is a fundamental problem in stochastic nonconvex optimization. However, this problem is poorly understood in the presence of outliers. In this paper, we study the problem of finding SOSPs where a constant fraction of the datapoints are arbitrarily corrupted. As our main application, low-rank matrix sensing can be robustly solved in our framework, which allows for corruptions in both the sensing matrices and the measurements. We further take advantage of the geometry of low-rank matrix sensing to show that if measurements are taken with no additive noise, we can achieve exact recovery with gradient descent. On the lower bound side, we establish a Statistical Query lower bound showing that the quadratic dependence on the dimension in the sample complexity is necessary for computationally efficient algorithms.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB36

CC-North 222C
New advances in global optimization -- theory and applications
Community Committee Choice Session
Session Chair: Andy Sun, 1</sup

1 Advances in Constructing Tight Quadratic Underestimators for Global Optimization
William Strahl[1], Arvind Raghunathan[2], Nikolaos Sahinidis[3], Chrysanthos E. Gounaris[1], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Mitsubishi Electric Research Laboratories, Cambridge, MA, [3]Georgia Institute of Technology, Atlanta, GA
Global optimization algorithms typically rely on polyhedral outer approximations to determine lower bounds. We explore the potential of using quadratic outer approximations to expedite these algorithms by tightening bounds and increasing fathoming. Our approach is implemented in a cutting-plane algorithm that generates quadratic underestimators for C^2 convex and non-convex difference of convex functions by scaling the 2^{nd} order term of a Taylor series expansion. We will present methodological advances and computational results for these underestimators, including their hierarchical tightening through non-uniform Hessian matrix scaling and their impact in accelerating the convergence of outer approximation algorithms for MINLPs.

2 Facility Planning For EV Battery Recycling Via Adaptive Piecewise Linearization
Matthew Brun[1], Andy Sun[2], [1]Operations Research Center, MIT, Cambridge, MA, [2]MIT, Cambridge, MA, Contact: brunm@mit.edu
Recycling of spent electric vehicle (EV) batteries has the potential to address issues surrounding both disposal of retired batteries and sourcing of critical minerals required for new battery manufacture. We construct a long-term facility planning model to determine an optimal investment strategy in EV battery recycling plants. The model is a linearly constrained concave minimization problem, which we solve by a new global optimization algorithm that adaptively constructs piecewise linear approximations of the objective functions and solves them as a sequence of mixed-integer linear programs. This method converges to a global optimal solution in a finite number of iterations and allows for considerable speedup relative to spatial branch and bound algorithms by leveraging the power of MILP solvers to approach a continuous nonconvex problem.

3 Convexification Techniques for Fractional Programs
Mohit Tawarmalani[1], Taotao He[2], Siyue Liu[3], [1]Purdue University, West Lafayette, IN, [2]Shanghai Jiaotong University, Shanghai, China; [3]Carnegie Mellon University, Pittsburgh, PA, Contact: mtawarma@purdue.edu
We convexify various sets involving fractional functions using a projective transformation that allows us to clear denominators. This result recovers the SDP formulation for the convex hull of ratio of two nonconvex quadratics over an ellipsoid, yields new formulations to minimize quasiconvex functions defined as a ratio of a convex and a concave

function, and new results that relate convex hulls of certain functions that appear in distillation problems with the convex hull of moment curve.

4 Community/Committee'S Choice Submission

Rahul Mazumder, Massachusetts Institute of Technology, Cambridge, MA

Wednesday, October 18, 9:30 AM - 10:45 AM

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CC-North 223

Multi-Stage Stochastic and Robust Programs

Community Committee Choice Session

Session Chair: Beste Basciftci, University of Iowa

1 Distributionally Robust Optimization with Decision-Dependent Information Discovery

Qing Jin[1], Angelos Georghiou[2], Phebe Vayanos[3], Grani Adiwena Hanasusanto[4], [1]University of Southern California, LA, CA, [2]University of Cyprus, Nicosia, Cyprus; [3]University of Southern California, Los Angeles, CA, [4]University of Illinois Urbana-Champaign, Urbana, IL, Contact: qingjin@usc.edu

We study two-stage distributionally robust optimization problems with decision-dependent information discovery (DRO-DDID) wherein (a portion of) the uncertain parameters are revealed only if an (often costly) investment is made in the first stage. We formulate the problem as a min-max-min-max problem and adopt the popular K-adaptability approximation scheme. We then present a decomposition algorithm that solves the K-adaptable formulation exactly. In particular, we devise a cutting plane algorithm which iteratively solves a relaxed version of the problem, evaluates the true objective value of the corresponding solution by a branch-and-cut algorithm, generate valid cuts and imposes them in the master problem. We showcase the effectiveness of our framework on the R&D project portfolio optimization problem and the best box problem.

2 Multi-Stage Stochastic Programming for Integrated Hurricane Evacuation and Logistics Planning

Sudhan Bhattarai, Yongjia Song, Clemson University, Clemson, SC, Contact: sudhanb@g.clemson.edu

We study an integrated hurricane relief logistics and evacuation planning (HRLEP) problem. We propose stochastic optimization models and methods that integrate the hurricane relief item pre-positioning problem and the hurricane evacuation planning problem, which are often treated as separate problems in the literature, by incorporating the forecast information as well as the forecast errors (FE). Specifically, we fit historical FE data into an auto-regressive model of order one (AR-1), from which we generate FE realizations to create evacuation demand scenarios. We propose a fully adaptive multi-stage stochastic programming method to solve HRLEP. We conduct a preliminary numerical experiment based on real-world data to validate the value of stochastic optimization.`

3 Adaptive Multistage Stochastic Programming

Sezen Ece Kayacik[1], Beste Basciftci[2], Albert Schrotenboer[3], Evrim Ursavas[4], [1]University of Groningen, Groningen, Netherlands; [2]University of Iowa, Iowa City, IA, [3]Eindhoven University of Technology, Eindhoven, -, Netherlands; [4]University of Groningen, Groningen, Netherlands

Multistage stochastic programming is a powerful tool that allows decision-makers to adapt decisions at each stage based on the realized uncertainty. However, fully adaptive approaches may not be applicable due to the need for consistency in decision-making. To strike a balance between adaptability and stability, we propose an adaptive multistage stochastic programming approach which revises the decisions at stages determined optimally providing a partial flexibility. We introduce a novel model with theoretical properties to reduce the model size. We develop a solution algorithm based on the Integer L-shaped method and Benders decomposition. Computational experiments on lot-sizing and generation expansion planning show the importance of partial flexibility, as our approach converges to optimal multistage stochastic programming even with limited revisions.

4 Markov Chain-Based Policies for Multi-Stage Stochastic Integer Linear Programming

Margarita Castro[1], Merve Bodur[2], Yongjia Song[3], [1]Pontificia Universidad Católica de Chile, Santiago, Chile; [2]University of Toronto, Toronto, ON, Canada; [3]Clemson University, Clemson, SC, Contact: bodur@mie.utoronto.ca

We introduce a novel aggregation framework to address multi-stage stochastic programs with mixed-integer state variables and continuous local variables (MSILPs). Our aggregation imposes additional structure to the integer state variables by leveraging the information of the underlying stochastic process, which is modeled as a Markov chain (MC). We demonstrate that the aggregated MSILP can be solved exactly via a branch-and-cut algorithm integrated with a variant of stochastic dual dynamic programming. To improve tractability, we propose to use this approach to obtain dual bounds. We apply two-stage linear decision rule approximations and propose MC-based variants to obtain high-quality decision policies with significantly reduced computational effort. We test the proposed methodologies in a novel MSILP model for hurricane disaster relief logistics planning.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB38

CC-North 224A

Exploring Equilibrium in Games

Contributed Session

Session Chair: Bill W. Corley, University of Texas at Arlington, Arlington, TX

1 Energy Function Based Approach for Generalized Nash Equilibrium Problems

Nabiha Nasir Orpa, Lichun Li, FAMU-FSU College of Engineering, Tallahassee, FL, Contact: no18k@fsu.edu

Generalized Nash Equilibrium (GNE) is an extended version of the traditional Nash Equilibrium, where players' objectives and strategy sets depend not only on their own actions but also on their opponents'. It has many practical applications in non-cooperative multi-agent problems, but its computational difficulties limit its application in practical scenarios. Our proposed algorithm uses an energy function-based approach to efficiently compute Nash Equilibrium of GNE problems, which include equality and inequality constraints. The energy function's unique structure produces a zero value when the players reach the equilibrium point. To address the constraint component of the problem, we have introduced a set of dual players with special objective functions, which act as opponents of the primal players when they go out of bounds.

2 Perfect Bayesian Equilibrium with Common-Action-Independent Consistency and Its Square-Root-Barrier Selection

Yiyin Cao[1], Chuangyin Dang[2], [1]City University of Hong Kong, Hong Kong, Hong Kong; [2]City University of Hong Kong, Kowloon, China. Contact: yiyincao2-c@my.cityu.edu.hk

The concept of perfect Bayesian equilibrium was established through a slight relaxation to the requirements of sequential equilibrium while sustaining the subgame perfection. However, this establishment lacks a practicable and effective formulation for computationally finding such an equilibrium. To resolve this deficiency, this paper introduces common-action-independent consistency on beliefs and develops a mathematical characterization of perfect Bayesian equilibrium with this consistency through local sequential rationality. As a result of this characterization, the perfect Bayesian equilibrium can be explicitly specified by a polynomial system, which leads to a differentiable path-following method for computing such an equilibrium. Numerical results further confirm the effectiveness and efficiency of the method.

3 Meta Heuristic Optimization of Mechanism Design

Zheyong Bian[1], Bijun Wang[2,2], [1]University of Houston, Houston, TX, [2]Florida Polytechnic University, Lakeland, FL, Contact: zbian2@central.uh.edu

This research innovates the optimization of mechanism design problems, in which multiple rational agents are coordinating a Nash Equilibrium state in complex systems. Different from conventional optimization, given a set of decision variables, an objective function, and a set of constraints for these decisions, mechanism optimization aims to selects the optimal mechanism from a set of feasible mechanisms with an objective function given a set of Nash Equilibrium states and a set of constraints for mechanism results. Instead of developing analytical solutions to mechanism optimization problems that can be formulated as stochastic bi-level optimization models, this research develops a novel concept of mechanism optimization meta-heuristics that iterate to search in a mechanism space by changing possible mechanism parameters and mechanism results.

4 Quasi-Sequential Equilibrium and Its Smooth-Path Selection

Yiyin Cao, Chuangyin Dang, City University of Hong Kong, Kowloon, Hong Kong

By slightly relaxing the requirements of sequential rationality and consistency on beliefs in a sequential equilibrium while retaining subgame perfection, we establish the concept of quasi-sequential equilibrium through the introduction of common-action-and-belief-independent consistency. This relaxation allows an explicit mathematical characterization through local sequential rationality, which directly yields a polynomial system as a necessary and sufficient condition for a quasi-sequential equilibrium. For many well-known games, a quasi-sequential equilibrium is identical to a sequential equilibrium. To compute such an equilibrium, we develop a differentiable path-following method by constituting a square-root-barrier agent extensive-form game. Numerical results further confirm the effectiveness and efficiency of the method.

5 Pure Scalar Equilibria for Normal Form Games

Bill Corley, University of Texas at Arlington, Arlington, TX, Contact: corley@uta.edu

A scalar equilibrium (SE) is an alternative type of equilibrium in pure strategies for an n-person normal-form game G. It yields a pure strategy for each player of G by maximizing an appropriate utility function chosen by the players or an arbitrator over the acceptable joint actions. An SE is an equilibrium since no players of G can increase the value of this utility function by changing their strategies. Examples include a greedy SE in which the players' action give them the largest individual payoffs jointly possible, as well as a satisficing SE in which each player achieves a personal target payoff value. The vector payoff associated with each of these SEs is shown to be Pareto optimal and computationally tractable.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB39

CC-North 224B

Security and Privacy of Intelligent Transportation Systems (ITS)

Community Committee Choice Session

Session Chair: Mohamadhossein Noruzoliaee, University of Texas Rio Grande Valley, Edinburg, TX

1 Anomaly Detection Against Gps Spoofing Attacks on Connected and Autonomous Vehicles Using Learning from Demonstration

Yiheng Feng, Purdue University, West Lafayette, IN, Contact: feng333@purdue.edu

GPS spoofing attacks pose great challenges to connected vehicle (CVs) safety applications and localization of autonomous vehicles (AVs). In this study, we a novel anomaly detection method using learning from demonstration is developed, which can be implemented in both vehicles and at the transportation infrastructure. A computational-efficient driving model, which can be learned from historical trajectories of the vehicles, is constructed to predict normal driving behaviors. Then a statistical method is developed to measure the dissimilarities between the observed trajectory and the predicted normal trajectory for anomaly detection. We validate the proposed method using two threat models on two real-world datasets. Results show that the proposed model is able to detect almost all of the attacks in time with low false positive and false negative rates.

2 Informational Cyber Resilience in Intelligent Transportation Systems

Quanyan Zhu, New York University, New York, NY, Contact: qz494@nyu.edu

Transportation systems rely heavily on information systems, creating vulnerabilities to data poisoning, manipulation, and misinformation across inter-vehicle, intra-vehicle, system, and human domains in intelligent transportation systems (ITS). Cyber resilience is critical for dependable and safe transportation infrastructure. Our framework enables quantification of tradeoffs and facilitates proactive mitigation through feedback and learning-based mechanisms. We will discuss zero-trust and proactive defense mechanisms to mitigate Advanced Persistent Threats (APTs) on 5G-enabled vehicle-to-vehicle communication systems, data poisoning attacks on GPS navigation systems, and misinformation attacks on route recommendation systems.

3 Anomaly Detection and String Stability Analysis in Connected Automated Vehicular Platoons

Yiyang Wang[1], Ruixuan Zhang[2], Neda Masoud[1], Henry Liu[1], [1]University of Michigan, Ann Arbor, MI, [2]New York University, New York, NY, Contact: ruixuan.zhang@nyu.edu

In this study, we develop a comprehensive framework for modeling the impact of cyberattacks on the safety, security, and head-to-tail stability of connected and automated vehicular platoons. We propose a platoon dynamics model with heterogeneous time delays from communication channels and/or sensors. Utilizing this model, we create an augmented state extended Kalman filter (ASEKF) for sensor data smoothing and anomaly detection. We introduce pseudo string stability, a novel concept for assessing platoon stability under cyberattacks and platoon model uncertainties. We demonstrate the relationship between a platoon's pseudo string stability and its detection rate, identifying the critical detection sensitivity/recall needed for maintaining pseudo string stability.

4 Toward Certified Cybersecurity of Learning-Based Traffic Signal Control

Mohamadhossein Noruzoliaee, University of Texas Rio Grande Valley, Edinburg, TX, Contact: h.noruzoliaee@utrgv.edu

Reinforcement learning (RL) has gained traction in traffic control applications, such as traffic signal control, due to its computational capability to deal with real-time changes in traffic flow dynamics. Despite growing popularity, RL has been recently found to be vulnerable to adversarial attacks, precluding its reliable application unless vulnerabilities are mitigated. This research aims to certify the security of an RL-based traffic signal controller (victim) against adversarial attack on the victim's state observations. We explore an optimal (strategic) adversary and an optimal (robust) victim, which can adapt to each other's actions. The adversary-victim interaction is characterized as a new state-adversarial Markov decision process (SAMDP), which is solved by decomposing it into two novel MDPs with redefined environment dynamics and reward functions.

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WB40

CC-North 225A

Machine Learning Approaches to Vehicle Routing

Community Committee Choice Session

Session Chair: Gustavo Hurovich, Erasmus University, Rotterdam, Netherlands

1 Machine Learning Approaches to Estimate Routing Costs in Home Delivery Time Slot Management

Gustavo M. Hurovich, Luuk P. Veelenturf, Niels Agatz, Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands. Contact: hurovich@rsm.nl

In the context of online attended home delivery services, customers are usually presented with a selection of available timeslots to choose from. When a customer shows up, the seller must quickly decide which timeslots to offer and whether to incentivize them to pick one that allows for efficient routes. To determine the extra cost and distance associated with accepting that customer in each available timeslot, a Vehicle Routing Problem with Time Windows (VRPTW) must be solved, which is a difficult problem. In practice, routing heuristics are in place to estimate these costs. We explored a different approach, based on Machine Learning, to get quick and reliable estimations of the marginal routing costs for each timeslot.

2 Application of Reinforcement Learning in Optimal Truck-Drone Fleet Sizing and Routing

Mohammadhosein Pourgholamali[1], Mohammad Miralinaghi[2], Samuel Labi[1], [1]Purdue University, West Lafayette, IN, [2]Illinois Institute of Technology, Chicago, IL

Recent advances in unmanned aerial vehicle (UAV) technology have encouraged logistics firms to adopt UAVs as a viable transport alternative. However, route optimization for delivery trucks and UAVs is challenging due to the special UAV operations (such as battery and loading limitations). This study leverages reinforcement learning (RL) to solve this problem and optimize the total delivery service cost. The control variables are the truck and UAV fleet sizes and their optimal routes, and the constraints include UAV range limitations and available fleet size. Trucks are assumed to provide battery swapping for the UAVs during the delivery service. The performance of the RL algorithm is evaluated by comparing the solutions generated by the RL algorithm with those generated by a metaheuristic using numerical experiments.

3 Combinatorial Optimization Enriched Machine Learning for the Dynamic and Stochastic Inventory Routing Problem

Toni Greif[1], Louis Bouvier[2], Christoph M. Flath[1], Sonja Rohmer[3], Axel Parmentier[2], Thibaut Vidal[4], [1]University of Wuerzburg, Wuerzburg, Germany; [2]CERMICS, Ecole des Ponts, Marne-la-Vallée, France; [3]HEC Montréal, Montréal, QC, Canada; [4]CIRRELT & SCALE-AI Chair in Data-Driven Supply Chains, Polytechnique Montréal, Montréal, QC, Canada. Contact: toni.greif@uni-wuerzburg.de

In this research, we introduce a novel combinatorial optimization-enriched imitation learning pipeline to solve inventory routing problems with stochastic demand and dynamic inventory updates. After each inventory update, our approach reduces replenishment and routing decisions to an optimal solution of a prize-collecting traveling salesman problem for which well-established algorithms exist. Discovering good prize parametrizations is non-trivial, and thus we use machine learning. We evaluate the performance of our pipelines in settings with steady-state and more complex demand patterns. Compared to previous works, we find good-quality decisions very quickly and can leverage contextual information.

4 An Optimal Order Consolidation Policy for Last-Mile Delivery: A Deep Q-Learning Approach to Vehicle Routing Plans

Yooneun Lee[1], Seokgi Lee[2], Hyeong Suk Na[3], Sang Jin Kweon[4], Yuncheol Kang[5], [1]University of Dayton, Dayton, OH, [2]Youngstown State University, Youngstown, OH, [3]University of Missouri-Columbia, Columbia, MO, [4]Ulsan National Institute of Science and Technology (UNIST), Ulsan, Korea, Republic of; [5]Ewha Womans University, Seoul, Korea, Republic of. Contact: ylee03@udayton.edu

In this study, we focus on developing an algorithm for order consolidation policies and vehicle routing problems with time windows for retailers. The proposed system consists of interactive modules to manage customer orders for a planning horizon. A gateway module handles real-time delivery requests. The simulator creates vehicle routing plans and makes decisions on shipment and order consolidation for various operating scenarios based on how customers place orders and how these orders are fulfilled by multiple warehouses. To learn optimal polices for the current system state, resulting expected rewards are fed back to the learning module, which updates and learns optimal using a double deep Q-learning algorithm. The efficiency of the proposed algorithm is demonstrated through numerical experiments of medium-size problems for a month-long period.

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CC-North 225B

New Methods for Inventory Policies

Contributed Session

Session Chair: Nayan Chakrabarty, University of Arkansas, Fayetteville, AR

1 Adapting the Inventory Routing Problem to Improve Water Access and Quality in Water Insecure Areas

Emerald Dudzinski, Virginia Tech, Blacksburg, VA, Contact: emerald@vt.edu

Access to clean drinking water can be a luxury in impoverished communities in the United States. Nationally, more than 2 million people lack access to safe drinking water and indoor plumbing, and this figure does not include homes with a working tap of unsafe drinking water. Therefore, a far larger number of Americans face water insecurity. A recent examination of US Census and Safe Drinking Water Act violation data reveals that rural low-income and minority communities are significantly more likely to be burdened with unavailable or unsafe in-home drinking water. This research explores an alternative to traditional water infrastructure: how to optimally deliver drinking water to households without access to reliable, clean water sources by adapting the inventory routing problem and creating heuristic algorithms to schedule efficient water delivery.

2 Integrating Neural Network And Genetic Algorithms For Location-inventory-routing Problem

Guoqing Zhang, Behrang Bootaki, University of Windsor, Windsor, ON, Canada. Contact: gzhang@uwindsor.ca

We consider a new type of Location-Inventory-Routing (LIR) model, which can be leveraged to configure production and delivery systems. Considering the complexity of the LIR problems, a new solution strategy is presented by integrating the genetic algorithm (GA) and the neural network regression models. In our solution method, the problem is decomposed into two parts: (1) the location-allocation decision, and (2) lot-sizing and routing sub-decisions. The neural network regression models help GA evaluate the total fitness of each chromosome by giving the cost feedback for lot-sizing and routing subproblems. The numerical results are presented. We also applied the method to a real-world problem.

3 Improved Iterated Greedy Constraint Programming for Scheduling Steelmaking Continuous Casting

Dongyun Kim, Yeonjun Choi, Kyungduk Moon, Myungho Lee, Kangbok Lee, POSTECH, Pohang, Korea, Republic of. Contact: choichoi@postech.ac.kr

We study a steelmaking-continuous casting (SCC) scheduling problem, which is a variant of the hybrid flow shop scheduling problem. We improve the existing method called Iterated Greedy Constraint Programming (IGC) which contains a greedy heuristic constructing an initial solution and a large neighborhood search (LNS) while iteratively solving constraint programming models. Various neighborhood designs were introduced for the LNS of our algorithm and the influence of each neighborhood on the performance was measured across different scenarios. Computational experiments show that our improved algorithm gives a superior solution for the given instances, and we discover it can also be successfully applied to other SCC scheduling problems.

4 A Partial Survival Signature Method to Identify Time-Based Policies for Redeploying Nodes into a Wireless Sensor Network

Nayan Chakrabarty, Kelly Sullivan, University of Arkansas, Fayetteville, AR, Contact: nchakrab@uark.edu

We consider the problem of redeploying nodes into a wireless sensor network (WSN), where the network is inspected after a fixed time interval, and new sensor nodes are deployed to maintain reliable area coverage. Whereas previous research assumes *i.i.d.* failure for all nodes, we use multiple classes of sensor nodes to present a situation where positioning within the network affects failure rate of sensor nodes. We propose a partial survival signature (PSS) approach for estimating coverage reliability under a given time-based redeployment policy, where the PSS is estimated by Monte Carlo simulation. This PSS representation enables efficient re-evaluation of coverage reliability under different redeployment policies; so, we show that the method can be applied to identify time-based redeployment policies that are efficient with respect to cost and coverage reliability.

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CC-North 226A

AI/ML in Surface Mining and Processing

Community Committee Choice Session

Session Chair: Bart Maciszewski, Imperial Oil, Calgary, AB, Canada

Session Chair: Andrew Milne, 1</sup

1 Primary Separation Vessel Control Using Rl

Jansen Fajar Soesanto[1], Bart Maciszewski[2], Leyli Mirmontazeri[2], Sabrina Romero[2], Mike Michonski[2], Andrew Milne[2], Biao Huang[1], [1]University of Alberta, Edmonton, AB, Canada; [2]Imperial Oil, Calgary, AB, Canada. Contact: soesanto@ualberta.ca

The primary separation vessel is critical for bitumen extraction from oil sands. However, controlling its operation is complicated due to complex separation mechanisms, upstream mining uncertainties, and process constraints. While Reinforcement Learning (RL) is mostly unexplored in industrial processes, our study applies the state-of-the-art RL strategy to hierarchical decision-making in the primary separation vessel operation. By leveraging RL, we optimize primary separation vessel operation, thus improving bitumen extraction efficiency. Our presentation showcases the potential of RL in industrial process control and the steps toward achieving autonomous operation and decision-making.

2 Integrated Machine Learning and Optimization for the Simultaneous Stochastic Optimization of Mining Complexes

Yassine Yaakoubi, Roussos Dimitrakopoulos, McGill University, Montreal, QC, Canada. Contact: yassine.yaakoubi@mcgill.ca

Addressing large-scale, nonlinear, and stochastic optimization challenges in industrial mining complexes (mineral supply/value chains) necessitates innovative solutions. To produce robust mine plans and production schedules under both supply and demand uncertainties, optimization and machine learning are combined. The proposed approach comprises a hyper-heuristic optimizing supply/value chain dynamics, a neural diving policy for primal heuristic selection trees, and a neural (soft) branching policy mapping variable features to their impact on the objective function value, all in one-shot learning. Results on large-scale mining complexes demonstrate a 40% increase in net present value and three-orders of magnitude reduction in execution time, underscoring the potential of this self-learning task-informed solution to optimize supply/value chains.

3 Production Planning in Mining Complexes: A Stochastic Programming and Reinforcement Learning Approach for Connecting Short- and Long-Term Production Schedules

Zachary Levinson, Roussos Dimitrakopoulos, McGill University, Montreal, QC, Canada. Contact: zachary.levinson@mail.mcgill.ca

Short- and long-term production schedules in mining complexes are highly dependent. Typically, schedules of different timescales are optimized separately ignoring key considerations related to schedules of different timescales. Connecting short- and long-term production schedules and optimizing across timescales increases value, mitigates risk, and considers key operational aspects that improve production plans. A stochastic programming and actor-critic reinforcement framework that connects short- and long-term production scheduling is developed. An actor-critic reinforcement learning agent learns a discrete-continuous neural network policy for production scheduling decisions that is embedded within a stochastic programming framework. The method is applied at a large-scale mining complex improving compliance between schedules by 21%.

4 Predicting Extraction Excursions Using Explainable Ai

Bart Maciszewski[1], Andrew Milne[1], Bhanuday Sharma[2], Stefano Scaini[1], Leyli Mirmontazeri[1], Charles Cook[1], Andrew Bonnell[1], Farah El Mallah[1], Anastasia Startseva[1], Jamie Neil[1], Ian Macisaac[1], Patrick Mccrady[1], [1]Imperial Oil, Calgary, AB, Canada; [2]ExxonMobil Services & Technology Private Limited, Bangalore, India. Contact: andrew.c.milne@esso.ca

Kearl oil sands is a large open pit mine in Northern Alberta leveraging a fleet of shovels and autonomous haul trucks feeding two processing facilities. Water based gravity separation is used as a primary method of oil extraction. The ore varies in geologic properties and has different processibility characteristics. In this work we build a model to predict likelihood of elevated extraction excursions based on the ore characteristics and plant processing variables. We employ SHAP analysis to identify shovels or process variables that are likely causes for the excursions. We evaluate the model for ability to reduce excursions and their durations.

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WB43

CC-North 226B

Data-driven approaches in reliability analysis

Contributed Session

Session Chair: Jamie R. Wieland, Illinois State University, Normal, IL

1 Quantile Degradation Modeling and Lifetime Estimation for Accelerated Destructive Degradation Test

Munwon Lim[1], Suk Joo Bae[2], [1]Hanyang University, Seoul, Korea, Republic of; [2]Hanyang University, Seoul, Korea, Republic of. Contact: moonmunwon@psm.hanyang.ac.kr

As product development period has been shortened, manufacturing industry conducts accelerated destructive degradation tests (ADDT) to predict the lifetime of the products within a short period of time. In general ADDT, lifetime estimation based on mean degradation path is conducted, but if the failure or deterioration pattern has non-normal distribution, the modeling result can lead to the biased estimation results. To resolve this problem, we propose an ADDT model based on quantile regression (QR), considering the asymmetry of lifetime distribution. According to the application to the test data for real automobile components, the proposed method effectively describes the imbalanced lifetime distribution and provides more precise prediction results compared to the general ADDT model.

2 Quality And Reliability Monitoring In Multi-stage Processes

Emmanuel Yashchin, IBM TJ Watson Research Center, Yorktown Heights, NY, Contact: yashchi@us.ibm.com

In multi-stage processes, downstream variables are influenced by events in upstream stages. One example is the assembly process of a computing system, which relies on components produced at various locations over wide timeframes. The quality and reliability (Q&R) assurance process involves models and data pertaining to the components, assembly process itself, and product experience in the field. In this paper, we focus on the process of monitoring Q&R, diagnostics and root cause analysis based on the so-called timeslides: data orderings corresponding to passage of components, sub-assemblies and the product itself through various stages. Given that the product and component Q&R can be impacted by numerous stages, the problem acquires a combinatorial character and complexity. We discuss the design of search engines for selecting timeslides that merit investigation.

3 A Retesting Model For Binary Classification With Random Error

Jamie R. Wieland, Illinois State University, Normal, IL

We consider a binary classification problem, where given a sample of interest, a test is used to classify the sample as either a 0 or 1. The test is assumed to be a stochastic oracle, in which the binary outcome is noisy due to random error. Our objective is to determine the impact of retesting on the probability of correct sample classification, as compared to conducting only a single test. Retesting is common practice in numerous applications of importance, including quality control, identification of forensic evidence, and medical diagnostics. We develop a probability model for retesting, and two decision polices for retesting are analyzed. Conditions under which retesting policies improve the probability of correct sample classification are identified and discussed, along with the effects of dependence.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB44

CC-North 226C

Transforming business via reinforcement learning

Community Committee Choice Session

Session Chair: Linda Zhao, University of Pennsylvania, Philadelphia, PA

1 Personalized Reinforcement Learning with Application to Business

Junhui Cai[1], Ran Chen[2], Martin Wainwright[2], Linda Zhao[3], [1]University of Notre Dame, Notre Dame, IN, [2]MIT, Cambridge, MA, [3]University of Pennsylvania, Philadelphia, PA, Contact: jcai2@nd.edu

Reinforcement learning, while has gained great success in low-stake fields (e.g., game, ChatGPT), has involved a great sacrifice of interpretability, reliability and fundamental understanding. However, the price of incorrect actions, non-interpretable procedures and model fragility is high in files like e-commerce, start-up fund-raising and healthcare. In particular, the crucial personalized information is not accounted for in the model in the hope that high-complexity and high-expressive model can somehow learn it out from the relatively scarce data. We propose a personalized reinforcement learning model encoding personalized information into the transition mechanism and reward-generating mechanism and develop an algorithm to address it. We study its performance both numerically and theoretically.

2 Reinforcement Learning with Heterogeneous Data

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RL has the promise of providing data-driven supports to decision-making in a wide range of social settings such as healthcare, education, and business. Classical methods focus on the mean of the total return and, thus, may provide misleading results for heterogeneous populations that commonly underlie large-scale datasets. We introduce K-Hetero Markov Decision Process to address sequential decision problems with population heterogeneity. We propose Auto-Clustered Policy Evaluation for estimating the value of a given policy, and Auto-Clustered Policy Iteration for estimating the optimal policy in a parametric policy class. Our auto-clustered algorithms can automatically detect and identify homogeneous subpopulations while estimating the action value function and the optimal policy for each subpopulation.

3 Doubly High-Dimensional Contextual Bandits: An Interpretable Model for Joint Assortment and Pricing

Junhui Cai[1], Ran Chen[2], Martin J. Wainwright[2], Linda Zhao[3], [1]University of Notre Dame, Notre Dame, IN, [2]MIT, Cambridge, MA, [3]University of Pennsylvania, Philadelphia, PA, Contact: ran1chen@mit.edu

Both assortment and pricing are important problems in revenue management that usually appear together. But current literature addresses them separately due to technical difficulties. We formulate the joint assortment and pricing problem as contextual bandits that are doubly high-dimensional in the sense that both covariates and actions are allowed to take continuous values in high-dimensional spaces. Our formulation is expressive, structure-rich, and interpretable. We propose an efficient bandit algorithm for our new model with theoretical justification. We demonstrate the effectiveness of our algorithm on joint assortment and pricing for two giant online retailers. In addition, the generality of our model makes several bandit problems and dynamic pricing models its special cases and allows wider applications in business and healthcare.

4 A More Realistic Mnl Model for Assortment

Wu Zhu[1], Ran Chen[2], Junhui Cai[3], Qitao Huang[4], Linda Zhao[5], [1]Tsinghua University, Beijing, China; [2]Massachusetts Institute of Technology, Cambridge, MA, [3]University of Notre Dame, Notre Dame, IN, [4]Tsinghua University, Beijing, China; [5]University of Pennsylvania, Philadelphia, PA

Joint assortment and pricing optimization is critical in maximizing revenue in the retail sector. Traditional models, such as the Multinomial Logit (MNL) model, effectively address this problem but miss the dynamic arrivals of customers. To bridge this gap, we extend the MNL model with a Poisson arrival that depends on the current assortment and pricing. The challenge lies in balancing the \emph{popularity} in the Poisson model to attract more customers and the \emph{profitability} in the MNL to increase conversion and revenue for each visit. We propose an efficient algorithm to jointly solve the Poisson and MNL model and provide a non-asymptotic bound for regret. We finally demonstrate the effectiveness of our approach for one of the largest instant noodles producers on an e-commerce platform.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB45

CC-North 227A

Machine Learning Applications in Disaster Management

Contributed Session

Session Chair: Samiul Hasan, University of Central Florida, Orlando, FL

1 A Data-Driven Strategy to Predict Incident Hotspots

Hiruni Niwunhella, Asya Atik, Leila Hajibabai, North Carolina State University, Raleigh, NC, Contact: dhniwunh@ncsu.edu

This study predicts incident hotspot locations using deep learning techniques including neural networks and long short-term memory (LSTM) network methods. The proposed study validates the models using real-world incident data in North Carolina and incorporating additional variables such as weather information, holidays, unusual events, and annual average daily traffic (AADT) index that affect the likelihood of a crash. The error estimates are compared against those of other machine learning techniques. Numerical experiments indicate that the proposed approach provides better predictions with higher accuracy compared to benchmarks.

2 Surge Level Responses in Emergency Medical Services

Qixuan Zhao[1], Peter Vanberkel[2], [1]Dalhousie University, Halifax, NS, Canada; [2]Dahousie University, Halifax, NS,

Canada. Contact: peter.vanberkel@dal.ca
This study proposes a machine learning and simulation-based approach for categorizing surge levels in Emergency Medical Services. Instead of using traditional performance metrics, this study will use simulation to evaluate the machine learning-based categorization models. Particularly, simulation's responses to different interventions based on different surge levels categorization are used to evaluate the machine learning models.

3 Integrating Ml-Based Reverse Engineering of Cge Models with Optimization for Enhancing Resilience

Nushra Zannat, University of Oklahoma, Norman, OK, Contact: nzannat@ou.edu
This study presents a novel approach that utilizes machine learning techniques to reverse engineer CGE models. The outputs obtained from the model are then connected to optimization models used to enhance hazard mitigation and improve community resilience. The integration of ML and optimization holds the potential to improve policy analysis and decision-making in disaster risk management.

4 Monitoring the Mental Health of Individuals Post Earthquake Through Space Time Textual Analysis

Edwin Y. Wang[1], Adeela Gulzari[2], Victor R. Prybutok[2], [1]Kean University, Union, NJ, [2]University of North Texas, Denton, TX
This study analyzes geo-referenced social media data to explore emotional responses of users after a significant natural disaster. It focuses on the 2023 Turkey-Syria earthquake and investigates mental health effects using data mining and machine learning techniques. Twitter data is collected and preprocessed, followed by sentiment analysis using a clustering ensemble model. The study introduces a categorical distribution for Monte Carlo simulation to enhance reliability. By assessing the assigned sentiment score generated by this research in every tweet from affected areas and worldwide (the ratings can then be aggregated to give an overall sentiment for each cluster, which reveals the public's perceptions of the earthquakes.), the research aims to identify mental health conditions, understand exposure impact, and propose post-disaster interventions.

5 A Deep Learning Approach for Predicting Traffic During Evacuation Using Social and Infrastructure Sensors Data: A Case Study from Hurricane Ian

Samiul Hasan, Md Mobasshir Rashid, University of Central florida, Orlando, FL, Contact: samiul.hasan@ucf.edu
A network-wide traffic prediction model is developed which exploits traffic flow data available from detectors and population movement data available from social media (e.g., Facebook) during a hurricane. The model uses a deep learning based approach that is trained on regular period data to learn typical traffic movement patterns. The model achieves an R-square of 0.96 during regular period traffic prediction, but it performs poorly during an evacuation period. To better predict evacuation period traffic, a transfer learning approach is developed utilizing evacuation related features. The model is trained and tested over real-world evacuation data available from Hurricane Ian (2022). Transportation agencies can use the developed model to predict traffic congestions in advance and take protective measures to reduce delays during evacuation.

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CC-North 227B

Functional data in manufacturing

Community Committee Choice Session

Session Chair: Shilan Jin, 1</sup

Session Chair: Yu Ding, Texas A&M University, College Station, TX

1 A Sensor-Based Monitoring Approach for Real-Time Characterizations of Nanomachining Using Ensemble Kriging Model

Xinchen Wang, Zimo Wang, SUNY Binghamton, Binghamton, NY, Contact: xwang295@binghamton.edu
We present a sensor-based modeling approach incorporating ensemble kriging for autonomously recognizing temporal-spectral features of the acoustic emission (AE) sensor signals to predict the surface profile during nanomachining. The experimental case study suggests that the presented approach allows accurate prediction (R-squared value around 92%) for the surface morphology under the nanoscale. This presented framework opens up an opportunity to realize real-time characterization, quality inspection, and autonomous control for nanofabrication.

2 Inverse Process Parameter Design for Additive Manufacturing with Bayesian-Pinn

Raghav Gnanasambandam, Zhenyu James Kong, Virginia Tech, Blacksburg, VA, Contact: raghavg@vt.edu

Designing process parameters in metal Additive Manufacturing is challenging due to complexity of process and restriction on data collection due to cost of operation. "Black-box" approaches like Bayesian Optimization are not that accurate whereas using solely physics-based simulations do not conform with real process data. In this work, we propose a Bayesian framework based on Bayesian Physics Informed Neural Networks (B-PINNs) for sequential design of process parameters to optimize the desired quality. B-PINNs solve Partial Differential Equations (PDEs) to provide uncertainty estimates of the process signatures like thermal history. The proposed method relates process signatures with quality to quantify uncertainty, and in turn utilize the uncertainty estimates for sequential design.

3 Optimized Block Maxima For Extreme Statistics In Predicting Surface Roughness Of Additive Manufacturing

Jia Liu, Shehzaib Irfan, Auburn University, Auburn, AL, Contact: lzj0040@auburn.edu

The fatigue performance of additively manufactured parts is largely impacted by local extreme surface roughness features, such as deep valleys with high stress concentration. Extreme statistics can be used to infer the deepest valley with the highest stress concentration and predict the fatigue life accordingly based on the sampled surface profiles from the block maxima method. This work aims to use multi-objective Bayesian optimization and extreme value statistics to build a framework for optimizing the block number and the size for surface roughness characterization in terms of goodness of fit, prediction accuracy, and quality of estimates of extreme value distribution parameters. This framework could be extended beyond the AM to areas for which accurate modeling of extreme events is paramount, including hydrology, climatology, and finance.

4 Vibration Signal-Assisted Endpoint Detection for Long-Stretch, Ultraprecision Polishing Processes

Shilan Jin, Yu Ding, Texas A&M University, College Station, TX, Contact: jin0541@tamu.edu

The research reported in this article concerns the question of detecting and subsequently determining the endpoint in a long-stretch, ultraprecision surface polishing process. We develop an offline method that utilizes a functional regression to relate the vibration signals to the surface roughness. The method shows that the polishing process progresses in three states, including a saturation phase, over which the polishing action could be substantially shortened. The three states revealed are consistent with the polishing literature studies. Our work is the first work that quantifies these polishing phases. When appropriately implemented, our method could lead to substantial savings in polishing time and energy and significantly improve the throughput of such polishing processes without inadvertently affecting the quality of the final polish.

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CC-North 227C

Deep Learning for Quality Assurance in Manufacturing Systems

Community Committee Choice Session

Session Chair: Wenbo Sun, University of Michigan Transportation Research Institute, Ann Arbor, MI

1 Out-Of-Distribution (Ood) Learning with Few Ood Samples

Xiaoyang Song[1], Wenbo Sun[2], Jionghua Jin[3], Raed Al Kontar[3], Maher Nouiehed[4], [1]University of Michigan, Ann Arbor, MI, [2]University of Michigan Transportation Research Institute, Ann Arbor, MI, [3]University of Michigan, Ann Arbor, MI, [4]American University of Beirut, Burbank, CA, Contact: xysong@umich.edu

Deep Neural Networks (DNNs) have shown promising capabilities in many benchmark tasks yet are known to be not robust to Out-of-Distribution (OOD) data that fall outside the distribution of the training data (In-Distribution (InD) data). OOD detection thus becomes an important task to be tackled before reliably deploying DNNs to real-world applications. In this work, we introduce a model that separates InD and OoD data in a Wasserstein-distance-based space and exploits the advantages of a few observed OOD samples using Generate Adversarial Network (GAN). The proposed model is compared with the state-of-the-art methods on various datasets and achieves better OOD detection performance, especially when fewer OOD samples are observed. Through data augmentation, the proposed model shows better generalizability, robustness, and interpretability.

2 Continual Learning for In-Situ Quality Prediction in Dynamic Manufacturing Processes

Mengfei Chen[1], Rajiv Malhotra[2], Weihong (Grace) Guo[1], [1]Rutgers, The State University of New Jersey, Piscataway, NJ, [2]Rutgers, The State University of New Jersey, Piscataway, NJ

Manufacturing processes undergo continuous changes in order to meet various requirements, such as process changes and variations in tool conditions. Thus, a quality prediction model trained from previous data may not perform well when new tasks emerge. This study proposes a deep learning method with continual learning for in-situ quality prediction capable of learning from new tasks without forgetting previous ones. A deep CNN is designed to analyze acoustic emission data from the laser-induced plasma micro-machining process. To be applicable in both old and new tasks, the deep CNN consists of shared layers to capture common underlying features across all tasks, and task-specific layers that capture characteristics of each individual task. When new data come in, the model first identifies the task, followed by predicting quality of the current part under its own task.

3 Interpretable Thermal Physics-Informed Machine Learning Methodology for Weld Bead Distortion in Wire Arc Additive Manufacturing

Christian Zamiela[1], Ryan Stokes[2], Linkan Bian[1], Wenmeng Tian[1], [1]Mississippi State University, Mississippi State University, MS, [2]Mississippi State University, Mississippi State University, MS

The objective is to develop an interpretable physics-informed machine learning (PIML) model for in-situ weld bead distortion detection in Wire-Arc Additive Manufacturing (WAAM). A core problem with WAAM is that the rapid deposition of metal wire to join successive layers results in distortion and residual stresses from thermal expansion and heat transfer. There is a lack of interpretability of PIML model's prediction logic from real-time thermal spatial-temporal data features that lead to detecting anomalies. This work aims to enhance the interpretability of valuable input features by decoding predictions using physics-informed gradient mapping. Furthermore, it addresses the need for rapid processing of thermal data-driven knowledge within a neural network, guided by physical constraints, to improve model detection accuracy and ensure real-time quality.

4 A Novel Data Augmentation Method Using Machine Learning for Wafer Defect Detection with Imbalanced Wafer Bin Map Data

Jihoon Chung[1], Bo Shen[2], Zhenyu James Kong[1], [1]Virginia Tech, Blacksburg, VA, [2]New Jersey Institute of Technology, Newark, NJ, Contact: jihoon7@vt.edu

Since hundreds of processes are involved in wafer manufacturing, errors in different processes can lead to various wafer defects. The different defects which occur along the processes cause the highly imbalanced wafer bin map (WBM) data between defects used to identify the defective patterns of each wafer. Consequently, this leads to low classification results in wafer pattern recognition, hindering the process adjustment to mitigate each defect. The failure to mitigate the defects timely causes the low reliability and yields of integrated circuits in the semiconductor manufacturing process. To overcome the limitation, we propose a novel machine learning-based data augmentation method to address the imbalanced WBM data.

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CC-North 228A

Adaptive sampling strategies for real-time anomaly detection

Community Committee Choice Session

Session Chair: Ana Maria Estrada Gomez, Purdue University, West Lafayette, IN

1 Adaptive Sampling Strategy for Real-Time Anomaly Detection with Unmanned Sensing Vehicles

Yue Jiang, Ana Maria Estrada Gomez, Purdue University, West Lafayette, IN, Contact: jiang905@purdue.edu

Unmanned sensing vehicles (USVs) have been widely used for real-time anomaly detection. The collected data only provide partial information about the space. Thus, it is critical to decide the locations of USVs at each time to maximize the change detection capability while considering deployment costs. This paper proposes an adaptive sampling strategy for real-time anomaly detection with USVs. First, a novel Spatio-Temporal Sequential Tensor Decomposition algorithm is developed to decompose the high-dimensional data into a spatial-temporal structure and a sparse component that captures suspicious locations. The spatial-temporal structure is used for prediction. The strategy is designed to balance exploration and exploitation by designing a sampling function to decide the locations of USVs. The movement of the USVs is controlled by using Voronoi tessellations.

2 Implicit Regularization Based Quickest Detection in High-Dimensional Linear Regression Models

Qunzhi Xu[1], Yajun Mei[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]ISyE Georgia Tech, Atlanta, GA, Contact: xuqunzhi@gatech.edu

In this work, we present a method for detection of change-point in a linear regression model, where the high-dimensional coefficient vector may change at an unknown time and only the projection matrix and low-dimensional projection can be observed in a sequential manner. We propose to estimate the unknown coefficient based on the data within a sliding window, and raise an alarm if the L_∞- norm of the estimator is extremely large. We also investigate the theoretical properties on the average run length (ARL) to false alarm and expected detection delay. Numerical studies are conducted to validate our theoretical results.

3 A Deep Learning Framework for Adaptive Sampling Strategy in Monitoring High-Dimensional Processes

Ziqian Zheng[1], Haoqian Li[1], Kaibo Liu[2], [1]University of Wisconsin-Madison, Madison, WI, [2]UW-Madison, Madison, WI, Contact: zzheng92@wisc.edu

The advancements in sensing technology have created data-rich environments that offer unprecedented opportunities for enhancing system monitoring. However, the limited transmission bandwidth presents a challenge as only a subset of data streams can be accessed. Existing methods for adaptively sampling informative data streams rely on heuristic approaches, lacking a systematic framework. In this study, we address this issue by proposing a deep learning framework. We utilize a monotonic deep neural network to learn a function that quantifies the urgency of collecting new observations from the current data stream. The training process of the network is based on simulations and incorporates a carefully designed loss function. Through simulations and a case study, we evaluate the performance of our approach and demonstrate its superiority over existing methods.

4 Thompson Sampling Based Partially Observable Online Monitoring Approach for Large Dynamic Networks

Jie Guo, Chen Zhang, Tsinghua University, Beijing, China

The monitoring of high-dimensional dynamic network data has gained significant attention in various applications. However, it is difficult to acquire complete relations in a network each time due to the limited sensing resources. We propose an adaptive sampling strategy for prompt change detection in the networks. Our approach utilizes a latent space model to represent the underlying mechanism of edge formation in networks, where latent states evolve with time according to a bi-transit state space model. Besides, we employ a variational Bayesian method to infer abnormal variables on each node. Then, we employ a likelihood ratio test to detect changes on the edges. By further formulating the test statistic as the reward function of combinatorial multi-armed bandit, Thompson sampling is proposed to select changed edges with the balance of exploration and exploitation.

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CC-North 228B

Innovations in Data-Driven Approaches for Process Optimization and Quality Enhancement

Community Committee Choice Session

Session Chair: Jinming Wan, State University of New York at Binghamton, Vestal, NY

Session Chair: Changqing Cheng, Binghamton University, Binghamton, NY

1 Design and Analysis of Experiments to Support Facility Location Applied to Sanitizer Dispensers

Abedallah Al Kader[1], Theodore T. Allen[2], James Arbogast[3], Stephen Wagner[3], Nanshan Chen[4], Cathy Honghui Xia[4], Susan O'Hara[4], [1]The Ohio State University, Columbus, OH, [2]Ohio State University, Columbus, OH, [3]Gojo Industries, Inc, Akron, OH, [4]The Ohio State University, Columbus, OH, Contact: alkader.1@osu.edu

The subject of optimal facility location has received considerable attention. Recent research has addressed highly random and spatial-temporal demand. The complications of large numbers of facilities and demand dependent on location and varying over time have been considered. We present the first experimental exploration of the implication of facility location on demand. Using an optimal split-plot design with augmentation, we show that, at least in the case of PURREL dispensers generate new demand, and location factors influence demand exponentially. The implications for optimal location problems are explored.

2 Exploratory Image Data Analysis for Quality Improvement Hypothesis Generation

Yifei Zhang, Theodore T. Allen, Ramiro Rodriguez Buno, Ohio State University, Columbus, OH, Contact: rodriguezbuno.1@osu.edu

This work proposes Exploratory Image Data Analysis (EIDA) as a special case of EDA (Exploratory Data Analysis) for quality improvement problems with image data. The proposed four steps of EIDA are: (1) image processing, (2) quantitative image data analysis and display, (3) salient feature identification, and (4) salient feature interpretation.

4 Optimal Path Mining Of Small Steel Bar Manufacturing Process

KwangHo Jeong, Sungkyunkwan University, Suwon, Korea, Republic of. Contact: jebiri98@g.skku.edu

Surface defects in small steel bars (SSBs) are a significant quality concern. Existing studies about SSB surface quality overlook two common issues: "merged measurement" and "variation over operational dates." This study proposes a method to find the faulty process path that cause surface defects of small steel bars manufacturing process, while considering the issues. The method divides factor value in several groups, see continuous combination of factor groups as process path and finds faulty process path using data mining. A case study using operational data demonstrates the effectiveness of the proposed method in finding faulty process path of SSB causing surface defects.

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CC-North 229A

The Hydrogen Economy: Challenges and Opportunities in Production, Transportation, and Use

Community Committee Choice Session

Session Chair: Tyler Ruggles, Carnegie Science, Stanford, CA

Session Chair: Jacqueline Dowling, California Institute of Technology, Pasadena, CA

1 Grid-Powered Hydrogen Production: Emission Metrics and Carbon Intensity Criteria

Tyler H. Ruggles, Carnegie Science, Stanford, CA

The US Inflation Reduction Act (IRA) incentivizes H_2 production based on the carbon intensity (CI) of production instead of the production mechanism. In this study, we analyze three methods for quantifying the CI of grid power: average grid CI, and short- and long-run marginal emission rates. We use a least-cost model constrained by these grid CI metrics to model equipment sizing and operations of electrolysis facilities producing H_2 and suppling offtakers. Hourly power prices and grid emissions rates are taken from NREL's Cambium dataset representing possible future electricity systems. This work shows the cost of producing low-CI H_2 from the grid could vary substantially depending on how grid CI is defined and shows how the CI of the H_2 could vary when a system is planned and operated under one interpretation, then evaluated using a different CI metric.

2 Decarbonizing the European Ammonia Industry via Low-Carbon Hydrogen Production

Paolo Gabrielli, ETH Zurich, Zurich, Switzerland

The European ammonia industry is responsible for 36 Mt of CO_2 per year, primarily due to hydrogen production from steam methane reforming. These emissions can be mitigated via electrolytic hydrogen, namely hydrogen produced via water electrolysis powered by dedicated renewable energy sources. We investigate the conditions under which electrolytic hydrogen is cost-competitive against steam methane reforming, and we focus on the impact of emissions targets on the economic viability and technical feasibility of on-site production of electrolytic hydrogen in European ammonia plants. Results show that an emission cap of 1 kg CO_2/kg H_2 might lead to an emissions reduction of 95% while maintaining cost-competitiveness with steam methane reforming.

3 Hydrogen Production from Biogenic Sources Coupled with Ccs

Cristina Antonini, OST University of Applied Sciences of Eastern Switzerland, Rapperswil, Switzerland

Hydrogen will play a crucial role to decarbonize the world energy system. However, the current benchmark hydrogen production pathway is fossil-based (i.e., via methane reforming). While H2 production by means of water electrolysis is expected to become the benchmark by 2050, in the next decades the existing infrastructure will still be used. An effective way to defossilize the current hydrogen production plants and reach net zero is to couple existing methane reformers with CCS and blend biogenic fuels (i.e., biomethane or the product gas from biomass gasification) to compensate for the residual emissions that are not captured. This work focuses on the techno- and economic aspects of blending biogenic sources coupled with CCS to make the existing H2 production plants net zero. Different regions allover the world, such as Asia, US and Europe, will be considered as case studies

4 Modelling Use-Dependent Degradation of Electrolyzers in Capacity Expansion Models

Ruaridh Macdonald, Landon Schofield, Dharik Sanchan Mallapragada, MIT Energy Initiative, Massachusetts Institute of Technology, Cambridge, MA, Contact: rmacd@mit.edu

Water electrolysis is predicted to be the primary source of hydrogen by models of future low-emission hydrogen economies because of its potential to produce hydrogen with zero emissions. To keep the cost of hydrogen as low as possible, these electrolyzers will operate dynamically, over-producing and storing hydrogen during periods of low electricity prices. Existing capacity expansion models limit electrolyzers to their rated output. However, it is possible for electrolyzers to raise their output further at the cost of increased wear and tear and more frequent replacement. We present a method to incorporate this tradeoff between higher capital costs and lower operating costs into capacity expansion models. We show the impact it has in example energy systems, particularly for high temperature electrolyzers which have rated outputs much lower than their maximums.

5 Exploring the Broad Range of Energy Technologies Available to Firm up Wind and Solar Generation in Least-Cost Decarbonized Electricity Systems

Alicia Wongel, Ken Caldeira, Carnegie Institution of Science, Stanford, CA, Contact: awongel@carnegiescience.edu

Additional technologies are needed if variable wind and solar generation is to reliably meet demand. Options that could participate in this firming role include dispatchable energy generators, electricity storage technologies, atmospheric carbon dioxide removal, and demand management. Firming technologies are typically studied individually or in small groups. In this study, we allow for a large variety of firm technologies to participate in the system. By examining a series of least-cost systems, in which the dominant firming technologies are sequentially removed resulting in other technologies playing a firming role, we demonstrate that a wide range of technologies and approaches could potentially contribute to system reliability.

Wednesday, October 18, 9:30 AM - 10:45 AM

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CC-North 229B

New Approaches to Risk Management in Power Markets

Community Committee Choice Session

Session Chair: Jon Glass, arpa-e, DC

Session Chair: Richard Paul O'Neill, ARPA-E, Silver Spring, MD

1 System Risk of Renewable Technologies and Its Impact on Clearing Power Markets

Alexander Wasilkoff[1], Panagiotis Andrianesis[2], Michael C, Caramanis[1], [1]Boston University, Boston, MA, [2]Boston University, Boston, MA, Contact: wasilkof@bu.edu

Day Ahead Market bidding Renewable Generation Farms (RGFs) are scheduled and dispatched subject to their bids and transmission congestion. Since RGF available capacity in real time may fall short of RGF economic dispatch, reserve requirements exceeding the conventional generating technologies N-1 contingency must be additionally secured. We add a reasonably likely worse-case endogenous reserve requirement constraint to ensure robust system reliability. Our contribution is the use of system wide correlations to assign RGF-Specific contributions to these additional reserve requirements and to reflect their impact on (i) optimal LMC and RGF Specific clearing prices and (ii) RGF Security Constrained Economic Dispatch.

2 Abscores, Managing Risk and Uncertainty in Electricity Systems Using Banking Scoring and Rating Methodologies

Alberto Lamadrid, Lehigh University, Philadelphia, PA

We present a multi-layered framework that facilitates the implementation of data-enabled recourse actions, instead of worst-case risk management, and manages prospective decisions about the system dispatch and planningThe ABSCORES platform establishes an Electric Assets Risk Bureau, with different scores customized according to the application required. We leverage scoring and ratings methodologies from banking and financial institutions alongside current optimization methods in dispatching power systems to help system operators and electricity markets schedule resources.

3 Performance Risk Scoring of Risk-Free Renewable Generation Bids

Aparna Gupta[1], Denis Osipov[2], [1]Rensselaer Polytechnic Institute, Troy, NY, [2]Rensselaer Polytechnic Institute, Troy, NY, Contact: guptaa@rpi.edu

Renewable generators can bid a conservative segment of the forecasted power generated into the day-ahead market with the aim of generating greater risk-adjusted profitability. However, these bids and their underlying risks may vary across renewable generators, which must be calibrated for a reliable clearing of the day-ahead market. A rigorous third-party performance risk scoring of these risk-free bids is a valuable input and validation in support of a robust day-ahead market clearing framework. In this paper, we develop an ensemble machine learning approach for performance risk scoring of risk-free renewable generation bids and evaluate the performance of these bids made by different renewable resources and in different geographies.

4 Enhancing Decision Support for Electricity Markets with Machine Learning
Yury Dvorkin, Johns Hopkins University, Baltimore, MD
This presentation describes how machine learning can be leveraged to enhance computational speed of day-ahead and real-time unit commitment and optimal power flow routines, which are at the core of market-clearing procedures in US ISOs. Our machine learning architecture embeds both power flow physics and market design properties (e.g., cost recovery and revenue adequacy) into the training stage, which increases accuracy of computations and preserves a relationship between primal (dispatch) and dual (prices) variables. The accuracy and scalability of the proposed method is tested on a realistic 1814-bus NYISO system with current and future renewable energy penetration levels. We also demonstrate ~100x gain in computations relative to traditional optimization approaches.

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CC-North 230
Electric Reliability and Resilience
Community Committee Choice Session
Session Chair: Benjamin D. Leibowicz, The University of Texas at Austin, Austin, TX

1 Optimal Restoration of Power Infrastructure Following a Disaster with Environmental Hazards
Rachel Moglen[1], Benjamin D. Leibowicz[1], Alexis Kwasinski[2], Grant Cruse[2], [1]The University of Texas at Austin, Austin, TX, [2]The University of Pittsburgh, Pittsburgh, PA, Contact: rmoglen@utexas.edu
After a disaster, the power grid helps support infrastructure systems that are essential to the recovery effort in addition to the critical services it provides every day. While many studies discuss optimal power grid restoration, they ignore coincident environmental hazards like debris, chemical hazards, or abnormal radioactivity that may constrain the restoration process. We formulate an optimal restoration planning framework with constraints imposed by acute and cumulative environmental hazards. In our analysis, we compare the performance of an optimal restoration strategy to a heuristic based on best practice restoration in the field. We apply our formulation to a case study of a nuclear event causing abnormal radioactivity.

2 Optimal Resource Placement for Electric Grid Resilience via Network Topology
Balasubramanian Sambasivam, Connor Colombe, John Hasenbein, Benjamin D. Leibowicz, The University of Texas at Austin, Austin, TX
In this paper, we investigate the resilience of alternative electric grid configurations (binary trees and rectangular lattices) by adopting a stylized approach based on graph theory, probabilistic analysis, and simulation. For each configuration, we derive the probabilities that customers located at various nodes in the network will continue to have power following a disaster, depending on the locations of resources (e.g., generators, storage units) in the network. Then, these probabilities are incorporated into the problem of optimally placing resources throughout the network. This is a cost-benefit problem that weighs the benefits of placing resources closer to customers - that is, pursuing a distributed resilience strategy - against the higher total cost of deploying a greater number of smaller resource units.

3 Enhancing Climate Resilience of Electric Vehicles by Coordinated Charging and Heating in Extreme Cold
Guangchun Ruan, Massachusetts Institute of Technology, Boston, MA, Contact: gruan@mit.edu
The performance and service life of electric vehicle (EV) batteries degrade deadly in extreme cold temperatures, and heating is a common-but-expensive option to survive EVs in this case. Coordinating the heating and charging demand at scale has great potential to enhance the climate resilience of EVs. In this talk, we propose a novel station-level decision system to simultaneously manage the EV heating and charging demand. With a thermal dynamic model and a temperature-aware EV charging model, we conduct a rigorous assessment of extreme cold impacts on the EV charging performance and lifespan. The key findings of this talk are informative to enhance the climate resilience of EVs and contribute to the construction of green charging stations.

4 Estimating the Economic Impacts of Widespread, Long Duration Power Interruptions
Peter Larsen, Lawrence Berkeley National Laboratory, Berkeley, CA
Estimates of the economic impact of widespread, long duration (WLD) power interruptions can be used to prioritize and justify significant investments in power system resilience. This project involved surveying Commonwealth

Edison (ComEd) customers to understand how they might respond when confronted with a WLD power interruption. The research team used the survey responses to calibrate a state-of-the-art regional economic model ("POET") to estimate economic impacts to households and 38 industry sectors across 17 impacted micro-regions (individual counties or aggregations of counties) within ComEd's service territory and beyond. We ran one day, three day, and 14 day interruption duration scenarios and various geographic extents as well as estimated the benefits of deploying additional backup generation across the service territory.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB53

CC-North 231A

Emerging research on electric vehicles operations

Community Committee Choice Session

Session Chair: Ali Fattahi, Johns Hopkins University, Baltimore, MD

Session Chair: Hang Ren, George Mason University, Fairfax, VA

1 The Role of Dealer Demonstration in the Adoption of Electric Vehicles

Vishal Agrawal[1], Ioannis Bellos[2], Hang Ren[2], [1]Georgetown University, Washington, [2]George Mason University, Fairfax, VA, Contact: hren5@gmu.edu

Drivers' uncertainty around the extent to which they will be able to meet their mobility needs with an electric vehicle (EV) is often cited as one of the barriers to EV adoption. It has been suggested that one way to alleviate this issue is by offering demonstration services such as extended test drives. However, it has been noted that not all dealers adopt such practices. Empirical evidence also suggest that some dealers exhibit a lackluster attitude toward familiarizing customers with the electric vehicle technology. In this work we consider a monopolist dealer offering conventional and/or electric vehicles to customers who differ in their mobility needs. In addition to vehicle prices, the dealer determines whether to offer demonstration services. We explore the economic and environmental implications of this decision.

2 Circular Economy of Ev Batteries: Economic and Environmental Impacts of Repurposing

Lingling Shi[1], Metin Cakanyildirim[2], Sila Cetinkaya[3], [1]The University of Texas-Dallas, Richardson, TX, [2]The University of Texas at Dallas, Richardson, TX, [3]SMU, Dallas, TX, Contact: lingling.shi@utdallas.edu

The fast growth of electric vehicle (EV) market and the increased energy storage market stimulate the demand for batteries and in turn the critical minerals, which face high supply uncertainty. We investigate the economic and environmental impacts of repurposing spent EV batteries for energy storage in addition to recycling.

3 Optimal Vehicle Charging In Bilevel Power-traffic Networks Via Charging Demand Function

Yufan Zhang[1], Sujit Dey[1], Long He[2], Yuanyuan Shi[1], [1]University of California San Diego, San Diego, CA, [2]George Washington University, Washington, Contact: yuz254@ucsd.edu

We model EV charging management by a bilevel program, with the power network at the upper-level settling the price and the traffic network at the lower-level optimizing the charging power given the price. Solving it is nontrivial, as the two networks are managed by separate entities and the charging expense term, calculated as the product of charging price and charging demand, is nonlinear. To overcome these challenges, we derive the charging demand function. This function establishes a piecewise linear relationship between the charging price and the optimal charging power, enabling the power network operator to manage EV charging power independently while accounting for the coupling between the two networks. With the derived function, we can replace the nonlinear charging expense term with a piecewise quadratic one, thus guaranteeing solution optimality.

4 Utilities' Managed Home-Charging Programs for Electric Vehicles

Ali Fattahi, Johns Hopkins University, Baltimore, MD

Experts estimate 20 million electric vehicles (EVs) will be on U.S. roads by 2030, and around 80% of EV drivers will perform home charging. Many utilities are designing managed home-charging (MH) programs to centrally manage EV drivers' home charging to reduce cost, avoid new and aggravated peaks and blackouts, and ensure grid stability. We present a program-design model and a load-management model for jointly designing and executing various forms of MH programs. We present an effective approximation method, conduct thorough theoretical and numerical analyses of our approximation, and provide worst-case error bounds. We present managerial insights on jointly designing MH programs, effects of high participation in MH programs, trade-off between cost and demand variability, importance of customizing MH programs, and effects of charging frequency.

Wednesday, October 18, 9:30 AM

- 10:45 AM

WB54

CC-North 231B

Machine Learning for Modeling, Optimization, and Applications

Community Committee Choice Session

Session Chair: Qingyang Xiao, 1</sup

1 A Machine Learning-Based L-Shaped Method for Large Scale Two-Stage Stochastic Programming

Qingyang Xiao[1], Haowei Yang[2], Zhijie "Sasha" Dong[1], [1]University of Houston, Missouri City, TX, [2]University of Houston, Houston, TX, Contact: qxiao2@uh.edu

In this work, we focus on developing a machine learning (ML) framework to enhance the L-shaped method to improve the computational efficiency for large scale two-stage stochastic programming (SP). The proposed supervised learning is designed for the decomposition-based SP second stage upper bound prediction. The performance analysis of ML based L-shaped method is conducted per classical SP problems comparing to benchmarks. The targeted achievement of this research is to generate a new class of theoretical optimization methods for various real-world applications.

2 Spidarman: System Physics-informed Detection Of Anomalies In Reactors Considering Human Errors

Ezgi Gursel[1], Jamie Coble[1], Mahboubeh Madadi[2], Vivek Agarwal[3], Ronald Boring[3], Vaibhav Yadav[3], Anahita Khojandi[1], [1]University of Tennessee, Knoxville, TN, [2]San Jose State University, San Jose, CA, [3]Idaho National Laboratory, Idaho Falls, ID

In nuclear power plants (NPPs), anomalies arising from sensors or human errors (HEs) can undermine the performance and reliability of plant operations. Anomaly detection models can be employed to detect sensor errors and human errors. Additionally, physics-informed machine learning (PIML) models can utilize the known physics of the system, as described by mathematical equations, to ensure sensor values are consistent with physical laws. Hence, we propose SPIDARman: System Physics-Informed Detection of Anomalies in Reactors Considering Human Errors, a holistic physics-informed anomaly detection approach based on generative adversarial networks to detect anomalies in both automatically collected sensor data and manually collected surveillance data. We test our approach on data collected from a flow loop testbed, showcasing its potential to detect anomalies.

3 Extending Conformal Prediction to Hidden Markov Models with Exact Validity via De Finetti'S Theorem for Markov Chains

Buddhika Nettasinghe[1], Samrat Chatterjee[2], Ramakrishna Tipireddy[3], Mahantesh Halappanavar[2], [1]University of Iowa, Iowa City, IA, [2]Pacific Northwest National Laboratory, Richland, WA, [3]Palo Alto Networks, Santa Clara, CA

Conformal prediction is a widely used method to quantify the uncertainty of a classifier under the assumption of exchangeability (e.g., IID data). We generalize conformal prediction to the Hidden Markov Model (HMM) framework where the assumption of exchangeability is not valid. The key idea of the proposed method is to partition the non-exchangeable Markovian data from the HMM into exchangeable blocks by exploiting the de Finetti's Theorem for Markov Chains discovered by Diaconis and Freedman (1980). The permutations of the exchangeable blocks are viewed as randomizations of the observed Markovian data from the HMM. The proposed method provably retains all desirable theoretical guarantees offered by the classical conformal prediction framework in both exchangeable and Markovian settings.

Session Chair: Farzane Ezzati, University of Houston

Session Chair: Haowei Yang, Houston, TX

Wednesday, October 18, 9:30 AM - 10:45 AM

WB55

CC-North 231C

Energy Consumption and Decarbonization

Contributed Session

Session Chair: Esra Agca Aktunc, Rensselaer Polytechnic Institute, Troy, NY

1 The Impact of Macroeconomic Indicators on Oil Prices: Evidence from Emerging Economies

Muhammad Suleman, Xi'an Jiaotong University, xian, China. Contact: suleman@stu.xjtu.edu.cn

The research endeavours to understand the concept of macroeconomic indicators and assessment of variations in oil prices in any country, the impact of macroeconomic indicators on oil prices and to provide recommendations in this regard. The data from the years 1999-2019 was adopted where the variables used for assessment were inflation, interest, exchange rate, GDP and oil prices of the global market. It was concluded that the variables are interrelated with each other as it explains the association between the variables as having an impact on the oil prices in the country. Based on results from the current research it is recommended to provide the balance regarding four macroeconomic factors, taken in this research such as interest rate, inflation rate, exchange rate and real GDP of a country that could influence the development of the economy.

2 Frequency Regulation and Storage: On Losses and Profits

Dirk Lauinger[1], Francois Vuille[2], Daniel Kuhn[3], [1]MIT, Cambridge, MA, [2]Etat de Vaud, Lausanne, Switzerland; [3]Ecole Polytechnique Federale de Lausanne (EPFL), Lausanne, Switzerland

We derive an analytical solution to the decision-making problem of storage operators who sell frequency regulation power to grid operators and trade electricity on day-ahead markets. Thanks to a constraint on the expected terminal state-of-charge, the amount of electricity traded on day-ahead markets becomes an implicit function of the regulation power sold to grid operators. The implicit function quantifies the amount of power that needs to be purchased to cover the expected energy loss that results from providing frequency regulation. We show how the associated marginal cost of frequency regulation decreases with roundtrip efficiency and increases with frequency deviation dispersion. We find that the profits over the lifetime of energy-constrained storage devices are inversely proportional to the length of time for which regulation power must be committed.

3 An Overview of Electricity Consumption in Europe Using Classification, Segregation, and Prediction Models

Esra Agca Aktunc[1], Ergun Yukseltan[2], Ayse Bilge[2], Ahmet Yucekaya[2], [1]Rensselaer Polytechnic Institute, Troy, NY, [2]Kadir Has University, Istanbul, Turkey. Contact: agcaae@rpi.edu

Although aggregate electricity consumption provides valuable information for market analysis, demand composition of industrial, residential, illumination, and other uses, and special days, such as holidays and industrial shutdowns, differ for each country. We analyze the hourly electricity consumption of countries in the European Transmission System Operation for Electricity (ENTSO-E) grid from 2006 to 2018. We propose an outlier detection method to identify special days using the hourly time series and a modulated Fourier Series Expansion model to determine the breakdown of industrial-household and heating-cooling consumption. The proposed demand prediction model has a 3% average error when heating use is not dominant. It also allows country classification by consumption patterns to efficiently manage regional or country-based electricity markets.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB56

CC-North 232A

Stochastic Analysis of Energy Power Systems

Contributed Session

Session Chair: Sam Chakrabarti, Princeton University, Princeton, NJ

1 Impacts of Regional Allowance Allocation Difference on Capacity Portfolios and Facility Location Under Cap-And-Trade

Xiangzhou Cao, Tsinghua University, Beijing, China. Contact: 2038118374@qq.com

This study presents a two-stage modeling approach to investigate the effect of environmental regulation in the form of carbon allowance allocation under Cap-and-Trade system on capacity portfolio and facility location decisions of a firm. In this context, carbon allowance for a facility has a regional difference and is allocated based some rule (grandfathering, benchmark). Carbon emission of a facility includes its production emission and transportation emission from production location to market. As a response, the firm decides facility locations and corresponding capacity portfolios, which include capacity size and the type of technology (dirty or green). Uncertainties like carbon price and consumer demand are considered. L-shaped method is implemented to get sight into the firm's optimal decisions under different allocation rules.

2 A Binary Expansion Approach for the Optimal Demand Response in Large and High Altitude Water Distribution Networks

Denise Carolina Cariaga Sandoval, University of Edinburgh, Edinburgh, United Kingdom. Contact: D.C.Cariaga-Sandoval@sms.ed.ac.uk

Demand response for water networks is an optimisation model that determines which water pumps will be turned on or off every time according to a dynamic electrical tariff. The problem is relevant in mining due to the high power usage of water pumps and the power prices uncertainty. The problem faces difficulties: i) nonlinearities of the frictional losses along the pipes and pumps; ii) many possible combinations of pressure head and flow rate, which leads to high computational costs. These limitations prevent the problem from being solved in a reasonable computational time in water networks with more than two pumps and reservoirs. Therefore, we develop new models for this problem that use a binary expansion approach to account for the nonlinearities and minimise the systemic cost; and it reduces the computational time compared to the current nonlinear Gurobi solver.

3 Resilient Planning of Power Systems - Fundamental Value Analysis

Farhad Billimoria[1], Sam Chakrabarti[2], [1]University of Oxford, Oxford, United Kingdom; [2]Princeton University, Princeton, NJ, Contact: sc87@princeton.edu

This paper addresses the increasing vulnerability of power systems to extreme weather and climate events resulting from climate change. Resilience of the power system is critical, and optimal planning requires a granular representation of risk relating to extremes. We examine the trade-offs between the variability of new sources of supply and demand and the codependence of existing fossil generation infrastructure and supply chains. To understand fundamental exposures of the system to extremes and the resilient system mix for future power systems, we develop a risk-averse stochastic electricity planning model adapted from the state of the art GenX power system planning model. Our results provide insights for policymakers and power system planners to design more resilient power systems.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB57

CC-North 232B

Understanding customer behavior to inform decision making

Contributed Session

Session Chair: Shan Li, City University of New York, New York, NY

1 Mobile Advertisement Campaigns for Boosting In-Store Visits: A Design Framework and Case Study

Kimia Keshanian[1], Narayan Ramasubbu[2], Kaushik Dutta[3], [1]University of Tampa, Tampa, FL, [2]University of Pittsburgh, Pittsburgh, PA, [3]University of South Florida, Tampa, FL, Contact: kkeshanian@ut.edu

Brick-and-mortar retailers aim to increase foot traffic in their stores for better sales opportunities. Mobile location-based advertising has become a crucial marketing tool for reaching potential customers. However, designing effective campaigns requires complex analysis of data to target the right customers at the right time and place. We present a campaign design framework that considers data acquisition costs, data utilization, and the varying effects of data on campaign performance. Using a real-world case study, we demonstrate that the optimal attributes for targeting customers depend on their proximity to the store. Campaigns that use all or a naïve subset of data attributes yield lower returns compared to our proposed approach. Our findings have implications for mobile advertising campaign design, deployment, and further research in targeted advertising.

2 Selection And Moral Hazard In Gig And Traditional Agents: Evidence From A Field Experiment In E-commerce Call Center

Qiaowen Guo, Olin business school at Washington University in St. Louis, Saint Louis, MO, Contact: qiaowenguo@wustl.edu

We conduct a field experiment in the call center of Alibaba to compare the performance of gig agents and traditional agents. We investigate whether gig agents perform better than traditional agents in the context of e-commerce call centers when incentivized by sharing platforms through earnings, ratings, and penalties. We also examine if gig agents still outperform traditional agents when all features that could influence performance are controlled. Finally, we seek to identify the driving incentives that lead to the results.

3 Product Design and Branding Decision in the Presence of Brand Spillovers

Katsunari Tajima, Nobuo Matsubayashi, Keio University, Yokohama, Japan

When consumers evaluate the quality of a branded firm's new product, their perception of that firm's existing products can influence their evaluation with some bias. Considering such a brand spillover effect, we analytically examine a branded firm's quality choice and brand strategy for its new product. Our results show that the firm's optimal strategy depends on the quality level of its existing product and the ratio of two types of consumers who differ in their attitudes to the quality change with the new product offering. Unlike the results in the related literature, it can be optimal to set the strength of spillover at an intermediate level through a use of sub-brand.

4 How to Make You Trust Me All the Time? Guidance Strategies in a Cost-Loss Game

Bochen Zhu[1,2], Lijia Tan[2], Rob Basten[2], Lijia Wei[1],

[1]Wuhan University, Wuhan, China; [2]Eindhoven University of Technology, Eindhoven, Netherlands. Contact: b.zhu1@tue.nl

The expert possesses knowledge regarding the possibility of a state's realization that the decision maker lacks and offers an unequivocal advice to the decision maker, who then determines whether to follow the advice. The decision maker's action impacts the welfare of both players. How can the expert persuade the nonexpert decision maker to follow his advice, even when their benefits are not completely aligned? We test two strategies to convey this advice: Bayesian Persuasion and Third Threshold. We consider a cost-loss game with heterogeneous payoffs between players, in which decision makers decide whether to take a risk of a loss or pay a cost to avoid the risk. We find that the Third Threshold strategy is superior for the expert.

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WB58

CC-North 232C

AI Applications

Contributed Session

Session Chair: Benjamin Cohen, University of Connecticut, Storrs, CT

1 Bpm Methodology for Implementing Ai in Business Processes

Vinayaka Gude, Texas A&M University - Commerce, Commerce, TX, Contact: vinayaka.gude@tamuc.edu

AI has already begun to automate specific tasks and roles, leading to changes in the job market. Therefore, it is crucial to establish a framework for implementing changes in the business process that involve completing or partially replacing tasks with AI. This research aims to present a BPM-based methodology that enables the identification of criteria and the extent to which tasks within a process can be either replaced or complemented by AI. The simulation results for a loan approval process comparing the pre-and post-implementation phases indicate substantial long-term cost savings and reduced processing time. Furthermore, this paper delves into the challenges of implementing AI technologies in a business process, encompassing accuracy, effective information transfer, and ethical and security considerations.

2 Large Language Models and Knowledge Graphs to Optimize Commercial Real Estate Portfolio

Fearghal O'Donncha[1], John Sheehan[1], Fabio Lorenzi[1], Alexander Timms[1], Malgorzata J. Zimon[2], Joern Ploennigs[1], [1]IBM Research Europe - Ireland, Mulhuddart, Ireland; [2]IBM Research Europe, Warrington, United Kingdom. Contact: feardonn@ie.ibm.com

Commercial real estate decision making is a complex process influenced by various factors. Factors such as supply and demand, economic conditions, sustainability objectives, government regulations, infrastructure, socioeconomic and demographic trends, and market sentiment all play a role in shaping the dynamics of the market. To optimize real estate portfolios, companies need cost-effective and efficient space utilization through data-informed decision frameworks supported by AI-backed intelligence. Extracting insights from diverse data with complex causal dynamics requires contextual knowledge. Additionally, as economic and market conditions evolve, synoptic evaluations may lose value. In this talk, we explore the potential of combining knowledge graphs and insights from large language models to enhance real estate decision making.

3 Enhancing Interpretability and Prediction Reliability in Regression Tasks Through Constrained Mixture of Experts

Francis Kim[1], Minseok Han[2], Jong-Seok Lee[2], [1]Sungkyunkwan University, Suwon, Korea, Republic of; [2]Sungkyunkwan University, Suwon, Korea, Republic of. Contact: kimfrancis.cg@gmail.com

In this paper, we introduce a new method leveraging Mixture of Experts (MOE) models for reliability prediction in regression tasks, with a focus on interpretability. Traditional MOE models can capture complex relationships but lack in interpretability. We mitigate this by constraining MOEs into simple, localized linear models. The MOE gating network weights, usually employed to weigh the contribution of each expert, are repurposed in our work. They are used to measure prediction confidence, offering an insightful reliability evaluation. Our model was trained on both synthetic and real data and consistently showed accurate reliability measures in different scenarios, demonstraing the robustness of our approach.

4 Learning Human-Interpretable Models Using Machine Learning and a Smooth Information Criterion

Benjamin Cohen, Nazia Aslam, Burcu Beykal, George M. Bollas, University of Connecticut, Storrs, CT, Contact: benjamin.2.cohen@uconn.edu

We propose a method that harnesses scarce data and domain-expert knowledge to discover human-interpretable models. Our approach combines a smooth information criterion within a physics-informed machine learning loss function, allowing for simultaneous identification of a human-interpretable model and its parameter estimates. Our method can discover physics from data, without the biases inherent in sequential threshold regression techniques. We demonstrate our approach through a study of various nonlinear dynamic systems, comparing it to symbolic regression and physics-informed neural networks. Our results emphasize the significance of smooth information criterion loss functions on data-driven model discovery and parameter identification.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB59

CC-West 101A

Sensitivity Analysis and Optimization

Contributed Session

Session Chair: Benjamin Hamlin, Clemson University, Central, SC

1 Physics-enhanced Neural Ordinary Differential Equations: A Hybrid Framework for Chemical Reaction Systems

You Peng[1], Farshud Sorourifar[2], Ivan Castillo[3], Linh Bui[4], Juan Venegas[5], Joel A. Paulson[2], [1]The Dow Chemical Company, Columbus, OH, [2]The Ohio State University, Columbus, OH, [3]The Dow Chemical Company, Lake Jackson, TX, [4]The Dow Chemical Company, Lake Jackson, TX, [5]The Dow Chemical Company, Midland, MI

Ordinary differential equations (ODEs) are of critical importance to science and engineering. Fields of research are dedicated to the task of building such models through domain expertise. A data-driven framework for constructing dynamic models has the potential to accelerate the lab-to-market pipeline by removing some of the need for domain expertise. In this work we investigate the applicability of neural ODEs (NODEs) for building models of reaction kinetics from experimental data, and how available domain knowledge may be used to accelerate learning. Using a simulation case-study we show that utilizing information of the system's dynamics can aid in training models; however, extreme care should be taken when attempting to use additional information. Our findings on two industrial reaction data sets suggest that even weak assumptions can impair NODE training.

2 Design Variable Selection in Personalized System Design Through Bayesian Optimization

Jiacheng Liu[1], Wenbo Sun[2], Judy Jin[1], Jingwen Hu[2], [1]University of Michigan, Ann Arbor, MI, [2]University of Michigan Transportation Research Institute, Ann Arbor, MI, Contact: liujc@umich.edu

Achieving an effective personalized design policy through Bayesian Optimization (BO) remains a computational challenge with high-dimensional design variables. Constructing a reliable surrogate model involves conducting computationally intensive simulations and costly predictions. Moreover, policy parameters optimization is time-consuming. Conventional BO tackles the first task by taking a lower-dimensional subspace with the important variables. However, in personalized system design, the design variable selection must account not only for their importance in surrogate model but also for their variance in design policy. We propose a BO algorithm that develops a new importance score to assess the relevance of each design variable in GP and design policy. Both the results on the synthetic data and case study demonstrate the effectiveness and robustness.

3 A Parametric Perspective on Benders' Decomposition

Benjamin J. Hamlin, Margaret M. Wiecek, Clemson University, Clemson, SC, Contact: bjhamli@clemson.edu

We consider a linear program suitable for Benders' decomposition with a parameter in the objective function. Applying parametric linear programming duality and following on the original results by Benders on the feasible region of the relaxed master problem to yield an optimal solution of the original problem, we develop a theory for a parametric master problem and parametric sub-problem in support of analogous conditions. Examples are included.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB60

CC-West 101B

Evidence-based Interventions using Causal Inference

Community Committee Choice Session

Session Chair: Nur Kaynar, Cornell University, Ithaca, NY

1 Staggered Rollout Designs for Estimating the Total Treatment Effect Under Network Interference

Mayleen Cortez-Rodriguez, Cornell University, Ithaca, NY, Contact: mec383@cornell.edu
Interference, where the treatment of an individual influences the outcomes of others, arises in many causal inference settings. We present methods for estimating the total treatment effect (TTE), or the average difference between the outcomes when the population is treated versus when the population is untreated, when interference is constrained to low-order interactions among neighbors of an individual. We leverage a staggered rollout design, in which treatment is incrementally given to random subsets of individuals, to construct estimators for the TTE. We also consider a bias-variance trade-off when we introduce cluster-correlated designs, highlighting regimes where utilizing staggered rollout designs, information about the network, and estimators exploiting low-order interactions in the potential outcomes leads to useful estimation methods.

2 Causal Discovery in Retailing Choice Estimation
Vishal Gaur, Nur Kaynar, Ziwei Zhu, Cornell University, Ithaca, NY, Contact: zz575@cornell.edu
Causal discovery is widely used to uncover causal relationships from observational data. In our study, we utilize this approach to construct directed acyclic graphs (DAGs) that represent causal links between product purchases in basket shopping data in retailing. Using the estimated DAGs, we estimate choice and substitution behavior between products. This method is useful for verifying established assumptions in category choice models, such as symmetric substitution effects across categories. To validate these classical assumptions, we apply the PC algorithm, which is a widely used algorithm in causal discovery, to Walmart retail data. Additionally, we demonstrate how the causal discovery approach can enhance the accuracy of predicting customer choice.

3 Causal Discovery for Instrument Validity
Nur Kaynar[1], Auyon Siddiq[2], Frederick Eberhardt[3], [1]Cornell University, Ithaca, NY, [2]University of California-Los Angrles, Los Angeles, CA, [3]Caltech, Pasadena, CA
We propose a new optimization-based method for learning causal structures from observational data, a process known as causal discovery. We consider a highly general search space that accommodates latent confounders and feedback cycles, which few extant methods do. We formulate the discovery problem as an integer program, and propose a solution technique that identifies promising edges for inclusion in the output graph. We leverage our method to develop a graphical test for the validity of an instrumental variable and demonstrate it on the influential instruments for estimating the returns to education from Angrist and Krueger (1991) and Card (1993). In particular, our test complements existing instrument tests by revealing the precise causal pathways that undermine instrument validity, highlighting the unique merits of the graphical perspective on causality.

4 Evaluating Instrument Validity Using the Principle of Independent Mechanisms
Patrick Burauel, California Institute of Technology, Pasadena, CA, Contact: pburauel@caltech.edu
The validity of instrumental variables to estimate causal effects is typically justified narratively and often remains controversial. Critical assumptions are difficult to evaluate since they involve unobserved variables. Building on Janzing and Schölkopf's (2018) method to quantify a degree of confounding in multivariate linear models, we develop a test that evaluates IV validity without relying on Balke and Pearl's (1997) inequality constraints. Instead, our approach is based on the Principle of Independent Mechanisms (causal models have a modular structure). Monte Carlo studies show a high accuracy of the procedure. We apply our method to two empirical studies: e.g., we can corroborate the narrative justification given by Card (1995) for the validity of college proximity as an instrument for educational attainment to estimate financial returns to education.

Wednesday, October 18, 9:30 PM - 10:45 AM

WB61

CC-West 101C
Innovations in Public Sector Operations
Community Committee Choice Session
Session Chair: Andrew C. Trapp, Worcester Polytechnic Institute, Worcester, MA
Session Chair: Weixiao Huang, Worcester Polytechnic Institute, Worcester, MA

1 Mission vs. Profit: The Interplay Between Social Service Agencies and Private Service Providers
Gulten Busra Karkili, Senay Solak, University of Massachusetts Amherst, Amherst, MA
In this paper, we consider subsidy welfare programs that involve mission-oriented service agencies cooperating with profit-oriented service providers. We identify funding-based mechanisms for service agencies to incentivize program participation and capacity allocation by private service providers. A provider's decision process is impacted by funds received from the service agency, demand uncertainty, and participation decisions of competitors. We characterize

optimal fund allocation policies for service agencies to providers such that total social impact of the subsidy welfare programs is maximized.

2 Improving Foster Care Visitation Scheduling: Maximizing Visitation Appointments via Time-Space Networks

Shima Azizi[1], Caroline Johnston[2], Erhun Kundakcioglu[3], Rizk Makroum[4], Andrew C. Trapp[5], [1]St. John's University, New York, NY, [2]University of Southern California, Los Angeles, CA, [3]Ozyegin University, Istanbul, Turkey; [4]Aubay, Lisbonne, Portugal; [5]Worcester Polytechnic Institute, Worcester, MA, Contact: azizis@stjohns.edu

Child welfare agencies charged with ensuring foster children regularly visit biological parents can be challenged due to fixed workforce levels and fluctuating caseloads. We introduce the Foster Care Visitation Scheduling Problem to assign, schedule, and route workers to foster children. We develop a two-phased network-based optimization approach that 1) preprocesses and pre-computes a time-space network structure, and 2) solves a novel large-scale integer optimization problem over this network. We incorporate our approach into an interface, assists foster care organizations to better operationalize their resources, and improves the consistency of visits and so quality of life for foster children. We discuss computational experiments on a variety of instances inspired by real data from New York State that reveal encouraging computational performance.

3 Performance Evaluation Of Child Welfare Departments Using Data Envelopment Analysis: A Comparative Study Across Us States

Sepideh Sedghi[1], Shima Azizi[2], Charles Vincent[3], Andrew C. Trapp[1], [1]Worcester Polytechnic Institute, Worcester, MA, [2]St. John's University, Queens, NY, [3]University of Bradford, Bradford, United Kingdom

The performance of departments of children and families is of critical importance to the future of our society. However, limited previous research appears to exist in performance analysis in the context of child welfare. We use Data Envelopment Analysis (DEA) to evaluate the performance of departments of children and families across different US states. Key inputs and outputs include child welfare spending and the re-entry rate of children, respectively. We conduct multiple analyses toward identifying high-performing states and explore additional methodological directions concerning the factors that contribute to disparities in DEA scores. The findings from this study provide valuable insights into the performance of foster care agencies and offer guidance for improving the quality of care provided to children in need.

4 Lessons Learned: New Perspectives on Cognitive Engineering in Child Welfare

Connor Wurst, University at Buffalo, Buffalo, NY

The child welfare system functions under high stakes, tight constraints, and a wide range of different stakeholder perspectives. There has been a number of calls for technological interventions to improve practitioner decision making and outcomes for youth in care, and our multidisciplinary team set out nearly four years ago to attempt to answer these calls. Through a number of different studies and approaches we have shifted our perspectives on this complex domain and the best path forward. This presentation broadly outlines the work that we have conducted, our shifts in perspective, and our hopes for future work, focusing particularly on our application of cognitive engineering to the domain.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB62

CC-West 102A

Advances in Project Management

Contributed Session

Session Chair: Yihong Liu, The University of Texas at Dallas, Richardson, TX

1 An Improved Simulated Annealing Algorithm for Centralised Resource-Constrained Multiproject Scheduling to Minimise the Maximal Cash Flow Gap

Yukang He, Xi'an Jiaotong University, Xi'an, China

This paper involves a centralised resource-constrained multiproject scheduling problem, where renewable resources can be shared by all the individual projects and the task is to arrange activities' start times to minimise the contractor's maximal cash flow gap. First, we construct an optimisation model and propose some properties for the problem. Then, we develop a simulated annealing algorithm and design an improvement measure to enhance its searching efficiency. Finally, we conduct an computational experiment on an existing dataset, and the obtained results indicate that the developed algorithm is the most promising algorithm for the studied problem and some key parameters may exert important effects on the objective function value.

2 Research On Bi-level Project Network Control Method Based On Schedule Risk Analysis

Shuting Wang, Xiaobing Liu, Zhaoyang Bai, Dalian University of Technology, Dalian, China

Schedule Risk Analysis (SRA) has been shown to identify highly sensitive activities that significantly impact project duration, highlighting project control management priorities. The bi-level project planning model is strongly motivated by real-world applications. Since SRA focuses solely on single-level networks, traditional SRA metrics do not accurately reflect activity sensitivity in bi-level networks. This paper extends the traditional SRA metrics, introduces the sensitivity metrics (B-SRA) applicable to bi-level activity networks, and integrates them into buffer management. Five different B-SRA metrics are proposed to allocate project buffers and set tolerance limits. We conducted computational experiments on a set of large projects with different characteristics. Results show that the proposed project control method is effective and reliable.

3 A Dynamic Programming Approach to Multi Skilled Decentralized Multi Projects Scheduling with Uncertain Resource Availabilities

Xinyu Lin[1], Min Wang[2], [1]Renmin University of China, Beijing, China; [2]Fujian Jiangxia University, Fujian, China. Contact: lxylinxinyu@163.com

The paper studied the effect of multi-skilled resources in mitigating resource conflicts and coping with resource disruption in decentralized multi-project scheduling. Due to the geographical or organizational decentralization of multiple projects, global resource conflicts can easily occur while unexpected resource disruption brings new challenges. How to reduce the adverse effects of resource scarcity has become a widely concerned issue. Multi-skilled resources play a vital role in resolving resource conflicts and reducing project delays. Idle resources can replenish excess or missing resources, whose skills can be dynamically switched. The paper designed a bi-level model, proposed two new priority rules for multi-skilled resource scheduling, and designed a stochastic scheduling policy. The effectiveness of the algorithm was verified by experiment.

4 An Incremental Approach to Team Formation: A Markov Decision Process Framework

Yihong Liu, Sumit Sarkar, Syam Menon, The University of Texas at Dallas, Richardson, TX

Finding good team members for complex tasks in online platforms can be difficult when many candidates with diverse skills are available. We propose a novel recommendation framework that forms teams incrementally using a Markov decision process. The framework suggests potential collaborators to a focal participant (requester) based on the current team state and the expected contribution of potential candidates. Our approach aims to optimize team performance while accounting for the uncertainty associated with candidates' willingness to join the team.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB64

CC-West 102C

Advances in Simulation Methodologies

Contributed Session

Session Chair: Eunji Lim, Adelphi University, Mineola, NY

1 Mining Simulation Log Data

Farhad Moeeni, Arkansas State University, Jonesboro, AR, Contact: moeeni@astate.edu

Discrete-event simulation (DES) is a powerful tool to model systems' behavior and to measure performance under various values of decision or input variables. Analysis of output is typically performed through the traditional statistical sampling methods, for example, the method of batch means and replication deletion. Each simulation run produces massive volume of "log data" including those corresponding to state variables as the simulation clock advances. Traditionally, the log data has been used for validation and verification of the simulation model. This exploratory study investigates the usefulness of data mining techniques to analyze log data to potentially extract insights not possible through the conventional output analysis.

2 Resolving Pert Ambiguity: A Unified Framework for Classifying Pert-Beta Rng Models

Byung-Cheol Kim, Penn State Behrend, Erie, PA, Contact: buk70@psu.edu

This study explores the ambiguity errors in ostensibly interchangeable PERT(program evaluation and review technique)-beta reparameterization models for project risk simulations, challenging the implicit assumption of their functional equivalency. Through empirical and theoretical assessments, we demonstrate the presence of ambiguity errors and identify three distinct PERT-beta distribution variants. We present empirical evidence by applying seven PERT RNG (random number generation) models to anecdotal cases in the literature. Moreover, our research introduces a unified visual classification framework to resolve the PERT ambiguity problem, contributing to the theory and practice of PERT-based risk simulation in project management.

3 Efficient Influence Function Estimation via Nonparametric Regression Method to Quantify Simulation Input Uncertainty

Jaime Gonzalez[1], Eunhye Song[2], [1]Georgia Institute of Technology, Atlanta, GA, [2]Georgia Institute of Technology, Atlanta, GA, Contact: jhodar3@gatech.edu

In this talk, we discuss efficient input uncertainty (IU) quantification when nonparametric input models estimated from data are adopted to run simulations. IU refers to the variance in the simulation output due to the estimation error of the input models. To construct the asymptotically correct confidence interval (CI) for the true performance measure of the system, the nonparametric delta method can be applied, which requires influence function (IF) estimation for the simulation output mean. However, estimating the IF is computationally expensive. We present a method to reduce the cost of estimation via nonparametric regression. We numerically demonstrate its computational efficiency using some discrete-event simulation examples for which it significantly reduces the estimation error in IF and empirical coverage of the CI.

4 Integrated Robust Simulation-Optimization

Pengxiang Zhou[1], Wai Kin (Victor) Chan[1], Zuo-Jun Max Shen[2], [1]Tsinghua University, Tsinghua Shenzhen International Graduate School, Shenzhen, China; [2]University of California Berkeley, Berkeley, CA, Contact: zpx20@mails.tsinghua.edu.cn

Simulation-optimization involves generating candidate system configurations and evaluating their performance through simulation. The integrated robust simulation-optimization models efficiently integrate optimization and evaluation using closed-form robust performance measure in a two-stage formulation, where the first-stage objective is to minimize system costs, and the second stage involves costs associated with worst scenarios. Integrating optimization models with simulation enables the generation of the worst-case scenarios which are unavailable in simulation, and facilitates optimal robust simulation-optimization strategies. Numerical experiments show that the integrated models balance cost and system reliability, and demonstrate the efficacy of decomposition methods along with simulation module for fast performance evaluation.

5 Simulation-Based Prediction

Eunji Lim[1], Peter W. Glynn[2], [1]Adelphi University, Garden City, NY, [2]Stanford University, Stanford, CA, Contact: elim@adelphi.edu

We are concerned with the use of simulation in computing predictors in settings in which real-world observations are collected. A major challenge is that the state description underlying the simulation will typically include information that is not observed in the real system. This makes it challenging to initialize simulations that are aligned with the most recent observation collected in the real-world system, especially when the simulation does not visit the most recently observed value frequently. Our estimation methodology involves "splitting," so that multiple simulations are launched from states that are aligned with the most recently collected observation. We provide estimators both in the setting that the observed real-world values are discrete and are continuous, with kernel smoothing methods being systematically exploited in the continuous setting.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB65

CC-West 103A

Innovations for Product Development and Adoption

Contributed Session

Session Chair: Yixuan Zhang, University of Science and Technology Beijing, Beijing, China

1 Characterizing Dis/Misinformation Spreading Patterns in Online Social Media

Ensheng Ensheng[1], Andreas Nearchou[1], Lauren Gardner[1,2], [1]Johns Hopkins University, Baltimore, MD, [2]Bloomberg School of Public Health, Baltimore, MD, Contact: edong1@jhu.edu

Online social media platforms play a critical role in the sharing of information, ranging from scientific facts to harmful dis/misinformation. While misinformation spread is well-studied, the mechanisms that characterize information sharing are still unclear, in particular, how information flow differs by content type. In this study we utilize 40M+ COVID-19 and vaccine-related tweets (Jan-May 2021), and categorize these tweets into left, right, center and misinformation subgroupings. We characterize the information flow patterns by generating directed, weighted retweet networks, and evaluate the difference in content-specific information spread using a suite of network analysis tools. The study reveals differences in structural flow patterns, top influencers, and other content-specific behaviors that shed new light on information spread and impact.

2 Optimal Mixed Subsidy Policy for Innovation

Myeonghun Lee, KAIST, Seoul, Korea, Republic of. Contact: mhlee96@kaist.ac.kr

Government intervention plays a pivotal role in fostering the development and adoption of socially beneficial technology. In this study, we explore the optimal mix of two distinct subsidy types utilized by the government: a technology push that incentivizes manufacturers' R&D efforts, and a demand pull that directly rewards consumers. We formulate a multi-period model incorporating multiple firms that initiate R&D investments early on and subsequently engage in market competition. Interestingly, while a more beneficial technology corresponds to an increased overall subsidy budget, the distribution between push and pull subsidies exhibits non-monotonic shifts contingent on the equilibrium regime. We further show that contrary to the convention that spillover dissuades firms from R&D investment, spillover may indeed stimulate R&D investment.

3 The Distance Between Ideal and Reality: How Do Firms Embracing Artificial Intelligence Respond to Innovation Activities?

Yixuan Zhang, Xiangbin Yan, University of Science and Technology Beijing, Beijing, China. Contact: d202210500@xs.ustb.edu.cn

We aim to explore how artificial intelligence (AI) application practices create valuables for corporate innovation activities in the global data revolution context. Using large datasets from firms, we develop econometric models that consider moderating factors of managers' ecological concerns and corporate privacy-protecting to provide clearer support for our research. We have some interesting findings that AI applications can change innovation activities from multiple perspectives, such as substituting labor, introducing new tasks, strengthening user co-create abilities, and facilitating the development of green energy products. This study provides valuable insights for firms to achieve technology-driven innovation activities.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB66

CC-West 103B

Predictive Analysis in Medical Care

Community Committee Choice Session

Session Chair: Syed Hasib Akhter Faruqui, Northwestern University, Chicago, IL

1 Probabilistic Ensemble Learning for Prediction of Stroke Thrombectomy Outcomes from the Neurovascular Quality Initiative - Quality Outcomes Database (Nvqi-Qod) Registry

Chaochao Zhou, Syed Hasib Akhter Faruqui, Abhinav Patel, Ramez Abdalla, Ali Shaibani, Matthew Potts, Babak Jahromi, Sameer Ansari, Donald Cantrell, Northwestern University, Chicago, IL, Contact: chaochao.zhou@northwestern.edu

Mechanical Thrombectomy is the standard-of-care in the interventional management of Acute Ischemic Stroke. We identified feature variables from the NVQI-QOD registry. We introduced a Probabilistic Neural Network (PNN) that predicts the expected distribution of NIH Stroke Scale (NIHSS) changes and 90-day modified Rankin Scale (mRS). The predictions of the PNN were compared to those of XGBoost, with both PNN and XGBoost trained using bagging ensemble learning. For both regression and classification, there were almost no differences in the prediction performance between the PNN and XGBoost ensembles. However, PNN can accurately describe the distributions of NIHSS changes represented by predicted means and SDs. This study demonstrates the utility of probabilistic ensemble learning in providing robust predictions while simultaneously quantifying uncertainty.

2 Application of Cnn to Detect and Compare the Dyslexia Level

Niamat Hossain, Jonathan Stubblefield, Arkansas State University, Jonesboro, AR

Dyslexia is a common neurodevelopmental disorder affecting individuals' reading and writing abilities. In recent years, the use of artificial intelligence, particularly Convolutional Neural Networks (CNNs), has shown promising results in dyslexia detection. While several CNN types of research have been conducted to detect dyslexia, there is a lack of research that examines the dyslexia proneness of the alphabet. To void this gap, this study uses a CNN classifier to identify alphabets with higher dyslexia by running CNN models to classify dyslexia-prone letters and comparing the F1 scores to see which alphabet is most deviated from the norm. The dataset in hand on Dyslexia contains handwritten normal alphabets and alphabets written for dyslexia patients. Finally, the paper discusses future directions and challenges in the field of dyslexia detection using CNN.

3 A Systematic Review and Tutorial of Machine Learning Approaches in Predicting Cardiovascular Diseases

Rakib Hasan[1], Syed Hasib Akhter Faruqui[2], [1]University of Texas at San Antonio, San Antonio, TX, [2]Northwestern University, Chicago, IL

Cardiovascular diseases (CVDs) pose a significant health burden for patients with multimorbidity. Post-COVID, this has become more concerning as several case studies have shown that the long-COVID involves CVD manifestations such as chest pain, palpitations, and persistent myocardial inflammation, which may contribute to long-term CVD consequences. Machine Learning (ML) techniques can support and facilitate medical practitioners in swift decision-making and adopt a patient-centered approach. This work systematically reviews ML techniques in predicting CVDs and their contributing factors. Additionally, we provide a comprehensive list of datasets, code tutorials, and guidelines for best practices in developing such ML models.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB67

CC-West 104A

Data-driven vs. Rule-based: The Capability of Data-Driven Solutions for Real-World Applications

Community Committee Choice Session

Session Chair: Jiajing Huang, Arizona State University, Tempe, AZ

1 Doing Well By Doing Good: Interest Rate Determination For Unsecured Personal Loans

Ram Gopal[1], Xiao Qiao[2], Moris Simon Strub[1], Zonghao Yang[2], [1]University of Warwick, Coventry, United Kingdom; [2]City University of Hong Kong, Kowloon, China. Contact: zonghao.y@my.cityu.edu.hk

Perhaps the most important aspect of an unsecured personal loan is its interest rate. In practice, interest rates often fail to accurately reflect loan risk, which can lead to biases of borrowers and sub-optimal credit allocation. We propose a novel method to determine interest rates based on the economic rationale that interest rates should provide the same risk-return trade-off across loans. We evaluate the pricing framework using loan samples from LendingClub. Compared with LendingClub, our method effectively narrow the gap in interest rates between prime and super-prime borrowers by 42.5% and remove the existing bias against African Americans. Our results show that by setting interest rates that reflect the inherent risk of loans, online lending platforms can effectively improve social welfare and promote fair lending practices - doing well by doing good.

2 Optimal Integration of Supervised Tensor Decomposition and Ensemble Learning for in Situ Quality Evaluation in Friction Stir Blind Riveting

Zhe Gao[1], Weihong Guo[2], Xiaowei Yue[3], [1]Shanghai Normal University, Shanghai, China; [2]Rutgers, The State University of New Jersey, Piscataway, NJ, [3]Virginia Tech, Blacksburg, VA

We develops an in situ nondestructive quality evaluation for friction stir blind riveting in joining lightweight materials. This method is able to solve the small sample size problem that is commonly occurred in manufacturing experiments. Our method achieves an optimal integration of the tensor decomposition and ensemble learning by utilizing the mutual benefits. Diversified feature matrices are extracted via tensor decomposition to maximize the ensemble learning performance. Regularized tensor decomposition results deviate with different regularization parameter values and ensemble learning is able to determine the optimal parameter value via a heuristic algorithm, which stabilizes the tensor decomposition results. Numerical and case studies are performed to demonstrate the effectiveness of our method as well as its superiority over the existing methods.

3 Eigen Entropy Based Time Series Signatures to Support Multivariate Time Series Classification

Abhidnya Patharkar[1], Jiajing Huang[2], Teresa Wu[2], [1]ARIZONA STATE UNIVERSITY, Tempe, AZ, [2]Arizona State University, Tempe, AZ

Current multivariate time series classification algorithms typically do not consider the correlations between time series of different variables, leading to inaccurate predictions. To address this issue, we propose a new framework called Eigen Entropy based Time Series Signatures. This incorporates Eigen Entropy, which captures correlations between different time series, and utilizes a cumulative moving window to generate time series signatures. Additionally, we employ Dense Multi Scale Entropy to preprocess the data to accommodate its dynamic nature. This approach preserves both temporal and dynamic aspects of the dataset, thus has potential to improve multivariate time series classification accuracy. Our algorithm outperforms the baseline algorithm for datasets under consideration in terms of recall, with an average value of 22% across all datasets.

4 Cardiovascular Disease Management via Rule-Based Personalized Lifestyle Recommendation

Thamer S. Alnazzal[1], Ying Lin[2], [1]University of Houston, Houston, TX, [2]University of Houston, Houston, TX, Contact: t.alnazzal@hotmail.com

Modifying lifestyle behaviors can prevent cardiovascular disease (CVD). Personalized lifestyle recommendation which was enabled by the machine learning (ML)-based CVD risk prediction and optimization algorithms recommends lifestyle changes tailored to individuals. But their utility in clinical practice is limited due to the lack of interpretability and patient adherence. To solve this, we develop a Rule-based personalized lifestyle recommendation method to discover decision-support rules from data and integrate discovered rules with optimization techniques to recommend feasible lifestyle change criteria to individuals. This method effectively predicts CVD risk and suggests better lifestyle behavior to prevent CVD in a real-world population. This method holds promise for advancing CVD knowledge and developing new lifestyle modification guidelines.

5 Estimating Treatment Effects over Time with Causal Forests: An Application to the Acic 2022 Data Challenge

Shu Wan[1], Guanghui Zhang[2], [1]Arizona State University, Tempe, AZ, [2]Didi Global, Beijing, China. Contact: swan@asu.edu

We present DiConfounder, our winning approach for ACIC 2022 Data Science challenge, ranking 1st in RMSE and 5th in coverage among 58 submissions. It's a transformed outcome estimator combining difference-in-difference and conditional average treatment effect estimation. Our multistage pipeline includes feature engineering, missing value imputation, outcome and propensity score modeling, treatment effects modeling, and SATT and uncertainty estimations. Our model achieves an RMSE of 11 and 84.5% coverage. We discuss confidence intervals, limitations, and highlight the importance of clustered data structure. Source code is available on GitHub.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB68

CC-West 104B

Advancing Interpretable Machine Learning: Novel Approaches and Applications

Community Committee Choice Session

Session Chair: Chudi Zhong, Morrisville, NC
Session Chair: Jiachang Liu, Duke University, Durham, NC

1 Fast Interpretable Matching for Observational Causal Inference

Cynthia Rudin, Duke University, Durham, NC

Our goal is to produce methods for observational causal inference that are auditable, easy to troubleshoot, yield accurate treatment effect estimates, and scalable to high-dimensional data. We describe an almost-exact matching approach that achieves these goals by (i) learning a distance metric via outcome modeling, (ii) creating matched groups using the distance metric, and (iii) using the matched groups to estimate treatment effects. Our proposed method uses variable importance measurements to construct a distance metric, making it a flexible method that can be adapted to various applications. Joint work with Quinn Lanners, Harsh Parikh, Alexander Volfovsky and David Page

2 Misuse of Post-Hoc Explainers in Business Applications

Ronilo Ragodos[1], Tong Wang[2], Feng Lu[3], Yu Jeffrey Hu[4], [1]University Of Iowa, Iowa City, IA, [2]University of Iowa, Iowa City, IA, [3]University of Electronic Science and Technology of China, Chengdu, China; [4]Georgia Institute of Technologuy, Atlanta, GA, Contact: ronilo-ragodos@uiowa.edu

Attributive post hoc explanation methods, and counterfactual explainers to a lesser extent, have become very popular in machine learning. A unique problem arises when they are used in business contexts since stakeholders may want to make decisions on post hoc explanations or draw managerial insights from feature importance measures. This is a problem because post hoc explainers have been shown to have intrinsic issues that may make their results untrustworthy. In this work, we investigate how and why post hoc explanations can be misused or misunderstood in business contexts. We also identify two crucial choices users make that affect the quality of post hoc explanations: the choice of explainer and the choice of hyperparameters. We summarize theoretical and practical reasons for the importance of these choices and demonstrate their consequences on managerial decisions.

3 Optimal Linear Classification Without Optimization

Berk Ustun, 1</sup

We introduce an enumerative paradigm for Boolean classification. Our approach enumerates a set of all possible labellings that can be realized by a model class (e.g., linear classifiers). Given this set, we can learn using map and filter operations. To learn the most accurate model, we compute the accuracy of each labelling and return the best ones. To learn a model that obeys constraints, we filter the set. We show how the labellings from these operations can be cast to a representative model without compromising performance or feasibility (e.g., a linear classifier with integer weights). We present procedures to enumerate major classes of interpretable classifiers, and an algorithm to fit certifiably optimal sparse models from these classes without an optimization solver.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB69

CC-West 105A

Advances in Machine Learning for Economics and Finance

Community Committee Choice Session

Session Chair: Artem Prokhorov, University of Sydney Business School, CEBA, CIREQ, Woodcroft, Australia

1 Copula and Optimal Transport in Finance

Jessica Leung[1], Robert James[2], Artem Prokhorov[3], [1]Monash University, Melbourne, Australia; [2]University of Sydney, Sydney, Australia; [3]University of Sydney Business School, Sydney, Australia. Contact: jessica.leung@monash.edu

The optimal mass transport problem seeks the most cost-efficient way to transform one distribution of mass into another. This problem has been studied extensively in countless applications such as economics, transportation modelling, and natural language processing. We study a copula-based approach to the optimal transport problem and consider its application in dependence modelling in financial markets.

2 Bi-Objective Cost-Sensitive Machine Learning: Predicting Stock Return Direction Using Option Prices

Robert James, Artem Prokhorov, University Of Sydney, Sydney, Australia. Contact: r.james@sydney.edu.au

This paper design a bi-objective loss function for training binary classification machine learning models that predict the direction of future equity market index returns. Our bi-objective loss function combines the log-loss with a second objective which asymmetrically penalizes individual false-positive and false-negative miss-classification errors. We discuss how put and call option prices are natural measures of the miss-classification costs. Using 21 years of data and a comprehensive suite of classification performance metrics we demonstrate that both a linear logistic regression model and a non-linear gradient boosting model trained using our bi-objective outperform their traditional counterparts. A long/short investment strategy that uses predictions from our bi-objective models generates superior risk-adjusted returns net of transaction costs.

3 On Robust Causal Inference in Models of Firm Productivity and Efficiency in the Presence of Many Environmental Variables

Artem Prokhorov[1], Valentin Zelenyuk[2], Christopher Parmeter[3], [1]University of Sydney Business School, PEMA, CEBA, CIREQ, Woodcroft, Australia; [2]University of Queensland, Brisbane, Australia; [3]University of Miami, Miami, FL

The paper provides a moment-based framework for consistent estimation and normal inference for a firm's production function and inefficiency scores, when relevant confounding factors are selected from a large set of variables using various machine learning tools such as lasso or deep neural networks. We discussed connections between the estimator and the concept of moment and parameter redundancy and we work out the specific case of a debiased lasso estimator.

4 Dependence Maps: Graphical Analysis of Multivariate Dependence

Ivan Medovikov, Brock University, St Catharines, ON, Canada. Contact: imedovikov@brocku.ca

We propose a new graphical tool for the discovery of multivariate dependence that we term "dependence map". The map enables quick identification of feature clusters and can be applied to the discovery multivariate predictive features. We illustrate the applicability of dependence maps by searching for non-obvious predictive signals of the daily energy demand in New England.

Wednesday, October 18, 9:30 AM - 10:45 AM

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CC-West 105B

(TBD)

Community Committee Choice Session

Session Chair: Mohammed Alyakoob, New York

1 Consumer Privacy Concerns, Multihoming, and Platform Competition in Two-Sided Markets

Xin Zhang[1], Hong Xu[2], Wei Thoo Yue[3], Yugang Yu[1], [1]University of Science and Technology of China, Hefei, China; [2]Hong Kong University of Science and Technology, Hong Kong, Hong Kong; [3]City University of Hong Kong, Hong Kong, Hong Kong

Many online platforms adopt the ad-sponsored business model, which involves offering free services to consumers while collecting their data and selling targeted advertising space to advertisers. However, collecting consumer data has raised growing privacy concerns, which may affect consumers' homing behavior, i.e., using one platform (i.e., singlehoming) or multiple platforms (multihoming). This study develops a game-theoretic model to examine how consumer privacy concerns affect platform competition. Our model allows both consumers and advertisers to choose singlehoming or multihoming endogenously. Our results show that growing privacy concerns may be more likely to benefit the disadvantaged platforms, thereby promoting platform competition. We discuss relevant managerial and theoretical implications.

2 standardized Tools and Worker Mobility

Milan Miric[1], Hakan Ozalp[2], [1]USC Marshall, Los Angeles, CA, [2]University of Amsterdam, Amsterdam, Netherlands. Contact: mmiric@marshall.usc.edu

As new technologies emerge, they impact the value of worker skills. We study the diffusion and de-facto standardization of technologies (middleware tools) that made human capital more general and industry specific (rather than firm-specific), which in turn, increases the ability of individuals to move between companies. We contrast the impact on individuals with skills that are complementary to these technologies in comparison to those being substituted by these technologies. We exploit the uneven diffusion of tools and find that the diffusion of these tools lead to an increase in labor mobility on average but was associated with higher mobility for individuals with skills that complemented those tools, in comparison to those that were partly substituted by these tools. These effects were compounded by worker experiences.

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CC-West 105C

Digital Economy and Platforms

Community Committee Choice Session

Session Chair: Siliang Tong, Nanyang Technological University, Singapore, Singapore

1 Location Divide in Digital Platforms: Evidence from a Natural Experiment

Lanfei Shi[1], Raveesh K. Mayya[2], Shun Ye[3], [1]University of Virginia, Charlottesville, VA, [2]NYU Stern School of Business, New York, NY, [3]George Mason University, Fairfax, VA, Contact: ls4tj@comm.virginia.edu

This study examines a less investigated information signal—*the seller's location*—in digital platforms. We ask whether and how the disclosure of seller location affects sellers' product sales and pricing strategies. Our findings show that the seller location disclosure policy may create a competitive disadvantage for international sellers, leading to a location divide on global e-commerce platforms. These findings highlight the unintended consequences of information disclosure and provide valuable implications for managing global e-commerce platforms.

2 Skill-Biased Technical Change Again? Online Gig Platforms and Local Employment

Aaron Cheng[1], Xue Guo[2], Paul A. Pavlou[3], [1]London School of Economics, London, United Kingdom; [2]University of North Carolina at Charlotte, Charlotte, NC, [3]University of Houston, Houston, TX

Online gig platforms are on the rise, but their roles in labor markets have been little understood. We study the impact of TaskRabbit and find a significant decrease in traditional housekeeping employment after the platform entry. This is driven by a decline in middle-skilled workers (i.e., first-line managers) whose labor tasks could easily be automated by the matching algorithms of TaskRabbit, rather than low-skilled manual workers (i.e., janitors). Interestingly, online gig platforms do not lay middle-skilled housekeeping workers off or shift them to other occupations, but rather they facilitate local entrepreneurial activities in the same industry. Our findings have profound implications: gig platforms could not simply be viewed as skill-biased; instead, they exert a labor redistribution that reconciles the tension between automation with labor augmentation.

3 The Value of External Data for Digital Platforms: Evidence from a Field Experiment on Search Suggestions

Ananya Sen[1], Xiaoxia Lei[2], [1]Carnegie Mellon University, Pittsburgh, PA, [2]Shanghai Jiao Tong University, Shanghai, China

Firms increasingly leverage external data with an aim to unlock improvements in products and services. Collaborating with a large Chinese technology company, we analyze a field experiment where we manipulate access to the market leader's application programming interface (API) to measure the causal impact of depersonalized external data on CTR for the focal company's nascent search product. We report three main findings: First, compared to the baseline with access to the market leader's API, API removal leads to a

4.6% decrease in CTR for search suggestions. Second, the negative effect due to API removal is more prevalent among heavy users, when users' search intent is implicit, and for mainstream (popular) content. Third, the magnitude of this negative effect in the long run is half as much as what we would have obtained with a short-term experiment.

4 Payout Frequency and Gig Workers' Performance: Evidence from a Multination Quasi-Natural Experiment

Jack Tong[1], Shiyi Wang[2], Nan Jia[3], [1]Nanyang Technological University, Singapore, Singapore; [2]Nanyang Technological University, Singapore, Singapore; [3]University of Southern California, Los Angeles, CA, Contact: jack.tong@ntu.edu.sg

In this study, we investigate how the design of payout frequency schemes motivates gig workers' commitment to work and improves the quality of work on the platform. In collaboration with an online social streaming platform, we explore a quasi-natural experiment in which the platform's payout cycle for gig workers (streamers) in the South Asia region is changed from 30 days to 10 days because of the system upgrade of a local financial vendor. Our analyses provide the first empirical evidence showing that a shorter payout cycle induces gig workers to expend more effort at work (produce more streaming sessions with longer streaming duration). Moreover, a shorter payout cycle motivates gig workers to deliver higher quality of work (more audiences engaged with the streamer for a longer viewing duration and higher gifting value).

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CC-West 106A

Advancements in Complex Systems and Digital Health Technologies

Community Committee Choice Session

Session Chair: Quoc Nguyen, University of South Florida, Tampa, FL

Session Chair: Trung Le, University of South Florida, Tampa, FL

1 The Impact of Exercise and Nutrition on Mental Distress in Men and Women During Different Stages of Covid-19

Zeynep Ertem, State University of New York- Binghamton, Vesta;l, NY

2 Multiplex Network Analysis of ***F. Covae*** Genomes

Harun Pirim[1], Zaidur Rahman[1], Yusuf Akbulut[1], Hasan C. Tekedar[2], Larry Hanson[2], Matt Griffin[2], [1]North Dakota State University, Fargo, ND, [2]Mississippi State University, Starkville, MS, Contact: harun.pirim@ndsu.edu

Multiplex network analysis (MNA) provides a framework to analyze multiple relationships of the same nodes represented as different layers. MNA can help better understand the resilience and robustness of complex systems such as protein interactions that can be defined based on different criteria. We are interested in eliciting diverse relationships between proteins including hypothetical ones. Hence, we focused on unique proteins (singletons) of four distinct genomes of F. *covae* downloaded from NCBI database. PANNZER annotation server is used to filter proteins with the highest annotation scores and PPV values higher than 0.5. Sequence, physicochemical features, and cellular localization information are used to construct three layers of the multiplex network for the retained 192 proteins. R multinet and muxViz libraries are used for the analysis and visualization.

3 Label Conditioning Diffusion Model With Application To Brain Tumor Mri Synthesis

Quoc Nguyen[1], Thang Nguyen[1], Minh Nguyen[2], Trung Le[1], [1]University of South Florida, Tampa, FL, [2]Digital Science and Technology Institute, The University of Danang—Vietnam-Korea University of Information and Communication Technology, Da Nang, Viet Nam. Contact: nguyenq29@usf.edu

Medical image synthesis is an important area of research that has seen significant advancements in recent years, particularly with the advent of deep learning-based approaches. In this article, we proposes a conditional diffusion model-based framework for generating synthetic medical images for MRI brain tumor classification tasks. The proposed framework was also found to be able to handle the similarity of non-tumor areas in brain tumor images and differences in tumor location, surpassing the performance of other generative models like GANs. Overall, the results highlight the potential of conditional diffusion models for medical image synthesis and their ability to address challenges associated with imbalanced data in medical image classification tasks.

Wednesday, October 18, 9:30 AM - 10:45 AM

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CC-West 106B

Applications of Data Mining II

Community Committee Choice Session

Session Chair: Yanjing Wang, University of Miami, Miami, FL

1 Typology-Enhanced Origin-Destination-Transfer Inference from Noisy Mobile Boarding Observations

Mohammed A. A. Mohammed[1], Jimi Oke[2], [1]University of Massachusetts Amherst, Amherst, MA, [2]University of Massachusetts Amherst, Amherst, MA

Addressing data limitations is crucial in cost-effective transit planning. In this study, we present a computational method that transforms sparse mobile automatic fare collection (AFC) and automatic passenger count data into a precise origin-destination-transfer model for the Pioneer Valley Transit Authority, our case study network. We begin with the identification of spatiotemporal trip pattern typologies, revealing the distinct character of passenger behaviors and informing a seasonal trip chaining framework. These patterns enable the development of a transfer model that accounts for route interactions, ultimately leading to a data-driven transit planning dashboard that visualizes passenger demand and transfer dynamics. In the end, our cost-effective and adaptable method emerges as a valuable tool for transit planning in resource-constrained systems.

2 Unveiling the Intricacies of Physiological Signals: A Novel Network-Based Approach for Complex Dynamic System Quantification and Characterization

Yujie Wang[1], Cheng-Bang Chen[1], Diane Lim[2], [1]University of Miami, Miami, FL, [2]Miami VA Healthcare System, Miami, FL, Contact: yxw509@miami.edu

This research presents a novel weighted-network-based approach to measure and profile intricate dynamic systems in physiological signals. Many existing methods often overlook the nonlinear and nonstationary properties, hindering comprehensive characterization. By leveraging sophisticated network topology structures to model the recurrence patterns, our approach proficiently captures the nonstationary dynamic properties, offering significant insights into complex physiological phenomena. The experimental results illustrate its potential of physiological signal processing in the fields of healthcare and biomedicine, indicating a promising direction comprehending intricate physiological systems.

3 Prediction Models for Inter-Stop Travel Time of Urban Buses Using Automatic Vehicle Location Data

Fateme Hafizi[1], Seyedehsan Seyedabrishami[2], Mohammad Miralinaghi[3], [1]Illinois Institute of Technology, chicago, IL, [2]Tarbiat Modares University, Tehran, Iran, Islamic Republic of; [3]Illinois Institute of Technology, Chicago, IL, Contact: fhafizi@hawk.iit.edu

To optimally use the existing transportation infrastructure, urban authorities and travelers need reliable travel time forecasts for the public transportation systems. Emerging technologies, such as automatic vehicle location (AVL) systems, are able to improve public transit data forecasting. Using AVL data collected in Tehran, Iran, this study evaluates the efficacy of both statistical and deep learning methods for predicting inter-stop travel time, which can be beneficial for both transit users and agencies. The results indicate that deep learning is superior to the statistical method. It is also found that the static features of the public transit routes have the greatest impact on predicted travel times.

4 AI Trend in the Exploration of Public Opinion Analysis About ChatGPT

Yanjing Wang, Yihan Wang, Ziru Wang, Clark University, Worcester, MA, Contact: yanjwang222@outlook.com

ChatGPT is considered a revolutionary innovation in human civilization, yet what exactly is the public factual perception of ChatGPT? This study aims to measure the public's use of ChatGPT and its outlook. We decided to use Twitter to monitor and analyze real-time events, using a programming language for sentiment analysis, first using API integration to collect the latest tweets about ChatGPT, immediately followed by machine learning algorithms that can be used to classify tweets as positive, negative or neutral sentiment. By analyzing these results, valuable insights can be gained, and then the model can be enhanced to ultimately provide a comprehensive understanding of the overall sentiment of the public towards it.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB76

Session.Location:CC-West 208B

Improving Inventory and Supply Chain Management

Contributed Session

Session Chair: Xiaotong Liu, Tsinghua University,

Shenzhen, China

1 Forecast-Driven Dual-Sourcing Inventory Management Using Simulation-Optimization

Ashwin Pothen, Benoit Montreuil, Georgia Institute of Technology, Atlanta, GA, Contact: ashwinpothen@gatech.edu

Dynamic supplier management is an effective strategy for a supply chain operating in a volatile and disruptive environment. We study a dual-mode forecast-driven inventory management problem for a real-world furniture manufacturer. The manufacturer faces a non-stationary stochastic demand and enforces a chance stock-out constraint for consistent product availability. We consider two suppliers, regular who has stochastic lead time, and an emergency supplier with a constant lead time but highly vulnerable to disruptions. With daily update of demand forecasts, we employ a simulation-optimization approach to estimate inventory policy parameters. We compare the performance of three relevant policies namely single-index, dual-index and tailored base-surge, and investigate the sensitivity of the policy parameters to supplier characteristics and constraints.

2 Optimizing Air Cargo Operations: An Integrated Model for Flight Scheduling, Aircraft Routing, and Cargo Assignment to Ulds

Matias Alvo[1], Alessandro Bombelli[2], Felipe Delgado[3], Gustavo Angulo[1], Bruno Santos[4], [1]Pontificia Universidad Católica de Chile, Santiago, Chile; [2]Delft University of Technology, Delft, Netherlands; [3]Pontificia U Catolica-Chile, Santiago, Chile; [4]TU Delft, Delft, Netherlands. Contact: a.bombelli@tudelft.nl

Planning air cargo operations entails aircraft routing, cargo routing, and cargo assignment to available Unit Load Devices (ULDs), among other decisions. These decisions are often made in sequence due to the complexity of the operations. This work proposes an integrated model to solve the flight schedule, aircraft routing, ULD routing, and cargo assignment to ULDs of a full freighter fleet of aircraft. We propose two different formulations, a fully arc-based and a hybrid one. We tested our models on a set of synthetic instances inspired by a major European airline's full freighter operations. Our results showed that the integrated approach consistently outperforms solving the problem sequentially with profits that are 10-15% higher, particularly for instances with many incompatibilities and special handling requirements.

3 Who Should Donate? a Socially Responsible Supply Chain with Prosocial Customers

Xiuyi Zhang, Yongbo Xiao, School of Economics and Management, Tsinghua University, Beijing, China. Contact: xy-zhang21@mails.tsinghua.edu.cn

In a society that advocates corporate social responsibility, it has been common for firms to make donations to the "bottom of the pyramid". Besides improving consumer welfare, donation helps firms expand their demand base because customers are prosocial. In this paper, we consider a socially responsible supply chain that consists of a manufacturer and a retailer. We study the interactive donation and inventory decisions between the supply chain members and show that, under equilibrium, only one firm donates and the other firm acts as a free-rider. To improve the supply chain performance, we suggest the firms to make a joint donation; that is, each firm shares a portion of the other party's donation cost. Furthermore, we examine two intervention policies, i.e., donation subsidy and tax deduction, from the perspective of the government, who seeks to optimize the social welfare.

4 Improving Resilience in a Multi-Tier Supply Chain Network: Roles of Delegation and Deferred Payment

Xiaotong Liu[1], Lijian Lu[2], Zuo-Jun Max Shen[3], Li Xiao[4], [1]Tsinghua University, Shenzhen, China; [2]The Hong Kong University of Science and Technology, Hong Kong, China; [3]University of California Berkeley, Berkeley, CA, [4]Tsinghua University, shenzhen, China. Contact: xiaotong18@mails.tsinghua.edu.cn

Deferred payment allows suppliers to secure financing for resilience improvement by deferring payment based on their reliability. However, implementing this scheme in a complex supply network is challenging. Our game-theoretic model analyzes the interactions among a buyer, a tier 1 supplier, and a tier 2 sub-supplier who can improve delivery reliability through costly effort. We find that the deferred payment under control mechanism is preferred when the retail price is low, especially when the supply chain network has multiple competing tier 2 suppliers or when the retail price is endogenous. Finally, we conduct an empirical analysis to verify the main results we derive.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB78

Session.Location:CC-West 211A

Optimization on Graphical Models

Contributed Session

Session Chair: Shabnam Mahmoudzadeh Vaziri, Concordia University, Montreal, QC, Canada

1 Dc Algorithm For Estimation Of Sparse Gaussian Graphical Models

Tomokaze Shiratori, Yuichi Takano, University of Tsukuba, Tsukuba-Shi, Japan. Contact: s2230119@u.tsukuba.ac.jp

Graphical lasso is widely used as a method for estimation of sparse Gaussian graphical models, where the L1 norm of elements in the precision matrix is used as a regularization term for sparse estimation. However, since the L1 norm is a convex approximation of the L0 pseudo-norm (i.e., total number of nonzero elements), it is more desirable to use the L0 pseudo-norm as a regularization term to obtain high-quality solutions. We propose a method that leverages the DC algorithm based on the L0 pseudo-norm to achieve estimation of sparse Gaussian graphical models. To demonstrate the effectiveness of the proposed method, we conduct computational experiments for comparing the performance of the proposed method with the graphical lasso for various experimental settings with different sample sizes and numbers of features.

2 A Biased Random-Key Genetic Algorithm for the Minimum Quasi-Clique Partitioning Problem

Celso C. Ribeiro[1], Rafael Melo[2], Jose Angel Riveaux[3], [1]Universidade Federal Fluminense, Niterói, Brazil; [2]Universidade Federal da Bahia, Salvador, Brazil; [3]Universidade de São Paulo, São Paulo, Brazil. Contact: celso.ribeiro@gmail.com

Let G=(V, E) be a graph with vertex set V and edge set E, and ⍰ in [0,1) a constant. A quasi-clique is a subset V' of V inducing a subgraph of G with edge density at least ⍰. The minimum quasi-clique partitioning problem (MQCPP) consists of obtaining a minimum cardinality partition of V into quasi-cliques. We propose a biased random-key genetic algorithm (BRKGA) for MQCPP that relies on an efficient partitioning decoder. The BRKGA is very effective in obtaining high-quality solutions for MQCPP in low computational times. It matches all best solutions available in the literature, improving over them for 20.3% of the benchmark instances. The approach is robust as it obtains small deviations from the best-achieved solutions when executing multiple independent runs. We also consider the performance of the BRKGA on a set of new, larger challenging instances with up to 2851 vertices.

3 Approximation Algorithms for Generalizations of Strong Connectivity Augmentation Problem

Ryoma Norose, Yutaro Yamaguchi, Osaka University, Osaka, Japan. Contact: ryoma.norose@ist.osaka-u.ac.jp

Strong connectivity augmentation (SCA) problem is one of the fundamental problems on graphs. In SCA we are required to make a given directed graph strongly connected by adding an edge set of minimum weight. SCA is NP-hard and the best known approximation factor is 2. We consider several generalizations of SCA and try to design approximation algorithms for them.

4 A Graph Neural Network for Optimum Communication Spanning Tree Fortification Problem

Shabnam Mahmoudzadeh Vaziri, Onur Kuzgunkaya, Navneet Vidyarthi, Concordia University, Montreal, QC, Canada

We present a tri-level mathematical model for the fortification decisions of optimum communication spanning tree problem (OCST) against worst-case disruptions, using a game theoretic framework between the defender and the interdictor. We consider uncertainty in the number of disruptions since the defender may not have complete information about the interdictor's capabilities. To solve the stochastic tri-level model, we use backward sampling framework where OCST is solved using branch-and-Benders-cut algorithm (BBC). BBC is not able to solve large-size instances; therefore, we use graph neural network (GNN) to solve OCST. Through extensive numerical experiments, we compare the computational performance of BBC algorithm and GNN method and demonstrate the advantages of the proposed stochastic model.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB79

Session.Location:CC-West 211B

New Methods for Combinatorial Problems

Contributed Session

Session Chair: Avinash Bhardwaj, Indian Institute of Technology Bombay, Mumbai, India

1 A Learning-Based Exact Algorithm for the Quadratic Multiple Knapsack Problem

Qingyang Wang, Ying Meng, Lixin Tang, National Frontiers Science Center for Industrial Intelligence and Systems Optimization, Northeastern University, Shenyang, 110819, China, Shenyang, China. Contact: 2407242535@qq.com

The quadratic multiple knapsack problem (QMKP) is a classic combinatorial optimization problem that finds wide applications in various scenarios. Despite a plethora of heuristics, only a few exact algorithms for QMKP have been developed. This paper proposes a new exact branch-and-price algorithm to solve QMKP, in which we reformulate the master problem model using the identity of pricing subproblems. In addition, a learning-based method is used to generate the near-optimal solution quickly for the pricing subproblems, thus enhancing the efficiency of column generation. The experiments show that our method exhibits excellent performance in solving large-scale quadratic multiple knapsack problems compared to existing exact algorithms.

2 An Efficient Linearization Technique for Project Portfolio Selection Problem

Yao-Huei Huang[1], Chiayi Wang[2], Hao-Chun Lu[2], [1]Fu Jen Catholic University, New Taipei City, Taiwan; [2]National Yang Ming Chiao Tung University, Hsinchu, Taiwan. Contact: erica880430@gmail.com

This study addresses the problem of project portfolio selection (PPS), which is a classical problem in management science and operational research. By solving the problem efficiently and effectively, the decision maker can not only choose the right projects conveniently but also obtain good benefits. In conventional PPS, each project is considered selected or not using binary variables. This study proposes a reformulation of PPS where projects can be selected multiple times using integer variables. An efficient linearization technique is proposed for the reformed PPS to allow the decision maker to conveniently find the optimal solution. Numerical experimental results show that the proposed linearization technique not only outperforms state-of-the-art methods but also solves large-scale problems efficiently and effectively.

3 Bipartite Graph for Boolean Pattern Recognition

Yoonsik Jung, Hong Seo Ryoo, Korea University, Seoul, Korea, Republic of. Contact: ys_jung@korea.ac.kr

Boolean pattern recognition can be formulated as an IP with min cover inequalities. To address this problem, we utilize a bipartite graph to represent the Boolean literals as nodes on one side and the inequalities as the other. Next, we introduce an edge between a literal and a constraint if the literal appears in the corresponding cover inequality. For solution, we design scores based on local optimality and feasibility criteria and integrate them to yield a combinatorial algorithm that strives to identify solutions that are optimal in a 'large' neighborhood. Through preliminary experiments on public data mining datasets, we test robustness and efficiency of the proposed algorithm.

4 A Few More Lonely Runners

Avinash Bhardwaj[1], Vishnu Narayanan[1], Hrishikesh Venkataraman[2], [1]Indian Institute of Technology Bombay, Mumbai, India; [2]Indian Institute of Science Education and Research, Pune, Pune, India. Contact: abhardwaj@iitb.ac.in

Lonely Runner Conjecture, proposed by Jörg M. Wills and so nomenclatured by Luis Goddyn, has been an object of interest since it was first conceived in 1967 : Given positive integers k and n1, n2,...,nk there exists a positive real number t such that the distance of t nj to the nearest integer is at least 1⁄k+1, for all 1 ≤ j ≤ k. In a recent article Beck, Hosten and Schymura described the Lonely Runner polyhedron and provided a polyhedral approach to identifying families of lonely runner instances. We revisit the Lonely Runner polyhedron and highlight some new families of instances satisfying the conjecture.

5 Continuous And Integer Formulations For Spacecraft With Water-based Propulsion

Emily Pitts[1], Matthew Harris[2], [1]Utah State University, Logan, UT, [2]Utah State University, Logan, UT

The work considers spacecraft equipped with water-based propulsion systems. These systems provide impulsive thrust and require a minimal recharge, or rest, time between thrust events. The impulsive nature and recharge constraint render the spacecraft trajectory design problem an integer program. Continuous-time and discrete-time formulations are developed. In the context of learning to branch, numerical solve times are studied statistically across multiple solver settings to identify settings suitable for onboard implementation.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB80

Session.Location:CC-West 212A

Emerging Topics in eBusiness

Contributed Session

Session Chair: Sunil Erevelles, University of North Carolina, Charlotte, Charlotte, NC

1 Metaverse and User Engagement: The Role of Psychological Ownership and the Benefits of Virtual Assets

Minyoung Lee, Sanghyun Kim, Kyungpook national university, Daege, Korea, Republic of. Contact: bibianna0910@naver.com

This study studied the engagement of metaverse users in the context of virtual communities and psychological ownership. To this end, the factors affecting psychological ownership of virtual space were identified, and the structural relationship between individual psychological ownership and collective psychological ownership was examined. Studies have shown that the interaction between individual psychological ownership and social identity affects collective psychological ownership of metaverse community, and the relationship between psychological ownership and engagement intention is moderated by the perceived benefits of virtual assets. This study is expected to expand research on metaverse communities by verifying how psychological ownership, social identity, and the virtual assets affect the engagement behavior of metaverse platform users.

2 Brand Exploration in Metaverse: Effects of User-Avatar Resemblance on Engagement and Brand Attitude

Jaehyun Lee, MinChung Kim, Yeolib Kim, Ulsan National Institute of Science and Technology (UNIST), Ulsan, Korea, Republic of. Contact: jhyunlee@unist.ac.kr

Brand metaverse, which refers to the brand in a virtual world, has become an important medium for brands to communicate with customers. In this study, we investigate the influence of user-avatar resemblance on brand metaverse engagement and brand attitude. Specifically, we propose that user-avatar resemblance affects brand attitude by virtue of the engagement with the brand metaverse. Furthermore, we posit that copresence, the simultaneous presence of multiple avatars in the brand metaverse, acts as a moderator that strengthens the mediation. We conducted an experiment using a fashion brand's virtual world in a popular metaverse platform. Our hypotheses were supported for the main and interaction effects. The findings provide meaningful implications for marketing practitioners who have intentions to implement 'metaverse marketing.'

3 Consumer Privacy Concerns, Multihoming, and Platform Competition in Two-Sided Markets

Xin Zhang[1], Hong Xu[2], Wei Thoo Yue[3], Yugang Yu[1], [1]University of Science and Technology of China, Hefei, China; [2]Hong Kong University of Science and Technology, Hong Kong, Hong Kong; [3]City University of Hong Kong, Hong Kong, Hong Kong

Many online platforms adopt the ad-sponsored business model, which involves offering free services to consumers while collecting their data and selling targeted advertising space to advertisers. However, collecting consumer data has raised growing privacy concerns, which may affect consumers' homing behavior, i.e., using one platform (i.e., singlehoming) or multiple platforms (multihoming). This study develops a game-theoretic model to examine how consumer privacy concerns affect platform competition. Our model allows both consumers and advertisers to choose singlehoming or multihoming endogenously. Our results show that growing privacy concerns may be more likely to benefit the disadvantaged platforms, thereby promoting platform competition. We discuss relevant managerial and theoretical implications.

4 standardized Tools and Worker Mobility

Milan Miric[1], Hakan Ozalp[2], [1]USC Marshall, Los Angeles, CA, [2]University of Amsterdam, Amsterdam, Netherlands. Contact: mmiric@marshall.usc.edu

As new technologies emerge, they impact the value of worker skills. We study the diffusion and de-facto standardization of technologies (middleware tools) that made human capital more general and industry specific (rather than firm-specific), which in turn, increases the ability of individuals to move between companies. We contrast the impact on individuals with skills that are complementary to these technologies in comparison to those being substituted by these technologies. We exploit the uneven diffusion of tools and find that the diffusion of these tools lead to an increase in labor mobility on average but was associated with higher mobility for individuals with skills that complemented those tools, in comparison to those that were partly substituted by these tools. These effects were compounded by worker experiences.

5 Market Genomics: Genomics Big Data on the Blockchain

Sunil Erevelles[1], Anthony Erevelles[2], Erin Erevelles[2], [1]University of North Carolina, Charlotte, NC, [2]GeneBlock, Charlotte, NC, Contact: sunil.erevelles@uncc.edu

The Genomic Data Revolution represents a monumental paradigm shift in research on markets and consumer behavior. Approximately 50% of human behavioral traits are driven by genomics, and can potentially be predicted at birth. However, approximately 120 years of market research has mostly focused on the other 50%. Additionally, the effects of genomics increase, not decrease, over a person's lifetime. In this paper, the authors introduce a new field that they term, "Market Genomics," that delineates how Genomic Big Data can be used to predict market behavior at birth. Genomic Big Data cannot, however, be ethically or practically used without the blockchain. The authors thus present a theoretical framework and model for Genomic Big Data on the Blockchain. The framework may serve as a seminal foundation for future research, and may stimulate a new field of research on markets.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB81

Session.Location:CC-West 212B

Sustainable Sourcing, Packing, and Service

Contributed Session

Session Chair: Nima Safaei, University of Illinois Urbana-Champaign, , IL, Champaign, IL

1 Direct Trade Sourcing Strategies for Specialty Coffee

Scott Webster[1], Burak Kazaz[2], Shahryar Gheibi[3], [1]Arizona State University, Tempe, AZ, [2]Syracuse University, Syracuse, NY, [3]Siena College, Loudonville, NY, Contact: scott.webster@asu.edu

Leading specialty coffee roasters rely on direct trade to source premium coffee beans. We study how characteristics of the operating and market environment affect the optimal sourcing strategy and incentives for a closer relationship with a grower.

2 The Impact of Different Contracting Mechanisms on the Performance of Reusable Packaging Systems

Sandra Transchel, Kuehne Logistics University, Hamburg, Germany. Contact: sandra.transchel@the-klu.org

Implementing functioning reusable packaging systems that guarantee a smooth circulation of the reusables requires the collaboration and coordination of various stakeholders in a supply chain. We investigate the impact of different contractual agreements in a two-stage supply chain consisting of two producers with different products and a wholesaler, who has to invest in sorting capacity to manage these return rates. We develop a game-theoretical model and study different types of contracts and their impact on the performance of the reuse system along different dimensions (cost and return rates).

3 Risk Management for Second-Hand Clothing Imports in the Least-Developed-Countries: The Design of Sterilization Legislation Schemes

Shu Guo, University of Liverpool, Liverpool, United Kingdom

The second-hand clothing imports are very popular in the Least-Developed-Countries (LDCs). The social health risk associated with second-hand clothing products and the lack of relevant legislations in LDCs, however, bring substantial challenges. This research is therefore developed to explore the sterilization legislation design for second-hand clothing supply chains in LDCs. Both the Extended Exporter Responsibility legislation scheme and the Extended Importer Responsibility legislation scheme are considered. We compare the performance of sterilization legislation schemes under different sterilization legislation structures. Our findings complement the extant knowledge on risk management of second-hand clothing in LDCs, and provide an important guidance regarding the design of sterilization legislations on second-hand clothing imports.

4 No News About Climate Action is Good News for the Firm

Nima Safaei[1], Gautam Pant[2], [1]University of Illinois Urbana-Champaign, Champaign, IL, [2]University of Illinois Urbana-Champaign, Champaign, IL, Contact: nimaasafaei@gmail.com

Heightened societal focus on corporate environmental responsibility encourages firms to publicize climate actions via media. Yet, media spotlight can also unveil negative environmental activities. Despite extensive study on media influence on corporate finance, the impact of media spotlight on firms' climate action on their financial performance remains unexplored. Our study fills this void, revealing that increased media spotlight negatively impacts financial performance due to higher costs incurred by the firm. Interestingly, this negative effect is less for high-pollution industries and firms with poor environmental performance. This research informs corporate leaders on the financial implications of media exposure of environmental initiatives, guiding informed decision-making about media engagement and strategic responses.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB82

Session.Location:CC-West 212C

Scheduling Problems in Health Operations

Contributed Session

Session Chair: Muhammad Adnan Zahid Chudhery, School of Management, University of Science and Technology of China, Hefei, China

1 Outpatient Appointment Scheduling: Developing New Scheduling Systems to Improve a Psychiatric Clinic Scheduling Efficiency

Alireza Kasaie[1], Suchithra Rajendran[2], [1]University of Missouri-Columbia, Columbia, MO, [2]University of Missouri, Columbia, MO, Contact: skdx2@umsystem.edu

This study examines new scheduling rules to minimize physician idle time, overtime, patient waiting time, number of unscheduled patients, and total cost in psychiatric clinics. Results show that VBVI rules are most effective in reducing

idle time, overtime, waiting time, and total cost, while VBFI rules have the lowest number of unscheduled patients. VBVI rules are also more robust and less sensitive to patient unpunctuality rates. The study highlights the negative impact of lower punctuality on productivity and patient waiting time. Overall, VBVI rules are recommended for improved patient outcomes and cost reduction.

2 A Novel Mobile-Based Outpatient Healthcare Service Delivery Model: Investigating Acceptance and Its Impact on Physicians' Performance

Muhammad Adnan Zahid Chudhery[1], Sarah Safdar[2], [1]School of Management, University of Science and Technology of China, Hefei, China; [2]School of Management, Hefei University of Technology, Hefei, China. Contact: adnanzahidpk@yahoo.com

China's tertiary hospitals are overcrowded despite increased emergency department capacity, while primary healthcare centers are well-equipped to treat outpatients but underutilized and could help address the issue. Therefore, we first suggest a mobile-based healthcare service delivery model to streamline outpatient flow and optimize resource utilization between emergency departments of tertiary hospitals and primary healthcare centers. Secondly, the technology and public-private sharing economy-based nature of the suggested healthcare service delivery model provoked us to employ task technology fit and channel expansion theories in this study to investigate its acceptance and impact on physicians' performance. This study has implications for researchers, government healthcare authorities, policymakers, and online healthcare service companies.

3 Anesthesiologist Scheduling of Cases in Geographically Dispersed Locations

Elizabeth Loggia, Pelin Damci Kurt, Perfectserve, Knoxville, TN, Contact: eloggia@perfectserve.com

The scheduling of cases for anesthesia groups often follow a daily tiered system. Each day, anesthesiologists are ranked according to their previous day's case load, assigning the most complex and time-consuming cases to the highest-ranked provider and continuing down to the lowest. The manual scheduling process typically takes about an hour each day. Using mixed integer programming, we formulated this problem and found that a commercial solver can find a schedule in less than a second.

Wednesday, October 18, 9:30 AM - 10:45 AM

WB84

Session.Location:CC-West 213B

Online Retail Platforms

Contributed Session

Session Chair: Ji Soo Park, Georgia Institute of Technology, Atlanta, GA

1 Secondary Marketplace of Online Retail Platforms

Yuanyuan Yang[1], Yunjie Wang[1], Guoming Lai[2], [1]Renmin University of China, Beijing, China; [2]The University of Texas at Austin, Austin, TX, Contact: 2021102688@ruc.edu.cn

We examine the incentive and the impact of an online retail platform introducing a secondary market in addition to the existing new-product market. We consider a supply chain with a manufacturer selling a new product through the platform under reselling or agency channel. Given each channel structure, the platform determines whether or not to open a secondary market where consumers can resell or purchase used products. If so, he further decides whether to operate the secondary market under a consumer-to-consumer strategy or a buy-back strategy. We develop a multi-stage game-theoretic model, fully characterize these equilibrium decisions, and show how they depend on key factors such as product durability and service commission rate. We also examine the impact of the existence of the secondary market on the manufacturer, the consumer surplus and the environment.

2 Freemium Versus Free Trial : The Art of Attracting Customers and Winning in the Business World

Sangyoon Cha, Seoul National University, Seoul, Korea, Republic of. Contact: 97chadol@snu.ac.kr

A stylized model is developed in order to quantitatively analyze and compare two major business models which is applicable to a variety of products and services; Freemium model and Free Trial model. While Freemium model offers a limited portion of the maximum providable product or service for unlimited time length, Free Trial model gives a potential customer an opportunity to experience the complete version of the same product or service but with a fairly limited time frame. Taking various factors(the learning rate of customers upon the utility of a given product or service, cost to provide a product or service for a unit length of time, etc.) into consideration, the study aims to characterize which business model is more favorable under what circumstances. Thereby the result of this study may contribute to the never-ending debate on 'Freemium vs Free Trial'.

3 Optimal Fulfillment and Transshipment Strategies in Omnichannel Retailing with Cross-Channel Returns

Yuchi Guo[1], Armagan Bayram[2], [1]University of Michigan - Dearborn, Dearborn, MI, [2]University of Michigan Dearborn, Dearborn, MI, Contact: yuchig@umich.edu

To satisfy customer demand and maintain their competitiveness, retailers are exploring ways to exploit rising online sales, such as by investing in cross-channel strategies. Addressing the challenges in operating both the online and offline channels efficiently, in this study, we build a dynamic programming model and investigate optimal fulfillment and transshipment strategies in omnichannel retailing with cross-channel returns. With the objective of maximizing the total profit of the retailer, we investigate (i) from where to fulfill a home delivery order when it occurs, (ii) when and how to transship returns to balance inventory. In order to develop the optimal omnichannel fulfillment and transshipment policy, we accommodate the uncertainty in the customer demand, returns, and the product per unit cost of shipping and transshipping.

4 Dynamic Effects of Store Promotions on Conversion Fraction: Expanding Technology Applications with Innovative Analytics

Ignacio E. Inostroza-Quezada[1], Leonardo D. Epstein[2], Ronald C. Goodstein[3], S. Chan Choi[4], [1]University of the Andes, Santiago, Chile; [2]Universidad de Los Andes, Santiago, Chile; [3]Georgetown University, Washington DC, WA, [4]Rutgers University, Newark, NJ

In retail settings conversion fractions (CFs) matter to managers because they measure the stores' effectiveness to convert visitors into buyers. Despite CFs importance, available methods to evaluate effects of marketing action (MA) on CF are scarce and provide limited evaluations of these effects. We present an approach that (i) builds a model for conversion probabilities with data outside the MA period, (ii) uses this model to predict a baseline for conversion probabilities during the promotional period conditional on the counterfactual hypothesis that the MA had not occurred, and (iii) evaluates MA effects on CF by comparing this baseline to observed data during the MA period. We illustrate our approach with data from an actual MA consisting of a two-day promotion. The analysis combines arrival data from video images and conversion data from cash registers.

5 Substitution-Based Portfolio Optimization

Ji Soo Park, Ashwin Pothen, Benoit Montreuil, Georgia Institute of Technology, Atlanta, GA, Contact: jisoopark@gatech.edu

With limited capacity, budgetary, and operational constraints, retailers are often unable to produce and offer all items in the portfolio and thus need to decide on the subset that best meets the customers' expectations and maximizes profit. One approach is to focus on the most popular items based on historical or forecasted demands, but doing so fails to adequately model customer behavior especially in regard to substitution. In this work, we study optimization of a product portfolio to maximize the expected profit over the planning horizon. We provide empirical results for a case study with our industry partner to compare the resulting product portfolio and expected profit with and without considering the substitution behavior.

Wednesday, October 18, 11:05 AM - 11:55 AM

WP01

CC-West 301BC

Closing Plenary: Reinventing Operations Management's Research and Practice with Data Science

Plenary Session

1 Reinventing Operations Management's Research and Practice with Data Science

David Simchi-Levi, Massachusetts Institute of Technology, Cambridge, MA

Machine learning is playing increasingly important roles in decision making, with key applications ranging from dynamic pricing and recommendation systems to personalized medicine and clinical trials. While supervised machine learning traditionally excels at making predictions based on i.i.d. offline data, many modern decision-making tasks, in particular in operations management, require making sequential decisions based on data collected online. Such discrepancy gives rise to important challenges of bridging offline supervised learning and online interactive learning to unlock the full potential of data - driven decision making. The presentation will focus on the integration of online and offline learning to improve decision making in operations management. We highlight three examples. In the first, we consider the challenges of reducing difficult online decision-making problems to well-understood offline supervised learning problems. In the second, we show the impact of offline data on online decision making. Finally, in clinical trials, we show how to convert offline randomized control trials into adaptive, online, experimental design.