

Monday, June 17, 10:00 AM - 11:00 AM

Monday Plenary

Founders Auditorium

Tamás Terlaky - 70 and 40 Years of Interior Point Methods (IPMs)

Invited Session

Plenary

Chair: Kathryn Stecke, University of Texas at Dallas, Richardson, TX, United States

1 - 70 and 40 Years of Interior Point Methods (IPMs)

Tamás Terlaky, Lehigh University, Bethlehem, PA, United States

70 years ago, in 1954, Ragnar Frish proposed a “Logarithmic Potential Method” to solve Linear Optimization (LO) problems, and he also extended the methodology to solve convex optimization problems. In the 1969’s Fiacco and McCormick studied and expanded the logarithmic barrier methodology as SUMT: Sequential Unconstrained Minimization Technique. The modern age of polynomial time IPMs has been launched by Karmarkar’s 1984 paper. In the past four decades IPMs transformed the way we think of optimization; expanded the scope of efficiently solvable optimization problems from linear to smooth-convex and conic LO. The powerful methodology of IPMs impacted most areas of optimization, including general nonlinear and combinatorial optimization, and most recently quantum computing optimization. This talk reviews the major milestones of the 7 decades of the Interior Point Revolution.

Monday, June 17, 11:30 AM - 1:00 PM

MB01

Bldg. 33 - 101

Advertising, Product, and Channel Management

Invited Session

OM/Marketing Interface

Chair: Jiong Sun, Purdue University, West Lafayette, IN, United States

1 - Deferred Payments in Crowdfunding: A Double-edged Sword Effect on Product Innovation

Mabel C. Chou, National University of Singapore, SG, Singapore, Jiancheng Lyu, Gongbing Bi

Introducing deferred payment mechanisms into crowdfunding is a double-edged sword: On the one hand, postponing partial funds raised and making the payment conditional on the realized product type can be an efficient measure to mitigate information asymmetry; on the other hand, access to less capital puts more pressure on entrepreneurs to produce innovative products. We develop a stylized game-theoretic model that captures this double-edged effect, exploring the optimal formulation of deferred payments to enhance innovation in crowdfunding. Our results underscore that information asymmetry acts as a barrier to product innovation, prompting entrepreneurs to leverage campaign design parameters for product type signaling. Notably, when fewer funds are reserved for entrepreneurs or the innovation cost is high, entrepreneurs are reluctant to produce innovative products. To incentivize innovation, crowdfunding platforms can strategically set reserved percentages for entrepreneurs. Additionally, we propose an innovative deferred payment formulation, withholding funds exceeding the funding target as a safeguard for backers. This target-based approach consistently encourages entrepreneurs to innovate by reducing signaling costs without imposing undue financial pressures. Our findings contribute insights into the diverse signaling strategies employed by entrepreneurs in signaling product quality, accounting for aftermarket profitability considerations. Moreover, we shed light on the varying perspectives among crowdfunding platforms regarding the adoption of deferred payment mechanisms.

2 - Managerial Incentives, Passive Ownership, and Downward Decentralization

Jiong Sun, Purdue University, West Lafayette, IN, United States, Bangdong Zhi

This study proposes a mechanism in which passive ownership creates economic incentives for downward decentralization by enhancing managerial motivation. The improved productivity stemming from greater managerial efforts leads to a higher profit for the firm selling the product through a reseller than selling it directly. This ownership structure also yields enhanced channel efficiency, surpassing that of the centralized channel.

3 - Color Substitution, the Lipstick Effect, and Optimal Advertising

Ashutosh Prasad, University of California-Riverside, Riverside, CA, United States, Norris Bruce, Anand Krishnamoorthy

This paper examines analytically a scenario where consumer preferences for different colors in their consumed goods are influenced by the state of the economy and it proposes how firms can schedule their advertising to exploit such effects. To determine the optimal advertising expenditures for such scenarios, we propose a differential-game model of the sales-advertising relationship, which features sales and advertising at the brand level, color substitution, and the effect of brand strength. As in many product-adoption models, advertising influences non-adopters to adopt the product with some probability, thereby capturing competitive effects between the brands and colors. Each firm advertises to consumers at the brand level and sets pricing to retailers at the color level. Furthermore, the retailer selects the retail prices, which also affect the sales. The analysis yields explicit solutions for the optimal advertising, value function, and comparative statics.

MB02

Bldg. 33 - 102

Industrial Applications of OR I

Invited Session

Industrial Applications of OR

Chair: Mario Velez-Gallego, Universidad EAFIT, Cra 49 7 sur 50, Medellin, 00000050021, Colombia

1 - A Two-dimensional Truck Loading Problem with Heterogeneous Fleet and Delay Minimization

Alice Smith, Auburn University, Auburn, AL, United States, Juan Morande, Juan Pina, Mario Velez, Daniel Silva

Freight transportation systems are one of the main components of supply chains all over the world. The timely and efficient transportation of goods is necessary for every logistics network that aims to satisfy customer needs. In this context, our research aims to explore how the items are loaded into a fleet of heterogeneous trucks that must travel along routes with multiple demand sites. Specifically, this paper examines the cases in which multiple goods can be placed in either the width or the depth of the loading space of the trucks. In other words, a two-dimensional truck-loading problem where single trucks must satisfy the demand of multiple customers at multiple sites is proposed. Our approach is a *hierarchical* three-stage one in which three different mixed-integer linear programming models are used to reach a solution considering multiple objectives. We tested instances based on a Colombian motorcycle assembly company case study, where motorcycles must be distributed along different routes with multiple dealers in each route. The results validate the effectiveness of using this approach to model freight transportation with heterogeneous fleets that allow loading items of different sizes.

2 - Exploring the Role of Drone-assisted Material Handling in Smart Manufacturing

Daniel Silva, Auburn University, Auburn, AL, United States, Julio Jimenez, Alice Smith

Amidst labor shortages, increasing land prices, and other aspects of the post-pandemic world, our logistics chain must consider new technological alternatives. 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 MTCVRP-TW 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.

3 - Forward-Reserve Problem (FRP) in Order Picking Warehouses: Space and Product Allocation Problems

Eliana Pena-Tibaduiza, Auburn University, Auburn, AL, United States, Alice Smith, Mario Velez-Gallego

The order-picking process is responsible for approximately half of the operational costs within a warehouse, particularly in the context of the burgeoning e-commerce operations that prioritize Business-to-Consumer transactions, accentuating the necessity for individual item picks over bulk handling. To minimize these costs, a strategic approach involves the conceptualization of a compact warehouse within the larger warehouse infrastructure, termed a forward or fast-pick area. Forward areas are most suitable for small parts warehouses such as pharmaceuticals, cosmetics, or office supplies. The FRP is centered on the optimization of operational costs through the strategic allocation of specific Stock Keeping Units (SKUs) within this small area, thus achieving a balance between the costs associated with picking and replenishment costs. In the literature, considerations for designing a forward area include its dimensions, the selection of the SKUs for storage in the forward area, and the distribution of space allocated to each SKU. This study integrates the last decision with the product allocation problem (slotting) in the forward area to enhance the efficiency of the picking and replenishment processes. We formulated a Mixed-Integer Linear Programming (MILP) model to minimize the total distances for both picking and replenishment. Given the NP-hard nature of this problem, we employed a two-phase solution approach to obtain high-quality

solutions. Initially, we determined the optimal minimum flow between the reserve and the forward areas. Subsequently, this optimal flow serves as an input to refine the slotting process, optimizing SKU placement within the forward area.

4 - Using Mobile Factories and Drones for Supplying Spare Parts to Offshore Platforms

Daniela Granados Rivera, Auburn University, Auburn, AL, United States, Daniel Silva, Alice Smith, Fabio Sgarbossa, Nils Knofius

This research explores operational planning and logistics for mobile factories using uncrewed autonomous vehicles (i.e., drones). We have partnered with FIELDMADE, a Norwegian company that offers mobile factories inside shipping containers equipped with additive manufacturing technology, and NORDIC UNMMANED, a Norwegian drone manufacturer. We propose an extension of the Mobile Facility Location Problem (MFLP) to analyze spare parts supply to offshore platforms using these mobile factories along with delivery drones.

The model assumes that the mobile factories are located onshore and that the delivery options include the use of drones, as well as trucks and ships. The existing literature lacks delivery decisions combined with the MFLP, as past approaches typically restrict mobile facility relocation directly to customer locations. This is not feasible for our application due to its offshore nature. We also consider the capability of the manufacturing equipment available at each mobile factory regarding capacity and type of product producible. To our knowledge, this has not been done in previous work. We consider relocation time as a distance-dependent issue whereas most previous articles do not consider the time to move a factory from one location to another.

Since the joint MFLP-Delivery Problem integrates complex decisions, the model is solved in two stages. The first stage considers relocation and production decisions while the second stage determines delivery decisions, including drone routing and shipments via truck and ship. Preliminary results suggest that mobile factories with drone deliveries can swiftly meet the demand, reducing potential costly downtimes on offshore platforms.

MB03

Bldg. 33 - 103

OR Applications to Sustainability (Logistics, Circular Economy, and Food Security)

Invited Session

ASOCIO – OR Applications to Sustainability

Chair: Gonzalo Mejia, Campus Puente del Común Km 7, 250001

1 - Environmental Sustainability in Major Ports: An International Comparative Assessment

Marvin Gonzalez, College of Charleston, Charleston, SC, United States, Gioconda Quesada

Sustainability is currently at the forefront of 21st-century paradigms, demanding seamless integration into the long-term policies of organizations. The recent surge in international freight traffic has notably amplified the significance of the port industry within local economies. However, a conscientious consideration of environmental and social responsibilities is imperative in this rapid growth phase. The dynamics driving the port economy are diverse and intricate, negating a universal productivity model for each port. This study rigorously identified strategic positions across continents, meticulously examining multiple facets related to environmentally sustainable practices within each port. We use benchmarking methodologies to distill best practices and propose a robust strategy for implementing green procedures within port operations.

This study determined the most significant ports by continent based on secondary information about each port. Clusters of three ports per geographic area were established based on the cargo Throughput. Subsequently, an extensive bibliographic review guided the analysis of the seven green practices implemented by the selected ports, enabling an international comparison to craft a green practice strategy for port administration.

The benchmarking study focuses on identifying and emphasizing the best practices developed by various ports, prioritizing sustainability, and green initiatives. In the latter part of the study, port size or cargo volume is not factored into the analysis; instead, these factors are only considered during the initial selection of ports. Practices related to sustainability and existing green initiatives are thoroughly examined. Information obtained undergoes independent analysis, leveraging bibliographic references to establish a standardized framework for benchmarking analysis.

2 - Carbon Intensity Assessment of Biomass Gasification for Hydrogen Production from Palm Oil Residue

Ariel Rodriguez, Imperial College London, London, United Kingdom, Javier Lizcano-Prada, Víctor Hugo Grisales Díaz

A Life Cycle Assessment (LCA) was conducted for a bio hydrogen production process based on the gasification of residual biomass from oil palm. The LCA comprises land cultivation, biomass gathering, pretreatment, and gasification to convert the palm oil agricultural residues such as palm kernel shells (PKS), empty fruit bunch (EFB), and fiber (F) into biohydrogen. Pretreatment and gasification stages were simulated using Aspen Plus to provide mass and energy balances as inputs for the LCA study. The biomass pretreatment process involves drying and torrefaction of EFB and F. The gasification process considers a dual fluidized bed (DFB) reactor simulated in three stages: pyrolysis, combustion, and reduction. The synthesis gas obtained during gasification undergoes treatment to remove tars and impurities. Treated gases then enter a water gas shift reaction (WGSR) system to increase hydrogen content, followed by hydrogen separation from CO₂. The carbon footprint of biohydrogen was quantified applying a cradle to the gate approach. In terms of implementation, we use the well known ecoinvent database and the software OpenLCA. Primary emission sources are linked to electricity consumption from the national grid (SIN SIN). The electricity is required for the rotating equipment, highlighting the relevance of reducing carbon intensity in the electricity supply. The high CO₂ concentration generated during hydrogen purification presents opportunities for utilization or sequestration, potentially achieving a negative carbon footprint. This research highlights the environmental benefits of biomass gasification for sustainable hydrogen production.

3 - Strategic hub location modeling for an Agri-Food Supply Chain: A multilogit approach with a case study on the potato Supply Chain in the cundiboyacense region in Colombia

Diana Tascón, Universidad Distrital Francisco José de Caldas, Bogotá, Colombia, Colombia, Gonzalo Mejia

The presented paper introduces a hub location model tailored for the agri-food sector, aiming to provide decision-making support in the design of a food distribution and supply network. The model is of interests of the diverse stakeholders. The model is built upon a logistic regression model, estimating the probability of a producer selecting a hub based on different attributes, including distance, potential markets, and trading prices. The model originates from identified hub locations, and the central decision revolves around enabling each of these locations. Profit maximization is determined by evaluating sales revenue, production costs, and logistics costs. Constraints include storage capacities of hubs, transport vehicles, and production capacities of producers. To demonstrate its applicability, we present a case study focusing on the potato supply chain in the regions of Cundinamarca and Boyacá (Colombia). The results suggest that a hub concession model can be sustainable in the long term. The model's findings are pertinent to various stakeholders in the potato supply chain, including the Secretariat of Economic Development of Cundinamarca and Boyacá, the Chamber of Commerce of Bogotá, and the Colombian Association of Potato Producers.

4 - Sustainable crop planning for mixed cropping systems – An optimisation approach

Alfaima L. Solano-Blanco, Eindhoven University of Technology, Eindhoven, Netherlands, Sonja U.K. Rohmer, Tom Van Woensel

Playing a vital role in global food supply, agriculture contributes significantly to current challenges such as biodiversity loss and greenhouse gas emissions. The pursuit of sustainable agriculture aims to find a balance between food production, environmental conservation, and financial viability. Strip cropping presents a promising solution, in this context, by organising farmland into smaller plots of different crops to enhance their resistance to pests, increase biodiversity and improve overall soil health. However, at the same time, simultaneous crop management poses operational challenges that prevent the implementation of strip cropping on a large scale. The use of broader strips can decrease these implementation barriers for farmers yet may dilute the ecological benefits by reducing interactions between adjacent crops. These trade-offs complicate the process of devising efficient strip cropping strategies. The aim of this research is to support farmers in this process through the development of a decision support tool. For this purpose, we propose a crop planning model which integrates crop selection and land allocation decisions under consideration of both spatial and temporal diversity. By determining ideal strip widths and cropping schedules, the model guides farmers towards strip cropping practices that are both economically viable as well as ecologically favourable, thereby promoting a sustainable future for agriculture and global food supply.

5 - Optimization of the donations' delivery process at the Food Bank of Bogotá.

Gonzalo Mejia, Universidad de La Sabana, Chía, Colombia, Luz Helena Arroyo, Alejandra Castellanos, Viviana Reina, Agatha Da Silva

The Food Bank of Bogotá, a non-profit organization with a central mission of providing food assistance to economically vulnerable populations, annually serves over 500.000 individuals across the country through 993 non-profit entities, distributing more than 10 thousand tons of products (Banco de Alimentos de Bogotá, 2022). However, existing logistic inefficiencies in donation distribution result in suboptimal resource utilization. To address this, a Capacitated Periodic Vehicle Routing model to optimize the distribution process is proposed. The approach involves clustering beneficiaries by geographic area, allocating them to weeks for equitable distribution, utilizing heuristics and metaheuristics for routing

solution methods, to have as a result a daily schedule for donation deliveries. Notably, the "Best Insertion - Guided Local Search" combination proves most effective, reducing travel time by 21% in one week and increasing total demand served by 24%. This leads to fostering improved coordination, mitigating delays, and enhancing overall operational control. The implementation of this proposed model stands to significantly enhance the operational efficiency of the Food Bank of Bogotá, thereby reducing costs and augmenting beneficiary satisfaction, contributing to the organization's overarching mission.

MB04

Bldg. 33 - 201

Optimization Techniques for Health Care, Humanitarian Logistics, and Agriculture

Invited Session

Combinatorial Optimization and Applications

Chair: Alfredo Moreno, Universidad del Norte

1 - Preventing Drug Shortages: The Untapped Potential of Postponement and Flexibility in Pharmaceutical Supply Chain Networks

Gregor Blossey, University of Innsbruck, Innsbruck, Austria, Achim Koberstein, Gerd Hahn

Pharmaceutical supply chains have become increasingly fragmented and rigid, which severely impairs their ability to manage uncertainties. A symptom of this development is the growing number of drug shortages including the serious implications for patient care. Against this backdrop, this work explores the use of postponement and various types of flexibilities as means to improve the management of uncertainties and, thus, avert drug shortages. A stochastic multi-stage MILP model is developed to investigate the optimal postponement and flexibility profiles in a multi-tier pharmaceutical supply chain with uncertain demands. Extensive numerical studies based on a case from a global pharmaceutical company are conducted. Depending on specific properties of the uncertainty, we identify four distinct network design strategies that allow to consistently and efficiently avert shortages. In these strategies, postponement is generally used to shift flexibility toward the source of uncertainty. Moreover, a concept known as chaining, which allows to manage uncertainty effectively with limited flexibility, is incrementally applied. We also find that strategic inventory allocations follow a distinct pattern leading to upstream, downstream, or mixed-policy allocations. Overall, this work offers a rare integrated perspective on postponement and flexibility with valuable insights for theory and practice.

2 - A Multi-Objective Optimization Model for Outpatient Care Delivery and Service Fairness

Rohit Kapoor, Indian Institute of Management Indore, Indore, Madhya Pradesh, India, Soumyajyoti Datta, Peeyush Mehta

Purpose: Outpatient care delivery is one of the key revenue sources of a hospital which plays a salient role in timely care delivery. The key purpose of the study is to propose a multi-objective simulation-based decision support model that considers the cost of care delivery and patient dissatisfaction as its two key conflicting objectives. Patient dissatisfaction considers service fairness. Patient idiosyncrasies such as no-show, unpunctuality and balking have been considered in the model involving multiple classes of patients.

Design/methodology/approach: Model has been designed using data collected from field investigations. In the first stage, queuing theory based discrete event simulation model has been developed. Genetic algorithm has been used to solve the scalarized problem and obtain actionable insights. In the second stage, non-dominated sorting genetic algorithm II (NSGA-II) has been involved to achieve the Pareto-optimal fronts considering equal priority of the two objectives.

Findings: The computational results considering various parameter settings can help in efficient resource planning while ensuring better care delivery. Our model provides structural insights on the business strategy of healthcare service providers on optimizing the dual goals of care delivery cost and service fairness.

Originality: The study is one of the early works that helps to improve the care delivery process by taking into consideration the environmental factors as well as service fairness. The study demonstrates the usage of simulation-based multi-objective optimization to provide a more sustainable patient centric care delivery.

3 - Stochastic Scheduling in the Presence of Side Data Case: Surgery Scheduling with Downstream Capacity

Ricardo Otero, Pontificia Universidad Javeriana, Bogotá, Colombia

In this research, we focus on the stochastic Advance Scheduling Problem with Downstream Capacity Constraints (ASPDCC) in the case where the decision maker has access to side data. We begin formulating the stochastic ASPDCC as a two-stage stochastic program, using a sample average approximation (SAA) approach. Unlike the common method to characterize

uncertainty, which assumes a lognormal distribution as the true data-generating process for each surgical specialty, we propose a data-driven framework which integrates a machine learning algorithm (decision trees) to estimate the conditional probability distribution for the surgery durations and the length of stay (LoS), in the presence of side data. Finally, to speed up the solution of the SAA model, we use a benders decomposition incorporated into a branch-and-cut framework. To justify the value of using side data, we perform an extensive experimentation using real data from a reference hospital in Bogota, Colombia. Results show that our algorithm generates schedules that outperform the traditional method of fitting a lognormal distribution for each surgery specialty.

4 - Optimizing Prioritization of Erosion-Prone Riverbank Points

Alfredo Moreno, Universidad del Norte, Barranquilla, Colombia

In recent years, floods caused by breached riverbank barriers have devastated small Colombian villages. Within this context, limited budgets are typically available to intervene in risky areas and prevent such events. Our research objective is to consider the vulnerabilities of communities in these risky areas and prioritize intervention actions accordingly. This ensures that resources are efficiently allocated to protect the most vulnerable and at-risk communities. Thus, we propose an optimization resource allocation model for prioritizing interventions at critical erosion-prone points along riverbanks, considering the budget constraints. The efficacy of the model was validated using empirical data collected from a real-life case study on the Sinú River in the department of Córdoba, Colombia.

MB05

Bldg. 33 - 203

Data Driven Optimization and Applications

Invited Session

Data Driven Optimization and Risk Management

Chair: Mabel C. Chou, National University of Singapore, SG, Singapore

1 - Data-Driven Submodular Set-function Optimization: Theory and Applications in Assortment Planning and Recommender Systems

Jigar Patel, University of Miami, Coral Gables, FL, United States

Recommender systems and informed assortment planning facilitate the display of goods or services tailored to individual customer needs/characteristics, promote the visibility of assorted products, and revenue growth. We address the problem of optimal assortment and display of online search results for goods or services. The objective is to maximize the platform's revenue and customer engagement by leveraging the menu of displayed search results to users, subject to catering to their individual search criteria or characteristics. Our analysis is based on a detailed data set from a leading online platform. Assortment planning involves optimization over a utility set-function. For example, a supermodular utility function is related to complementary goods, and a submodular utility function is related to substitutes. By analyzing our data, we identify properties of our utility function and implement the proper optimization algorithm tailored to individual users. Recent advances in the discrete optimization field has enabled us to provide optimal or near-optimal algorithms in polynomial time to tackle the difficult problem of submodular function optimization

2 - Equilibria in Interdependent Natural-Gas and Power Markets: An Analytical Approach

Amir Mousavian, Clarkson University, Potsdam, NY, United States, Beheshteh Raouf, Antonio Conejo

Natural-gas and power systems and their corresponding markets have evolved over time rather independently. However, both systems are increasingly interdependent since combined cycle gas turbines (that use natural gas to produce electricity) increasingly couple them together. Therefore, suitable analysis techniques are most needed to comprehend the consequences on market outcomes of an increasing level of integration of both systems. There is a vast literature on integrated natural-gas and power markets assuming that the two markets are operated centrally by a single operator. This assumption is often not true in the real world, which necessitates developing models for these interdependent yet independent markets. In this vein, this paper addresses this gap in the literature and provides analytical Nash-Cournot equilibrium models to represent the joint operation of natural-gas and power markets with the assumption that the market participants in each market make their own decisions independently seeking maximum profits, as often is the case in the real world. We develop an analytical equilibrium model and apply the Karush-Kuhn-Tucker (KKT) approach to obtain Nash-Cournot equilibria for the interdependent natural-gas and power markets. We use a double-duopoly case to study the interaction of both markets and to derive insightful analytical results. Moreover, we derive closed-form analytical expressions for spot-market equilibria in both natural-gas and power markets, which are relevant and of practical significance for decision makers. We complement the duopoly-duopoly study with a detailed sensitivity analysis.

3 - Optimal Quality-Based Inventory Management for Fresh Produce

Mabel C. Chou, National University of Singapore, SG, Singapore

Fresh produce such as fruits and vegetables pose enormous challenges for supply chain operations due to their short shelf-life. In addition, the quality of fresh produce is sometimes hard to estimate through human experience, because some defects are internal and not readily visible. As the quality of fresh produce can heavily affect customers' purchase decisions and thus how one should manage the inventory, in this talk, we discuss how we incorporate food quality data into our proposed inventory management policies.

MB06

Bldg. 33 - 204

Healthcare Analytics

Invited Session

Service Operations

Chair: Daniel Rojas, N/A

1 - A deprivation costs approach in measuring accessibility to primary healthcare services in a rural region in Colombia

Elena Valentina Gutierrez, Universidad del Valle, Cali, Colombia, Valentina Castañeda Torres, Sofía Pérez Guzmán

In Colombia, the goal to achieve universal healthcare coverage is a challenge, particularly in rural areas. According to the Commission on Global Health of Lancet, about 12.000 people died in 2019 due to lack of access to health services in rural areas. To improve universal coverage, the country is committed to renew and expand primary healthcare services (PHS), as a basis of a sustainable health system. However, accessibility to PHS is still limited in rural areas, mainly due to geographical distances between populations and care centers, as well as waiting times to obtain medical appointments. Moreover, sociodemographic factors make rural populations more vulnerable, and the country lacks a unique system that allows quantifying accessibility to PHS. Consequently, we developed a study to measure the accessibility to PHS in a rural region of Colombia using deprivation costs as an approach to consider vulnerability, explicitly. Based on data analysis of public registers, we adapted a *p-median* model to minimize transportation, deprivation, and terminal costs. Deprivation and terminal costs are based on the sociodemographic characteristics of the population. Scenario analysis of the model show the impact of considering deprivation and terminal costs related to transportation costs and allows quantifying the access to PHS in rural areas considering vulnerability.

2 - Business Intelligence and Analytics Maturity Factors in Hospitals: A Case Study in Bogota, Colombia

Katherine Maldonado, Universidad Nacional de Colombia, Bogota, Colombia, Pedro Julian Ramirez-Angulo, SHIKUI WU

The healthcare sector has improved patient care quality by leveraging Business Intelligence and Analytics (BI&A). However, the focus has been primarily on technological or medical aspects, ignoring managerial perspectives towards public hospitals. In Bogotá, Colombia, these institutions face several challenges regarding allocating resources efficiently and decision-making. The ongoing healthcare system reform in Colombia is bringing significant changes regarding financing, system structure and digital transformation within the sector.

This research aims to identify the BI&A maturity factors in their daily use of data and information for decision making with an in-depth case study of a hospital in Bogotá, Colombia. This study includes a thorough literature review regarding BI&A and maturity models, semi-structured interviews with administrators and users of BI&A systems, qualitative data analysis with coding and visualizing the themes of key factors, and models of their structures and relationships. The expected outcomes are to identify key maturity factors for general guidance to improve BI&A capabilities in healthcare regarding data, people/organization, processes and technology. The results of the study identify constraints, challenges, and opportunities to leverage BI&A within the decision-making process.

Future research involves a cross-country study to better understand cultural characteristics and the overall dimensions of public hospitals. This research is beneficial for hospitals in Bogota, Colombia, in their BI&A strategies and practices. This study contributes to the better understanding of BI&A maturity in the healthcare sector, representing an opportunity for researchers and practitioners to enhance BI&A capabilities and improve public health management and health services.

3 - Overbooking outpatient appointments: a fair machine learning approach.

Santiago Ospina Ferreira, Pontificia Universidad Javeriana, Bogotá, Colombia, Jose Rafael Peña Gutiérrez, Julian Romero, David Barrera Ferro, Gabriel Zambrano Rey

No-show behavior has been identified as a critical issue for health systems, leading to poor service quality and increased financial burden for service providers. Two main approaches can be followed to tackle this problem, active or passive interventions. While in the former, the objective is to increase attendance levels, the latter is aimed at minimizing no-show impact by improving resource allocation. This work studies overbooking policies for outpatient appointments, using an active intervention. Previous research has found that such policies might be linked to high (direct) waiting times and physician overburden. However, we argue that using individual no-show probabilities it is possible to increase system's efficiency and provide good service levels. First, historical data is used to train machine learning techniques to predict individual attendance probabilities. Then, using simulation we assess the performance of different overbooking policies. Finally, we propose a post-processing approach to mitigate the impact of data bias.

4 - Niche Determination through Heat Over Graphs

Daniel Rojas, Universidad EAFIT, Medellín, Colombia, Maria Eugenia Puerta, Carlos Alberto Cadavid, Nicolás Moreno

In this study, we redefine a niche as a region within a feature space where a phenomenon is likely to occur, extending the scope beyond traditional ecological niche modeling to include a wider array of feature spaces and types of occurrence information. Our novel methodology for niche identification aims to estimate these regions and their likelihoods using data on occurrences of the phenomenon alone, diverging from binary classification problems that require both occurrence and non-occurrence data. Utilizing principles from discrete Ricci-flow, we developed a method for calculating stable heat distribution on a graph structured by occurrence data, allowing for efficient likelihood assignment across the feature space at low computational cost. Although our methodology has broad applicability, we selected as case study the evaluation of the risk of Dengue propagation—a vector-borne disease—using real data from Medellín, Colombia. This approach not only aims to enhance disease propagation risk forecasting but also offers a new perspective on leveraging data-driven insights for public health strategies and interventions, showcasing potential benefits for the scientific and decision-makers communities.

MB07

Bldg. 33 - 301

Claudia Rave - Bridging Sectoral Modeling and Institutions Reengineering: Empowering OR Practitioners to Collaborate with the Public Power Design

Invited Session

Tutorial

Chair: Emilio Carrizosa, Universidad de Sevilla, Sevilla, Spain

1 - Tutorial - Bridging Sectoral Modeling and Institutions Reengineering: Empowering OR Practitioners to Collaborate with the Public Power Design

Claudia Rave, Fluir.D.Lab Laboratorio de Decisión SAS, Medellín, Colombia

Public institutions, servicing to both productive and social services (such as transportation, infrastructure, utilities, land issues, among others), often adhere to decision-making frameworks based on administrative regions or conventional functional areas (like human resources, operations, management). However, these frameworks may not always reflect the underlying dynamics pertinent to the organization's goals.

Advancing and implementing Operations Research (OR) modeling solutions for development necessitates aligning the organization's decision-making processes with its array of services and capabilities. OR practitioners are increasingly required to delve into the intricacies of political and policy dialogues to effectively assess either or both processes modeling and institutional reengineering.

During the tutorial, we will delve into 2 case studies involving land management and transportation institutions, exploring their journey towards enhanced performance and service modernization.

MB08

Bldg. 33 - 302

People-centric Approach in Policy Development

Invited Session

People-Centric Operations

Chair: Nagihan Dolgan, Ozyegin University, Istanbul, N/A, Turkey

1 - Descriptive Study of the Phenomenon of Suicide in the City of Medellin Based on Data Analytics

Esteban Genes, Universidad Pontificia Bolivariana, Medellín, Colombia, Tomás Gómez, Maritza Jiménez

Suicide has been listed by the World Health Organization (WHO) as one of the most prevalent causes of death among young people. Therefore, the design of public policies that contribute to its prevention and management has been set as a priority. In this research, a descriptive study is developed based on the analysis of official open data, which is oriented to the identification of different demographic factors associated with suicide attempts in the city of Medellín, Colombia, to identify potential points of action for regulators and competent authorities. It was found that suicide attempts prevail in people between 12 and 25 years of age, with 60% of occurrences; that women have a higher rate of occurrence than men (more than 60%), and that the most common triggering factor is associated with relationship problems

3 - Integrating Data Analytics and Simulation Models for Enhanced Decision-Making in Automotive Supply Chains: A Case Study of a Leading German Company in Mexico

Andres Acero, Tecnologico de Monterrey, Puebla, Mexico, Eduardo-Arturo Garzón-Garnica

The landscape of contemporary manufacturing is marked by a multitude of challenges, with supply chain management emerging as a critical focal point for companies seeking to maintain competitiveness. Within the automotive industry, intricate logistics networks, coupled with the need for just-in-time delivery and stringent cost controls, create barriers that prevent efficiency on operations. Moreover, the ever-evolving regulatory environment and fluctuating market demands intensify the complexities faced by manufacturers, underscoring the pressing need for innovative solutions to enhance decision-making capabilities. Within this context, this study introduces a novel framework for integrating data analytics and simulation models to streamline decision-making processes in the automotive industry, with a particular focus on a leading German automotive company operating in Mexico. Through a meticulously designed multi-methodological approach that combines data science techniques with simulation modeling, the project endeavors to bolster supply chain performance and address pivotal challenges in storage, procurement, and capital reduction. The methodology encompasses four distinct phases: business and process understanding, data comprehension and KPI translation, model development and evaluation, and model-driven decision-making. A detailed case study of the automotive company situated in the state of Puebla, Mexico, offers insights into specific hurdles encountered in inbound and outbound logistics, as well as storage and procurement practices. The research outcomes exhibit noteworthy reductions in decision-making timeframes, facilitating enhanced efficiency and informed supply chain management practices. By seamlessly integrating simulation models with data science methodologies, this study showcases the potential for optimizing automotive operations and empowering strategic decision-making processes.

MB09

Bldg. 33 - 303

AI Developments for Healthcare

Invited Session

Advanced Developments for AI with Applications in Healthcare, Industry and Fintech

Chair: Henry Horng-Shing Lu, N/A

1 - Improving the Management of Elder Care Services in Taiwan

Grace Lin, UFLAI, Chappaqua, NY, United States

This talk presents lessons learned from developing a mobile-enabled in-home elder care service management system in Taiwan. The system enables care institutions to improve resource utilization & care quality while ensuring regulatory compliance. This work also supports patients, families, and care workers by simplifying the coordination and management of care service and the secure sharing of personal health & financial information between home care institutions, local & central governments, care givers, and elders.

2 - Toward Healthcare GPT

Henry Horng-Shing Lu, National Yang Ming Chiao Tung University, Taiwan, Taiwan

Healthcare GPT is a large language model designed for the medical field, combining internal hospital data with literature from the world's leading medical journals. With its rich medical knowledge and understanding, Healthcare GPT has a wide range of applications, including assisting doctors in writing summaries of medical records, providing an AI consultation system with text and voice input, assisting social workers in understanding emails and automatically generating replies, and creating its own KM agent to quickly obtain minutes of hospital meetings. In addition, by combining artificial intelligence with medical expertise, it helps medical staff to quickly acquire medical knowledge, save time, improve workflow and

provide more efficient and higher quality medical services. With the advancement of technology, the emergence of Healthcare GPT will drive the digital transformation of the healthcare industry and bring more innovation and progress to the healthcare field.

3 - An Integrated Analysis of the Cancer Genome Atlas Data Discovers a Hierarchical Association Structure across Thirty-three Cancer Types

Chen-Hsiang Yeang, Academia Sinica, Taipei, Taiwan

Cancer cells harbor molecular alterations at all levels of information processing. Genomic/epigenomic and transcriptomic alterations are inter-related between genes, within and across cancer types and may affect clinical phenotypes. Despite the abundant prior studies of integrating cancer multi-omics data, none of them organizes these associations in a hierarchical structure and validates the discoveries in extensive external data. We infer this Integrated Hierarchical Association Structure (IHAS) from the complete data of The Cancer Genome Atlas (TCGA) and compile a compendium of cancer multi-omics associations. Intriguingly, diverse alterations on genomes/epigenomes from multiple cancer types impact transcriptions of 18 Gene Groups. Half of them are further reduced to three Meta Gene Groups enriched with (1) immune and inflammatory responses, (2) embryonic development and neurogenesis, (3) cell cycle process and DNA repair. Over 80% of the clinical/molecular phenotypes reported in TCGA are aligned with the combinatorial expressions of Meta Gene Groups, Gene Groups, and other IHAS subunits. Furthermore, IHAS derived from TCGA is validated in more than 300 external datasets including multi-omics measurements and cellular responses upon drug treatments and gene perturbations in tumors, cancer cell lines, and normal tissues. To sum up, IHAS stratifies patients in terms of molecular signatures of its subunits, selects targeted genes or drugs for precision cancer therapy, and demonstrates that associations between survival times and transcriptional biomarkers may vary with cancer types. These rich information is critical for diagnosis and treatments of cancers.

Monday, June 17, 2:30 PM - 3:30 PM

Monday Keynote

Founders Auditorium

Robert Ashford - Optimization: Past, Present and Future

Invited Session

Keynote

Chair: Kathryn Stecke, University of Texas at Dallas, Richardson, TX, United States

1 - Keynote - Optimization: Past, Present and Future

Robert Ashford, Optimization Direct, Inc., Harrington Park, NJ, United States

Optimization, particularly in the form of linear programming and mixed integer programming, has emerged as the most powerful and widely-used tool in the field of Operations Research. Its applications span across virtually all industries and enterprises, revolutionizing decision-making processes and driving operational efficiency. This talk explores the essence of optimization and its practical applications, tracing the evolution of software and solution methods from their early beginnings to the present day. It highlights the significant advancements brought about by new mathematical methods and hardware developments. It goes on to look at cutting edge technologies using the latest multi-threaded hardware which push the envelope of applications today. The talk concludes by discussing their likely future development and the impact of Big Data and AI.

Monday Keynote

Bldg. 38 - Auditorium 110

Tarkan Tan - Collaborate for Good: Orchestrating Sustainability in Supply Chains

Invited Session

Keynote

Chair: Fernando Ordonez, Universidad de Chile, Santiago, Chile

1 - Collaborate for Good: Orchestrating Sustainability in Supply Chains

Tarkan Tan, University of Zurich, Zurich, Switzerland

Firms are under increasing pressure from their stakeholders to adopt sustainability measures. However, the risks and opportunities associated with sustainability go beyond a firm's own operations and extend to their supply chain partners. In this talk, we will explore ways in which firms can enhance sustainability in their supply chains through collaboration.

Monday Keynote

Bldg. 38 - Auditorium 101

Zelda Zabinsky - Insights Into Scalable Black-box Global Optimization

Invited Session

Keynote

Chair: Grace Lin, UFI.AI, Chappaqua, NY, United States

1 - Insights Into Scalable Black-box Global Optimization

Zelda Zabinsky, University of Washington, Seattle, WA, United States

Optimization algorithms are addressing large-scale problems, with millions of variables that have complex interactions. Machine learning is creating models from huge data sets and large numbers of model parameters and hyper-parameters. How is this possible? A key issue is how to dynamically allocate computational effort efficiently in the search for the global optimum. This talk will provide some insights into how to adapt sampling distributions to achieve desirable performance in high dimensions. It will summarize finite-time analyses of adaptive random search methods to shed some light on important features of scalable algorithms. New results on the use of partitioning the domain to address heterogeneity of the response with the use of surrogate modeling, e.g., Gaussian processes, will be presented. The finite-time analyses provide an interpretation of the balance between exploration and exploitation while maintaining scalable algorithms.

Monday, June 17, 4:00 PM - 5:30 PM

MC01

Bldg. 33 - 101

Channel Structure, Sourcing, Advertising, and Live Streaming

Invited Session

OM/Marketing Interface

Chair: Xuying Zhao, Texas A&M University, College Station, TX, United States

1 - A Model of Shoppertainment Live Streaming

Xuying Zhao, Texas A&M University, College Station, TX, United States, Jane Gu, D.J. (Dongjun) Wu

“Shoppertainment” live streaming, a blend of entertainment and product selling, is becoming increasingly popular. In shoppertainment sessions, streamers face bandwidth constraints so balance between providing product information and entertainment (such as singing, dancing, and storytelling). We conceptualize a shoppertainment live streamer as a novel type of online retail platform that maximizes total commissions from selling a range of manufacturer products. Our study investigates how streamers can leverage entertainment bandwidth as a long-term strategy to influence manufacturers’ pricing decisions and consumers’ attendance as well as purchasing behaviors. Our model reveals several intriguing findings. First, we find that higher entertainment bandwidth encourages more manufacturers to adopt a demand-oriented, low-pricing strategy to attract buyers, rather than a margin-oriented, high-pricing strategy that appeals only to buyers who perceive a high likelihood of finding a suitable product. Second, we observe that an increase in entertainment bandwidth initially boosts consumer traffic to shoppertainment sessions, but this trend may reverse once the bandwidth becomes excessively high, indicating an inverted-U-shaped relationship. Conversely, the streamer’s expected profit per attending consumer first decreases and then increases with higher entertainment bandwidth, forming a U-shaped relationship. Third, our results suggest that a commission-maximizing streamer facing bandwidth constraints should not exclusively focus on providing product information. Instead, it is advantageous to allocate significant bandwidth to entertainment, even with limited entertaining capability, and potentially beneficial to dedicate all bandwidth to entertainment if the capability is substantial. Lastly, we demonstrate that the streamer’s quality threshold moderates the impact of entertainment bandwidth on these dynamics.

2 - Equilibrium Channel Structures for Branded Variants under Uniform and Non-uniform Pricing

Jing-Sheng Song, Duke University, Durham, NC, United States

This paper examines why, despite the common belief that manufacturers should control their product prices to avoid double marginalization, we often see products being sold through independent retailers, either exclusive or non-exclusive. We consider two manufacturers in a Bertrand competition, each selling two product variants through both exclusive and non-exclusive retailers. Manufacturers choose between direct sales via an integrated channel or indirect sales through a decentralized channel. We explore how equilibrium channel structures vary under two prevalent pricing schemes: uniform pricing (identical prices for all variants) and non-uniform pricing (variant-specific prices). We show that a decentralized system is more likely to occur with non-uniform pricing than with uniform pricing. The key determining factors include

cross-product substitutability and branded variant market size. Specifically, in the case of exclusive retailers, under uniform pricing, decentralization can only become an equilibrium if product substitutability is high in both product variant markets. Under non-uniform pricing, however, decentralization can prevail even if one of the branded variants has a low product substitutability, provided that the market for the other variant is not too small. Furthermore, the tendency of decentralization is non-monotone in product substitutability. When the market size gap is medium, an increase in product substitutability does not necessarily lead to decentralization. Interestingly, in the presence of a non-exclusive retailer, decentralization can become an equilibrium without high substitutability. Thus, channel selection for branded variants must weigh the trade-offs among channel integration, market dynamics, and the interplay of consumer preferences and brand interactions.

3 - Advertising by Recruiting Influencers

Vasiliki Kostami, HEC Paris, Jouy-En-Josas, France, Maya Jalloul

The growth of social media platforms allowed customers to rely on influencers and past consumers' experiences for their purchase decision. With products becoming more tied to the experiences they offer, firms wish to adopt them as effective marketing tools. In this paper, 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. We introduce a two-period model. In the first period, the firm launches a new service experience of unknown quality and an influencer marketing campaign. The campaign can rely on two types of influencers that differ in popularity and credibility and two potential partnerships; sponsored advertising and public relations. Customers make their purchasing decision using their original (heterogeneous) beliefs, the information obtained via the influencers they follow, and reviews of early adopters as they become available in the second period. We suggest the strategic partnerships a firm should establish with social media influencers depending on their credibility and popularity, on the market composition and on the characteristics of the social media platform and instruct on how to capitalize on social learning.

4 - Direct Trade Sourcing Strategies for Specialty Coffee

Scott Webster, Arizona State University, Tempe, AZ, United States, Burak Kazaz, Shahyrrar Gheibi

Leading specialty coffee roasters rely on direct trade to source premium coffee beans. We characterize a specialty roaster's optimal sourcing strategies and environmental characteristics under which each strategy dominates. We also investigate the interaction between the optimal sourcing strategy and incentives for a closer relationship with a grower over time.

MC02

Bldg. 33 - 102

Industrial Applications of OR II

Invited Session

Industrial Applications of OR

Chair: Edgar Gutierrez-Franco, Massachusetts Institute of Technology, Cambridge, MA, United States

1 - Optimizing Water Supply Chain in Arid Regions: A Case Study from Chile's Mining Sector

Edgar Gutierrez-Franco, Massachusetts Institute of Technology, Cambridge, MA, United States

2 - Prediction of Banana Production: A Comparative Analysis ARIMA, AutoML and Recurrent Neural Network methodologies

Guisselle García, Universidad del Norte, Barranquilla, Colombia, Carlos Paternina, Jorge Vélez

Colombia is a country with a tradition of producing and exporting bananas from the Cavendish Valery variety, and Criollo bananas for domestic consumption. Altogether, these two varieties account for 0.4% of the Gross Domestic Product (GDP), generate an approximate value of US\$ 730 million per year in income and constitute 3.0% of total exports and 6.0% of non-traditional exports. The main banana-producing areas are in the departments of Antioquia, Magdalena, and the southern part of La Guajira. The object of this work corresponds to the use of the widely used Box-Jenkins integrated moving average (ARIMA), AutoML and Recurrent Neural Networks (RNN) to forecast banana production in 10 plantations, which cover a production area of approximately 1030 hectares, and are located at the Northern Caribbean coast. From the results it has been identified that the best overall models are those obtained through AutoML, followed by RNN-LSTM outperforming ARIMA as a time series method.

3 - Artificial Intelligence and Blockchain for Supply Chain Resilience and Sustainability: An Assessment of the Peruvian Coffee Supply Chain Network

Donovan Fuqua, New Mexico State University, Las Cruces, NM, United States

Peru is among the leading coffee producers in Latin America and is a key exporters of items labeled as "organic" for the European, Asian, and North American markets. However, additional requirements for certifying products as "organic" may jeopardize this growing market. Therefore, the combination of blockchain technology and AI represents a powerful toolset to address the current supply chain issues. While blockchain provides a secure and transparent infrastructure, AI offers enhanced analytical capabilities to manage and predict disruptions, thereby collectively boosting the responsiveness and efficiency of the supply chain supply networks. Integrating AI and blockchain can enhance the supply chain responsiveness and efficiency; moreover, this synergy is important in adapting to external shocks or disruptions that significantly alter the competitive business landscape. In this study, we use surveys of coffee growers, co-ops, warehouse agents, shippers, and export companies to gauge the potential impacts and barriers toward adoption of blockchain and use of AI artifacts. The eventual goal of the study is creation and implementation of applications and systems to verify and track coffee from farmer to consumer.

MC03

Bldg. 33 - 103

OR Applications to Sustainability (Risk, Climate, and trends)

Invited Session

ASOCIO – OR Applications to Sustainability

Chair: Nicolas Clavijo-Buritica, University of Porto, Porto, N/A, Portugal

1 - Economic, Reliability and Environmental Benefits from a Risk-adjusted Stochastic Unit Commitment Model

Xiaodong Zhang, Duke University, Durham, NC, United States, Dimitris Floros, Mauricio Hernandez, Dalia Patino-Echeverri

We propose an Energy Management System (EMS) with a Risk-Adjusted Stochastic Unit Commitment model (RAS-UC) and explore its economic, reliability, and environmental benefits. A comparison of the proposed approach with different configurations of a deterministic EMS representing current industry practices provides insights into the mechanisms by which costs are reduced and reliability enhanced. An analysis of the Duke Energy Carolina & Duke Energy Progress (DEC & DEP) electric power system in the United States shows that there would have been a reduction in operational cost and an increase in available reserves if a RAS-UC had been used instead of a deterministic UC in past years.

2 - Introducing the Probabilistic Forecast Generator (PFG) for effective Stochastic Unit Commitment

Dalia Patino-Echeverri, Duke University, Durham, NC, United States, Dimitrios Floros, Wei Wang, Jordan Kern, Mauricio Hernandez

Increased probability of extreme weather events and ongoing and planned increases in the penetration of Variable Renewable Energy (VRE) resources in electric power systems highlight the need for improved uncertainty characterization and commitment and dispatch methods that account for such uncertainty.

This paper proposes the Probabilistic Forecast Generator (PFG), an approach for generating high quality Probabilistic Forecasts of weather variables, load, and variable renewable energy, for use in a Stochastic Unit Commitment (SUC). The outputs of the PFG are ensembles of time-series each with the same probability of occurrence. Each multivariable time series represents a plausible trajectory for weather variables, load, and wind solar energy production for each hour of a week-long planning horizon, in a specific geographical area.

Acknowledging that quality probabilistic forecasts for SUC cannot be presented as quantile trajectories -as often presented, with unrealistic temporal patterns of electricity demand (i.e., load) and/or renewable generation, where all hours have a load in the same percentile, the PFG forecasts are realistic as assessed by six metrics focusing on the Probability Distribution Function, the Autocorrelation Function, the geographic and variable cross correlations, the forecast errors, and the Continuous Ranked Probability Score.

3 - Locating Street Markets: Analysis from Qualitative and Quantitative Factors using a Discrete Choice Model and Fuzzy AHP

Jaime Pesca, Universidad de La Sabana, Chía, Colombia, Gonzalo Mejia, Valentina Cardenas, Maria Alejandra Castañeda, Daniela Granados

This paper explores the optimization of street market locations in urban areas, integrating quantitative and qualitative factors. Our study presents a Mixed Integer Non-Linear Programming (MINLP) model combined with a Fuzzy Analytic Hierarchy Process (Fuzzy AHP) to evaluate potential locations in a realistic scenario. We present a case study in the highly populated district of Engativá, Bogotá, Colombia. The novelty of this approach lies in the fact that few studies incorporate urban planning criteria and restrictions in the mathematical model of a facility location. In our study, we first analyze each potential

street market location using Fuzzy AHP. To do so, we performed pairwise comparisons with different features such as access to transport, social stratification, the morphology of the site, parking space, and access to public services among other things. These were suggested by an expert in urban planning. Next, we developed MINLP model of a competitive facility location problem in which other food retailers compete for demand. The results show the validity of the approach. This research contributes to the broader fields of both urban planning and food security, providing insights into the optimization of street market locations to enhance access to fresh foods and support local economies.

4 - Reducing GHG Emissions: The impact of Replenishment Strategies on Basket-of-Goods Consumers in Food Waste

CELIA FABIOLA VASQUEZ GARCIA, Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico, Mexico, JOSUE VELAZQUEZ

On average, 30% of the food produced is wasted. This implies that, of all the greenhouse gasses associated with the product lifecycle, food waste disproportionately increases the environmental impact of the supply chain. In this paper, we study different alternatives to reduce food waste, particularly at the consumer level; the level with the highest rate of food waste compared to other stages of the supply chain. Via considering different replenishment strategies, we present an analytical model that defines optimal policies for consumers to buy products from the basket-of-goods from both retail formats, the modern and the traditional channel. In Mexico, our results provide managerial insights into the policies that decrease environmental impacts by balancing the emissions associated with food waste, transportation, and refrigeration, among others.

5 - Intersections between resilience and sustainability: the case of agri-food supply networks.

Nicolas Clavijo-Buritica, University of Porto, Porto, Portugal

Frequent disruptions in transportation networks can significantly impact the Agri-food Supply Chain Networks. This research examines how such disruptions affect the operations of Supply Networks by focusing on Colombia's dairy supply chain. Initially, the study employed Machine Learning to model these disruptions, comparing different prediction models for binary outcomes. Subsequently, the network's capacity was analyzed through Mixed Integer Programming (MIP). In the final stage, through computational experimentation, the study assessed strategies to enhance resilience, evaluating their practical applicability in developing economies. Partial results allow us to compare implications in environmental and social perspectives.

MC05

Bldg. 33 - 203

Data Driven Optimization and Risk Management

Invited Session

Data Driven Optimization and Risk Management

Chair: Alberto Lamadrid, Lehigh University, Bethlehem, PA, United States

1 - AI-Driven Resilience for Stable Rice Supply Chain

Mark Goh, NUS BIZ Sch, Singapore, Singapore, Elifcan Dursun Ozguven, Tan Kia Meng

The rice supply chain is global, feeding about 45% of the world's population. Global events such as climate change, trade restrictions, and wars have disrupted this chain notably on pricing and availability. Despite the nature of this commodity, the sale price of rice needs to be stable under various risk regimes which are escalating in magnitude, frequency, scope, and complexity, due to unintended climatic and supply side disruptions. The existing pricing structure can be managed more optimally through newer optimization technologies such as machine learning classification and AI. Our paper seeks to identify the respective risks, general and specific, and mitigate them using AI and data to handle the uncertainties optimally and build resilience in the rice supply chain. Our use case and data are extracted from the Philippines, where rice is a staple with political and social ramifications. Local actors are mostly small-time farmers lacking the pricing power, certainty, and profit stability of the larger agribusinesses. We develop a stochastic programming model aided by AI to maximize farm revenue under a slew of uncertainties. Our model performs demand prediction with AI to dynamically target the key factors of price optimization considering production, storage, international supply, and risk assessment with the right social, environmental and economic strategies. Doing so can assist the Philippines, who is the world's largest rice importer, to reduce import reliance, stimulate farm productivity, scale local supply, and strengthen resilience against destabilizing international situations.

Keywords: Data Driven Optimization, Risk Management, Rice supply chain, Stochastic Programming, Pricing

2 - Joint Prediction and Stopping in Treatment of Aortic Aneurysms

Huan Yu, University of Southampton, Southampton, United Kingdom, Qingxia (Cynthia) Kong, Gar Goei Loke, Merieke Stevens, Merel Verhagen, Jan Van Schaik

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 (LUMC). Our model has the potential to open the door to preventive medicine as it forms individualized treatment decisions for each patient based on their unique data and characteristics.

3 - Risk Management for Electricity Systems with High Penetration of Renewable Energy Sources

Alberto Lamadrid, Lehigh University, Bethlehem, PA, United States

We present a usable 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 planning. The 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. This approach is based on the observation that there are major discrepancies between the power scheduled by a system operator and the actual power generated/consumed. These discrepancies—exacerbated by unplanned contingencies (e.g., natural disasters)—are caused by multiple factors, including the different financial, environmental and risk preferences of power producers, consumers, and aggregators.

MC06

Bldg. 33 - 204

Healthcare and Logistics

Invited Session

Service Operations

Chair: Michel Gendreau, Polytechnique Montreal, C.P. 6079, succ. Centre-ville, Montreal, QC, H3C 3A7, Canada

1 - Optimal Inventory Reserves for Preventing Drug Shortages: A Decision Model

Afschin Gandjour, Frankfurt School of Finance & Management, Frankfurt am Main, Germany, Afschin Gandjour

Background: Maintaining inventory reserves is crucial for preventing pharmaceutical shortages, with trade-offs between extending supply duration, increased inventory costs, and medication expiration rates. This study identifies the optimal inventory reserve duration. Methods: Analyzing a database of German drug shortages from 2012 to May 2023 (n = 2797), we evaluated the preventable shortages in relation to supply duration. Costs associated with inventory (storage, capital, expiration) and the QALY gain from avoiding shortages were assessed. A mathematical model was used to determine the optimal supply duration, considering the marginal cost-per-QALY ratio and the German cost threshold. Results: The median duration of drug shortages was found to be 90 days, varying across therapeutic areas. Due to the right skewed distribution of drug shortages, the mean duration was 195 days. The analysis shows a diminishing return on extending supply duration, reflected in an increasing marginal cost-per-QALY ratio. The optimal supply duration hinges on the QALY gain from preventing critical shortages. Conclusions: Cost-effectiveness analysis can guide drug shortage mitigation strategies, highlighting the importance of balancing supply duration extension against the increasing cost-effectiveness ratio.

2 - Improved LISA Analysis for Zero-Heavy Crack Cocaine Seizure Data

S. Raghavan, University of Maryland-College Park, College Park, MD, United States, Eunseong Jang, Margret Bjarnadottir, Marcus Boyd

Local Indicators of Spatial Association (LISA) analysis is a useful tool for analyzing and extracting meaningful insights from geographic data. It provides informative statistical analysis that highlights areas of high and low activity. However, applying LISA analysis methods to zero-heavy data may not be appropriate, as without the correct mathematical context the meaning of the patterns identified by the analysis may be distorted. We highlight these issues through statistical analysis and provide the appropriate context for interpreting LISA results for zero-heavy data. We then propose an improved LISA analysis method for spatial data with majority zero values. Applying our proposed methodology to crack cocaine seizure data in the U.S., we demonstrate its benefits in zero-heavy contexts as well as finer categorization of observed data. As LISA analysis is a popular approach that supports policy analysis and design, and as zero-heavy data is common in these scenarios, our work provides a framework that is better tailored for result interpretation and an improved approach for zero-heavy geographic data, ultimately leading to better decisions.

3 - Reliable Adjustable Planning in the Case of Dynamically Arriving Information: The example of E-Commerce Warehouses

Michel Gendreau, École Polytechnique, Montreal, QC, Canada, Catherine Lorenz, Alena Otto

The ongoing transition towards Industry 4.0, digitizes and connects processes and machines, thereby generating vast data available for dynamic decision-making within enterprises. Concurrently, planners seek to leverage optimization algorithms for well-informed decision-making in these dynamic contexts, which are capable of solving inherently complex planning problems rapidly in real-time. This necessitates the development of intelligent adjustable algorithms, whose behavior is well-understood for reliable practical deployment.

This talk focuses on the application of adjustable planning for picking operations in E-commerce warehouses. Since order picking accounts for a substantial portion (60-70%) of total operating costs in warehouses, it holds a pivotal role. In E-commerce settings, picking operations are essentially online, with customer orders arriving dynamically in real-time, highlighting the need for adjustable algorithms, or *online policies*.

Although several online policies for order picking have been suggested in the literature, there is a notable lack of understanding of their performance with respect to optimality. In this talk, we conduct a comprehensive examination of a prominent online warehousing policy – *myopic, immediate reoptimization (Reopt)* – and establish analytical performance bounds using probabilistic and worst-case analysis. We demonstrate that, under broad stochastic assumptions, Reopt is almost surely asymptotically optimal and, notably, we validate its near-optimal performance empirically.

Our analysis offers significant insights into long-standing discussions in the warehousing literature about the merits of forward-looking policies that aim to anticipate future orders. The low – or neglectable - gaps to optimality of Reopt, which eschews anticipation, establish a clear benchmark for assessing the benefits of anticipatory online policies.

MC07

Bldg. 33 - 301

Ruslan Shaydulin & Tamás Terlaky - Quantum Computing Optimization: From Foundations to Combinatorial and Conic Optimization

Invited Session

Tutorial

Chair: Michel Gendreau, Polytechnique Montreal, C.P. 6079, succ. Centre-ville, Montreal, QC, H3C 3A7, Canada

1 - Quantum Computing Optimization: From Foundations to Combinatorial and Conic Optimization

Tamás Terlaky, Lehigh University, Bethlehem, PA, United States, Ruslan Shaydulin

The tutorial begins with a gentle introduction to the foundations of quantum computing, including a brief review of the state of the current state of existing quantum computers and development trends.

Then we review how combinatorial optimization problems are solved in the quantum computing paradigm using a commonly considered near-term quantum optimization heuristic called the Quantum Approximate Optimization Algorithm (QAOA). We discuss both the theoretical aspects of QAOA as well as its implementation on hardware.

The last part of the tutorial presets variants of Inexact-Feasible-Quantum-Interior-Point-Methods enhanced with Iterative Refinement for solving Linear Optimization Problems. Extensions to Semidefinite and Second-order Conic Optimization will be fleshed.

MC08

Bldg. 33 - 302

OR in Health

Invited Session

AI, Analytics, and Healthcare

Chair: Diana Margarita Prieto Santa, Pontificia Universidad Católica de Valparaíso, Chile

1 - Mitigating the Horn Effect for Safety Net Hospitals in the Internet Age

Ankita Shirahatti, Boston University, Boston, MA, United States

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Safety-net hospitals in the United States who aim to provide care regardless of patients' ability to pay have historically underperformed on government measures of hospital performance. As a result, these already cash-strapped hospitals receive less Medicare funding relative to their non-safety-net counterparts. In the first part of this work, we explore mechanisms underlying U.S. safety-net hospital performance on government measures of patient experience. We hypothesize and find, using a regression discontinuity design, that a horn effect exists for safety-nets in which patients disproportionately penalize these hospitals on overall ratings by up to 2 points. In the second part, we use natural language processing methods to discover novel measures of patient experience from online hospital reviews that may help these hospitals improve performance on experience ratings. Finally, we provide recommendations for U.S value-based programs to help mitigate the horn effect for safety-net hospitals.

2 - Optimal Routing for Mobile Methadone Clinics

Anthony Bonifonte, Denison University, Granville, OH, United States, Erin Garcia

Methadone treatment is proven to be highly successful in combating opioid addiction and preventing overdoses, but many patients have geographic restrictions on access. In 2021 the Drug Enforcement Agency of the United States changed regulations to allow for easier operation of narcotic treatment programs with a mobile component, also known as mobile methadone clinics. These mobile clinics can expand access to methadone in rural and underserved communities. In this talk we estimate the demand for methadone in areas that do not currently have access and formulate a MIP to maximize the number of clients served. We solve the model to optimality within each state nationwide. We find additional policy changes need to be considered and efficiency improvements made to incentivize the operation of mobile methadone units for serving rural and unmet demand for methadone maintenance treatment. These findings are generalizable to planning other mobile health services with uncertain demand.

3 - An Integrated Bi-Objective Beam Angle Selection and Direct Aperture Optimisation Framework for the IMRT Problem

Guillermo Cabrera-Guerrero, Pontificia Universidad Catolica de Valparaiso, Valparaiso, Chile, Carolina Lagos, Mauricio Moyano, Maximiliano Beltran

Intensity-modulated radiation therapy (IMRT) is one of the most common radiotherapy techniques. It aims to irradiate the tumour's cells according to a medical prescription while sparing surrounding organs at risk (OAR). To this end, we first need to select a set of beam angles (BAC) from which radiation will be delivered (BAO problem). Then, the optimal intensities for each BAC (FMO problem). Finally, the aperture shapes radiation will pass through are generated (Sequencing Problem). These three sub-problems are usually addressed as a sequential problem. Unfortunately, following this approach means the obtained treatment plan highly depends on the selected beam angles in the first step. Further, computing the optimal intensities without considering the physical constraints of the delivery process (Sequencing Problem) means that computing the aperture shapes during the third step leads to an impairment in the final treatment plan's quality. To address the first problem (BAC's dependency), researchers have proposed integrating the selection of beam angles and the intensities' optimisation process. Also, to overcome the second problem (treatment plan impairment during the sequencing stage), researchers have proposed integrating physical constraints during the intensities optimisation step (Direct Aperture Optimisation problem, DAO). Although these two approaches have improved the whole process, the issues remain. In this work, we present a framework that integrates the three problems (beam angle selection, intensities optimisation and sequencing) into one model that also considers the inherent multi-objective nature of the IMRT problem. Preliminary results show that our framework can produce high-quality treatment plans within clinically acceptable times.

MC09

Bldg. 33 - 303

Generative Modeling and Its Applications

Invited Session

Advanced Developments for AI with Applications in Healthcare, Industry and Fintech

Chair: Xiaodong Shen, University of Minnesota

Co-Chair: Haoda Fu, Eli Lilly and Company, Carmel, IN, United States

1 - Haoda Fu (Please update title)

2 - Jie Ding (Please update title)

3 - Enhancing Operational Efficiency through Predictive Maintenance and AI: Opportunities and Challenges

Aisha Najera, RAND Corporation, Santa Monica, CA, United States, Giovanni Malloy

This talk delves into the critical role of predictive maintenance, advanced data analytics, and AI in boosting operational efficiency and ensuring equipment availability. Predictive maintenance, distinguished from traditional preventative and reactive approaches, utilizes deep learning algorithms to forecast equipment failures before they occur. A further investigation evaluates the drivers of equipment availability using a robust methodological framework that incorporates both statistical and tree-based machine learning models. Both studies highlight the potential of integrating machine learning and data analytics in optimizing logistics. Nonetheless, challenges such as complex data management, data quality challenges, the necessity for specialized expertise, and the demand for advanced computational resources persist. This presentation will outline strategies to navigate these challenges.

4 - Interactivity, Interpretability, and Generative Models

Kris Sankaran, UW Madison, Madison, WI, United States

Society's capacity for algorithmic problem-solving has never been greater. Generative Artificial Intelligence is now applied across more domains than ever, a consequence of powerful abstractions, abundant data, and accessible software. As capabilities have expanded, so have risks, with models often deployed without fully understanding their potential impacts. Interpretable and interactive machine learning aims to make complex models more transparent and controllable, enhancing user agency. We first introduce precise vocabulary for discussing interpretability, like the distinction between glass box and explainable algorithms. We then explore connections to classical statistical and design principles, like parsimony and the gulfs of interaction. In the process, we will reflect on the strengths of generative modeling in interdisciplinary applications ranging from bioinformatics experimental design to the response to COVID-19, where the modularity and iterability of generative mechanisms is essential. We also review criteria for objectively evaluating models and their interpretation. Finally, we outline open challenges and discuss the potential role of data science in addressing them.

Tuesday, June 18, 9:00 AM - 10:30 AM

TA01

Bldg. 33 - 101

Optimization, Learning, and Decision Making: I

Invited Session

Optimization, Learning, and Decision Making

Chair: Luis Zuluaga, Lehigh University, Bethlehem, PA, United States

Co-Chair: Mateo Diaz, Johns Hopkins University, Baltimore, MD, United States

1 - Constraint Penalization for Non-convex Optimization Problems: Applications to Quantum Computing

Luis Zuluaga, Lehigh University, Bethlehem, PA, United States, Rodolfo Quintero, Juan Vera

We begin by showing that conditions for strong Lagrangian duality of non-convex optimization problems can be obtained via a proof inspired by polynomial optimization techniques. By further looking into conditions for dual attainment, this approach leads to a generic way to reformulate equality constrained binary optimization problems as unconstrained binary optimization problems. This type of reformulations have gained recent importance, thanks to the fact that they allow quantum computers to be used to address the solution of a wide range of combinatorial optimization problems. We finish by discussing how our results can be extended to the case of mixed binary optimization problems.

2 - On Graphs with Finite-Time Consensus

Cesar A. Uribe, Rice University, Houston, TX, United States, Edward Duc Hien Nguyen

In this talk, we present sequences of graphs satisfying the finite-time consensus property (i.e., iterating through such a finite sequence is equivalent to performing global or exact averaging) and their use in Gradient Tracking. We provide an explicit weight matrix representation of the studied sequences and prove its finite-time consensus property. Moreover, we incorporate the studied finite-time consensus topologies into Gradient Tracking and present a new algorithmic scheme called Gradient Tracking for Finite-Time Consensus Topologies (GT-FT). We analyze the new scheme for nonconvex problems with stochastic gradient estimates. Our analysis shows that the convergence rate of GT-FT does not depend on the heterogeneity of the agents' functions or the connectivity of any individual graph in the topology sequence. Furthermore, owing to the sparsity of the graphs, GT-FT requires lower communication costs than Gradient Tracking using the static counterpart of the topology sequence.

3 - Model-Free Analysis of Dynamical Systems Using Recurrent Sets

Enrique Mallada, Johns Hopkins University, Baltimore, MD, United States, Yue Shen, Roy Siegelmann

In this talk, we develop model-free methods for analyzing dynamical systems using trajectory data. Our critical insight is to replace the notion of invariance, a core concept in Lyapunov Theory, with the more relaxed notion of recurrence.

Specifically, a set is τ -recurrent (resp. k -recurrent) if every trajectory that starts within the set returns to it after at most τ seconds (resp. k steps). We leverage this notion of recurrence to develop several analysis tools and algorithms to study dynamical systems. Firstly, we consider the problem of learning an inner approximation of the region of attraction (ROA) of an asymptotically stable equilibrium point using trajectory data. We show that a τ -recurrent set containing a stable equilibrium must be a subset of its ROA under mild assumptions. We then develop algorithms that compute inner approximations of the ROA using counter-examples of recurrence that are obtained by sampling finite-length trajectories. Secondly, we generalize Lyapunov's Direct Method to allow for non-monotonic evolution of the function values by only requiring sub-level sets to be τ -recurrent (instead of invariant). We provide conditions for stability, asymptotic stability, and exponential stability of an equilibrium using τ -decreasing functions (functions whose value along trajectories decrease after at most τ seconds) and develop a verification algorithm that leverages GPU parallel processing to verify such conditions using trajectories. We finalize discussing future research directions and possible extensions for control.

4 - Affine-invariant Convergence of Frank-Wolfe Algorithms on Polytopes

Javier Pena, Carnegie Mellon University, Pittsburgh, PA, United States, Elias Wirth

We provide a unified analysis of the following popular versions of the Frank-Wolfe method on polytopes: vanilla Frank-Wolfe, Frank-Wolfe with away steps, Frank-Wolfe with blended pairwise steps, and Frank-Wolfe with in-face directions. For each of these algorithms we establish convergence rates ranging from sublinear to linear. Our approach is entirely affine-invariant as it relies on some suitable error bound and curvature properties that depend solely on the objective function and the polytope but not on any affine-dependent objects such as norms. We highlight the interesting geometric interpretation of the error bound and curvature properties underlying our main developments.

TA02

Bldg. 33 - 102

Industrial Applications of OR III

Invited Session

Industrial Applications of OR

Chair: Alejandro Montoya

1 - An Optimization Algorithm for a Truck Driver Scheduling Problem with Multiple Constraints in a Colombian-based Package Delivery Company

Daniel Villa, Coordinadora Mercantil, Medellín, Colombia, Alejandro Montoya

Middle mile operation is one of the most expensive activities in the package delivery industry across Latin America. Package delivery companies experience high costs due to the complexity of their networks, roads geographical conditions, and the drivers' circumstances. Truck driver scheduling becomes challenging in high-complexity networks when, in each facility, there is a disparity between the number of required trucks for dispatching and the availability thereof. This means empty trucks will always be necessary to ensure the minimum required availability each facility needs. In addition, drivers' constraints are determined by maximum driving time, maximum driving range per week, minimum distance to assign per month, and other special conditions such as medical appointments or personal commitments. Besides, drivers should end the week in their city of origin at least every two weeks. Given these time frames and constraints, we propose a heuristic method based on smart prioritization criteria for the drivers and a random search which can meet all the scheduling requirements, considerably reducing the number of empty trucks and the total distance traveled by the fleet. This approach also balances the distance assigned to all drivers. The results show a reduction in the operating cost of around 3% and a reduction in the number of empty truck close to 25%.

2 - A Parallel Machine Scheduling Problem in the Coffee Industry

Santiago Lopez, Colcafé, Medellín, Colombia, Alejandro Montoya

It is crucial for companies to achieve higher levels of satisfaction, meet established commitments with customers, and adhere to production deadlines in order to gain competitive advantages. Production scheduling is therefore one of the most critical tasks in manufacturing systems, as it involves allocating jobs with limited resources. This research focuses on optimizing the total tardiness in job scheduling for parallel machines, using a case study of a coffee roaster. This research addresses the optimization of the total tardiness in the scheduling of jobs in parallel machines for a case study in a coffee roaster. This is an NP-hard problem where each job requires the roasting process and, in addition, has an associated delivery time. Each job's processing time depends on the machine that is designated and not all machines can run all jobs. We propose a Mixed Integer Linear programming (MILP) formulation for solving the problem. Additionally, we use a matheuristic method based on the ATC heuristic as alternative method. To test the MILP formulation and the matheuristic, we use a set of instances based on real data from the roasting process. The results show that our matheuristic is able to find a near-optimal solution in a competitive computational time.

Keywords: Scheduling, Optimization, Unrelated parallel machines, Total tardiness, Mathematical model, Heuristics, Mateheuristics, ATC, Coffee, Roasting

3 - Your Order, Delivered: Navigating the Complexity of Real-time Optimization Systems

Sebastian Quintero, Nextmv, Bogota, Colombia

Real-time planning for applications such as food delivery or ridesharing is not an isolated analytical problem. It is an integral part of a decision supply chain and deeply interconnected with other decision models. More and more, decision science teams are treating these systems as engineered software components complete with testing and integration for other software systems. This session explores how these practices lead to a more resilient and adaptive real-time planning process.

4 - The 1.5D Cutting Stock Problem with Heterogeneous Slitting Lines Allocation Applied to the Steel Industry

Antonio Alonos-Ayuso, Universidad Rey Juan Carlos, Mostoles, Spain, María Sierra-Paradinas, Oscar Soto-Sánchez, Micael Gallego, Javier Campo-Campo

We present a mathematical optimisation model to solve the slitting problem in a Spanish steel manufacturing company. In order to satisfy the demand for steel strip, coils are selected from the warehouse and cut lengthwise on the slitting lines. The main challenge in this problem is to determine a slitting plan, which involves defining a set of cutting patterns for the coils and selecting the slitting line where the coils will be cut. The cutting patterns must meet the customer's requirements and the ongoing operational constraints imposed by the slitting lines. The differences between the lines limit the allocation of coils - cutting pattern - slitting line, with a high impact on the company's productivity. It is therefore necessary to integrate the slitting line allocation into the coil selection and cutting pattern definition. The model is validated with real data and outperforms the results obtained without this integration, thus improving the company's performance without reducing the quality of the solutions. Three different objectives are taken into account 1) reducing the leftovers generated in the process, 2) maximizing the productivity of the process and 3) reducing the difference between the quantity of product actually delivered and the quantity demanded by the customer.

TA03

Bldg. 33 - 103

Smart Mobility

Invited Session

Combinatorial Optimization and Applications

Chair: Luisa Chaparro Sierra, EIC Tecnológico de Monterrey

Co-Chair: Jenny Díaz-Ramírez, Paseo del acueducto 3609, 64920

1 - Stochastic Models for Locating and Dispatching Two Types of Ambulances

Beatriz Alejandra García Ramos, Universidad Autónoma de Nuevo León, Monterrey, Mexico, Yasmín Ríos Solís, Roger Ríos Mercado

We propose a two-stage stochastic program for the emergency vehicle planning problem that locates the ambulances in different city points and dispatches them to the emergency scenes considering the uncertainty of the emergency calls, ambulance demand, emergency locations, and patients' urgent medical care; and allows partial coverage of the accidents.

2 - An Inter-University Bus Routing Problem

Jenny Díaz-Ramírez, Tecnológico de Monterrey, Monterrey, Mexico, Angela María Rosas, Barbara García-Colis, Paula Sofia Valencia-Torres

Using universities as living laboratories to experiment with smart transport solutions has been evolving over the last decade. In this work, we present an interscholastic bus routing problem in a university context that can be solved through a mixed-load model that optimizes a bi-objective function of coverage and bus utilization. In the study case, with data-driven sensitivity analysis for parameter tuning, a bus stop location problem is solved previously to the routing problem whose resulting routes can be also interpreted as schedules.

3 - A Broad Spectrum of Policy Assessment for Energy Transition to Zero and Low-emission Technologies in Private Vehicles: The Mexican Case

Jose Daniel Morcillo Bastidas, Universidad de Monterrey, Monterrey, Mexico, Julieth Stefany Garcia, Laura Cardenas, Carlos Franco

Given the growing concern about the environmental impact of transport, especially its significant contribution to greenhouse gas emissions, it is imperative to implement essential strategies aimed at reducing emissions in road transport. Among these strategies, the widespread adoption of zero and low-emission vehicles powered by electricity emerges as pivotal. In the

context of Mexico, where private vehicles play a role in air pollution, enacting effective policies targeting these vehicles is essential not only to mitigate pollution but also to align with the country's decarbonization objectives. This research introduces a simulation model grounded in System Dynamics, offering insight into the dynamics surrounding the adoption of zero and low-emission vehicles, with a specific emphasis on private vehicles and drawing upon data from the Mexican context. By exploring various scenarios for policy evaluation through the simulation model, this study aims to identify the most effective mix of incentives or disincentives for various types of vehicles, including hybrid electric vehicles (HEV), plug-in hybrid electric vehicles (PHEV), internal combustion engine (ICE) vehicles, compressed natural gas (CNG) vehicles, and battery electric vehicles (BEV). Through this sensitivity analysis, it is possible to identify the most effective policies for maximizing emission reduction in the country.

TA04

Bldg. 33 - 201

Mathematical Programming and Heuristic Techniques for Logistic Planning

Invited Session

Combinatorial Optimization and Applications

Chair: Aldo Vecchietti, INGAR

1 - Disjunctive Multi-Objective Model for the Economic-Environmental Analysis of Purchasing Policies and Product Distribution Decisions

Aldo Vecchietti, INGAR, Santa Fe, Argentina, María Laura Cunico, Julio Flores

Production companies face challenges due to evolving marketing trends and a competitive global market. Climate change necessitates rethinking logistics to reduce the carbon footprint of goods transportation while balancing cost reduction and environmental requirements. Logistic planning involves inventory management and delivery optimization, and it can be oriented towards reducing both transportation costs and greenhouse gas emissions.

This article introduces a disjunctive, multi-product, and multi-objective mathematical programming model for infrastructure and delivery policy planning in wholesale companies with seasonal demands. The decision-making process involves various levels, including the planning of distribution infrastructure. The infrastructure consists of fixed storage points (SP), which offer the flexibility to expand their facilities or convert into cross-docking points (CD). Furthermore, storage points can temporarily increase their capacity by renting additional storage space or choosing to lease cross-docking points to meet seasonal demand. The proposal also includes merchandise purchasing at each storage point, with prices varying by location. Distribution planning considers environmental requirements by evaluating the use of different types and sizes of vehicles, including diesel and electric trucks with their respective ranges and loading capacities. Larger vehicles transport goods from storage points to cross-docking points, while smaller vehicles transport merchandise to final consumption points (FC).

The model evaluates seasonal distribution network planning based on two optimization criteria: total cost minimization and environmental impact reduction. It analyzes product volumes, merchandise flows, stock levels, supply points for final consumption, vehicle types and sizes, and storage investment decisions. A case study demonstrates the model's capabilities.

2 - Implementation of the Scape Strategies Algorithm Metaheuristic for Solving the Berth Allocation Problem

Mario Alberto Mendoza Villalba, Universidade Estadual de Campinas, Limeira-SP, Colombia, Priscila Rampazzo, Diego Jacinto Fiorotto

According to the United Nations Conference on Trade and Development (UNCTAD, 2016), maritime transport carried over 80% of global trade merchandise in 2015 due to the expansion of transactions between nations caused by globalization. The intermodal transportation of goods by vessels has increased over the years. In this context, the Berth Allocation Problem (BAP) arises and becomes fundamental in guaranteeing the efficiency of maritime terminals and deciding where and when to allocate the vessel over a planning horizon. Several models have been developed for the BAP based on other problems in the literature, such as cutting and packing, scheduling, vehicle routing, or generalized set partitioning. BAP is an NP-hard problem, and several heuristic approaches have been proposed. Therefore, we applied a new metaheuristic: Scape Strategies Algorithm [1]. Our proposed metaheuristic has a similar structure (codification and initialization) as PSO, developed by [2]. The solution representation is a floating point vector: each vessel is assigned a number between (0, m). The integer part is the berth number to which the vessel is allocated, and the fractional part is used to sort the vessels allocated to each berth. Comparisons are carried out to identify classes of problems in which the proposed approach performs well.

[1] M. M. Villalba, "Escape Strategies Algorithm (ESSA): A New Metaheuristic Global Optimization Algorithm for Real-Valued Problems, Inspired by Predator-Prey Interaction,". dissertation, Universidad de Córdoba, 2016

[2] J. Kennedy and R. Eberhart, "Particle swarm optimization," in Proceedings of the IEEE International Conference on Neural Networks, 1995, pp. 1942-1948

3 - A Branch-and-Price Algorithm for Bridge Maintenance Planning Optimization

Daniel Yamín, Universidad de los Andes, Bogota, Cundinamarca, Colombia, Esteban Prada, Diego Noriega, Juan Correal, Andres Medaglia

Bridges are susceptible to various deterioration mechanisms that gradually increase their risk of collapse. As a result, national transportation and road agencies must cleverly invest their budget in rehabilitation and maintenance plans to avoid significant social impact and economic losses. The bridge maintenance planning problem arises from this context. We propose a column-oriented mathematical formulation of the problem and a branch-and-price algorithm to solve it. We illustrate the use of the proposed algorithm on a dataset drawn from the Colombian bridge network system.

4 - Multi-objective Logistic Model to Select the Transport Technology in the Agri-food Sector

Aldo Vecchiatti, INGAR, Santa Fe, Argentina, Milagros Verrengia, Julio Flores

In an agri-food supply chain, the logistics operation is responsible for shipping products, controlling their flow and efficient storage. In this sector, the voluminous production of the farms must be harvested and transported in a short period of time, stored in a controlled manner, and then sent to factories that process it throughout the year. Currently, the logistics operation must be optimized not only economically and but also environmentally, in order to comply with regulations. This work presents a mathematical optimization model for the logistics of an agri-food chain that has two objectives, one economic, which minimizes investment and operation costs of transportation, and the other environmental, which minimizes the emission of greenhouse gases. (CO₂). The environmental objective is included in the model restrictions as a chance constraint. The chain is represented in 3 levels, production in the farms, storage in silos and final destination, which can be of two types: the factories that process them and the ports that export them. The model is applied to the soybean supply chain in Argentina, and the objective is to analyze four types of heavy trucks for transportation: hydrogen, electric, natural gas and bio-diesel. The results show the combination of different types of trucks that can be used to reduce greenhouse gas emissions, at the lowest possible cost. They provide an interesting insight about the fleet of trucks that operates the logistic of the supply chain.

TA05

Bldg. 33 - 203

Applications in Lean Six Sigma

Invited Session

Lean Six Sigma Applications

Chair: Kannan Ramanathan, University of Texas-Dallas, Richardson, TX, United States

1 - Strategic Classification of Critical Medicine Inventories: A Data-Based Analysis in the Colombian Clinical Context

William Guerrero, Universidad de La Sabana, Chía, Colombia, Daisy Puin, Elena Valentina Gutierrez

In healthcare institutions, the current approach to prioritizing logistically medicines tends to be practical experience, lacking an inventory classification system. This reliance on empirical decision-making contributes to imprecision, impacting patient service levels and incurring higher logistic costs. Thus, inventory medicine classification involves the implementation of a holistic system that considers methodologies to discover patterns in data without explicit guidance and an understanding of operative realities in healthcare. Our research centers on clustering historical data related to medicines, employing machine learning algorithms specifically, K-Means and the density-based spatial clustering of applications with noise [DBScan]. The clustering process incorporates six key logistics features: demand patterns, lead times, unit prices per period, order frequency, number of suppliers, and order size restrictions. Carried out in a Colombian university hospital managing 265 medicine references, our study not only contributes theoretical insights but also demonstrates practical applications in real-world scenarios. In our comparison between K-Means and DBScan, we find that DBScan proves more effective, exhibiting superior cluster consistency and temporal variability. The subsequent classification of medicines within these clusters is a collaborative effort involving logistics professionals, who assess the logistics features of each cluster, providing essential input for the classification process. This holistic approach allows us to effectively navigate the intricacies of healthcare logistics, capitalizing on the strengths of both quantitative and qualitative analysis.

2 - Working on: Mental Health Capacity Simulation with Digital Transformation

Ismael Aguilera, Universidad de Chile, Santiago, Chile

There is a gap in the scientific debate regarding management considerations necessary to identify the mechanisms that drive agents to increase mental health care capacity in the long term. Improved patient follow-up tracking and increased capacity at bottlenecks can be achieved by means of digital transformation. Some specific technologies, such as telemedicine, can

perfectly favor the attention of low-risk situations that require routine check-ups, medical prescription updating, renewal of medical certificates for sick leave, etc. This work compares two scenarios of a discrete event simulator. In the first instance, patients interact with different resources from the care process: administration, waiting rooms, psychiatrists, etc. In the second case, the scope is extended to remote care processes that patients access to achieve a prompt response. Both scenarios have been enhanced by including shared processes and numerous final services where patients arrive depending on their characteristics and conditions. Thus, the impact of digital transformation on the dynamics of capacity at the macro level and in the long term of health systems related to mental health is contrasted and its cost-effectiveness is measured. Both might be considered a contribution to literature.

3 - An Application of Lean Six Sigma in Establishing a Production Line

Varsha Ramanathan, ESAB, Denton, TX, United States

4 - An Application of Lean Six Sigma in Processing Warranty Claims

Kannan Ramanathan, University of Texas-Dallas, Richardson, TX, United States

TA06

Bldg. 33 - 204

Innovative Supply Chain Management

Invited Session

Service Operations

Chair: Mario Guajardo, NHH Norwegian School of Economics, Bergen, Norway

1 - Financing Suppliers under Risk Control: Retailer-Guaranteed Loan, Market Competition, and Expected Shortfall

Jia Yu, The Hong Kong Polytechnic University, Hong Kong, Hong Kong, Chi To Ng

We consider n different capital-constrained suppliers encountering potential disruptions in their normal operations with a financially sound retailer purchasing products from them. The supplier's capital shortage problem can be solved by buyer-backed purchase-order financing (BPOF) provided by the bank with the retailer's guarantee. We study the joint-decision problem of order allocation and bank loan pricing under risk controls besides suppliers' capital constraints and operational disruptions under the BPOF scheme with two different credit facilities. We analyze the optimal decisions of each player under four different trading schemes, including the wholesale contract without and with BPOF. Then, the social welfare for the four schemes is analyzed to obtain the optimal joint decisions for each player under different conditions. The results suggest that the risk preference of the bank, in addition to the risk levels of the suppliers, influences the performance of the entire supply chain and the social welfare. We find that the bank's risk management ability and the retailer's budget management capability are crucial to the success of the BPOF scheme. Under certain conditions, adopting the BPOF scheme can prompt social welfare at the expense of the suppliers' profits. Therefore, the government should provide suppliers with subsidies to simulate the BPOF scheme's adoption when social welfare can be improved.

2 - Scientometric Analysis for Coffee Supply Chain Management "CSCM", within the Framework of Digital Transformation and Industry 5.0

Diego A Marín Idárraga, Universidad de caldas - Universidad Nacional Abierta y a Distancia UNAD, Ibagué, Colombia, ALEXANDRA DUARTE

Duarte Castillo, Alexandra^{1*}, Marín Idárraga, Diego Alberto², Juan Carlos Uribe³

Currently, humanity faces the challenge of constant food supply, and the optimal design of chains plays an important role from raw materials to the production and agro-industrialization of valuable products. In the case of coffee, which has a short useful life, mathematically modeling the elements of "CSCM" is inevitable for product quality assurance, as it includes prospective challenges, including increased costs, complexities, risk management, volatility. of the market and post-pandemic uncertainties, they contributed to an awakening of disruptive thinking that leads towards a sustainable "CSCM", with maximum socioeconomic and environmental impact. To this end, the literature review examined the changing global geopolitical environment and the coffee-growing institutions, trust, balance, and resilience, in pursuit of the well-being of the rural family by giving new meaning to the coffee-growing woman; greater coverage in associations and promote successful cooperative experiences.

However, it is necessary to succinctly observe the behavior of socioeconomic, environmental, technological and governance variables, within the framework of digital transformation and industry 5.0. In this paper, a scientometric analysis is carried

out, obtaining 490 documentary sources organized in Mendeley Software, 210 were subject to exhaustive review, for contributing significantly to “CSCM”. When analyzing the current situation in this field of study, the trends of studies in planning or evaluation of uncertain scenarios are evident, and the development of technological platforms to support strategic, tactical, and operational decision making, a task still to be accomplished from big data, blockchain and machine learning.

3 - Harnessing Bullwhip and Ripple Effects in Military Supply Chains for Tactical Advantage

Alexander Roman, Universität der Bundeswehr München, Munich, Germany

Motivated by the critical role of military supply chains in ensuring state existence, particularly underscored by ongoing conflicts such as that in Ukraine, this study establishes a simulation pipeline tailored for military operations, focusing on the concept of an Effects-Based Approach to Operations (EBAO).

It explores the generation of localized demand fluctuations, and disrupting the civilian side supply chain through trade embargoes or forced infrastructure shutdowns. Additionally, it investigates the feasibility and potential benefits of strategically coordinating these effects within military campaigns to potentially shorten military engagements and save both combatant and civilian lives.

Our model-driven, agent-based simulation pipeline enables the exploration of diverse scenarios, unrestricted by real-world data limitations. For instance, historical data from World War II can be utilized to validate the model, potentially allowing for the prediction of the impact of bullwhip and ripple effects on contemporary conflicts.

The objective is to provide insights into the vulnerabilities of military supply chains and to formulate potential strategies for enhancing their resilience. For example, which infrastructure component or production facility is pivotal for military success? This research has implications for national defense planning, and the development of collaborative risk-pooling strategies to prepare nations for military conflicts.

By shedding light on the challenges and opportunities inherent in military supply chain management, this study contributes to the broader discourse on national security and supply chain resilience in the face of dynamic and uncertain operating environments.

4 - Conventional or Organic? Optimal Gross Margin Analysis of Cattle Farms

Mario Guajardo, NHH Norwegian School of Economics, Bergen, Norway, Rasmus Bang, Leif-Jarle Asheim, Ola Flaten, Bjørn-Gunnar Hansen, Jon-Kristian Sommerseth

Interest for organic products and concerns regarding sustainable practices raise an important question for farmers: should they run their farms conventionally or organically? We address this question by means of a mathematical programming model, which aims to optimize gross margin of cattle farms. We implement the model using data from Norway, including government support stipulations and a number of other features. A computational study allows us to assess the economic performance of organic farming compared to conventional farming systems. We derive some insights into the conditions when organic outperforms conventional systems, and vice versa. These hold significant relevance not only to farmers, but also to farm advisors and policy makers.

TA07

Bldg. 33 - 301

Emilio Carrizosa - Mathematical Optimization Models for Group Counterfactual Explanations

Invited Session

Tutorial

Chair: Fernando Ordonez, Universidad de Chile, Santiago, Chile

1 - Mathematical Optimization Models for Group Counterfactual Explanations

Emilio Carrizosa, Universidad de Sevilla, Sevilla, Spain

Counterfactual Analysis has shown to be a powerful tool for Explainable Artificial Intelligence. In Supervised Classification, this means associating with each record a so-called counterfactual explanation, i.e., an instance close to the record (closeness measured by an appropriate and context-dependent dissimilarity) and whose probability of being classified by a given classifier in the positive class is high.

While the literature focuses on the problem of finding one counterfactual for one record, in this talk a stakeholder perspective is taken, and we address the more general setting in which a group of counterfactual explanations is sought for a

group of instances. Mathematical optimization models are introduced to illustrate different instance-counterfactual allocation rules. A number of research challenges for the Operations Research community are identified.

TA08

Bldg. 33 - 302

Population Health Analytics

Invited Session

AI, Analytics, and Healthcare

Chair: Diana Margarita Prieto Santa, Pontificia Universidad Católica de Valparaíso, Chile

1 - Dissecting Socioeconomic Disparities in Lockdown Durations: A study of Santiago's Staged Reopening Amidst the Pre-vaccine Phase of the COVID-19 Pandemic

Diana Margarita Prieto Santa, Pontificia Universidad Católica de Valparaíso, Chile, Valparaíso, Chile, Diego Martinez, Felipe Pachano, Felipe Feijoo, Rodrigo Martínez, Sumona Datta, Carlton Evans

Methods: This ecological study employed municipality-level sociodemographic data from Chile's Population and Housing Census, the Police Crime Registry, and the Public Health Observatory. These datasets were integrated with epidemiological reports from Chile's Ministry of Health, focusing on COVID-19 in Metropolitan Santiago. Data analysis spanned July to November 2020, coinciding with the implementation of the Staged Closure and Reopening (SCR) policy, prior to widespread vaccine availability. Examined exposures included educational attainment, overcrowding, income poverty, domestic violence, and human development index. The primary outcome was the duration of SCR categorized into stages 1 (most restrictive) to 4 (least restrictive), adjusted for age, sex, COVID-19 incidence, and excess mortality. An unsupervised machine learning algorithm clustered municipalities based on similarities of sociodemographic characteristics. Multivariate survival analysis was utilized to correlate lockdown duration with these exposures

Results: The cumulative duration of the lockdown, adjusted for age, sex, and COVID-19 incidence across all municipalities, was 38.7 days in the most restrictive Stage 1, culminating in 115.2 days for full reopening from stage 1 to 4. The study found that domestic violence was inversely correlated with the likelihood of municipality reopening (hazard ratio [HR] = 0.41, 95% confidence interval [CI] 0.19–0.89). Furthermore, higher levels of educational attainment (HR = 5.99, 95% CI 2.46–14.53) and human development (HR = 5.08, 95% CI 2.07–12.44) were positively associated with increased chances of reopening at the municipal level.

Conclusions: The findings suggest that historic domestic violence was associated with prolonged municipality lockdowns, highlighting opportunities for geographically targeted outbreak control efforts.

2 - Development and Evaluation of Quality-of-life Indicators Based on Social Media Data

Gonzalo Rios, Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile, Hanns de la Fuente-Mella, Diana Prieto Santa, Claudio Elórtogui-Gómez

Streaming data from social media platforms, along with the application of techniques and methods from text analytics, provides a rich opportunity to gather information from social network users about a wide range of domains. This work explores the analysis of Twitter messages in Quality-of-Life (QoL) research by mapping people's perceptions of their daily lives in 37 communes from the Metropolitan Region in Chile. The methodology involves the extraction of sample data from Twitter, text processing through text analytics methods, and the calculation of metrics with sentiment analysis in three main domains: education, health, and safety. With results from text and sentiment analyses, QoL indexes are developed and compared to the Chilean Urban Quality of Life (UQoL) index from survey data. Results show our QoL index matches the level of welfare of the UQoL in 70% of the municipalities, evidencing that social media data and people's perceptions can be used as input for developing metrics of welfare as a complement to UQoL surveys. This study contributes a novel methodology for developing text analysis, developing indexes from social media data, and experimenting with the domains selected for building the QoL index.

3 - The Impact of Social Determinants of Health and Social History on Mental Health Patient Return to Emergency Departments: An Explainable AI Framework

Abdulaziz Ahmed, University of Alabama at Birmingham, Birmingham, AL, United States, Mohammad Saleem

The return of mental health patients to emergency departments (EDs) within a month of being discharged poses a substantial challenge to healthcare systems and healthcare providers. To develop effective interventions, it is important to understand the factors that contribute to return. This research investigates the relationship between social determinants of health (SDoH) and social history and the risk of return to ED among mental health patients. In this study, we retrospectively analyzed data from 300,000 mental health patients who visited the UABHS ED between 2018 and 2022. Our dataset included patient

demographics, mental health diagnoses, two SDoH, and three social history factors: social support, alcohol/tobacco use, substance abuse, diet, and socioeconomic status. To predict readmission within 30 days, we developed XAI model using an XGBoost algorithm. The model development includes three stages: processing text data using advanced natural language processing (NLP) technique, feature selection, and model training and testing. SHAP (SHapley Additive exPlanations) is utilized to explain the features that have the most significant influence on the model's predictions. This work is under development and will be ready by the time the presentation. Our analysis will reveal that several key predictors are associated with an increased risk of return within 30 days. This research provides a comprehensive explanation of how the clinical, SDoH, and social history factors affect mental health patients' return to ED within 30 days. This work allows social workers to identify patients at high risk of ED visit return and then develop strategies to minimize their return.

TA09

Bldg. 33 - 303

How to Pursue a Graduate Degree in OR in the U.S.

Invited Session

Operations Research

Chair: Daniel Silva, Auburn University, Auburn, AL, United States

1 - Panelist

Alice Smith, Auburn University, Auburn, AL, United States

Panel

2 - Panelist

Diana Ramirez-Rios, University at Buffalo, Buffalo, NY, United States

Panel

3 - Panelist

Ana Estrada-Gomez, Purdue University, West Lafayette, IN, United States

Panel

Tuesday, June 18, 11:00 AM - 12:00 PM

Tuesday Plenary

Founders Auditorium

Augustine Esogbue - Dynamic Programming, A Guided Tour: From Curse to Computational Intelligence, to Learning and Control

Invited Session

Plenary

Chair: Kathryn Stecke, University of Texas at Dallas, Richardson, TX, United States

1 - Dynamic Programming, A Guided Tour: From Curse to Computational Intelligence, to Learning and Control

Augustine Esogbue, Georgia Institute of Technology, Atlanta, GA, United States

Dynamic programming (DP), according to my advisor Bellman, its inventor, a misnomer for the mathematical theory of multistage decision processes, is one of the most powerful tools in Operations Research and Control Theory in our time. Its appeal in addressing a wide array of problems in diverse fields of endeavor was only limited by what Bellman termed in the late 50s and early 60s as the Curse of Dimensionality. This so called Curse referred to the appearance of n , the dimension of the state variable as an exponent in the number of rapid access memory required to solve any problem. This exponential rather than linear growth in memory requirements with the problem size rendered DP less attractive even though it usually guaranteed globally optimal solutions to most problems formulated.

Over the years, the future of DP in applied optimization appeared rested on advances in computational devices technology as well as adroit problem formulations and studios. Computational algorithm development is also usually always stimulated by interest in modeling and solving complex real world problems. These abound in many sectors especially those in societal systems.

Developments in Advanced Computational Intelligence as well as artificial Intelligence, have added a boom to the state of the art and appeal of dynamic programming. In this plenary, we discuss some of these resultant experiences leading to an impressive knowledge base in computational dynamic programming.

KEY WORDS:

Dynamic programming, Curse of dimensionality, advanced computational intelligence, artificial intelligence, large scale societal systems solutions. Boom in applied dynamic programming.

Tuesday, June 18, 1:30 PM - 3:00 PM

TB01

Bldg. 33 - 101

Optimization, Learning, and Decision Making: II

Invited Session

Optimization, Learning, and Decision Making

Chair: Andres Velez, Norwegian School of Economics

1 - Assessing the Effect of Consolidation of Freight Transport: A Case Study in Norway

Julio Goez, NHH Norwegian School of Economics, Bergen, Norway, Cosku Can Orhan, Mario Guajardo, Stein Wallace

The growing urban population and increasing e-commerce sales cause more and more parcel deliveries within cities. Motivated by these trends, in this project we cooperate with public authorities of a city in Norway to study the effect of consolidation of freight transportation. The effect is measured along metrics on distance and number of stops. To compute these metrics, we deploy a three-stage methodology, which involves clustering, capacitated vehicle routing, and split delivery problems. We use data on road network and population from the public authority, and on deliveries from a major carrier. We present results for a number of data instances, varying the number of companies, their size and the degree of consolidation. Ultimately, our work aims at providing city authorities with a tool for the assessment of freight transport regulations.

2 - Optimizing Offshore Wind Farm Maintenance: A Multi-modal Transportation Approach and the Future of Electric Vessels

Mateo Espitia Ibarra, University of Bergen, Bergen, Norway, Ahmad Hemmati

Ensuring the reliable power production of offshore wind farms (OWF) is crucial, particularly given their greater risk of breakdowns compared to their onshore counterparts. This study introduces an optimization method for transporting maintenance crews and equipment to OWFs using various transportation modes. The primary goal is to reduce total operational expenses, including fuel costs and crew salaries, while guaranteeing the prompt completion of preventive maintenance tasks at the OWFs. The approach considers the use of various vessel types and a strategy that allows technicians to be left to work independently while the rest of the crew is transported to another OWF terminal. This research, based on a Norwegian case study, and is intended to support the implementation of the Ocean Charge project, which seeks to integrate fully electric vessels into OWF maintenance operations. A mathematical model and a heuristic algorithm are proposed. The initial results from the proposed approach are compared with those from an exact method.

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3 - Stochastic Cardinality Optimization: High-Dimensional Sparse Portfolio Selection under Leverage Control

Chanaka Edirisinghe, Rensselaer Polytechnic Institute, Troy, NY, United States, Jaehwan Jeong

Portfolio selection often involves a large number of potential constituent assets, although relevant historical data samples utilized tend to be relatively small. Using a parameterized norm-1 and norm-2 constrained quadratic optimization sub-problem, we perform data-driven calibration of norm-thresholds within a cross validation scheme. The master problem is to maximize out-of-sample utility while satisfying sparsity as a probabilistic constraint. Our empirical analyses with large asset sets yield insights on setting norm-thresholds for specified risk aversion in meeting portfolio sparsity under leverage limits, leading to improved performance.

4 - Lifeboat Assignment on Cruise Emergencies: A Network Simplex-Inspired Procedure for Time-expanded Networks

Andres Velez, Norwegian School of Economics, Bergen, Vestland, Norway, Stein Wallace

We discuss the assignment of passengers to lifeboats during emergencies on cruise vessels within a time-dependent framework, taking into account passengers' positions, mobility restrictions, and corridor availability. With the development of sensor mesh technologies, it became possible to track passengers' positions in environments that previously relied exclusively on wired communication. Access to this information, along with other relevant measures, enables us to explore

strategies to guide people and enhance their chances of survival during hazardous situations. We model the assignment problem as a network flow problem on time-expanded networks (one for each considered walking speed) in which an optimal plan for the system will set the passengers' destinations. Addressing congestion within networks poses a significant challenge, as it compels to either increase the number of edges or find iterative approaches to represent delayed arrival times, in which the found solutions shape the network's topology. Although previous efforts have been made to model building evacuations with congestion by increasing the number of edges; in this context, the assignment of an exit is not as important as it is for cruises. Consequently, an additional flow decomposition problem must be solved, with some of its formulations proven to be NP-hard. In light of these considerations, we propose an iterative approach inspired by the network simplex method to minimize the network's clear time; this approach takes advantage of network properties to find heuristic solutions within a more reasonable timeframe compared to those obtained by LP solvers.

TB02

Bldg. 33 - 102

Industrial Applications of OR IV

Invited Session

Industrial Applications of OR

Chair: Juan C Duque, Carbon Solutions, 1986 Thistlewood Rd , Okemos, MI, 48864-3722, United States

1 - Agent-Based Modeling in Public Health: A Multifaceted Approach to Understanding and Controlling Epidemics

Paula Escudero, Universidad EAFIT, MEDELLIN, Colombia

Agent-Based Modeling and Simulation (ABMS) offers a versatile framework for understanding epidemiological patterns. It enables analyzing the multifaceted relations between human behavior, environmental variables, and geolocalized policies in spreading infectious diseases. ABMS allows for the simulation of complex interactions at the individual level, providing insights that traditional modeling techniques might overlook. By incorporating detailed representations of individual behaviors, ABMS facilitates the exploration of how human behavior, influenced by policy interventions and environmental conditions, affects the trajectory of disease outbreaks.

Here, I present some examples, including tuberculosis, COVID-19, and vector-borne diseases like Dengue, Zika, and Chikungunya. For tuberculosis, ABMS underscores the role of social determinants and interaction patterns in disease spread, highlighting the importance of targeted interventions. The COVID-19 pandemic emphasized the utility of ABMS in evaluating the efficacy of public health policies, such as lockdowns and social distancing, and their implications on disease progression within and across communities. Similarly, in studying vector-borne diseases, ABMS accounts for the critical influence of environmental variables and climate conditions on mosquito population dynamics, offering valuable insights for disease prevention strategies.

However, ABMS has some limitations. It demands extensive computational resources and relies heavily on the availability and accuracy of input data to simulate realistic scenarios. Moreover, the complexity of these models can pose challenges in terms of validation and calibration, requiring a careful balance between model detail and practical applicability. ABMS, though, remains a powerful tool for understanding epidemic control and management and shedding light on effective intervention strategies in public health.

2 - Minimizing Overtime in a Product-Mold-Machine Manufacturing System

Mario Velez-Gallego, Universidad EAFIT, Medellin, Colombia

This study presents a mathematical model designed to optimize the production process within a pillow manufacturing company, with a specific focus on minimizing overtime. The proposed mixed integer linear programming formulation aims at minimizing the time required for the final production run to complete. It strategically allocates molds, presses, and references for each production run while considering constraints such as preventing shortages and controlling inventory capacity. Compatibility constraints between molds, presses, and pillow references are considered. Computational experiments results demonstrate the model's capability to find feasible and optimal solutions within designated time limits. However, instances where the best solution proves infeasible due to limited production time underscore the necessity for overtime work to meet demand. Overall, this mathematical model offers significant potential for enhancing resource allocation and improving production processes, ultimately fostering greater efficiency, profitability, and customer satisfaction.

3 - Matheuristic for a Multi Depot Heterogeneous Fleet Periodic Capacitated Vehicle Routing Problem with Time Windows

Alejandro Arenas, Universidad EAFIT, Medellin, Colombia, Juan Carlos Rivera, Maria Gulnara Baldoquín

The present research aims to solve a real-life problem raised in the vending machine industry in Medellín, Colombia. The problem requires a set of vehicles with heterogeneous capacity to serve the vending machines of multiple clients using multiple depots. The clients must be served during a given time window. The company requires the routes to be planned for a working week (Monday to Saturday) taking into consideration that each client must be assigned one of their available visit patterns.

The previously described problem is a Vehicle Routing Problem (VRP) with a particular set of attributes considered: capacitated, periodicity, multiple depots, heterogeneous fleet, and time windows. To the best of our knowledge, these attributes have been considered at the same time only in four other papers, nevertheless, they each solved a different problem. In all of the aforementioned research, the authors solved the problem using heuristics or meta-heuristics.

The objective of this research is to present a novel matheuristic for a Multi Depot Heterogeneous Fleet Periodic Capacitated Vehicle Routing Problem with Time Windows (MDHFPCVRP-TW), and compare the performance of the proposed algorithm with a classical mathematical approach. The matheuristic aims to divide the problem into six independent routing problems (one for each day). This is done by assigning the clients certain patterns according to the solution of the linear relaxation. Knowing each client's pattern, each day becomes a routing problem with time windows, heterogeneous fleet, and multiple depots.

4 - SimCCS-H2: Model for Joint Optimization of H2-CO2 Networks

Juan C Duque, Carbon Solutions LLC, Okemos, MI, United States, Richard Middleton, Andrew Harrison, Qasim Mehdi, Erin Middleton, Jonathon Prehn, Christopher Upchurch, Sean Yaw, Ansh Nasta, Derek Wissmiller

Carbon dioxide (CO₂) capture or switching fuels to hydrogen (H₂) are two approaches for reducing CO₂ emissions from power and industrial facilities. Currently, no model exists to understand the balance between these two decarbonization approaches, including which technology to deploy where, when, and how, and to interdependently route CO₂ and H₂ pipelines. In this paper, we present the SimCCS-H₂ optimization model, a Mixed Integer Programming (MIP) model, to address this challenge. SimCCS-H₂, by establishing a specific decarbonization goal—such as reducing system-wide emissions in millions of tonnes of CO₂ each year (MtCO₂/yr.)—identifies the emission sources that can deploy CO₂ capture technology or transition to the use of H₂. In addition, it develops a detailed infrastructure plan, including pipeline networks for the efficient transport of captured CO₂ to storage sites, as well as H₂ from production facilities to consumption points. This includes evaluating the optimal circumstances to produce blue H₂ (cheaper hydrogen production from fossil fuels that requires CO₂ capture) or green H₂ (more expensive hydrogen production from renewable energy).

TB03

Bldg. 33 - 103

OR/MS Solutions for Humanitarian Challenges

Invited Session

ASOCIO – OR for Humanitarian Logistics

Chair: William Guerrero, Universidad de La Sabana, Cundinamarca, N/A, Colombia

Co-Chair: Elyn Solano Charris, Campus del Puente del Común, Km. 7, Autopista Norte de Bogotá. Chía, Cundinamarca, Colombia., 53753

1 - Road Damage and Food Inventory Management in a Disaster's Aftermath

William Guerrero, Universidad De La Sabana , Chia, Colombia, Nicolás Giedelmann Lasprilla, Lorena S. Reyes-Rubiano, Elyn Solano-Charris

Landslides generate a wide variety of impacts on the affected populations. In Colombia, recently we have observed that this type of disaster affects the road network of the country and some communities become isolated if the single existing road connecting the communities is damaged. Depending on the magnitude of the disaster and speed of the response capabilities of humanitarian organisms and governmental entities, the crisis may last several days or weeks. The work of repairing the road network becomes critical for humanitarian action. In this study, we present a system dynamics simulation model developed to analyze scenarios stemming from the 2023 landslide event in Rosas Municipality, Colombia. This model assesses the extended deterioration of roads due to excessive use of transport vehicles and its repercussions on transportation times and the stock levels of perishable foods. The results show the importance of limiting vehicle flow during repair and care work for the affected population to minimize food waste and reduce the average inventory level of foods such as meat and potatoes.

2 - Inventory in Times of War

Juan Camilo Serpa, McGill University, Montreal, QC, Canada, Andres Jola-Sanchez

Using data from 38,916 businesses in war-torn Colombia and from 5,138 attacks by the two rebel groups, FARC and ELN, we study how firms manage inventory during civil war. We obtain exogenous variation in the conflict intensity via a difference-in-differences model, which hinges on the peace process between Colombia's government and FARC. Relying on this identification strategy, we hypothesize and show that war causes two effects on firm-level inventories. First, it leads firms to replace physical assets (inventory) with fungible assets (cash), causing them to operate with an oversecured financial buffer, but a fragile operational buffer. Second, this inventory reduction occurs mostly in unprocessed inventories (finished-goods inventories are insensitive to violence), meaning that, although war-torn businesses are equipped to fulfill planned orders, they become inflexible at handling uncertain future demand. We then show that the magnitude of these effects is highly contingent on the firm's position in the supply chain, its proximity to distribution markets, and the type of attacks it is subject to. We then propose policies to address war-related risk in supply chains.

3 - Reconfiguring Fire Service Provision in Cheektowaga, New York

Sabrina Casucci, University at Buffalo-SUNY, Amherst, New York, United States, Robert Dell, Sai Reddi

We present a multiple objective integer linear program to balance efficiency and equity in volunteer fire service provision exemplified through a case study in Cheektowaga, New York, USA. The town of Cheektowaga consists of nearly 900 census blocks serving as demand locations that are currently served by 11 fire stations. When compared to existing fire district boundaries, our computational results reveal opportunities for significant improvements in emergency response times and coverage, particularly within critical travel time thresholds.

TB04

Bldg. 33 - 201

Optimization in Public Transportation and Logistics (Part I)

Invited Session

Combinatorial Optimization and Applications

Chair: Luis Torres, Escuela Politécnica Nacional, Quito, Ecuador

Co-Chair: Juan Jose Bront, University of Buenos Aires, Ciudad Autonoma de Bs Aires, Argentina

1 - An Extended Network approach for the EVRP with Steep Roads and Congestion

Fernanda Salazar, Escuela Politecnica Nacional, Quito, Ecuador, Emilio Garcia, Sandra Gutiérrez, Diego Recalde, Ramiro Torres, Luis M. Torres, Guillermo Aguilera, Sthevven Valenzuela

This work addresses a last-mile logistics problem in the Historic Centre of Quito, where electric cargo bikes must deliver commodities to a number of clients from a single depot, aiming to reduce emissions in the area. The underlying problem corresponds to an Electric Vehicle Routing Problem, where feasible routes are sought to meet the demand of a set of clients at the lowest cost while satisfying a set of battery-related restrictions, respecting vehicle capacity constraints and the available fleet. In this study, two additional criteria are included. First, steep roads as they affect battery consumption, and congestion since the velocity varies at specific times during a labor day. The solution approach considers two linear integer programming formulations based on a time-space network, discretizing both time horizon and load. There, each node is defined as a triplet of the form client-time-load whereas the arcs are feasible connections between such nodes and also to the depot. Moreover, travel times and battery consumption are modeled as non-linear functions on the arcs. Lower bounds as well as results for small instances are provided for both formulations. Finally, an adaptive large neighborhood search (ALNS) metaheuristic method is proposed to solve large-size problems, and preliminary computational results are reported.

2 - Integer Linear Formulation and a Heuristic Algorithm for the Rural Postman Problem with Load-dependent Costs

Xavier Cabezas, ESPOL (Escuela Superior Politécnica del Litoral), Guayaquil, GA, Ecuador

Currently, Arc Routing Problems (ARPs) represent a well-established field of hard-to-solve combinatorial optimization problems with many applications. Among the variations of ARPs lies The Chinese Postman Problem with Load Dependent Cost (CPP-LC), where the costs associated with traversing an edge within an undirected graph is contingent upon both its length and the vehicle's weight at the time of passage. In this study, we introduce the Rural Postman Problem with Load-Dependent Costs (RPP-LC), a scenario featuring load-dependent costs limited to a specific subset of edges. We address this issue through an integer linear formulation and approach it using a heuristic algorithm inspired by genetic algorithms. We evaluate the formulation's utility and the effectiveness of our algorithmic approach through a series of computational experiments conducted on well-known benchmark instances related to similar problems. The results of these experiments are also discussed.

3 - On the Electric Vehicle Scheduling Problem: Addressing the Capacity of Charging Stations

Gabriel Salvador, Escuela Politécnica Nacional, Quito, Ecuador

One important phase in public transportation planning is the vehicle scheduling problem, which consists in finding an optimal assignment of the available vehicles in the fleet to cover a specific set of given service trips. The growing adoption of electric buses poses new challenges for public transportation companies: their autonomy is much more limited, when compared to diesel vehicles, and the battery recharging times are usually longer. Motivated by this fact, electric vehicle scheduling problems that consider these new constraints have been the focus of a wide range of recent studies. In this talk, we explore models that consider the capacity of the charging stations when planning the vehicle routes, in order to avoid potential undesirable effects such as long waiting times and queueing at the charging stations that may arise from the combination of large charging times and limited vehicle autonomy. We propose two integer programming formulations for this problem: an arc-based model and a route-based model. The latter is solved using a column generation approach in which the pricing problem is a weight-constrained shortest path problem with replenishment. Computational results obtained by both algorithms on several test instances are reported.

TB05

Bldg. 33 - 203

Applications of Multimodal Data Fusion

Invited Session

Quality, Statistics, and Reliability

Chair: Nathan Gaw, Air Force Institute of Technology

Co-Chair: Ana Estrada-Gomez, Purdue University, 315 N. Grant Street West Lafayette, West Lafayette, IN, 47907, United States

1 - Directed Graphical Models for Root Cause Analysis in Multimodal Systems Collecting Heterogeneous Data

Ana Estrada Gomez, Purdue University, West Lafayette, IN, United States, Manni Zhang

Complex sensing systems collect heterogeneous data, including scalars, functional signals, images, and point clouds. We use direct graphical models to represent the relationships between the variables and learn the system's structure for 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 additive interactions between the variables. When the structure is known, we learn the parameters of tensor regressions; when it is unknown, we minimize the sum of least squares, group lasso, and L_2 penalties using a cyclic coordinate accelerated proximal gradient descent algorithm. The performance of our method is showcased with simulations and a case study.

2 - Improving Quality Control Testing Using Deep Learning Techniques

Juan Jaramillo, Long Island University, Mineola, NY, United States

This work describes two methodologies to reduce testing times, to improve precision, and to facilitate results archival for a quality test used in the sanitary-ware industry by a well-known corporation. In the ASME A112.19.2-2018/CSA B45.1-18 quality test, 2,500 granules are added to a toilet and flushed. To pass the test, 125 or less granules should remain in the toilet. Counting granules has been done manually, which is time consuming and is prone to error. Therefore, we developed two methodologies to automate the process using computer vision. More precisely, both techniques count the number of granules that remains in the toilet in real time. The first one is based on convolutional neural networks (U-Net) integrated with a variation of Connected Components Algorithm. The second one is Vision-Transformers based. Both algorithms have been trained with a proprietary data set of 35,180 images ranging from 0 to 180 granules. The U-Net methodology showed an accuracy of 94.3% in general and 98% for images with 125 granules or less. Meanwhile, the Vision-Transformer achieves an accuracy of 97% in general and 99% for images with 125 granules or less. The accuracy of both methods achieves values closer to 100% when piloted in the assembly line. That is because each test generates about 400 images and the average result from all images is used. At the end, personnel in charge decided to implement the U-Net methodology in the production line due to its lower computational requirements.

3 - Assessing the Calibration and Performance of Attention-based Spatiotemporal Neural Networks for Lightning Prediction

Nathan Gaw, Air Force Institute of Technology, Wright-Patterson AFB, OH, United States, Brian Popick, Chancellor Johnstone, Kyle Fitch, Bruce Cox

Lightning is a chaotic atmospheric phenomenon that is incredibly challenging to forecast accurately and poses a significant threat to life and property. Complex numerical weather prediction models are often used to predict lightning occurrences but fail to provide adequate short-term forecasts, or nowcasts, due to their design and computational cost. In the past decade, researchers have demonstrated that spatiotemporal deep learning models can produce accurate lightning nowcasts using remotely sensed meteorological data, such as radar, satellite, and previous lightning occurrence imagery. However, these

models are generally designed to predict lightning occurrence an hour or more in advance, leaving a forecasting gap in the sub-hour timeframe. This research develops novel sequence-to-sequence attention-based and non-attention-based spatiotemporal deep learning neural networks that ingest multi-modal, remotely sensed weather data to produce a time series of lightning nowcasts in the sub-hour interval. Furthermore, model error is uniquely incorporated into the model developmental process, resulting in more reliable predictions. Comparing the performance of these models to models seen in previous literature shows that the novel models perform comparably to, if not better than, prior lightning nowcast models. Additionally, the results show that adding attention mechanisms benefits specific model architectures more than others.

TB06

Bldg. 33 - 204

Dynamical Systems for AI

Invited Session

OR Methods and Analyses in AI

Chair: Katherine Maldonado, N/A

1 - Game Theory Analysis of a Quality Contract between Supplier and Buyer

Fidel Torres, Universidad de los Andes, Bogota, Colombia

Between a supplier manufacturing a product or service and a buyer or user purchasing the product or receiving the service, a contract is established whereby the supplier decides to offer different levels of quality, while the buyer rewards or penalizes the quality of the product or service. The agents may also eventually decide to share the costs of quality inspections and penalties for poor quality, thus setting up a non-collaborative game in which each agent can receive gains or penalties based on the decisions they make. This project aims to construct a model inspired by game theory to serve as a reference for studying in detail the strategies that can be established between the supplier and the buyer in a contract that includes quality requirements of the product or service, in addition to the traditional elements of such contracts. Dynamic equilibrium analysis will characterize the strategies adopted by agents in supply chain systems, with implications for the quality of products and services offered to customers and their impact on agent profits. An additional Pareto optimal model allows maximizing the joint gains of the agents in the quality-focused contract for the collaborative game. The dynamic behavior of agents in the non-collaborative game will be simulated using the continuous approach of replicator dynamics through a system of ordinary differential equations. Additionally, adapting this technique to a geographical network of suppliers and buyers with finite populations will allow for a comparison of dynamic performance between continuous and discrete approaches.

2 - Can Large Language Models Replace Survey Respondents?

Stephen Hill, Samford University, Birmingham, AL, United States

In this work we consider the ability of Large Language Models (LLMs) such as ChatGPT to serve as generators of survey responses. We test a variety of survey question types and prompting strategies and compare LLM-generated responses to human responses. Insights for future applications are described.

3 - Dynamic Effects of Store Promotions on Conversion Fraction: Expanding Technology Applications with Innovative Analytics

Ignacio Inostroza, Universidad de Los Andes, Santiago, Chile, Leonardo Epstein

In retail settings, conversion fractions (CFs) matter to managers because they measure stores' efficacy to convert visitors into buyers. Despite CFs importance, available methods to evaluate a given marketing action's (MA) effects on CF are scarce and limited. We present a method that (1) builds a model for conversion probabilities with observed data outside the MA period, (2) uses this model to predict a counterfactual baseline for CFs during the MA period as if the MA had not occurred, and (3) evaluates the MA effects on CFs by comparing this baseline to the observed CFs during the MA period. An illustrative example uses a two-day promotion in an actual store, with an analysis that combines data from video images and cash registers.

4 - Automatic Classification of Academic Articles via Machine Learning

Natalia Pacheco-Carvajal, Universidad de los Andes, Bogotá, Colombia, Katherinne Quiroga-Duran, Daniel Yamín, Alfaima L. Solano-Blanco

The rapid increase in academic article production has urged the development of models for classifying these documents automatically. In this case study, we compared seven supervised learning models for classifying academic articles of a research group into eight predetermined categories based on their titles. We consolidated a training set of 23,000 academic articles scrapped from bibliographic databases. To facilitate the processing of the titles we employed two data vector representations: Bag-of-Words (BoW) and Term frequency – Inverse document frequency (TF-IDF). Our experiments reveal

that a “one vs. rest” logistic regression with a BoW vector representation yields the highest accuracy, outperforming more complex models like random forest and support vector machines. To improve the performance of the model and reduce the impact of dependency among categories, we calibrated a threshold to allow the classification of an academic article into up to two categories. With this threshold, the logistic regression model has an accuracy of 68.65%. We embedded this model into a workflow to update and organize of the latest academic publications on the website of the research group.

5 - Critical Success Factors for Business Intelligence Implementation in Public Universities: An in-depth Case Study

Katherine Maldonado, Universidad Nacional de Colombia, Bogotá, Colombia, Claudia Alexandra Garzon-Santos

Governments and their institutions have adopted technologies and information systems (IS) to improve their performance. The Covid-19 pandemic highlighted the need to accelerate this adoption for governments to make quicker decisions and respond more effectively. The education sector, specifically public universities, was greatly affected and must prioritize digital transformation to respond efficiently and to improve their daily use of data and information for decision making.

Therefore, the goal of this research is to identify the factors regarding BI implementation in public universities. This study includes a systematic literature review that identifies critical success factors associated with the implementation of BI systems -categorized by technology, people, and processes-, from an in-depth case study in Bogotá, Colombia, qualitative data is collected from semi-structure interviews and analyzed with the software NVivo. The expected outcomes are to compare the findings of the literature review with insights gathered from these organizations. Allowing the identification of particularities within the public sector -needs, strengths, weaknesses- that contributes to build an implementation proposal that collects these findings.

This research is not only beneficial for public universities in Bogotá, Colombia in their BI strategies and practices but also contributes to the academic literature on BI implementation in the public sector. This research presents an opportunity for researchers and practitioners to develop business intelligence capabilities in public universities, enhancing the ability to make informed decisions based on data, ultimately leading to more efficient and effective operations.

TB07

Bldg. 33 - 301

Kannan Ramanathan - How to use Visual Basic for Applications (VBA) in Excel – For Beginners

Invited Session

Tutorial

Chair: Andres Medaglia, Universidad de los Andes, Bogota, Cundinamarca, Colombia

1 - How to use Visual Basic for Applications (VBA) in Excel – For Beginners

Kannan Ramanathan, University of Texas-Dallas, Richardson, TX, United States

This is not a lecture – it is a workshop.

VBA (Visual Basic for Applications) can be used with several Microsoft applications. It is recommended that you participate in this workshop with your laptop as we will do some hands-on exercises. There have been some discussion that AI tools will make VBA obsolete. However, VBA is going to be around for some more time. We will discuss how we can leverage the power of AI to make it easier to work with VBA.

This workshop:

- Is meant for beginners and will cover basics in VBA
- Will focus primarily on how to use VBA in MS Excel
- Will touch on its usage in MS Word and MS Powerpoint

TB08

Bldg. 33 - 302

Freight Deliveries and Vehicle Routing

Invited Session

Transportation and Mobility

Co-Chair: Julio Goez, NHH Norwegian School of Economics, Bergen, Norway

1 - Performance Prediction of Drivers in Full Truck Load Transport

Neslihan Cevik, Eindhoven University of Technology, Eindhoven, Netherlands

Sustainability and cost minimization stand as the primary objectives for logistics service providers worldwide. A crucial aspect of achieving these goals lies in optimizing truck driver performance and allocating them to routes that are both cost-effective and sustainable. This not only enhances operational efficiency but also contributes to driver satisfaction—a particularly pertinent issue amidst the growing driver shortage, notably in Europe. This study draws upon data from a logistics service provider to forecast driver performance when assigned specific routes, considering factors such as total distance, number of stops, vehicle configuration, and stops within the route. Driver experience, planning abilities, and driving style, measured data provided by the logistics company, serve as indicators for driver performance, gauged in terms of fuel consumption and CO₂ emissions. The research employs a combination of cluster analysis, utilizing the mentioned features, and regression analysis. The regression models yield promising results, with successful Root Mean Squared Error (RMSE) and R-squared values, indicating the efficacy of the predictive models

2 - Air Quality Impacts of Freight Deliveries Emissions in U.S. Urban Areas

Diana Ramirez-Rios, University at Buffalo, Buffalo, NY, United States, Lily MacIver, Angelo Soto-Vergel

This research focuses on the freight vehicles' emissions caused by daily deliveries estimated by the freight trip generation (FTG) activity in US urban areas. We used business establishment data (employment and industry sector) of the city to estimate daily FTG and its air quality impacts on the city's residents by estimating freight-related air pollutants. Using FTG state-of-the-art models, we estimate daily freight trips and develop a stratified sampling approach to estimate freight tour distances by ZIP code and industry sector. In addition, we compute the freight-related air pollutants (TOG, ROG, CO, CO₂, NO_x, PM_{2.5}, and PM₁₀) from the route distances and expected daily FTG. We implemented the shortest-path algorithm to calculate route distances from sampled locations. We implemented this methodology for Oakland, California, a U.S. city that is characterized by having a port and airport that moves heavy freight at the daily basis. The businesses in the study area belong to the industry sectors with freight as their primary activity, and that would potentially be leaving or arriving at the Port of Oakland. The results indicate the magnitude of the emissions generated from daily freight trips by location, land use, and industry sector. These findings translate into novel data-driven permitting and land use management strategies that could potentially reduce air pollution exposure from freight activity for residents adjacent to industrial and commercial areas in Oakland.

3 - Two-Echelon Prize-Collecting Vehicle Routing with Time Windows and Vehicle Synchronization: A Branch-and-Price Approach

Edhem Sakarya, Eindhoven University of Technology, Eindhoven, Netherlands, Milad Elyasi, Sonja Rohmer, Okan Ozener, Ali Ekici

The steady growth in e-commerce and grocery deliveries within cities strains the available infrastructure in urban areas by increasing freight movements, aggravating traffic congestion, and air and noise pollution. This research introduces the *Two-Echelon Prize-Collecting Vehicle Routing Problem with Time Windows and Vehicle Synchronization*, where deliveries are carried out by smaller low- or zero-emission vehicles and larger trucks. Given their capacity restrictions, the smaller vehicles can only deliver small-sized orders and must be replenished via depot locations or larger-sized trucks. Besides replenishing smaller vehicles at satellite locations, larger trucks can deliver small orders and larger items. Managing these two types of fleets in an urban setting under consideration of capacity limitations, tight delivery time windows, vehicle synchronization, and selective order fulfillment is challenging. We model this problem on a time-expanded network and apply network reduction by considering the time window constraints. In addition, we propose a branch-and-price algorithm capable of solving instances with up to 200 customers and continuously outperforms a state-of-the-art general-purpose optimization solver. Moreover, we present several managerial insights concerning synchronization, vehicles, and the placement of depot/satellite locations.

4 - 2-phase Algorithm using Clustering and Tabu Search for Solving the Multi-Trip Vehicle Routing Problem (MTVRP)

Gustavo Gatica, Universidad Andres Bello, Santiago de Chile, Chile, Víctor Salazar, Rodrigo Linfati, Daniel Morillo-Torres, Jairo Coronado-Hernandez

Vehicle routing and its generalizations propose a classic optimization problem. This paper presents a two-phase method to address the complexities of the Multi-Trip Vehicle Routing Problem (MTVRP). Initially, nodes are clustered to streamline routing, followed by tabu search applied to each sub-route to

obtain an initial solution. A 2-OPT algorithm further enhances routing efficiency by exploring edge exchanges. Results are rigorously evaluated, comparing them with mathematical modeling using AMPL and Cplex[1] engine for a 6-hour simulation, demonstrating computational efficiency and practical applicability.

Node clustering organizes routing effectively, with tabu search and the 2-OPT algorithm refining solutions iteratively. The methodology achieves an approximation to the solution within a limited time. Results demonstrate the method's effectiveness in addressing MTVRP, surpassing traditional mathematical modeling approaches. This two-phase framework offers a versatile solution for optimizing vehicle routes with multiple trips, contributing to transportation logistics optimization.

Experimentally, results show a percentage margin of error (GAP) ranging from 2.66% to 19.73%, varying with instances, nodes, and vehicles involved. Additionally, there is a significant reduction in computation time, from no solutions in 6 hours using AMPL to approximate solutions found within 0.35 to 3.66 seconds, respectively.

TB09

Bldg. 33 - 303

Automated Algorithm Design in Combinatorial Optimization

Invited Session

Combinatorial Optimization and Applications

Chair: Victor Parada, Universidad de Santiago

Co-Chair: Carlos Rey, Universidad del Bio-Bio

Co-Chair: Carlos Contreras-Bloton, .

1 - Improving Automatic Algorithm Generation with Genetic Programming through Machine Learning

Carlos Rey, Departamento de Ingeniería Industrial, Universidad del Bío-Bío, Concepción, Chile

Automatic Generation of Algorithms represents an innovative paradigm in artificial intelligence aimed at the autonomous creation of algorithms. This approach promises to radically transform conventional problem-solving methods, facilitating the automatic generation of algorithmic solutions through the intelligent integration of components. Within this context, Genetic Programming emerges as a promising metaheuristic technique, although its effectiveness critically depends on the appropriate setting of evolutionary parameters and detailed analysis of individual behavior. This study introduces a novel methodology incorporating Machine Learning models based on supervised learning to optimize the evolutionary process in the Automatic Generation of Algorithms. Our findings indicate that incorporating pre-trained models significantly improves the efficiency of evolutionary processes and offers a robust and versatile framework applicable to optimization problems. The findings significantly highlight the capability to synergize artificial intelligence techniques, thereby driving the evolution towards more sophisticated automation in algorithm design aimed at solving optimization problems.

2 - An Automatically Generated Metaheuristic for the Traveling Salesman Problem with Time-dependent Service Times

Carlos Contreras-Bolton, Universidad de Concepción, Concepción, Chile

The traveling salesman problem with time-dependent service times (TSPST) is a variant of the classical asymmetric traveling salesman problem. In TSPST, the service time at each customer varies according to a linear or quadratic function relative to the start time of service. The objective of TSPST is to determine an optimal tour that visits each customer exactly once, minimizing the total tour duration comprising travel and service times. However, due to its NP-hard nature, existing algorithms struggle to tackle larger TSPST instances efficiently. This paper presents an automatically generated metaheuristic for the TSPST. The artificial metaheuristic is generated by the automatic generation of algorithms, a technique that allows the construction of artificial metaheuristics, taking advantage of components of existing algorithms. Thus, the automatic generation of algorithms combines basic heuristics for the problem and metaheuristic components. With these components, the space of possible algorithms is traversed by employing genetic programming. We generate algorithms of small sizes to explore their structures and uncover innovative combinations. Then, we select the metaheuristic that finds solutions with the best computational performance among all the generated algorithms. Comparative analysis against state-of-the-art algorithms shows the promising performance of our approach in tackling the TSPST.

3 - A Master Optimization Problem to Generate Algorithms Automatically

Victor Parada, Universidad de Santiago de Chile, Santiago, Chile

The field of optimization offers various mathematical formulations to represent real-world problems; however, selecting the most efficient algorithm to solve them can be challenging, especially for complex NP-hard problems. To face this challenge, we propose an optimization problem itself, known as the Master Problem. The Master Problem involves simultaneously exploring the spaces of algorithms, parameter settings, and problem instances to identify the optimal combination that yields the best algorithm for a given set of problem instances or for a particular problem instance. Three key spaces are involved: the space of instances, characterized by structural complexities that influence algorithm performance; the space of algorithms, encompassing exact methods, heuristics, and metaheuristics; and the space of parameters, where tuning is crucial for enhancing algorithm efficiency. The Master Problem formulation aims to minimize an objective function by quantifying the error or maximizing performance across the three spaces. Various techniques can be utilized to explore the expansive algorithmic space, including metaheuristic methods, evolutionary algorithms, or exact methods. The No-Free-Lunch theorem underscores the necessity of a tailored approach, as no single algorithm can outperform all others across all instances. Addressing the Master Problem requires a deep understanding of the problem's feasible region, the algorithm space, and the interplay between algorithm parameters and instance characteristics. The objective function must dynamically adapt to the nuances of each instance, enabling the identification of the most appropriate algorithm and parameter settings for solving complex optimization problems effectively. Some examples illustrate this approach.

Tuesday, June 18, 3:30 PM - 4:30 PM

Tuesday Keynote

Bldg. 33 - 101

Saif Benjaafar - Operations in the Age of the Sharing Economy: What is Old and What is New?

Invited Session

Keynote

Chair: Fernando Ordonez, Universidad de Chile, Santiago, Chile

1 - Operations in the Age of the Sharing Economy: What is Old and What is New?

Saif Benjaafar, University of Michigan, Ann Arbor, MI, United States

The sharing economy – a term we use to refer to business models built around on-demand access to products and services mediated by online platforms that match many small suppliers or service providers to many small buyers – has emerged as an important area of study in operations. We first describe three “canonical” applications that have garnered much attention from the operations community: (1) peer-to-peer resource sharing, (2) on-demand service platforms, and (3) on-demand rental networks. We use these applications to highlight distinguishing features of sharing economy business models and to point out research questions that are new. For each application, we describe our attempt at addressing some of these questions. We conclude by drawing connections between classical operations theory/models and theory/models that have been used to study sharing economy applications.

Tuesday Keynote

Bldg. 38 - Auditorium 110

Jan Fransoo - Retail Operations in Emerging Markets: Digital Transformation of the Traditional Retail Channel

Invited Session

Keynote

Chair: Michel Gendreau, Polytechnique Montreal, C.P. 6079, succ. Centre-ville, Montreal, QC, H3C 3A7, Canada

1 - Retail Operations in Emerging Markets: Digital Transformation of the Traditional Retail Channel

Jan Fransoo, Tilburg University, Tilburg, Netherlands

Across emerging markets, 50 million nanostores – of which 5 million in Latin America – serve about 4 billion consumers with their daily groceries. Collectively, they are the largest client of many multinational manufacturers of consumer-packaged goods. These mom-and-pop operated stores are undergoing a multi-faceted digital transformation, that has the power to improve the livelihoods of millions of shopkeepers and to increase the access to affordable food for billions of consumers.

In his talk, Professor Fransoo will present recent research findings of empirical and model-based work that help understanding the operational dynamics and strategic performance of the channel, and outline further research opportunities for both empirical and model-based researchers across Latin America.

Tuesday Keynote

Bldg. 38 - Auditorium 101

Benoit Montreuil - Hyperconnecting Supply Chain and Logistics Ecosystems to Enable and Leverage the Physical Internet

Invited Session

Keynote

Chair: Grace Lin, UFI.AI, Chappaqua, NY, United States

1 - Hyperconnecting Supply Chain and Logistics Ecosystems to Enable and Leverage the Physical Internet

Benoit Montreuil, Georgia Tech, Atlanta, GA, United States

The emerging Physical Internet enables reframing supply chain and logistic ecosystems to address concurrent global challenges toward higher efficiency, equitability, resilience, responsiveness, scalability, security, and sustainability in a world that is evolving fast in terms of technological capabilities and is becoming ever more complex, prone to disruptions, volatile, and uncertain.

Enabling and leveraging the Physical Internet requires transformative decisions and actions about hyperconnecting supply, manufacturing, logistics, and transportation networks and operations to ease open resource sharing and flow consolidation at grand scope and scale. Building on collaborations with academic, business, and public partners, we present novel streams of Physical Internet research opening ways for this community to have major academic, economic, environmental, and societal impact.

Tuesday Keynote

Founders Auditorium

Yuehwen Yih - Beyond Topics: Engineering Change

Invited Session

Keynote

Chair: Kathryn Stecke, University of Texas at Dallas, Richardson, TX, United States

1 - Beyond Topics: Engineering Change

Yuehwen Yih, Purdue University, West Lafayette, IN, United States

How can we, as academic researchers, contribute to policies, practices, or support communities in need? Join us as we discuss how we could expand our current research practices and knowledge to shorten the pathway of research to impact, and share a personal journey in translational research, and the lessons learned. In this talk, we will reveal the ERT (Embedded Research Translation) framework to narrow the gap between research and real-world applications, synthesizing insights from 50 research projects across 21 countries, funded by the US Agency for International Development. The ERT framework was designed to source academic research to support evidence-based policymaking, practices, and funding priorities in advancing United Nations Sustainable Development Goals, such as no poverty, zero hunger, and good health.

Tuesday, June 18, 4:45 PM - 6:15 PM

TC01

Bldg. 33 - 101

Optimization, Learning, and Decision Making: III

Invited Session

Optimization, Learning, and Decision Making

Chair: Mateo Diaz, Johns Hopkins University, Baltimore, MD, United States

1 - Robust support vector machines via conic optimization**Andres Gomez, University of Southern California, Los Angeles, CA, United States, Valentina Cepeda, Shaoning Han**

We consider the problem of learning support vector machines robust to uncertainty. It has been established in the literature that typical loss functions, including the hinge loss, are sensible to data perturbations and outliers, thus performing poorly in the setting considered. In contrast, using the 0-1 loss or a suitable non-convex approximation results in robust estimators, at the expense of large computational costs. In this paper we use mixed-integer optimization techniques to derive a new loss function that better approximates the 0-1 loss compared with existing alternatives, while preserving the convexity of the learning problem. In our computational results, we show that the proposed estimator is competitive with the standard SVMs with the hinge loss in outlier-free regimes and better in the presence of outliers.

2 - What's In a Prior? Learned Proximal Networks for Inverse Problems**Jeremias Sulam, Johns Hopkins University, Baltimore, MD, United States**

Proximal operators are ubiquitous in inverse problems, commonly appearing as part of algorithmic strategies to regularize problems that are otherwise ill-posed. Modern deep learning models have been brought to bear for these tasks too, as in the framework of plug-and-play or deep unrolling, where they loosely resemble proximal operators. Yet, something essential is lost in employing these purely data-driven approaches: there is no guarantee that a general deep network represents the proximal operator of any function, nor is there any characterization of the function for which the network might provide some approximate proximal. In this talk we'll present a framework to develop learned proximal networks (LPN), which provide exact proximal operators for a data-driven nonconvex regularizer, and show how a new training strategy, dubbed proximal matching, provably promotes the recovery of the log-prior of the true data distribution.

3 - Controlling the False Discovery Rate in Subspace Selection**Mateo Diaz, Johns Hopkins University, Baltimore, MD, United States, Venkat Chandrasekaran**

Controlling the false discovery rate (FDR) is a popular approach to multiple testing, variable selection, and related problems of simultaneous inference. In many contemporary applications, models are not specified by discrete variables, which necessitates a broadening of the scope of the FDR control paradigm. Motivated by the ubiquity of low-rank models for high-dimensional matrices, we present methods for subspace selection in principal components analysis that provide control on a geometric analog of FDR that is adapted to subspaces. Our method crucially relies on recently-developed tools from random matrix theory, in particular on a characterization of the gaps between successive eigenvalues of large random matrices. Our procedure is parameter-free, and we show that it provides FDR control in subspace selection for common noise models considered in the literature. We demonstrate the utility of our algorithm with numerical experiments on synthetic data and on problems arising in single-cell RNA sequencing and hyperspectral imaging.

TC02

Bldg. 33 - 102

Understanding Supply Chains in Colombia

Invited Session

Supply Chain and Logistics Management

Chair: Diana Ramirez-Rios, University at Buffalo, 342 Bell Hall, Buffalo, NY, 14260-2000, United States

1 - From Farm to City: Tracing the Route of Dairy Products in Southern Colombia**Sofia Osorio, Universidad Icesi, Cali, Colombia, Julian Vidal, Nadia Rosero**

Colombia, ranking fourth in milk production among the 19 countries of Latin America and the Caribbean, faces unique challenges in the distribution of dairy products. In Nariño, a department in the southern region of the country, small-scale milk producers encounter obstacles, primarily stemming from the lack of coordination between producers and consumers. The city of Cali, the third-largest city in Colombia, serves as a pivotal destination for dairy products from Nariño. Local neighborhood bakeries play a significant role in the market, particularly for cheese curds and other dairy items. This project aims to establish an optimized distribution route for dairy products, connecting the southern Colombian region to the District

17 of Cali. The goal is twofold: to create a viable market for small-scale producers and enhance marketing strategies within local bakeries.

The methodology of the work includes: i) Localization of an optimal distribution point; ii) Customer identification and characterization within the District 17 of Cali; and iii) Route optimization, based on geographical factors and logistical considerations

As results the distribution point ensures efficient access to both producers and consumers; customers were profiled, considering their preferences, demands, and purchasing patterns and finally the optimal route minimizes transit time, and maximizes product freshness. This distribution model is adaptable to other districts within the city, aiming to enhance efficiency in marketing dairy products. By bridging the gap between producers and consumers, this work contributes to a sustainable and thriving dairy industry in Southern Colombia.

2 - Towards Tomorrow: How to Adopt the Digital Transformation of the Supply Chain in Colombian Companies

Santiago Ochoa, Universidad Icesi, Cali, Colombia, Helena Cancelado, Santiago Veloza

The emergence of Digital Supply Chain (DSC) integration represents a significant paradigm shift for companies globally, including those in Colombia. To explore the integration of DSC in Colombian business models, an exploratory qualitative study was carried out. This study involved a review of literature and success stories in high economy countries to identify best practices in DSC, which were then compared to the existing state of supply chains in Colombia, a medium economy country. In addition, semi-structured interviews were conducted with experts in the field, selected through convenience sampling, to understand the current panorama of DSC in Colombia.

The findings of this research led to the development of a validated path that Colombian companies can follow to integrate DSC into their operations. This route describes crucial aspects of DSC and aims to close the digitalization gap in medium-economy countries like Colombia. It suggests a progression through different levels of operational maturity, considering core values and the established Plan-Do-Check-Act (PDCA) cycle.

Ultimately, Colombian companies are recommended to begin laying the foundation laid out in the proposed route, gradually advancing through each level of operational maturity to achieve DSC integration. By doing so, they can improve their competitiveness and adapt to the changing landscape of the global supply chain industry.

3 - Understanding the Dynamics of Cocaine Production: Insights from System Dynamics Modeling

Sara García, Universidad de Antioquia, Medellín, Colombia, Valeria González, Laura Cárdenas

The fight against cocaine consumption is one of the main concerns of several governments because of its serious implications for society. Colombia is the largest coca leaf producer in the world, a primary ingredient for cocaine production. However, this illegal activity is influenced by complex social, cultural, and economic dynamics that hinder its approach. Despite the Colombian government's efforts to reduce cocaine production, its indicators have increased in recent years. This highlights the inherent complexity of the problem and emphasizes the need to understand the system. Therefore, this research focuses on characterizing these dynamics and modeling the cocaine production chain, from coca leaf cultivation to the production of the final product, cocaine hydrochloride. A system dynamics simulation model was used to understand the nature of the problem and how various variables interact to determine its behavior. The model results reveal that cocaine production is influenced by socioeconomic, institutional, and security factors. Additionally, it explains the failure of the eradication strategy using glyphosate and highlights how this policy displaces the problem and generates adverse effects that worsen the situation. This analysis suggests the need for a shift from fragmented and reactive policies to more comprehensive approaches aimed at containing the spread of illicit coca crops and the cocaine industry.

4 - Scientometric Analysis: Navigating the Future of Coffee Supply Chain in the Digital and Industry 5.0 Era

Diego Marin, Universidad de Caldas - Universidad Nacional Abierta y a Distancia UNAD, Manizales, Colombia, ALEXANDRA DUARTE, Juan Uribe

Currently, humanity faces the challenge of constant food supply, and the optimal design of chains plays an important role from raw materials to the production and agro-industrialization of valuable products. In the case of coffee, which has a short useful life, mathematically modeling the elements of "CSCM" is inevitable for product quality assurance, as it includes prospective challenges, including increased costs, complexities, risk management, volatility. of the market and post-pandemic uncertainties, they contributed to an awakening of disruptive thinking that leads towards a sustainable "CSCM", with maximum socioeconomic and environmental impact. To this end, the literature review examined the changing global geopolitical environment and the coffee-growing institutions, trust, balance, and resilience, in pursuit of the well-being of the rural family by giving new meaning to the coffee-growing woman; greater coverage in associations and promote successful cooperative experiences.

However, it is necessary to succinctly observe the behavior of socioeconomic, environmental, technological and governance variables, within the framework of digital transformation and industry 5.0. In this paper, a scientometric analysis is carried out, obtaining 490 documentary sources organized in Mendeley Software, 210 were subject to exhaustive review, for contributing significantly to “CSCM”. When analyzing the current situation in this field of study, the trends of studies in planning or evaluation of uncertain scenarios are evident, and the development of technological platforms to support strategic, tactical, and operational decision making, a task still to be accomplished from big data, blockchain and machine learning.

TC03

Bldg. 33 - 103

Decarbonizing Transportation through Electrification and Fleet Management

Invited Session

Sustainability in OM

Chair: Omer Verbas, Argonne National Laboratory, Lemont, IL, United States

1 - Stochastic Modeling and Dynamic Pricing for Efficient EV Fast-Charging Networks

R. Jayakrishnan, University of California-Irvine, Irvine, CA, United States, Navjyoth Jayashankar, Dingtong Yang, Michael Hyland

This study develops a stochastic dynamic simulation modeling framework of a regional system of EV fast-charging stations for real-time management and strategic planning purposes. A multinomial logit station choice model is used for EV user behavior and a multi-server queueing model is used demand-supply dynamics at each EV fast-charging station in the simulation. The study assumes that multiple fast-charging stations in a region are managed by a single entity and that the demand for these stations are interrelated. Results from application in Southern California, USA, indicate that our dynamic demand-responsive price adjustment (DDRPA) schemes based on station queue lengths are an effective mechanism to balance charging demand across fast-charging stations. The framework can evaluate the allocation of charging station capacity, and help identify areas needing additional stations.

2 - Electric Bus Scheduling and Infrastructure Location for a Multi-technology Electric Transportation System

Yasmin Rios-Solis, Tecnologico de Monterrey, Monterrey, Mexico

3 - Charger Location and Scheduling Optimization for Battery Electric Buses

Omer Verbas, Argonne National Laboratory, Lemont, IL, United States

In the effort to create more sustainable urban transportation, replacing fossil-fueled buses with battery electric buses (BEBs) marks a significant advancement. Yet, this transition brings about a crucial obstacle which is the electric bus scheduling and charger location (EBSCCL) problem. Because BEBs have limited driving range, there's a need to strategically plan bus assignments for service trips, a challenge referred to as the electric vehicle scheduling problem. Additionally, determining the best locations for charging infrastructure further complicates the overall process of transit electrification. Our study tackles this challenge by proposing an integrated model that optimizes both BEB scheduling and charger placement.

TC04

Bldg. 33 - 201

Optimization in Public Transportation and Logistics (Part II)

Invited Session

Combinatorial Optimization and Applications

Chair: Juan Jose Miranda Bront, Universidad Torcuato Di Tella / CONICET, Ciudad Autonoma de Buenos Aires, Argentina

Co-Chair: Luis M. Torres, N/A

1 - Integrating Public Transport in Sustainable Last-mile Delivery: Column Generation Approaches

Diego Delle Donne, ESSEC Business School, Cergy, France, Alberto Santini, Claudia Archetti

We tackle the problem of coordinating a three-echelon last-mile delivery system. In the first echelon, trucks transport parcels from distribution centres outside the city to public transport stops. In the second echelon, the parcels move on public transport and reach the city centre. In the third echelon, zero-emission vehicles pick up the parcels at public transport stops and deliver them to customers. We introduce two extended formulations for this problem. The first has two exponential sets

of variables, while the second has one. We propose column generation algorithms and compare several methods to solve the pricing problems on specially constructed graphs. We also devise dual bounds, which we can compute even when the graphs are so large that not a single round of pricing completes within the time limit. Compared to previous formulations, our models find 17 new best known solutions out of an existing dataset of 24 from the literature.

2 - Wave Order Picking Optimization at Mercado Libre

Juan Sebastian Piñeros Garcia, Mercado Libre, Regional, Colombia, Mauricio Zambon, Welverton Silva, Bernardo Moreira, Nadia Martarelli, Daniel Negrotto

At the heart of the outbound operation of any fulfillment center in Mercado Libre, there is the waving process, which is the step of selecting the next purchased orders to be picked and packaged. The selection criteria for this crucial step can be influenced by various, often conflicting, objectives such as maximizing picking productivity or ensuring compliance with Service Level Agreements (SLAs). In this study, we introduce an initial approach to automate the waving process. We employ a proxy metric designed to select orders that synergistically maximize the average number of units picked per aisle in the storage area, thereby improving the likelihood of creating more efficient picking routes. Observance of SLAs is another vital criterion. Therefore, the selected orders must adhere to a custom First-Expired-First-Out (FEFO) strategy, which essentially allows for adjustments to only those orders with the most distant deadlines. To address this challenge, we propose a novel integer programming model and share some preliminary results derived from real-world data.

3 - Electric Vehicle Routing with Steep Roads and Multiple Routes

Emilio Garcia, Escuela Politécnica Nacional, Quito, Ecuador, Luis M. Torres, Juan Jose Miranda Bront

The Quito local government aims to establish a low-emission zone in the city's historic center. A key focus is the shift to eco-friendly transportation for last-mile logistics, including electric cargo bikes and other types of light electric vehicles (LEVs). Our research delves into integer programming models to optimize the vehicle routes. We address a variation of the electric vehicle routing problem (EVRP), factoring in vehicle load and street slope for battery consumption and travel times. Moreover, we consider the existence of multiple paths between each pair of customers, which vary in distance and slope, yielding different travel times and battery consumption values. For instance, some paths may have small travel times but require high battery consumption, while other paths may have longer travel times and require less battery consumption. The problem is formulated on a customer multigraph that has one node for each customer and depot, and where parallel arcs are used to represent efficient paths in the original network. Road selection is carried out as part of the vehicle routing. This talk highlights findings on modeling strategies and reports some computational results to examine the impact of some model parameters upon the optimal solutions.

4 - Parcel Consolidation In Last Mile Delivery by Vehicle and Drone

Semih BOZ, University of Massachusetts Amherst, Amherst, MA, United States, Ahmed Ghoniem, Amro El-Adle

We study parcel consolidation within the context of last-mile delivery, employing both a vehicle and a companion drone to efficiently serve customers across multiple time periods. We present a mixed-integer program and an optimization-based heuristic to address large-scale instances. The efficacy of our methodology is assessed through computational experiments on randomly generated instances, focusing on a residential network in Amherst, Massachusetts.

TC05

Bldg. 33 - 203

Data Analytics Applications

Invited Session

Quality, Statistics, and Reliability

Chair: Daniela Orovwiroro, Business analyst in Technology company, SALT LAKE CITY, UT, United States

1 - Genomic Segmentation with Multiomic and Interdimensional Advances

Sunil Erevelles, University of North Carolina, Charlotte, Charlotte, NC, United States, Ysaswi Bhumireddy, Megala Caitlyn Rajkumar

The Genomic Big Data revolution represents a seminal paradigm shift in the future of marketing. Approximately half of all human behavioral traits are driven by genomics. Thus, it is suggested that consumption behavior over a person's lifetime can probabilistically be predicted at birth. However, over a hundred years of marketing thought has mostly focused on the other half- environmental factors that are largely random and individually account for only a small variance in consumption behavior. Moreover, relative to the environment, the effects of genomics increase, rather than decrease, over a person's lifetime.

In this paper, we introduce the concept of "Genomic Segmentation," and empirically demonstrate a model for segmenting markets using genomic data. Market segmentation is arguably one of the most important concepts in marketing. By minimizing within-group variance and maximizing between-group variance among consumers, marketers have traditionally been able to better target consumers and better position their offerings. With genomic segmentation, we suggest that "segments of one" can potentially be achieved, resulting in substantial advances in targeting precision and marketing effectiveness.

Finally, a concept called "Multiomic Segmentation," that adds four other sources of Big Data - transcriptomics, proteomics, metabolomics and epigenomics, is introduced to enhance the precision of genomic segmentation. All this is executed within an "interdimensional framework," which includes blockchain, to enhance security, and artificial intelligence to enhance genomic sequence interpretation and consumer segment richness. The framework presented may serve as a seminal foundation for future research, and may stimulate new fields of research in both healthcare and marketing.

2 - Advanced Binary Classification: SVM Kernel Construction

Yeisson Alexis Acevedo Agudelo, EAFIT University, Medellin, Colombia, Carlos Alberto Cadavid Moreno

Presenting an innovative perspective on the construction of kernels for classification algorithms, particularly focusing on Support Vector Machines (SVM). Our approach utilizes similarity functions based on diffusion processes in the Riemannian manifold, generated through q-Gaussian distributions and the q-Fisher metric, effectively solving the associated heat equation. Functioning as a robust alternative, this proposal introduces possibilities by seamlessly integrating Lie symmetries into the study of kernels.

Within this framework, we introduce a pioneering method for studying differential equations through Lie symmetries, outlining the approach proposed by Lafferty and Lebanon (2005) based on the diffusion kernel. Additionally, we actively explore extensions to broaden the methodology's applicability in computing.

The central objective of our research is to emphasize the significance of exploring methodological alternatives in computer science, particularly in the realm of binary classification problem-solving. Our aim is not only to provide effective solutions but also to inspire the development of advanced and efficient approaches. Committed propelling innovation and excellence, our work tackles complex classification problems, with applications spanning diverse domains globally. To further enhance our impact, we are actively collaborating with experts in the field to ensure the practical implementation and real-world effectiveness of our proposed methodologies.

This collaborative effort seeks to bridge the gap between theoretical advancements and practical applications, fostering a synergy that can revolutionize the landscape of computational approaches to classification challenges. Additionally, we are devoted to disseminating our findings through educational initiatives, workshops, and open-source contributions, nurturing a culture of continuous learning and advancement within the computational community.

3 - Towards Operational Excellence in Customer Service via AI-assisted Call Center Quality Control

Alessandro Huaman, Pacifico Seguros, Lima, Peru, Enrique Palacios, Ana Chucas, Gengis Gutierrez, Gonzalo Quispe, Luis Gutierrez

In service-oriented industries, customer service practices are continuously improving towards the achievement of greater levels of satisfaction from customers, which translate to a wide array of key performance indicators (KPIs) such as Net Promoter Scores (NPS), customer retention and engagement rates. As part of improving traditional practices in call centers that belong to service companies, there is an opportunity to integrate novel technological advances to operational methodologies designed by decision makers. In this work, we present a series of proposals that uses Large Language Models (LLMs), a subset of Artificial Intelligence, as a tool to aid the quality assurance diagnostics and creation of improved customer-agent speech scripts at a large insurance company. A series of proof-of-concept experiments are executed using cloud-based big data platforms that consumes audios of historical customer-agent interactions for different inquiries and after-sales support, leading to the creation of 1) a detailed topic segmentation of conversations, 2) content summarization, 3) automatic root-cause analysis via speech, 4) automatic sentiment analysis for the customer and the agent, and a 5) dashboard that allows for the overall tracking of analytical insights enabled by these discoveries. The proposed hybrid human-AI operation diagnostic and improvement methodologies allow for a deep understanding of the call center's specific challenges, driving the implementation of new strategies that have the direct impacts in operational efficiency KPIs such as NPS of customer satisfaction, time to solve an inquiry and time wasted in human-based analysis of complete recorded conversations.

4 - Exploratory and Explanatory Data Analysis: From Raw Data to Data-driven Business Decisions

Alan Ferrandiz, Core Analitica LLC, Tampa, FL, United States

Data analytics is the scientific process of discovering and communicating the meaningful patterns which can be found in data. It is also concerned with turning raw data into insight for making better decisions.

Most of the time we focus on the discovery part, also called exploratory data analysis, which is of paramount importance to understand what is behind the data and to obtain relevant findings, but as a result of this excessive focus on this stage of data analytics we usually forget the importance of effectively communicating these findings to an audience to help them making better decisions. This “last mile” of the data analytics process is what data professionals need to closely pay attention to connect data with business needs.

This part of the data analytics process is referred to as Explanatory Data Analysis and combines the skills: data, which is how we turn raw data into metrics and then KPIs, visualization, which is how we visually represent data using dashboards and reports, and storytelling, to create an impact in the audience through stories.

7-Minute Video Presentation

<https://youtu.be/reRCVO-oWuQ>

Presentation of the Research Work

<https://www.youtube.com/watch?v=RQYWyYF9bUc>

Research Poster

https://www.researchgate.net/publication/371174613_Explanatory_Data_Analysis_KPIs_Data_Visualization_and_Storytelling

TC06

Bldg. 33 - 204

OR/OM/MS for Logistics Service Operations

Invited Session

Service Operations

Chair: Diana Guzmán, Universidad del Rosario, Bogotá, N/A, Colombia

1 - Interactions between Service Design and Operations Management in Healthcare: A Co-word Analysis

Carlos Franco, Universidad del Rosario, Bogota, Colombia, Nubia Velasco

Service design and operations management are two related fields in the creation/improvement of healthcare services. Therefore we developed a co-word analysis to identify the interaction between these two concepts and contrast what is missing in the creation of value of the healthcare operations.

2 - Modeling the Covid-19 pandemic in Colombia Using System Dynamics

Luz Mancera, Universidad de La Sabana, Chía, Colombia

During the Covid-19 health emergency, Colombia faced challenges related to the prompt preparation of the health system. One of the main challenges in this preparation was the shortage of invasive mechanical ventilators. As response to this crisis, national government developed a plan to purchase ventilators; however, due to the growing demand for these devices worldwide, the required quantities were not available in the expected timeframe, so it was necessary to think in other strategies to provide a rapid response to the health emergency, including the local manufacture of ventilators.

In this context it was important to determine the number of ventilators that would be required throughout the pandemic in order to have information in advance for the planning of both equipment development and production. Therefore, the evolution of this crisis was modeled using system dynamics. The model considered the probability of contagion due to contact, the different types of severity of the disease, such as home recovery, hospitalization, and intensive care hospitalization, as well as the probability of recovery, the probability of death, hospitalization and recovery times, among other factors.

Considering the dynamics of the situation, the model was updated taking in account decisions of national government regarding quarantines. The resulting model was able to satisfactorily represent the evolution of the pandemic in the country, presenting maximum errors of 7.5% in detected cases and 13% in deaths. Likewise, the model allowed simulating different scenarios to predict the dates when the peaks of contagion and the need for ventilators would occur.

3 - Reverse Procurement Auctions for Humanitarian Logistics: A Case Study at the Colombian Red Cross

Diana C. Guzmán - Cortés, Universidad del Rosario, Bogotá, Colombia, Marie-Eve Rancourt, Jean-François Cordeau, William Guerrero

Establishing agreements with suppliers to ensure quick and cost-effective procurement of relief supplies is crucial when responding to sudden-onset disasters. This work focuses on sealed reverse procurement auctions, a commonly used mechanism for collaboration with the private sector in humanitarian logistics. We propose two two-stage stochastic programming models to support the decision-making, both for the auctioneer (the humanitarian organization) in the announcement phase and for the bidders (commercial suppliers) in the bid construction phase. We present a practical case study based on a public tender at the Colombian Red Cross and generate scenarios based on the historical data of disasters in

Colombia. Finally, we present insights resulting from numerical experiments and sensitivity analysis. Our results demonstrate that there can be an under-estimation of the maximum price for the humanitarian organization, and that the transportation cost and the transportation time are the parameters that have a significant impact on the utility of commercial suppliers.

4 - A Heuristic Approach for the Combined Inventory Routing and Crew Scheduling Problems

Carlos Franco, Universidad Distrital Francisco José de Caldas, Bogota, Colombia, Eduyn Lopez

We study the problem of combined inventory routing and crew scheduling problems. To solve, we propose a heuristic that consists in solving three mathematical models: inventory model, vehicle routing model and personnel allocation model. We state the general algorithm and main assumptions for our method and present preliminary results of a set of instances.

5 - Power in Oncology Drug Networks in Colombia: A Social Network Analysis Approach

Carlos Osorio, Universidad Nacional de Colombia, Bogota, Colombia, Egdda Vanegas

Power is a fundamental component in establishing and enhancing supply chain relationships. Given the complexity of interpreting and measuring power as a social phenomenon, one proposed tool is social network analysis, which helps interpret the distribution of power within a network.

This paper presents the evolution of the supply network of oncology medicines in Colombia between 1995 and 2022, considering various actors such as hospitals and clinics (IPS - healthcare institutions), insurers (EPS - health promotion companies), patients, pharmaceutical managers, and pharmaceutical laboratories (manufacturers or importers). The network was studied at different points in time, establishing measures of cohesion, equivalence, prominence, and rank. Observations reveal significant shifts within the supply network of oncology drugs in Colombia, primarily attributed to the emergence of key actors, notably pharmaceutical managers. These individuals now wield considerable influence in setting negotiation parameters within the supply chain. Additionally, pharmaceutical laboratories persist in their role as medicine importers, concurrently discontinuing direct sales to healthcare institutions (IPS). This study contributes to a deeper comprehension of how network structure, analyzed through social network analysis theory, impacts service levels within the network, particularly regarding health outcomes such as access to medicines.

TC07

Bldg. 33 - 301

Ko-Yang Wang - Generative AI and Its Responsible Applications in the Financial Industry

Invited Session

Tutorial

Chair: Henry Horng-Shing Lu, N/A

1 - Tutorial on Generative AI and Its Responsible Applications in the Financial Industry

Ko-Yang Wang, Fusion360-Taiwan FinTech Corp, Taipei, Taiwan

This lecture will explore the research and applications of generative AI in the financial industry. Topics include the latest trends, R&D opportunities, case studies, and impacts on the banking and financial industries. The complexity and challenges of responsible uses of AI and practical financial digital transformation issues will be discussed.

TC08

Bldg. 33 - 302

Transportation and Parking Management

Invited Session

Transportation and Mobility

Co-Chair: Brenda Cobena, Concordia University, 950 Notre Dame St West, Montreal, QC, H3C0K3, Canada

1 - Lane Management and Congestion Pricing for the Bottleneck with Mixed Traffic Flow of Autonomous and Human-Driven Vehicles

Yilin Wang, Department of Industrial Engineering, Tsinghua University, Beijing, China, People's Republic of, Junlong Zhang, Fang He

We consider a multi-lane heterogeneous bottleneck with the mixed traffic flow of autonomous vehicles (AVs) and human-driven vehicles (HVs) during the peak hour of the morning commute. We use the tradable credit scheme (TCS) instead of monetary congestion charging. From the perspective of reducing the total travel cost, we derive the optimal lane management policy for the bottleneck with and without TCS under different AV penetration rates. The AV platoon capacity

estimate is aggressive if the estimated value is more than double the HV's capacity; otherwise, it is conservative. The two estimates correspond to different expressions of the optimal TCS. We have the following major findings. First, the proportion of dedicated AV lanes in the optimal lane management policy is not exactly equal to the AV penetration rate due to the impact of heterogeneous commuters' departure time patterns. Second, the elevation of platoon capacity makes the cost reduction by increasing the AV penetration rate more prominent and lessens the effect of TCS. Finally, in the case of aggressive estimation of AV platoon capacity, compared with the conservative one, AVs have an increased preference for the dedicated lane under user equilibrium (UE) and a decreased preference for it under social optimum (SO).

2 - Optimization and Simulation of Angular Parking Lots using MIP formulations

Tarun Rambha, Indian Institute of Science, Bangalore, India, Helen Thomas

We consider the problem of designing optimal and efficient parking layouts within a plot of any shape. Optimality is defined from a supply-side perspective, wherein we maximize the number of parking spaces that can be accommodated. The efficiency of the layout, on the other hand, is measured using performance metrics such as emissions under demand-side scenarios that vary with parking volume and duration. Building on recent research on this topic, we first formulate a Mixed Integer Programming (MIP) model to maximize the number of parking spaces for angular parking. Multiple resolutions and different vehicle sizes are handled in a single formulation, eliminating the need for customized MIP formulations. Layouts for 30, 60, and 45-degree parking are designed using a triangular grid. The decision variables include the cells which anchor the angled parking stalls as well as square or rectangular shaped driving fields/tiles. Three types of constraints are modeled: (1) Single-purpose constraints, which require each cell in the lot to have at most one purpose, i.e., parking or driving but not both; (2) Accessibility constraints, ensuring every parking field is connected to a driving field; and (3) Driveway connectivity constraints, mandating that the driving fields must be connected to the entrances/exits. The performance of the proposed models on real-world instances is demonstrated using CPLEX and open datasets from New York City. Multiple optimal configurations are compared based on efficiency metrics using Vissim. Sensitivity to parking duration and demand is also studied.

3 - A Efficient Column Generation for the Profit-oriented Hub Line Location Problem with Elastic Demand

Brenda Cobena, Concordia University, Montreal, QC, Canada, Claudio Contardo

Major cities worldwide are facing common problems: traffic congestion and increasing use of private vehicles, resulting not merely in population growth but also in city sprawl. Developing efficient public transportation networks in many cities worldwide is crucial to ensuring adequate mobility. Hub Network Location models have been implemented to enhance passenger mobility in this context. Mainly, Hub Line Location Problems play an essential role in the rapid transit network in the public transportation industry and have generated a lot of interest for researchers in Operation Research, Transportation Engineering, and Urban Planning. This paper extends the profit-oriented hub line location problem (ED-HLLP), where a new methodology is proposed to solve its linear formulations. Due to the huge number of hub lines as variables in the ED-HLLP linear formulations, a column generation (CG) is proposed to solve its linear relaxation and integer model, respectively (CG-ED-HLLP). We tested CG-ED-HLLP on CAB instances to verify its capability to provide meaningful solutions. Furthermore, we apply this novel methodology to real-world settings; specifically, we considered the metropolitan area of Montreal. Finally, the results obtained using a general-purpose commercial solver are discussed to provide fruitful managerial implications.

TC09

Bldg. 33 - 303

AI for Optimization

Invited Session

AI for Optimization and its Applications

Chair: Santiago Ospina Ferreira, Pontificia Universidad Javeriana

1 - Sustainable Development of Advanced Machine Learning Techniques for Healthcare Applications

Samaneh Kouchaki, University of Surrey, Guildford, United Kingdom, Masoud Fakhimi, Osman Ozaltin, Maria Mayorga

The development of advanced machine learning techniques, particularly Transformers and language models, tailored for healthcare analysis holds immense significance in healthcare. However, the sustainable use of computational resources and minimizing the associated carbon footprint is equally crucial. This necessitates optimizing model architectures and designs for efficient resource utilization and energy conservation. Techniques like model compression and knowledge distillation are pivotal for creating lightweight models with reduced computational demands without compromising performance, thereby mitigating the environmental impact of training and inference processes. Furthermore, adopting sustainable practices throughout the development lifecycle, including efficient data management and waste reduction measures, can further curtail

the carbon footprint.

This study presents an innovative exploration into the sustainable application of Artificial Intelligence (AI) in Clinical data analysis, an area yet to be extensively researched. By delving into the challenges and opportunities at the intersection of Sustainable AI and clinical AI, this work proposes a new trajectory in interdisciplinary research. Through exploring the fundamental question of effectively leveraging AI while upholding sustainability, the study offers a unique perspective to address critical healthcare issues.

2 - Meta-modeling of Agent-Based Simulations of Infectious Diseases to Incorporate Human Behavior

Maria Mayorga, North Carolina State University, Raleigh, NC, United States, Osman Ozaltin, Julie Swann, Sebastian Rodriguez-Cartes

Agent-based models (ABMs) have been widely used to inform decision making and policy evaluation for pandemics and infectious disease outbreaks. ABMs are recognized as valuable tools due to their ability to integrate epidemiological models and complex human behaviors. However, realistic ABMs with a large number of agent types and complex behavioral and social processes are computationally intensive, analytically intractable and may not be generalizable. Thus, we propose to create a meta-model using machine learning techniques, such as biologically informed neural networks, to represent the ABM as a set of ordinary differential equations (ODEs), which can be easily analyzed. The proposed research will incorporate human behavioral and social processes into analytically tractable mathematical epidemiological models to inform decision making and policy evaluation during pandemics. This allows us to reduce the computational burden associated with large numbers of time consuming executions of complex agent-based models.

3 - Optimizing Drug Interaction Alerts: A Grouping-Based Approach to Mitigate Alert Fatigue Among Clinicians

Hossein Piri, Haskayen School of Business-University of Calgary, Calgary, AB, Canada, Michael Lingzhi Li

Computerized Physician Order Entry (CPOE) systems play a crucial role in healthcare, but the excessive generation of alerts often leads to alert fatigue among clinicians. To address this challenge, this research proposes a novel approach that utilizes artificial intelligence (AI) to categorize alerts based on their severity. By employing a Partially Observable Markov Decision Process, the research aims to strategically select and present alerts to prescribers, thereby reducing the likelihood of alert fatigue. This grouping-based methodology seeks to optimize the alert system by intelligently filtering out less critical alerts and prioritizing those of higher importance. Through the utilization of AI-driven severity classification and decision-making processes, the study endeavors to enhance the effectiveness of alert notifications within CPOE systems. By focusing on presenting alerts that are most relevant and crucial for clinical decision-making, this research strives to improve the overall alert management process and alleviate the burden of excessive alerts on healthcare providers. The implementation of this approach has the potential to streamline alert delivery, enhance provider acceptance of alerts, and ultimately contribute to more efficient and effective clinical workflows.

4 - Consensus, Upgrade and Skeleton Scenario Clustering in Stochastic Optimisation

Janosch Ortmann, University of Quebec-Montreal, Montréal, Quebec, Canada, Samah Abdalrhaman, Walter Rei

In stochastic programming, scenarios are used to approximate the distributions of the unknown parameters and formulate and solve multi-stage stochastic optimization models. However, in many applications, the number of scenarios required to realistically model the uncertainty typically makes the optimization problem numerically intractable.

In this talk I will discuss how to use problem-based clustering to extract information about the stochastic program from the single-scenario solutions. In particular, I will introduce new distance matrices on the scenario set that are based on the idea of giving the decision maker some flexibility to change the first-stage decisions after the uncertainty has been revealed. Unsupervised machine learning (clustering) is then applied to the scenario set equipped with these distances.

Preliminary result indicate promising bounds and reveal interesting new structures on the scenario set.

5 - High Dimensional Black-box Optimization with Branching Adaptive Surrogate Search and Subspace Decomposition

Zelda Zabinsky, University of Washington, Seattle, WA, United States, Pariyakorn Maneekul, Giulia Pedrielli

One of the inherent limitations of many surrogate modelling methods is that computational cost becomes intractable for problems in high dimensions. We propose branching adaptive surrogate search optimization (BASSO) with subspace decomposition and partitioning. We decompose the high dimensional problem into many low-dimensional problems to enable surrogate modelling within practical limits. The combination of decomposition and partitioning addresses heterogeneity of the black-box function, and aids in focusing the search on promising regions. The proposed BASSO implementations incorporate Gaussian processes and regularized quadratic regression as surrogate models. To evaluate the objective function in high dimensions, we concatenate the subspace variables as was done in Bayesian Optimization with Sampled Fictitious Play (BOFiP). BOFiP improved computational tractability by estimating surrogate models in low dimensions. We adapt the game theoretic basis of BOFiP to provide an adaptive sampling distribution in BASSO. Numerical

experiments compare the performance of BASSO with subspace decomposition to state-of-the-art approaches in the field of high dimensional black-box optimization, on several benchmark objective functions with dimensions ranging from 20 up to 1,000.

Wednesday, June 19, 9:00 AM - 10:00 AM

Wednesday Plenary

Founders Auditorium

Andres Medaglia - A (Not So) Shortest Path: Models, Solutions, and Applications

Invited Session

Plenary

Chair: Michel Gendreau, Polytechnique Montreal, C.P. 6079, succ. Centre-ville, Montreal, QC, H3C 3A7, Canada

Co-Chair: Fernando Ordonez, Universidad de Chile, Santiago, Chile

1 - A (Not So) Shortest Path: Models, Solutions, and Applications

Andres Medaglia, Universidad de los Andes, Bogota, Cundinamarca, Colombia

Shortest path structures are behind the solution of hard combinatorial problems in transportation and logistics (and beyond). This talk covers a personal journey on modeling shortest path problems, devising solution techniques, and unveiling embedded network structures that have opened the door for tackling pressing sustainability challenges.

Wednesday, June 19, 10:15 AM - 11:45 AM

WA01

Bldg. 33 - 101

Optimization and Complex Systems

Invited Session

Optimization, Learning, and Decision Making

Chair: Joerg Fliege, University of Southampton

1 - Min-Maxing Complexity on Digital Infrastructure Mechanisms through Occam's Razor and Ashby's Law of Requisite Variety

Danilo Lessa Bernardineli, BlockScience, Albany, NY, United States, Michael Zargham, Ilan Ben-Meir, Jakob Hackel

Because problems with only one solution do not exist outside the realm of theory, the process of solving a problem in the real world is better understood as one of selecting one solution from the set of available possibilities, which requires first identifying a heuristic for evaluating these possibilities' relative fitness to the problem that they are intended to solve. This presentation argues that two of the most frequently-invoked heuristics, Occam's Razor and Ashby's Law of Requisite Variety, frame the question in terms of specifying a solution's optimal degree of complexity; moreover, each heuristic functions as the "dual problem" for the "primal problem" framed by the other.

In other words, the two principles converge on the assertion that the best solution to a given problem is one that is as simple as possible (while affording the requisite degree of regulatory power), and as complex as necessary (without overly constraining the variety of the system being regulated) – a formulation which offers powerful practical insights for those seeking to design balanced protocols and mechanisms that are robust enough to account for the nuances of real-world interactions, while still being transparent and understandable to their users.

These insights will be illustrated with case studies drawn from the presenter's past work engineering digital infrastructure for complex socio-technical systems.

2 - Cancelled - Optimal Management of Defined Contribution Pension Funds under the Effect of Inflation, Mortality and Uncertainty

Gerhard-Wilhelm Weber, Poznan University of Technology, Poznan, Poland

In the present work, we study the problem of optimal management of defined contribution pension funds, during the distribution phase, under the effect of inflation, mortality and model uncertainty. More precisely, we consider a class of employees, who, at the time of retirement, enter a life assurance contract with the same insurance firm. The fund manager of the firm collects the entry fees to a portfolio savings account and this wealth is to be invested optimally in a Black–

Scholes type financial market. As such schemes usually last for many years, we extend our framework, by: (i) augmenting the financial market with an inflation-adjusted bond, and, (ii) taking into account mortality of the fund members. Model uncertainty aspects are introduced as the fund manager does not fully trust the model he/she faces. By resorting to robust control and dynamic programming techniques, we provide: (a) closed-form solutions for the case of the exponential utility function, (b) a detailed study of the qualitative features of the problem at hand that elucidates the effect of robustness and inflation on the optimal investment decisions.

(Based on joint work of I. Baltas, L. Dopierala, K. Kolodziejczyk, M. Szczepański, G.-W. Weber, A. N. Yannacopoulos, [European Journal of Operational Research](#), Volume 298, Issue 3, 1 May 2022, Pages 1162-1174, <https://doi.org/10.1016/j.ejor.2021.08.038>)

3 - A Mathematical Programming Approach for Trajectory Optimisation in the Presence of Adversary Sensors

Joerg Fliege, University of Southampton, Southampton, United Kingdom, Anvar Atayev

We consider a scenario in which a fleet of UAVs needs to reach a particular site of interest without being detected. The site of interest is surrounded by a network of fixed or moving sensors. Detection of a UAV is contingent on a sufficient level of detection by one or more sensors. Furthermore, assume that some UAVs are able to perform disabling/disrupting interventions to sensors along their path to the target, whereby a UAV is able to disrupt or disable all sensors within a given range for a given maximum period of time.

Our model takes explicitly into account the various measurements different sensors can take, for example received signal strength (RSS), angle-of-arrival (AOA), time-of-arrival (TOA), or time-difference-of arrival (TDOA). We provide explicit formula for probability of detection of a UAV as well as for the location error the sensors experience when trying to locate a UAV. This allows us to formulate a multiobjective mathematical programming formulation for this problem that computes optimal trajectories for all UAVs as well as optimal decisions on disabling sensors. We embed this optimisation problem into a rolling horizon optimisation approach that allows to update flight trajectories during mission time. Numerical results show the efficacy and flexibility of this approach.

This work is a result of the Dstl-sponsored activity Maths of a Contested Electromagnetic Environment.

4 - Daily Production and Inventory Management at a Fast-food Restaurant

Omid Jadidi, St Edward's University, Austin, TX, United States, Fatemeh Firouzi, John Loucks, Amirhossein Bazargan

Demand for a restaurant is rarely distributed evenly within a day or week. For example, 12 to 2 p.m. and 6 to 9 p.m. may be the most profitable times of a day when people go out to dine. Or Saturday and Sunday are the busiest days, to visit a restaurant.

In order to meet demand at the lowest cost possible, restaurants need to effectively handle demand fluctuations by taking the following steps. The first step is to use forecasting techniques that can estimate upcoming demand as accurately as possible based on past data and factoring in known current and future circumstances. The forecasting process typically involves the use of quantitative models along with expert judgement and opinion. The second step is to develop and implement inventory management models that balance the trade-off between inventory/production cost and customer service level. In the research, we investigate how the economic order quantity (EOQ) model can be an appropriate tool for this problem. We consider two types of EOQ models: the Fixed Production Cycle (FPC) model and the Fixed Production Quantity (FPQ) model:

- In the FPC model, the production cycle (time duration) between the production runs (PRs) is fixed, and production is triggered at the end of each production cycle.
- In the FPQ model, the production quantity is fixed for all the PRs (i.e.,) and production is triggered by inventory dropping to the reorder point.

We also develop two algorithms, one for the FPC model and the other for the FPQ model.

WA02

Bldg. 33 - 102

Optimization and Simulation

Invited Session

Industrial Applications of OR

Chair: Nimasha Udari, University of Ruhuna

1 - Simultaneously Updating Multiple Performance Measures of Manufacturing Systems after Scheduling Perturbations

Golshan Madraki, Clarkson University, Potsdam, NY, United States

The goal is to accelerate improvement heuristics which use a graph to model the system and calculates the makespan, i.e., longest path in the graph, during each iteration. These heuristics iteratively perturb the graph and recalculate the makespan in each iteration until a satisfactory schedule is determined. We propose *Improved Structural Perturbation Algorithm (ISPA)* to accelerate the calculation of the length of the longest path in the graph in each iteration. This will decrease the overall computation time of these scheduling improvement heuristics. Scheduling perturbations are represented by structural perturbations of the graph. ISPA partitions nodes in the graph into two types of sets and applies two different processes to calculate the effects of the perturbations depending on the set the node was in. The major contribution of this study is that ISPA executes once to update the length of the longest path regardless of the number of added and deleted edges. This results in a more efficient algorithm in terms of time complexity. An experiment was performed applying ISPA to a *Simulated Annealing* heuristic and compare it with applying the commonly used *Standard Longest Path Algorithm (SLPA)* and two other existing methods to the SA heuristic. The experiment shows that ISPA outperforms existing methods in all cases. For these SA problems, ISPA saved 9%-65% of the execution time compared to SLPA for the job-shop scheduling. The time savings increase with size of the problem. ISPA is applicable to other iterative heuristics, such as Tabu-search, Genetic Algorithms, and Shifting Bottleneck.

2 - Development of Strategic Map (BSC) with Fuzzy Logic and Multi-criteria Optimization

Armando Meza Angulo, Universidad de los Andes, Santiago, Chile, Juan Pérez Retamales, Héctor López-Ospina

The implementation of the Balanced Scorecard (BSC) represents a pivotal task in modern organizational management, facilitating the alignment of strategies with tangible and intangible assets. This research proposes a comprehensive framework aimed at refining the strategic mapping process within organizations, with a focus on enhancing decision-making capabilities.

The primary objective is to develop a methodology integrating Multicriteria Decision Making (MCDM) and optimization methods to construct BSC strategic maps effectively. By leveraging the DEMATEL method, causal relationships among strategic objectives are determined through expert consultations, enabling a nuanced understanding of interdependencies. Subsequently, a linear programming optimization model is employed to streamline the strategic map, prioritizing objectives based on expert ratings and maximizing financial outcomes and objective fulfillment levels.

The proposed framework addresses the complexity inherent in strategy mapping, providing clarity in planning and resource allocation. By identifying key objectives and their causal relationships, organizations can concentrate efforts where they generate the most significant impact, fostering strategic alignment and informed decision-making.

The optimization model, implemented using the Python programming language, facilitates the attainment of the Pareto frontier, allowing organizations to explore multiple optimal solutions simultaneously. Through this approach, the research aims to contribute to the advancement of strategic management practices, enabling organizations to navigate dynamic environments with agility and precision.

In conclusion, the proposed methodology offers a systematic approach to strategic mapping, empowering organizations to articulate and execute strategies effectively in pursuit of their vision and objectives.

3 - Fair Resource Allocation in Research and Development Projects with Public Funds

Nancy Maribel Arratia Martinez, Universidad de las Américas Puebla, Cholula, Mexico

The selection of research and development (R&D) projects funded by public institutions poses a significant challenge for governmental organizations. It involves choosing a subset of projects and allocating resources, typically aimed at addressing priority issues and strategic objectives. While extensively studied under conditions of full funding, this research explores the condition of resource allocation to R&D projects when partial funding is allowed.

In this context, poor decision-making can lead to imbalanced outcomes, especially when resources are shared among multiple interested agents. Therefore, achieving a fair allocation becomes imperative.

This study involves the discussion about mixed-integer linear programming models for making allocation decisions across various levels, including projects and tasks, with the aim of maintaining resource balance. Several existing approaches are

reviewed, and a novel approach is proposed and based in the concept of partial funding.

The proposed model is tested over a set of instances, and the impact of partial funding is analyzed, finally, potential avenues for future research are presented.

WA03

Bldg. 33 - 103

Yasmin Rios-Solis - Public Transportation in Developing Countries

Invited Session

Tutorial

Co-Chair: Grace Lin, UFI.AI, Chappaqua, NY, United States

1 - Public Transportation in Developing Countries

Yasmin Rios-Solis, Tecnológico de Monterrey, Monterrey, Mexico

Have you tried to implement a known transportation algorithm from developed countries in a developing one? Most researchers and practitioners know topologicalization is complex, and many features and utilities will be underused. What are the characteristics that make the developing countries' transport systems different? This tutorial will overview these characteristics and how to include them in the models and algorithms.

WA04

Bldg. 33 - 201

Integer Programming Applications in Transportation and Logistics

Invited Session

Combinatorial Optimization and Applications

Chair: Cristián Cortés, Universidad de Chile, Santiago, Chile

Co-Chair: Pablo Rey, Universidad Tecnológica Metropolitana, Santiago, N/A, Chile

1 - Electric Vehicles in Public Transport: A Depot-Charging Genetic Algorithm for Minimizing User and Operational Costs

Daniel Martínez, Universidad de Chile, Santiago, Chile, Marcela Munuzaga, Cristián E. Cortés, Antonio Mauttone

Integrating Battery Electric Vehicles (BEVs) in public transport systems can reduce greenhouse gas emissions and operational costs. However, BEVs have limited autonomy and require frequent charging, which depends on factors such as energy consumption, battery capacity, and network design. This study proposes a genetic algorithm for the Transit Network Design with Frequency Setting Problem (TNDSP) tailored for electric vehicles (E-TNDSP). The algorithm incorporates depot charging technology and assigns depots to routes or services. It also computes the energy requirements and battery State of Charge (SOC) at each stop. The algorithm optimizes the transit network design and frequency setting by minimizing the total user and operational costs. The results show that the algorithm improves the BEVs' autonomy and efficiency and reduces the number of depots and charging events. This method facilitates the transition to cleaner transportation solutions by providing a tool for transportation policymakers and operator decision-makers. It also offers insights for future research on integrating BEVs in public transport systems.

2 - Optimization Models for the Analysis of Extended Producer Responsibility Policies in the Packaging Sector: A Comparison of National Regulations

Jonathan Lozano-Oviedo, Universidad de Chile, Santiago de Chile, Chile, Cristian E. Cortes, Pablo Maya-Duque, Pablo A. Rey, Juan G Villegas

Currently, developing sustainability and circular economy approaches within supply chains is becoming an imperative aspect due to various legislations worldwide, aligned with the sustainable development goals established in the 2030 agenda proposed by the United Nations. Particularly within the packaging sector, Extended Producer Responsibility (EPR) policies are emerging and being developed to hold producers accountable for the packaging they introduce to the market. These policies aim to ensure proper waste management by facilitating collection and recovery through various circular strategies such as reuse, remanufacturing, recycling, and energy recovery. This article proposes an optimization model for analyzing Extended Producer Responsibility policies in the packaging sector. The model is validated using several EPR policies from countries including Colombia, Chile, Spain, and Belgium. The results are intriguing, revealing diverse impacts on economic sustainability depending on the application of each policy, as well as the optimal mix of packaging types suggested to achieve proper packaging waste management.

3 - Countrywide Optimization of Supply Chain Operations in the Food Industry

Cristián Cortés, Universidad de Chile, Santiago, Chile, Fernando Ordonez, David Revillot-Narváez, Raul Espinoza

We deal with the distribution problem faced by a large Chilean company that supplies over 50% of the Chilean meat market (chicken 56%, pork 53%, turkey 62%) and produces 1.2 million tons of product annually. A typical daily operation involves transporting about 2200 tons of more than 1000 different products from 7 production plants to 30 distribution centers and 40 additional large clients using more than 120 container trucks. The resulting problem could be conceived as a multi-commodity two-echelon distribution problem commonly found in applications to the supply chain of the fresh food industry. In this problem, trips can visit multiple plants or demand points with specific operational constraints. We consider stock of fresh and frozen products (chicken, pork, turkey, salmon, frozen vegetables) at production plants to meet a nationwide demand from large consumers and the company's distribution centers. The main objective is to meet demand for products at minimum transport cost. A second objective is to minimize the empty transport capacity of the fleet used to meet demand (truck filling problem). In this work, we develop a model and algorithm to optimize the daily transportation of products nationwide for the company. In addition, we propose a model to optimize the schedule of the trucks to fulfill the requirements of the flow model formulated above to effectively being able to move the freight from the plants to final distribution centers nationwide. Results show significant savings in both total distribution costs and costs per unit of transported product.

WA07

Bldg. 33 - 301

Juan Camilo Serpa - The Data Mangrove: Developing a World-leading Sustainability Data Hub

Invited Session

Tutorial

Chair: Ko-Yang Wang, Fusion\$360-Taiwan FinTech Corp, Taipei, Taiwan

1 - The Data Mangrove: Developing a World-leading Sustainability Data Hub

Juan Camilo Serpa, McGill University, Montreal, QC, Canada

The Data Mangrove (datamangrove.com) is a new hub uniting sustainability researchers, allowing them to share data (through an open-data platform), promote research papers, and to implement data-driven technologies for research partnerships. This virtual hub will facilitate connections across the sustainability research community, facilitating data-driven collaboration. This tutorial introduces the hub's features and invites researchers to join this academic hub before its late-summer launch.

WA08

Bldg. 33 - 302

Vehicle Routing: Applications

Invited Session

Vehicle Routing Problems

Chair: Juan G Villegas, Professor, Calle 70 No. 52 – 21. 050010 – Medellin, Medellin, 050025, Colombia

Co-Chair: Juan Carlos Rivera, Universidad EAFIT, Medellín, Colombia

1 - A Protocol for Transportation Operations in the Physical Internet

William Guerrero, Universidad de La Sabana, Chia, Colombia, Mariam Bouzid, Jairo R. Montoya-Torres

In this study, we present a flexible, collaborative, and decentralized protocol designed for transportation operations within the Physical Internet (PI). This protocol is tailored to accommodate both micro-hubs within urban areas and larger peripheral hubs. Given the assumptions and requirements of the PI, which aims to establish an open, seamless, and global transportation system, we propose a mathematical formulation outlining how nodes should operate using transportation requests. An Orienteering Pickup and Delivery Vehicle Routing Problem (OP-PD-VRP) with alternative delivery locations is provided to address routing and fleet management aspects at the node level. Each node is responsible for handling last-mile requests within its operational area, as well as mid/first mile requests from other nodes, thereby collaborating to bring goods closer to their final destinations for subsequent nodes to handle. Due to capacity limitations specific to each node, we acknowledge the potential for nodes to reject requests. A rejection mechanism is thus granted to give the possibility to the node to report a request for a future planning or to another node. In essence, our model maximizes request weighted throughput minus transportation costs. Routing decisions are influenced by assigning a distance-based weight to each pickup and its potential

delivery locations. Furthermore, we develop a Greedy Randomized Adaptive Search Procedure coupled with a Variable Neighbor Descent as our solving approach. Results show promising avenues of research.

2 - Comparison of Three Methods Applied to a Pickup and Delivery Vehicle Routing Problem in the Context of Home Health Care

Jorge Isaac Pemberthy Ruiz, Instituto Tecnológico Metropolitano, Medellin, Colombia, Juan Carlos Rivera, Christelle Jussien-Gueret, Hasan Al Hasan

This work addresses a scheduling and routing problem for the personnel of a Colombian company in charge of providing home health care to a set of users. The aim of this company is to improve the well-being of economically disadvantaged and severely disabled people through follow-up by four types of professionals: psychologist, nutritionist, nurse and physiotherapist. These professionals operate as teams of 4 (one professional of each specialty), each team being assigned a set of users. Chauffeur-driven vehicles are available to transport them to users' homes. All users must be visited once in their time window. And professionals belonging to the same team must all take their lunch break together, within a set time window. The objective function is the minimization of the total distance of the routes. Two organizations are explored: a first one, followed by the company, in which each team is assigned a chauffeur-driven vehicle, and a second one in which chauffeur-driven vehicles are mutualized over several teams.

Three approaches have been developed for each of the potential organizations: a mixed integer linear programming model, a metaheuristic approach based on local search, and a matheuristic. We have conducted experiments on a set of instances generated on the basis of real data, and compared the different methods, for the two alternative organizations. The results allow us to compare the different methods in terms of distance covered and execution times, but also the two organizations in terms of total distance, and waiting time for professionals and drivers.

3 - Understanding Transport Mode Choices in Developing Urban Contexts: A Machine Learning and Agent-Based Simulation Approach

Kathleen Salazar, Universidad Nacional de Colombia, Medellin, Colombia, Lorena Cadavid, Carlos Franco

Mode choice and travel behavior analysis are of interest to urban planners, as mode prediction plays a crucial role in formulating transport policies to enhance mobility in urban spaces. Previous research has shown that mode selection is significantly influenced by the built environment, cultural, and socio-economic characteristics. However, as these studies have mainly focused on developed countries, caution should be exercised in generalizing their results to developing territories. The unique contexts of developing countries add additional complexity to the analysis of transport mode choices for utilitarian urban travel. This research aims to contribute to understanding the factors influencing decision-making in developing countries and how policies that alter these factors impact mode choices at both individual and aggregate levels.

Using survey data from a Colombian case study city, we applied multinomial logit and classification models to identify determinants in mode choice and calculate probabilities of selection between private cars, public transit, and motorcycles. These findings were used to inform an agent-based model representing urban commuters during peak hours, who make decisions about their mode of transport. Preliminary results of the simulation indicate that under the current conditions of the transport system in the city, people will continue to decrease their use of public transit and migrate to private transportation, especially motorcycles, which already account for a higher share of the total fleet in the country. Our model can further serve as a test bed to analyze the impacts of public policies.

4 - A Bilevel Vehicle Routing Problem for a Colombian Package Delivery Company

Juan G Villegas, Universidad de Antioquia, Medellin, Colombia, Alejandro Montoya, José Fernando Camacho-Vallejo

This work presents an extension of the vehicle routing problem arising in the operation of a Colombian courier company that uses its private heterogeneous fleet of vehicles to serve its customers and outsources part of its deliveries with a heterogeneous set of external drivers. The proposed model extends the vehicle routing problem with private fleet and common carriers (VRPPC) by considering multiple common carriers in a bilevel fashion using a profitable tour problem (PTP) to model their explicit routing decisions. To solve this problem we propose an alternating heuristic that solves the VRPPC at the upper level and the PTP at the lower level iteratively and uses information of the obtained solutions in a tabu search-like fashion to obtain improved solutions.

In our computational experiments we compare the alternating heuristic results against those obtained under the so-called high point relaxation scheme. That is, the upper-level problem is solved, but ignoring the optimal reactions of the external drivers.

WA09

Bldg. 33 - 303

Applied AI and Inventory Management

Invited Session

AI for Optimization and its Applications

Chair: Elisenda Monina Ferragut, Universidad Complutense de Madrid

1 - Exploring policy-making strategies within System Dynamics models using Reinforcement Learning techniques

Sebastian Jaen, Universidad de Antioquia, Medellin, Colombia, Esteffany Peña-Puentes, Carlos Vasquez-Ortiz, Juan España-Lopera

Reinforcement learning is one of the most promising paradigms in artificial intelligence, with applications spanning various domains, particularly in robotics and video games. While the literature underscores its significant potential for addressing challenges in supply chain management, a notable obstacle arises from the high cost of experimentation and time consumption associated with its application. Consequently, simulation emerges as a pivotal tool for creating environments that facilitate interactions with agents trained through reinforcement learning algorithms, enabling the development of improved policies in simulation models. Although existing works have primarily employed reinforcement learning in agent-based simulation models and discrete event simulation paradigms, there is a noticeable scarcity of applications within system dynamics simulation—an approach widely used in supply chain management. On the other hand, within system dynamics, a need exists to explore new alternatives to addressing the challenges of seeking optimal policies, a task typically carried out manually through expert judgment or, less frequently, using other methods. This study addresses these gaps by constructing a system dynamic model simulation in Python and employing basic reinforcement learning algorithms to enhance system performance. We outline the advantages and disadvantages discovered during the experimentation process and compare the results with other approaches.

2 - Predictive Analytic Models to Support the Internal Audit Capacity Planning System of an IT Company

Patricio Alejandro Zamora Navarro, Universidad de Monterrey, Monterrey, Mexico, Rafael Alejandro Ruiz Miller, Roberto Serna Zuazua, Jose Daniel Morcillo Bastidas

The internal audits of a company are fundamental for quality assurance and proper compliance with various processes. Planning these audits adequately is crucial, yet companies often lack the necessary tools for effective planning. This planning involves factors like internal auditors' effort in work hours and audit capacity. These aspects are critical for organizing times and audits over time, as inadequate calculations can significantly affect planning and trigger various consequences for the company and its processes.

Given this, it was proposed to develop and implement predictive analytic models to facilitate the planning and optimization of internal audits in terms of hours and number of audits, thereby improving an existing digital planning tool. Historical audit information was obtained, worked, and processed within an IT company. Different Machine Learning Python libraries were applied in the modeling process, including PyCaret, H2O, FLAML, TPOT, LazyRegressor, among others.

Evaluation metrics such as coefficient of determination (R^2), root mean square error (RMSE), mean square error (MSE), and mean absolute percentage error (MAPE) were used to evaluate the models. The best results were obtained by Random Forest models, achieving an R^2 metric of 94.40% and a MAPE of 6.26% for the effort model; and an R^2 of 90.49% and MAPE of 6.77% for the capacity model. These results indicate significant improvements in the ability to forecast and optimize audit schedules, demonstrating the models' effectiveness.

3 - The Shapley Interaction Index on Networks

Elisenda Molina Ferragut, Universidad Complutense de Madrid, Madrid, Spain, Jorge González, Juan Tejada

Grabisch and Roubens (1999) proposed an interaction index based on the Shapley value, the Shapley Interaction Index, which tries to take into account the "information about the phenomena of interaction or cooperation that exists between players". In particular, a positive interaction value must indicate that players are interested in cooperating. Interaction indices have proven useful in various contexts, such as in Explainable Artificial Intelligence, where they are used to evaluate the interaction that may exist between two or more of the features considered in the model. In this paper, we propose a generalisation of the Shapley interaction index to the case where the communication between the players is restricted by a graph a la Myerson. We study its interpretation and give an axiomatic characterisation. Following Szczepanski et al. (2015), we also evaluate some interesting applications, such as predicting links in social networks or using it to detect communities in the same context.

4 - Enhancing E-commerce Inventory Management to Combat Product Obsolescence in Mexico

CELIA FABIOLA VASQUEZ GARCIA, Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico City, Mexico, JOSUE VELAZQUEZ, Lyssett Bellato

Product obsolescence poses a significant challenge for inventory management, especially in the dynamic e-commerce landscape of Mexico. This study investigates strategies to improve inventory management by focusing on faster execution, better product selection, and smarter decisions on brands having both physical and digital stores. In Mexico, e-commerce is rapidly growing, requiring efficient inventory management to meet customer demands. This research proposes leveraging e-commerce platforms to enhance inventory management practices.

The study suggests implementing a faster execution of the product information system, ensuring accurate and real-time data updates. Additionally, a better product selection strategy is recommended, incorporating customer preferences, market trends, and inventory turnover rates.

This research contributes to the operations management field by providing practical insights for businesses to improve inventory management in the context of e-commerce in Mexico and further benefits in CO2 emissions related to over inventory and low inventory rotation rates.

Wednesday, June 19, 12:00 PM - 1:00 PM

Wednesday Keynote

Founders Auditorium

Dionne Aleman - Pandemic Planning from A (agent-based simulation) to V (vaccine prioritization)

Invited Session

Keynote

Chair: Kathryn Stecke, University of Texas at Dallas, Richardson, TX, United States

1 - Pandemic Planning from A (agent-based simulation) to V (vaccine prioritization)

Dionne Aleman, University of Toronto, Toronto, ON, Canada

During COVID-19, numerous operations research tools to evaluate public policies emerged. This presentation covers experiences working with Newfoundland and Labrador (Canada), and changes to usual O.R. processes needed for real-world implementation and communication with nontechnical decision-makers.

Wednesday Keynote

Bldg. 38 - Auditorium 110

CANCELLED - Ozalp Ozer - Fulfillment by Amazon (FBA): Democratizing Supply Chain Science for Small- and Mid-size Businesses

Invited Session

Keynote

Chair: Grace Lin, UFI.AI, Chappaqua, NY, United States

1 - CANCELLED - Fulfillment by Amazon (FBA): Democratizing Supply Chain Science for Small- and Mid-size Businesses

Ozalp Ozer, Amazon, Richardson, TX, United States

Join us to learn how FBA partners with independent businesses to drive superior customer experience. We'll discuss how science, together with Amazon's leadership principles, helped us navigate challenges of the COVID-19 pandemic, and how we are applying those same principles to reinvent and dramatically simplify global supply chains on behalf of FBA sellers.

Wednesday Keynote

Bldg. 38 - Auditorium 101

CANCELLED - Celso Ribeiro - Biased Random-key Genetic Algorithms: An Application-oriented Tutorial

Invited Session

Keynote

Chair: Michel Gendreau, Polytechnique Montreal, C.P. 6079, succ. Centre-ville, Montreal, QC, H3C 3A7, Canada

1 - CANCELLED - Biased Random-key Genetic Algorithms: An Application-oriented Tutorial

Celso Ribeiro, Universidade Federal Fluminense, Rio de Janeiro, Brazil

This keynote overviews biased random-key genetic algorithms (BRKGAs) and their extensions and applications. BRKGAs are characterized by their solution encoding and population evolution. Selection and crossover are biased to produce better than purely random offspring. We discuss the population evolution dynamics, design and implementation issues, and a review of applications.