
2019 INFORMS-ALIO INTERNATIONAL CONFERENCE
CANCÚN
informs
June 9–12

Sunday, 10:00am - 11:00am

Welcome Plenary

JW Julum E

Will Artificial Intelligence Kill Markowitz?

Plenary Session

1 - Will Artificial Intelligence Kill Markowitz?

Enrique Covarrubias, Actinver, Santa Fe, Mexico

In the aftermath of the 2007 financial crisis, many specialists blamed Modern Portfolio Theory (MPT) for the chaos. While some of the critics to MPT have solid bases, many also defend the ideas of Markowitz. MPT is not about fancy financial engineering, algorithms or forecasting; it really is about the creation of investment portfolios that maximize expected return for each level of risk. The simplest, yet the most unquestionable rule of finance, is that if on average you want higher returns, you will have to accept greater risk in your portfolio. In this talk, we will discuss how to combine machine learning algorithms and modern portfolio theory to make investment decisions. The speaker manages the first artificial intelligence driven fund in Latin America.

Sunday, 11:30am - 1:00pm

■ SA02

JW Tulum B

Use of Operations Research for Social Good

General Session

Chair: Oscar Rodriguez-Espindola, Aston University, United Kingdom

Co-Chair: Soumyadeb Chowdhury, PhD, Aston University, Birmingham, B4 7ET, United Kingdom

Co-Chair: Pavel Albores, PhD, Aston University, Birmingham, B4 7ET, United Kingdom

Co-Chair: Prasanta Dey, United Kingdom

1 - Stochastic Formulation for Collaborative Disaster Management

Oscar Esteban Rodriguez-Espindola, Aston University, Aston Business School, Aston Triangle, B4 7ET, United Kingdom

Providing effective and efficient disaster response is a significant challenge for authorities. Complex coordination between different actors along with randomness about the conditions of the emergency call for the development of decision-making tools to support disaster preparedness and response activities. This research presents a stochastic optimisation model for disaster preparedness applied to a case study in Mexico. The results show the value of adding randomness for planning and preparation.

2 - The Value of Big Data in Creating Sustainable and Resilient Agricultural Supply Chains

Stella Despoudi, Lecturer in Operations and Supply Chain Management, Aston University, Birmingham, United Kingdom, Oscar Esteban Rodriguez-Espindola

The UK Agricultural Supply Chain (ASC) is becoming more environmentally sustainable, it is subject to increasing pressure from the impacts of global climatic changes. Rising temperatures and increasing frequency of severe weather events would all have an impact on operations, productivity and the range of products offered by the sector. Thus, the resilience of the UK's ASC to climatic changes is being questioned. Although it is essential that sustainability improvements are achieved, they may come at the expense of the overall ASC's resilience to exogenous shocks. Big data could improve current ASC's sustainability as it enables the adoption of smart farming and other process optimization solutions. Also, using Big Data increased transparency of the ASC could be achieved and this would lead to improved resilience of the supply chain. The research aims to identify the extent and current levels of Big Data usage in the UK ASC, and to examine the possible impact of Big Data usage on both sustainability and resilience of the UK ASC.

3 - Data Driven Decision Making: Artificial Intelligence Drivers and Challenges

Soumyadeb Chowdhury, Aston University, Aston Business School, ABS 277, OIM Department, Birmingham, B4 7ET, United Kingdom, Oscar Rodriguez-Espindola

The aim of the paper is to explore the role of Artificial Intelligence (AI) in decision-making. AI has the potential to augment decision-making by reducing the information and cognitive load. This is achieved through the state-of-the-art machine and deep learning algorithms as well as information asset. However, lack of transparency and bias introduced as a result of the historical data can impede accuracy of the recommendations. We will list an array of factors that are potential drivers and challenges to using AI for decision-making using real-life cases.

4 - Product Prioritisation in Disasters

Pavel Albores, Professor of Operations and Supply Chain Management, Aston University, Birmingham, United Kingdom, Oscar Esteban Rodriguez-Espindola, Soumyadeb Chowdhury

Disaster management is characterised by dynamic conditions, in which donors are unable to truly understand the real needs of the area, leading to convergence of low-priority items. This research presents an integrated platform using AI, Optimisation and Simulation to provide real-time support for donors. The AI prioritises the items based on the information available, the optimisation model finds the optimum set of solutions to maximise satisfaction and minimise congestion, and the simulation model is used to assess the resulting conditions and evaluate their performance.

■ SA03

JW Tulum C

Integration of Human and Artificial Intelligence

General Session

Chair: Mary L. Cummings, Duke University, Durham, NC, United States

1 - A Holistic Collaborative Approach to Human-Autonomy Teaming

Mary L. Cummings, PhD, Duke University, Durham, NC, United States

Collaborative intelligent systems should support human activity and ultimately promote collaboration between teams of humans and teams of autonomous systems. However, there are many challenges in developing such systems due to the high degrees of freedom of the behaviors of both individuals and teams of people, as well as the uncertainty introduced by probabilistic reasoning autonomy in the fog of war that occurs in combat environments. What is needed is a holistic modeling approach that can consider both the strengths and weaknesses of both humans and autonomous systems. To this end, this talk will examine how such models could be used to explore the boundary conditions of the joint systems.

2 - AI-Enhanced Dynamic Decision Making

Alfredo Garcia, Texas A&M University, College Station, TX, 77845-8987, United States

It is now widely agreed that AI methods can outperform humans in solving decision problems that involve large, well-organized data sets. While humans are prone to error when processing well-organized data sets, AI methods are not so good at dealing with ambiguity and/or changing structure. In this talk we consider a dynamic stochastic decision making problem with regime switching that is to be jointly solved (online) by a human expert and an intelligent machine assistant. While the human expert is assumed to be able to quickly detect regime switches, the machine is able to learn optimal policies via reinforcement learning (RL) when the underlying regime is held fixed. We consider the design of a meta-policy for decision making that exploits the complementarities between human and artificial intelligence.

■ SA04

JW Tulum F

Service Industry

Contributed Session

Chair: Ozlem Yildiz, University of Virginia, Darden School of Business, 100 Darden Blvd. Charlottesville, VA, 22903, United States

1 - Analytics and Optimization for FTE Allocation in IBM GTS

Ali Koc, IBM TJ Watson Research Center, Yorktown Heights, NY, United States, Brian Quanz, Ajay Deshpande

IBM GTS manages hundreds of accounts which are served at various competency levels. Slow response to tickets cause SLA violation. Ticket volumes and FTE are two levers that affects violation risks. We address the problem of optimal FTE allocation for reducing ticket violation risks and total FTE cost across multiple ticket competency levels. We develop and validate multiple machine learning algorithms to relate violation risks to ticket volumes and FTE levels. A forecasting algorithm addresses ticket volume prediction. A global nonlinear optimization algorithm finds optimal FTE levels that both minimize ticket violation risks and FTE costs. We test the overall solution over multiple GTS accounts.

2 - Assessing Investment in Customer Education for a Multi-channel Complex and Prolonged Service

Sara Babaee, PhD Candidate, Wilfred Laurier University, Waterloo, ON, Canada, Mojtaba Araghi, Ignacio Castillo

We study the problem of investing in the quality of customer participation in the service delivery. We focus on services with a high level of customer involvement such as educational services, fitness and weight loss programs. We develop a model that links the investment on facilitating customers' online education to their retention and the corresponding revenue flow. We analyze this model and prescribe an optimal level of the investment in customer participation.

3 - Organizational Buyers Choice of Decision Criteria When Selecting Professional Service Providers

Mahmut Sonmez, College of Business, University of Texas at San Antonio, San Antonio, TX, United States, Xiaoyan Sha

The purchasing of varying levels of professional services has become an increasingly critical component of the modern business firm. Despite the growing presence of services such as: accounting, legal, consulting, training, computing, etc. in the global business world, very little research has been conducted into the selection of decision criteria when purchasing a professional service. A global survey of organizational buyers reveals whether the differences in such demographics as company size, job title, department and type of industry alter the importance of decision criteria when purchasing professional service providers for sales training and negotiations.

4 - Pricing of Access Services

Ozlem Yildiz, Dr., University of Virginia, Darden School of Business, Charlottesville, VA, United States, Dana G. Popescu

In access services such as shared work spaces and parking lots, the consumers pay for the privilege of accessing the firm's facilities. The service capacity is often limited and the firms typically face a mix of consumers with different needs in terms of the time they need to use those facilities as well as different willingness to pay for service. In this paper, we study different pricing strategies for access service systems. We compare the performance of a price-per-service strategy scheme to that of a price-per-unit-time scheme and give insights into the factors that might influence a firm's adoption of one pricing strategy over the other.

■ SA05

JW Tulum G

Transportation and Vehicle Routing problems

General Session

Chair: Libertad Tansini, UDELAR, Montevideo, 11900, Uruguay

1 - Transit Network Design Considering Turns

Antonio Mauttone, Universidad de la República, J Herrera y Reissig 565, Montevideo, Uruguay, Paula Riganti

The optimization of transit routes from the perspective of users and operators is known as the Transit Network Design Problem (TNDP). Main parameters of the problem are the origin-destination demand matrix and the network of streets available for defining the routes. We investigate the relevance of considering turns into the model. A turn entails a change of street with a corresponding speed decrease, thus increasing the cost for both users and operators. We propose a new turning model and we conduct several computational experiments using real data, to show the importance of turns in the TNDP.

2 - A Matheuritic for the Locomotive Assignement Problem with DP

Camilo Ortiz-Astorquiza, Departamento de Matemáticas, Pontificia Universidad Javeriana, 2920, Chemin de la Tour, Bogota, Colombia, Jean-Francois Cordeau, Emma Frejinger

In this talk we present a Benders-based matheuristic for a general variant of the Locomotive Assignment Problem. The problem under study considers the operation mode of the trains in the decision process as well as the optimal assignment of locomotive types to scheduled trains while ensuring power requirements and flow balance. We also consider other operational constraints and preferences. We thus present a model in the context of network design, discuss the complexity of an IP formulation and present computational results to assess the performance of the proposed matheuristic.

3 - A Multi Phase Methodology for the MDVRP with Limited Supply Capacity at the Depots

Libertad Tansini, UDELAR, J Herrera y Reissig 565, Montevideo, 11900, Uruguay, Omar Viera, Pedro Piñeyro, Sandro Moscatelli, Javier de Prado

This work tackles the MDVRP where each depot has a finite supply capacity to meet the customers demand. We propose a multi phase methodology (MPM), that extends the "cluster first, route second" approach. It is based on iterative routings to find and reassign misplaced customers with the objective of improving the final routing. Several assignment and routing algorithms are considered to evaluate the proposed methodology under different settings.

A comparative study of MPM against an exact solution method and other approaches in the literature shows that the instantiated MPM yields competitive heuristics that can be successfully applied to the capacitated MDVRP and other related variants.

4 - Analyzing the Influence of Service Quality Factors on Ride Sharing

Aledia Bilali, BMW AG, Parkring 19, Garching, 85748, German, Florian Dandl, Ulrich Fastenrath, Klaus Bogenberger

Ride sharing demand will potentially increase with higher user convenience, however constraints on service quality parameters, such as detour time, waiting time of the customer or the time to board or disembark the vehicle, decrease the portion of trips that can be shared, a quantity called shareability. This study investigates this trade-off for various ride sharing demand levels, by means of analytical modeling and simulations. Therefore we create a model for operators to examine the shareability rate that can be reached when offering different quality of service for the customers.

■ SA06

JW Tulum H

Supply Chain Coordination and Optimization

General Session

Chair: Lian Qi, Rutgers University, Piscataway, NJ, 08854, United States

1 - Energy Sharing as An Opportunity for Managing Distributed Energy Resources

Ruwen Qin, Missouri University of Science & Technology, 218 Engineering Management Building, 600 W. 14th Street, Rolla, MO, 65409, United States

Distributed energy resources (DERs), such as photovoltaic systems, wind turbines, and energy storage systems, are small-scale power generation sources. DERs can operate as either standalone energy systems or grid-connected systems. The traditional way that utility companies manage the distribution of electricity to end-users is challenged by the increasing number of DERs connected to the distribution network. This presentation discusses energy sharing as an alternative approach to the management of DERs. A system of systems (SoS) architecture is proposed for individual energy sharing communities. The SoS characteristics of energy sharing community (e.g., autonomy, belonging, connectivity, diversity, and emergence) are analyzed from the view of supply chain management.

2 - Policy, Process, and Behavior Analysis for Healthcare Service Systems

Zheng Zeng, Rutgers University, Piscataway, NJ, United States, Xiaowei Xu, Lian Qi, Fulai Gu

In China, high aging level, basic coverage of public health insurance, and steeply increased medication costs lead to plenty of challenges in healthcare system. In this project, we study China's 2017 healthcare reform that caps hospitals' profit margin on medicine, but allows hospitals to raise service fees. We tackle the large datasets from the First Affiliated Hospital of the Dalian Medical University and conduct policy, process and behavior analysis to investigate the impact on the behaviors of patients and physicians. The dataset contains patient, physician, medical cost, and the detailed treatment records (2.5M inpatients per year) from Jan. 2011 to Dec. 2018, which enable us to further analyze the effects of policy changes on different disease groups, different physician types, and patients from different socio-economic strata. The research results are set to offer policy makers, insurers and healthcare service providers guidance to develop more effective policies, cost structures and service/capacity plans.

3 - Logistic Cost Impact in the Supplier's Selection; an Empirical Study

Marvin Gonzalez, College of Charleston, 6 Liberty Street, Charleston, SC, 29424, United States, Maria Urbina, Gioconda Quesada, Robert Hogan

Purpose- the objective of this research is to create a strategic frame of the costs of logistics in the manufacturing industry, as a case study. A detailed analysis of each factor involved in the determination of logistics costs was conducted. The purpose of this document is threefold: (a) to identify in detail the main components of the cost of information (b) to create an identification methodology for the manufacturing industry and (c) to clarify the practical and analytical implications of the proposed model. Design/methodology/approach- an extensive literature review was conducted in the area of logistic cost. In this section the authors present the theoretical evidence obtain in the literature. The review started with the most common logistics cost involved in the company and review some cost models available. Findings- the authors found several models that help industry to select their suppliers, when the main decision driver is cost. In general, costing methods available do not present the detailed explanation of the costs involved in any selection decision. Research limitations/implications- in the automobile and manufacturing industry the number of suppliers and the selection criteria is wide and complicate. Flexibility, lead time, quality and finally cost are the drivers that companies used in order to select their suppliers. In general cost represents an important element, but not a critical one. The authors developed several flowcharts to standardize the most common and representative logistic costs, using the automobile and manufacturing industry as an example. By gathering information about logistic cost, companies can increase the efficiency and control the real manufacturing cost. Practical implications- For practitioners, this study intend to define the steps in the supplier selection process as well as to list all the relevant logistic cost that impact the total manufacturing cost. Identification of each approach is based on dynamic analysis variable study that is also known as brainstorming. Originality/value- The researches available do not mention the specific structure and categorization of logistic cost. Flowcharts of the most representative logistic costs are designed to help companies choose the best suppliers when cost is the primary driver. This paper presents a real application of Cost Analysis Techniques that could help manufacturing organizations to better determine logistic costs.

■ SA07

M-Maya VI

Tutorial: Criterion Space Search Algorithms for Multi-objective Mixed Integer Programming

Emerging Topic: Tutorial

Emerging Topic Session

Chair: Pano Santos, Gurobi Optimization, Beaverton, OR

1 - Criterion Space Search Algorithms for Multi-objective Mixed Integer Programming

Martin W. Savelsbergh, Georgia Institute of Technology, School of Industrial and Systems Engineering, Atlanta, GA, 30332-0205, United States

Multi-objective optimization problems are pervasive in practice. In contrast to single-objective optimization, the goal in multi-objective optimization is to generate a set of solutions that induces the Pareto front, i.e., the set of all nondominated points. A nondominated point is a vector of objective function values evaluated at a feasible solution, with the property that there exists no other feasible solution that is at least as good in all objective function values and better in one or more of them. Recently, criterion space search algorithms, in which the search for the Pareto front takes place in the space of the vectors of objective function values, i.e., the criterion space, have gained in popularity. These methods exploit the advances in single-objective optimization solvers, since they repeatedly solve single-objective optimization problems. We will introduce and discuss criterion space search algorithms for both pure and mixed multi-objective integer programs.

■ SA08

M-Maya VII

Trends in Healthcare

General Session/Practice Session

Chair: Eva Lee, Georgia Tech, Atlanta, GA, 30332-0205, United States

1 - Assessing the Benefits of Reducing HIV Diagnosis Delay and Increasing Adherence to HIV Treatment

Evin Jacobson, CDC, 1600 Clifton Road MS E-48, Atlanta, GA, 30333, United States, Zihao Li, Paul Farnham, Stephanie Sansom

We used an agent-based simulation model to follow for 20 years a representative cohort of persons infected with HIV in the year 2015. We assessed the benefits of diagnosing HIV early and taking HIV antiretroviral therapy (ART) as prescribed on the percentage of persons surviving 20 years after infection and their average annual HIV transmission rate. Persons living with HIV or at risk of acquiring it can enhance their survival and greatly reduce their risk of sexual transmission to partners by frequent testing for HIV and, among those diagnosed with HIV, adhering to ART.

2 - Assessing the Potential Impact of a Kidney Exchange Program in Mexico

Yessica Reyna Fernández, Lic., Universidad Autónoma de Nuevo León, San Nicolás de los Garza, Mexico, Roger Z. Rios, Homero Zapata Chavira

A case study of optimal kidney transplant assignments in the state of Nuevo Leon, Mexico, is presented. The study, carried out by using data from the Mexican population, obtained from patients on the waiting list or in hemodialysis that pretends to assess the potential impact of a kidney exchange program in Mexico. Several scenarios depending on whether cycles and/or chains are allowed in the optimization model are explored. The results indicate a positive impact resulting in significant reductions in the patient waiting list.

■ SA10

M-Acapulco

Clique Relaxations

General Session

Chair: Baski Balasundaram, Oklahoma State University, Stillwater, OK, 74078, United States

1 - Robust Low-Diameter Subgraphs

Baski Balasundaram, Oklahoma State University, Industrial Engineering & Management, Stillwater, OK, 74078, United States, Yajun Lu, Hosseinali Salemi, Austin Buchanan

Cliques and their graph-theoretic generalizations are frequently used to model tightly knit clusters in graphs. One such model is the s-club, which is a vertex set that induces a subgraph of diameter at most s. This model has found use in a variety of fields because low-diameter clusters have practical significance in many applications of graph-based data mining and in the analysis of complex networks. As low diameter requires the presence of short paths in the induced subgraph, this property is not hereditary on vertex-induced subgraphs. Consequently, the diameter of a subgraph could increase upon the removal of some vertices, and could even become disconnected. The pursuit of a "robust" extension of the s-club model spawned the r-robust s-club model variant that we discuss in this talk. We address the complexity of the feasibility testing and optimization problems associated with these variants, propose cut-like formulations, and explore algorithmic ideas to solve benchmark instances with several thousand vertices.

2 - Notes on the Bandwidth Coloring Problem and IP / CP Models

Rosiane de Freitas, Associate Professor, PhD, UFAM, Manaus, Brazil, Nelson Maculan

We present recent results obtained on the Bandwidth Coloring Problem (BCP) and variations. In the BCP, given a graph, its vertices must be colored such that not only adjacent ones do not share the same color, and their colors must be separated by a minimum given value. These problems constitute models for real applications, such as the Minimum Span Channel Assignment Problem (MS-CAP). We present algorithmic strategies based on CP/IP models and heuristics, and the performance of such methods is tested on artificial, and real scenarios benchmarks, such as GEOM, Philadelphia, and Helsinki sets. We achieve optimal solutions or provide better upper bounds for these well-known instances.

3 - Automatic Text Summarization Using Graph Algorithms

Javier Ramírez Rodríguez, Profesor Investigador, Universidad Autónoma Metropolitana, Ciudad de México, Mexico

A graph approach is proposed for the generation of Automatic Text Summarization task, that consists of extracting relevant sentences of a text, according to their content. Using classical techniques of Natural Language Processing, a free-form textual document is pre-processed in order to generate a matrix TS with P phrases and M words. The matrix is then processed in order to construct a graph, the vertices represent the sentences and the edges the shared terms. The retained phrases are assembled in order of appearance and apply slight post-processing to generate a summary by extraction. This method does not need any learning resource and is language and thematic independent.

4 - Finding the Longest Path in a Structurally Perturbed Directed Acyclic Graph

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

In a perturbed Directed Acyclic Graph (PDAG) multiple edges are added and deleted simultaneously. This research finds the length of the longest path in PDAGs. The applications of this problem are in manufacturing systems, transportation, telecommunications, etc. Existing solutions consider a single edge addition/deletion at a time. However, this research proposes an algorithm to use as much as possible information from the graph before perturbations and handle all deletions/additions through a single pass. The worst time complexity of this solution is better than existing ones.

■ SA11

M-Mexico

Customer Driven Revenue Management and Product Assortment

General Session

Chair: Gonzalo Romero, Rotman, University of Toronto, Toronto, ON, M4K 3H6, Canada

Co-Chair: Dragos Florin Ciocan, INSEAD, Fontainebleau, France

1 - Efficient Strategic-Level Repositioning in Vehicle-Sharing Networks

Gonzalo Romero, Rotman, University of Toronto, Toronto, ON, M4K 3H6, Canada, Mahsa Hosseini, Joseph Milner

We propose a modeling framework to study the dynamic problem of repositioning vehicles using steady state behavior for a network with centralized control and uncertain, unbalanced demand. Applications include vehicle sharing with one-way rides such as bike-share and floating-license car sharing, taxi networks with centralized direction including those with autonomous vehicles, and logistic networks with anticipatory positioning of resources.

2 - Revenue Management with Repeated Interactions

Florin Ciocan, INSEAD, France, Gonzalo Romero, Andre Du Pin Calmon

We model and analyze a revenue management problem where a platform interacts with a set of customers over a number of periods. Unlike traditional network revenue management, we consider customers who can dynamically change state between peri- ods. A customer's state depends on the quality of their past service and determines the amount of budget that they allocate to the platform. These dynamics create a trade-off between the platform myopically maximizing short-term revenues, versus maximizing the long-term goodwill of its customers. We identify a set of reasonable condi- tions under which myopic policies that ignore the budget dynamics are either optimal or near-optimal and show that, in general, finite look-ahead policies can perform arbitrarily poorly in this repeated setting.

3 - Assortment Planning with Customer Reviews

Denis Saure, Assistant Professor, University of Chile, Republica 701, Santiago, 8370439, Chile, Felipe Carrasco

We study dynamic assortment planning for a retailer in settings when customers make purchase decisions following a discrete choice model. However, we assume that customers have incomplete information pertaining the product's quality, which we assume as random. By observing consumer reports, customers refine their knowledge on the products' qualities, and thus improve their purchase decisions. We study the dynamics of the customers beliefs about the products qualities under various modes of consumer reporting, and analyze their implications on social learning, as well as on the ability of the retailer to manipulate such a leaning to his/her advantage.

■ SA12

M-Cozumel

Telecommunications and Network Analytics

General Session

Chair: Eduardo Moreno, Universidad Adolfo Ibanez, Santiago, 837-0294, Chile

1 - Analytical Method for Dimensioning Dynamic WDM Optical Network

Marta Barria, Universidad de Valparaíso, Valparaiso, Chile, Reinaldo Vallejos, Nicolas Jara, José Manuel Martínez

A long-standing problem in optical networks has been to provide some end-to-end quality level to all the users, despite the existence of multiple classes of users. Quality level means, here, maximal user blocking probability. Remark that we consider optical networks with dynamic network operation and full wavelength conversion capabilities. In this work, we develop an analytical method to compute, for each user class, a minimum number of wavelengths while ensuring a minimum quality of service to all users. The proposed analytical method is very fast and can be used on-line by network operators.

2 - A Routing and Spectrum Allocation Solution for Elastic Optical Networks with Static Network Operation

Jesenia Salazar, Universidad Santa María, Valparaiso, Chile, Nicolas Jara, Reinaldo Vallejos

We present a heuristic method to solve the routing and spectrum allocation problem in elastic optical networks with a static operation for ring topologies. The strategy arranges the requests in decreasing order, prioritizing its route length over the spectrum demands. We use the ring topology as an advantage, allocating the users in spiral order. Each user utilizes a fixed shortest path and the spectrum allocation employed is the First-fit scheme. This strategy has a near-optimal performance when an optimal solution is possible and outperform methods in literature in the remaining scenarios.

3 - An Exact Method Based on Adaptive Partitions for the Stochastic Fixed-charge MCF

Eduardo Moreno, Universidad Adolfo Ibanez, Avda Diagonal las Torres 2700, Of 537C - Penalolen, Santiago, 837-0294, Chile, Cristian Ramirez Pico

We study the classical Stochastic Fixed Charge Multicommodity Flow (SFCMF) problem under stochastic demand as a Two-Stage Stochastic Program. We propose an adaptive partition-based resolution method where using a relaxation of the original problem exploits some special features of its solution, yielding an algorithm converging in a finite number of iterations to the optimal solution. Mainly, the method is based on the aggregation of an exponential number of constraints and variables, since a partition includes a subset of added constraints, one per scenario. Also, each is scenario variable is added with the other ones belonging to the same partition. At each iteration, the algorithm refines quality of the partitions, improving the lower bound by solving a "Master problem" and, also, enhances the upper bound by solving the subproblems generated once we fix the first stage solutions. The experimental results and benchmark against classical methods will be shown.

4 - The Multi-period Multi-commodity Network Design Problem

Ioannis Fragkos, Rotterdam School of Management, Rotterdam, Netherlands

The multi-commodity network design problem is an archetypal model that arises in a variety of transportation systems. Motivated by practical applications, we focus on a multi-period setting, where commodity demands expand over a discrete time horizon. Our model captures a key trade-off: the earlier an arc is opened, the more periods it can be used for, but its fixed cost is higher, since it accounts for construction, maintenance and operation over the remaining horizon. We develop decomposition algorithms and a heuristic that separates the arc selection and opening decisions. Finally, we provide computational results and insights on the structure of solutions of realistic freight rail networks.

Sunday, 2:30pm- 3:20pm

■ Keyote

Decision Science Inspired by Nature

Keynote Session

JW Tulum E

1 - Decision Science Inspired by Nature

Alice E. Smith, Auburn University, 3301 Shelby Center, Dept of Industrial/Sys Engineering, Auburn, AL, 36849, United States

This talk will put forth several straightforward but successful implementations of analytical approaches inspired by natural systems. These nature-based paradigms range in fidelity with their natural systems origins but all seek to leverage the structures and operations of nature doing what it does best - novelty detection, system optimization, adaptability to dynamic environments, robustness, and flexibility. More specifically, the well-known, but often misunderstood and misused, natural system computational paradigms of artificial neural networks, fuzzy logic, and evolutionary algorithms will be considered for use in decision science. Used judiciously and knowledgeably these approaches can offer significant advantages in diverse decision environments. A curated selection of diverse applications from the speaker's more than 25 years of experience in this field will be explained and objectively analyzed. The applications are (1) quality and process improvement of large-scale ceramic casting, (2) real-time placement of drones for ad hoc network connectivity, (3) continuous monitoring of vehicles for predictive maintenance, (4) the location of semi-obnoxious facilities in municipalities considering transport costs and social costs, and (5) the design of large order picking warehouses considering travel distance.

Sunday, 4:00pm - 5:30pm

■ SB01

JW Tulum A

Supply Chain Modeling

General Session

Chair: Fereshteh Mafakheri, Concordia University, Montreal, QC, H3G 1M8, Canada

1 - Evaluating the Supply Routing Tactics in a Global Multi-Facility Network

Seyed Mehdi Zahraei, Assistant Professor, Embry Riddle Aeronautical University, Miami, FL, United States, Chee-Chong Teo

With globalization of business, firms are sourcing and distributing components and finished goods across the globe. One of the important outcomes of geographically dispersed facilities is long replenishment lead-times which in turn lead to substantial imbalances between the facilities where some facilities have excess inventories while others have lower than desired inventory levels. In this study, we conduct a series of simulation experiments to provide managerial insights on the deployment of supply routing tactics under different exogenous operating conditions in terms of suppliers, network configurations and product types.

2 - An Effective Method to Solve the Call Center Staffing with Service-level Agreement under Uncertainty

Gianmaria Leo, IBM, Munich, Germany, Renzo Benavente Sotelo, Julio C. Casas Quiroz, Victor Terpstra

The call center staffing is a challenging business practice that aims to minimize the workforce costs, while the committed service level is met. The relevant stochastic nature of the problem leads to the design of complex methods that are often computationally intensive or hard to maintain. However, scaling and flexible solutions with reduced time-to-market turn out to be an essential need for the business. Our work focuses on a call center line managed by a major Bank of Peru. We introduced a simheuristic that we compared with a more typical approach adopted in the industry. The new method reduces the computational time from hours to few minutes, by preserving quality and accuracy required in production.

3 - A Comparative Analysis of Cooperative and Non-cooperative Bioenergy Supply Chain Coordination for Northern Canada

Fereshteh Mafakheri, Concordia University, Montreal, QC, Canada, Dotun Adebanjo, Audley Genus

This study investigates the supply chain coordination strategies in cooperative (joint pay-off for players) and non-cooperative (conflicting payoffs for players) settings in case of biomass supply to northern communities. The proposed multiple objective coordination model addresses the restricted ordering schedules (due to unavailability of pathways) through quantity discounts and coordinated/collective inventories.

■ SB02

JW Tulum B

Advances in Management of Risk

General Session

Chair: Manel Baucells, PhD, Darden School of Business, Charlottesville, VA, 22903, United States

4 - Mutual-excitation Relationship in Stock Prices

Muneki Kawaguchi, Mitsubishi UFJ Trust Investment Technology Institute Co., Ltd, Tokyo, Japan

There are various relationships between stock prices. The co-movements of stock prices are caused by the fundamental relationship, such as supply chain relationships, the change in the supply and demand of investors. In this paper, we analyze the mutual-excitation relationship of stock prices using high-frequency data and multivariate Hawkes processes. Hawkes process has the structure that event occurrences excite the intensity of the event occurrence or other event occurrences. We analyze the mutual-excitation relationship on the intensity of stock price changes.

5 - Importance Sampling for Systemic Risk Estimation under Dynamic Volatility Matrix Models

Chuan-Hsiang Han, Associate Professor, National Tsing-Hua University, Hsinchu, Taiwan

This paper proposes a two-step procedure for systemic risk estimation under the stochastic volatility/correlation models. The first step utilizes Fourier transform method for dynamic volatility matrix estimation, and the second step develops efficient importance sampling estimators for extreme event probability. For the empirical analysis, we find that the systemic risk can be useful to measure the stability of financial system because it seems be able to provide early signs for institutions in U.S. during the 2008-2010 financial crisis. Moreover, it can serve as a predictor of the capital injections during the crisis. SRISK in China and Taiwan are also compared.

1 - The Satiation Model: Foundations and Applications

Manel Baucells, University of Virginia, Darden School of Business, Charlottesville, VA, 22903, United States, Lin Zhao

Satiation is an essential factor influencing the design of experiential services. We provide behavioral foundations for the satiation model in continuous-time, and a novel proof of concept on how to elicit the preference parameters, including the state's initial level and decay rate, the discount rate, and the instant utility. Our preferences exhibit, in addition to the traditional discounting and smoothing motives, a de-satiation motive. On the implementation side, we develop a mixed integer formulation to solve the optimal design of experiential services. Finally, we discover an equivalence between event utility and recall utility.

2 - Benchmarked Stochastic Dominance

Rachel Huang, National Central University, Taoyuan City, Taiwan, Larry Y. Tzeng, Lin Zhao

The decision analysis literature has provided two common ways to characterize decision makers: One assumes the utility function of decision makers, and the other characterizes preferences by some properties. While the findings by using the first approach is limited to the specific utility functions, the second approach is too general and the rules are too demanding in applications. In this paper, we establish a consensus decision rule to rank distributions in between these two approaches, which is referred as "benchmarked stochastic dominance." We first specify one benchmark utility function. Then, we broaden the set of decision makers by allowing their preferences being "not too different from" the benchmarked utility function. The probability premium and risk premium approaches are adopted as the foundation to measure the closeness of preferences. The equivalent distribution conditions for the new rules are examined. Our rules include the traditional and almost stochastic dominance as special cases.

3 - Markov Decision Model for the Outsourcing Analysis in Closed-loop Supply Chains for Hazardous Materials

Victor Rayas, ITESM, 2514 Avenida General Ramon Corona, Guadalajara, 45138, Mexico

Companies around the world considers outsourcing as an option for some non-core functions of its supply chain in order to focus on the core activity and reduce risks and costs. Through this research, the current situation of the closed-loop supply chain systems for the hazardous materials is outlined and the activities likely to be outsourced are analyzed. A Markov decision model is developed to support outsourcing decisions for each one of these activities. The models are based on the risk levels and sales behavior of the product considered. The conditions for an optimal monotone nonincreasing policy are identified, which provides valuable insights for decision-makers involved in such systems.

■ SB03

JW Tulum C

Machine Learning and Data Analytics for Additive Manufacturing

General Session

Chair: Qiang Huang, University of Southern California, Los Angeles, CA, 90089, United States

1 - A Convolution Framework for Learning and Predicting 3D Printing Shape Accuracy

Qiang Huang, University of Southern California, Dept. of Industrial & Systems Engineering, Los Angeles, CA, 90089, United States

Geometric shape accuracy is an important quality measure for products built by additive manufacturing (AM) processes. With increased availability of AM product data and advances in computing, Machine Learning for AM (ML4AM) has become a viable strategy for enhancing printing performance. We propose a Shape Deviation Generator (SDG) under a novel convolution formulation to facilitate the learning and prediction of 3D printing accuracy. Shape deviation representation, individual layer input function and transfer function for the convolution formulation are proposed and derived. A deconvolution problem for identifying the convolution kernel is formulated to captures the inter-layer interaction effects in the layer-by-layer fabrication processes. The printed 2D and 3D shapes via a stereolithography (SLA) process are used to demonstrate the proposed modeling framework and derive new process insights for AM processes.

2 - A Data-driven Approach for Process Optimization of Metallic Additive Manufacturing under Uncertainty

Lei Chen, Mississippi State University, MS, United States, Zhou Wang, Peng Liu, Yaohong Xiao, Sankaran Mahadevan, Zhen Hu

The presence of various uncertainty sources in metal-based additive manufacturing (AM) process prevents producing AM products with consistently high quality. Using electron beam melting (EBM) of Ti-6Al-4V as an example, this paper presents a data-driven framework for process parameters optimization using physics-informed computer simulation models. The goal is to identify a robust manufacturing condition that allows us to constantly obtain equiaxed materials microstructures under uncertainty. To overcome the computational challenge in the robust design optimization under uncertainty, a two-level data-driven surrogate model is constructed based on the simulation data of a validated high-fidelity multi-physics AM simulation model. The robust design result, indicating a combination of low preheating temperature, low beam power and intermediate scanning speed, was acquired enabling the repetitive production of equiaxed-structure products as demonstrated by physics-based simulations. Global sensitivity analysis at the optimal design point indicates that among the studied six noise factors, specific heat capacity and grain growth activation energy have largest impact on the microstructure variation. Through this exemplar process optimization, the current study also demonstrates the promising potential of the presented approach in facilitating other complicate AM process optimizations, such as robust designs in terms of porosity control or direct mechanical property control.

3 - Physics Based Compressive Sensing for Additive Manufacturing Process Monitoring

Yan Wang, Georgia Institute of Technology, Atlanta, GA, United States, Yanglong Lu

The reliability and cost of sensors and communication bandwidth limit are challenges in modern manufacturing systems. We developed a physics based compressive sensing approach to monitor processes, which significantly improves the compression ratio from classical compressed sensing by incorporating physical knowledge. From limited measurements and finite-element alike models, unobservable quantities such as 3D temperature distributions and fluid flows in additive manufacturing can be obtained, with a new constrained OMP algorithm and a domain decomposition method.

4 - Splines with Optimized Knot Locations for Data Approximation and Application in Change Point Detection

LATE CANCELLATION

Zheng Wang, Assistant Professor, Northern Illinois University, DeKalb, IL, United States, Minfei Xie

Spline-based models can be a very useful tool in modeling time series data, sensor collected data, urban and natural terrain data and in recognizing patterns and objects of problem-specific interest. Recent development of L1 splines show robustness and computational efficiency over conventional ones. To further expand the modeling capability of L1 splines, this research optimizes the location of spline knots which allow the spline to more accurately capture the data shape. Application on change point detection is demonstrated.

■ SB04

JW Tulum F

Operations/Marketing Interface

Contributed Session

Chair: Naeem Bajwa, PhD, University of Arkansas at Little Rock, College of Business, 2801 South University Ave. Little Rock, AR, 72204-1099, United States

1 - Self Pricing Beating in a Market with Preference Interdependence and Uncertainty

Ting Luo, California State University - Fullerton, Fullerton, CA, United States

Self price beating pricing strategy promises the early buyers that if the seller lowers the price in the later period, an ex-post price refund that is more than the price difference will be refunded to them. We study self price beating as a pricing policy when there is market externality and uncertainty. We find this strategy blends advantages of both price commitment and no price commitment, and it produces the highest total profit as well.

2 - Fit-revelation Sampling and Advertising: Complements or Substitutes?

Shiming Deng, Professor, Huazhong University of Science and Technology, Wuhan, China, Lingli Wu, Rachel Rong Chen

We develop an analytic model to examine whether fit-revelation sampling is complementary or substitute with persuasive and market expansion (ME) advertising, respectively. We characterize conditions under which it is optimal to do sampling alone, persuasive/ME advertising alone, or a joint offering of both. Our findings shed light on the optimal pricing and selling strategies for markets characterized by consumerfit uncertainty.

3 - When Do Firms Benefit From Competition?

Zhengping Wu, Syracuse University, Syracuse, NY, United States, Yiqi Sun, Wanshan Zhu

This talk considers the optimal decisions of firms under joint price and lead-time competition, and examines the impact of competition on firm profit. Surprisingly, we find that firms can benefit from competition under certain parametric conditions.

4 - Coordinating Pricing Decisions for Strategic Customers

Naeem Bajwa, University of Arkansas at Little Rock, Little Rock, AR, United States

This research addresses issues related to optimal pricing for strategic customers. Instead of a sequential decision-making process where marketing decides selling prices and operations determines a production plan, the organization can benefit from coordinated and simultaneous decisions. The situation is relevant to a manufacturer with capacity constraints, producing multiple products, and selling these products through online and traditional sales channels.

■ SB05

JW Tulum G

Public Transportation

Contributed Session

Chair: Yajaira Cardona, Universidad Autónoma de Coahuila, Saltillo, Mexico.

1 - Optimal Slack Times for a Bus Route Schedule with Passenger Information

Jillian Cannons, Assistant Professor, Cal Poly Pomona, Pomona, CA, United States

Public transit timetabling aims to determine departure and arrival times for routes in a network. In this work, we develop a stochastic linear program to select slack times (extra time added into a schedule to mitigate the effects of the random nature of travel times) to minimize the expected total schedule deviation for a single bus line. We incorporate two operational strategies, namely drivers' schedule recovery and the holding control strategy. Finally, numerical comparisons of the optimal schedules produced for hypothetical urban and express bus routes are given.

2 - Heuristic for a Bus Routing Problem

Yajaira Cardona-Valdés, Universidad Autónoma de Coahuila, Saltillo, Mexico, Oliver Avalos-Rosales, Mayra Juárez-Peláez

We address a school bus routing problem (SBRP). A set of potencial bus stops and a set of students are given. The SBRP aims to select a subset of stops that will be visited by the buses, assign each student to a bus stop and determine a set of routes that minimize the total distance travelled by all buses. Each route begins from a bus station, visits its assigned bus stops and ends in the school. We present a hybrid constructive heuristic based on the Clarke and Wright algorithm where feasibility is verified by solving a mathematical model.

3 - Satisfaction Model for Bus-Type Public Transport Users

Jorge Eliecer Cordoba, National University of Colombia-Medellin, Medellin, Colombia, Julieth Katherine Heredia

A public transport user satisfaction model was developed from Hybrid discrete choice models, which allowed to construct the latent variable satisfaction and establish new relationships between this and the main variables of perception found: image, social norm and satisfaction. In the present article the case study was applied to two bus routes in the city of Medellin. Among the main results is that 81% of users are satisfied with the mode of transport they use; it was also found that the satisfaction with the life of the individual, directly influences the other areas of his life; hence, relationships between satisfaction with mode, social norm and image with satisfaction with life can be determined.

■ SB06

JW Tulum H

Operations Planning in Supply Chains

General Session

Chair: Yajaira Cardona, Universidad Autónoma de Coahuila, Saltillo, Mexico.

Co-Chair: Alexandra M. Newman, Colorado School of Mines, Golden, CO, 80401, United States,

1 - Reduction of Co2 in a Transportation Network

Sarahi Berenice Carranza Garrido, Universidad Autónoma de Nuevo León, San Nicolás de los Garza, Mexico
Sarahi Berenice Carranza Garrido, Universidad Autonoma de Nuevo Leon, San Nicolás de los Garza, Mexico,
Jania Astrid Saucedo Martinez

We propose a mixed-integer programming model for a multi-modal transportation problem, where commodities are transported using multiple transportation modes from an origin to a destination, that minimizes carbon emissions, while also considering transportation costs and time. We examine this model using an automotive company case study to prescribe an efficient transportation network with optimized sustainability, use of resources and customer satisfaction.

2 - Impact of Exponential Technologies on Global Supply Chain Management

Unsal Ozdogru, University of Illinois at Chicago, Chicago, IL, United States

Technology has been rapidly evolving over the last several decades and revolutionizing all industries. Leading technologies have been identified as having significant influence on global supply chain operations. We surveyed the literature on the implications of technologies in terms of their potential value creation such as, increasing profit, improving efficiency and agility, reducing cost and lead times, increasing visibility and eliminating waste. Based on the findings, we identified the challenges and limitations of these technologies within supply chain operations.

3 - Evaluating Sustainability of Energy Development using Multi Criteria Decision Analysis: A Case Study on Mexico

Rodrigo Mercado Fernandez, University of Massachusetts - Amherst, Amherst, MA, United States

This paper examines the use of multi criteria decision analysis (MCDA) to evaluate the sustainability of different expansionsin the Mexican Electrical Grid.In particular, we will include the transmission, generation, natural gas and CO2 storage networks into the evaluation of sustainability for each pathway. We use a set of social, economic and environmental criteria to evaluate the sustainability of each expansion plan up to 2050. The goal will be to use the insight of the sustainability of each expansion plan to better inform decision maker in developing energy policy.

4 - Supply Chain Flexibility and Operations Optimization under Demand Uncertainty: A Case in Disaster Relief

Weiwei Chen, Rutgers Business School, Piscataway, NJ, United States, Ju Myung Song, Lei Lei

This paper studies emergency response operations for rescue kits in disaster reliefs, so as to minimize the total and peak tardiness of product delivery over the multi-period horizon. In order to cope with demand uncertainty while maintaining the tractability of the optimization model, we decompose the demand into a relatively stable base demand predicted by historical data and unpredictable demand surges. An optimization model is developed for the former, and supply chain flexibility is deployed for the latter. An empirical study shows the effectiveness of increasing supply chain flexibility and suggests some managerial insights on configuring such flexibility in emergency operations.

■ SB07

M-Maya VI

Tutorial: Solving "Nice" Non-Convex Optimization Problems and its Connections to Training Deep Neural Networks

Tutorial Session

Chair: Andres Gomez, University of Pittsburgh, Pittsburgh, PA

1 - Solving "Nice" Non-Convex Optimization Problems and its Connections to Training Deep Neural Networks

Meisam Razaviyayn, University of Southern California, Los Angeles, CA, 90089, United States

When is solving a non-convex optimization problem easy? Despite significant research efforts to answer this question, most existing results are problem specific and cannot be applied even with simple changes in the objective function. In this talk, we provide theoretical insights to this question by answering two related questions: 1) Are all local optima of a given non-convex optimization problem globally optimal? 2) When can we compute a local optimum of a given non-convex constrained optimization problem efficiently? In the first part of the talk, motivated by the non-convex training problem of deep neural networks, we provide simple sufficient conditions under which any local optimum of a given highly composite optimization problem is globally optimal. Unlike existing results in the literature, our sufficient condition applies to many non-convex optimization problems such as training problem of non-convex multi-linear neural networks and non-linear neural networks with pyramidal structures. In the second part of the talk, we consider the problem of finding a local optimum of a constrained non-convex optimization problem under strict saddle point property. We show that, unlike the unconstrained scenario, the vanilla projected gradient descent algorithm fails to escape saddle points even in the presence of a single linear constraint. We then propose a trust region algorithm which converges to second order stationary points for optimization problems with small number of linear constraints. Our algorithm is the first optimization procedure, with polynomial per-iteration complexity, which converges to ϵ-first order stationary points of a non-manifold constrained optimization problem in $O(\epsilon^{-3/2})$ iterations, and at the same time can escape saddle points under strict saddle property.

■ SB08

M-Maya VII

Health Care I

Contributed Session/Practice Session

Chair: Luis Felipe Dias Lopes, UFSM, Santa Maria, Brazil.

1 - An Empirical Study on Factors Affecting Medical Information Sharing Between Hospitals in China

Liya Wang, Shanghai Jiao Tong University, Shanghai, China

This study examines the factors affecting medical information sharing between hospitals in China. Applying empirical study method, through semi-structured interviews followed by a scenario-based experiment, we classify 5 kinds of factors and examine their effects on promoting medical information sharing. We find that increase of external force, benefit-risk ratio and recognition can significantly promote medical information sharing between hospitals, trust and technical ability have no significant effect.

2 - Flowering and Engagement at Work: A Study under the Vision of Alpha Hospital Staff

Luis Felipe Dias Lopes, UFSM, Santa Maria, Brazil, Adriane Fabricio, Ana Cláudia da Luz

The aim of the study was to identify if there is a relationship between Engagement and Flowering in the Work of Alpha Hospital staff. The technical procedure used was a survey, operationalized from the application of the Flowering Scale at Work - EFLOT and the Engagement at Work Scale in a sample of 53 workers. The results indicate high Flowering and Engagement at Work, that is, these health workers are flourished and feel engaged with their work activities. Still, there is a positive correlation between the phenomena.d in their work activities.

3 - Workplace Wellbeing and Burnout in Penitentiary Work

Luis Felipe Dias Lopes, UFSM, Santa Maria, Brazil, Adriane Fabricio, Jonathan Saidelles Corrêa, Damiana Machado de Almeida

The objective of this study was to analyze the perspectives of correctional officers of the State of Rio Grande do Sul to understand the relationship between Workplace Wellbeing and Burnout. The research shows that Well-being at Work manifests itself partially in officers' routine, while most of them demonstrate low levels of positive affection, low levels of negative affection and high levels of achievement. However, Burnout was not detected, while the majority of the participants evinced high levels of enthusiasm towards job and low levels of psychological exhaustion, indolence and guild.

■ SB10

M-Acapulco

Metaheuristics: New Trends and Problems

General Session

Chair: Eduardo Pardo, Universidad Rey Juan Carlos, Madrid, Spain

Co-Chair: Edgar Possani, ITAM, Mexico City, 01080, Mexico

1 - Multipicker Order Batching Problem in Dynamic Environments

Eduardo G. Pardo, Universidad Politécnica de Madrid, Madrid, 28031, Spain, Sergio Gil-Borrás, Abraham Duarte, Antonio Alonso-Ayuso

This paper deals with a variant of the Order Batching Problem (OBP) in logistic warehouses. This problem consists in grouping the orders that arrive in a warehouse into batches and, later, designing a route to collect them. Each batch is assigned to a single picker, who is responsible for collecting all orders from the same batch. The variant of the problem studied in this paper adds two important characteristics: the orders to be processed arrive to the warehouse continuously during the working day (online) and, in addition, there are multiple pickers available. The objective is to minimize the total collection time. In this work, several heuristic algorithms are proposed.

2 - Solving Large-scale Quadratic Assignment Problem

Bahram Alidaee, University of Mississippi, Marketing Department, School of Business, University, MS, 38677, United States, Haibo Wang

This paper presents a multi-start sequential scatter search algorithm for solving quadratic assignment problem (QAP). We test the algorithm on the QAPLIB benchmark problems as well as newly generated large-scale test problems. We compare the performance of proposed algorithm with two other algorithms: diversification driven tabu search (D2TS) and GRASP with path relinking and give a detailed discussion of the results.

3 - Approximate Algorithms for Real Vehicle Routing Problems with Heterogeneous Fleet and Time Windows

John Escobar, Universidad del Valle, Cali, Colombia, Rodrigo Linfati, Jose Bernal

We proposed metaheuristic algorithms to solve two real cases of HVRPTW. The first case was applied to a franchise company bottling Coca-Cola products in Colombia. In this work, we proposed a Granular Tabu Search algorithm. The second case was applied to the distribution of products from a regional distribution center of a multinational company within the urban perimeter of Cali, Colombia. In this case, we applied a Simulated Annealing Scheme. The proposed algorithms were able to improve solutions applied by the companies by reducing the route length and the number of vehicles.

4 - Stochastic Modeling of Biomass Quality Variability in Biofuel Supply Chain Network Design

Krystel Castillo, University of Texas - San Antonio, San Antonio, TX, United States, Mario Aboytes-Ojeda

The design of biofuel supply chains involves fist-stage decisions such as facility location (i.e., selection of locations for depots to store and preprocess the biomass and biorefineries) and second-stage decisions such as transportation, supply selection and biomass flows. Biomass exhibits a high variability on its chemical and physical properties, which impacts the overall biofuel cost. This problem is formulated as a 2-stage stochastic hub-and-spoke location problem, which is an NP-hard problem. A hybrid meta-heuristic is proposed to solve large-scale problem in a reasonable amount of time.

■ SB11

M-Mexico

Data-Driven Pricing

General Session

Chair: Ioannis Stamatopoulos, University of Texas at Austin, McCombs School of Business, Austin, TX, 78705, United States

1 - Menu Costs and the Bullwhip Effect: Supply Chain Implications of Dynamic Pricing

Ioannis Stamatopoulos, University of Texas at Austin, McCombs School of Business, Austin, TX, 78705, United States

We study the supply chain implications of dynamic pricing. Specifically, we estimate how reducing menu costs — the operational burden of adjusting prices — would affect supply chain stability. We theorize that reducing menu costs would reduce the bullwhip effect by mitigating Lee et al.'s (1997) first bullwhip driver, demand signal processing. We test this prediction by fitting a structural econometric inventory model to data from a large Chinese supermarket. We estimate that removing menu costs would stabilize the supply chain, but not by mitigating Lee et al.'s first bullwhip driver as we had predicted, but by mitigating Lee et al.'s third bullwhip driver, order batching. Specifically, we estimate that removing menu costs would cut the average batch size by 5.0 percent, which would decrease the average standard deviation of orders by 3.9 percent.

2 - Click-Based MNL: Algorithmic Frameworks for Modeling Click Data in Assortment Optimization

Jacob Feldman, Olin Business School, Saint Louis, MO, 63108-1291, United States, Ali Aouad, Danny Segev, Dennis Zhang

In this paper, we introduce and study the click-based MNL choice model, a novel framework for capturing the customer purchasing decisions in e-commerce settings. Our main modeling idea is to assume that the click behavior within product recommendation or search results pages provides an exact signal regarding the alternatives considered by each customer. We investigate the resulting assortment optimization problem, where the objective is to select a subset of products, made available for purchase, to maximize the expected revenue. Our main algorithmic contribution comes in the form of a quasi-polynomial-time approximation scheme (QPTAS) for this problem, showing that the optimal expected revenue can be efficiently approached within any degree of accuracy. Furthermore, we present a case study whereby click-based MNL models and standard MNL models are fitted to historical sales and click data, acquired in collaboration with the online retail giant Alibaba.

3 - Sophistication in Decentralized Platform Price-Setting: Evidence from Fiverr.com

Robert E. Sanders, Assistant Professor of Marketing, University of California, San Diego, CA, United States

Large online platforms often decentralize seller prices entirely, leaving the pricing decisions up to the agents themselves. However, it is unclear if sellers possess the sophistication to set optimal prices in their own interest, much less in the interest of the platform. Using data from a large freelance platform, Fiverr.com, I find evidence that most sellers are not pricing in a manner consistent with profit maximization, but those who do earn higher revenues. I propose a field experiment to identify the cause of seller mis-pricing and identify a structural model price-setting behavior.

4 - Fake News Propagation and Detection
Yiangos Papanastasiou, University of California - Berkeley, Berkeley, CA, United States

We consider the problem faced by a social media platform that is observing the sharing actions of a sequence of rational agents and is dynamically choosing whether to conduct an inspection (i.e., a "fact-check") of an article whose validity is ex ante unknown. We present results pertaining to: (i) the properties of the agents' sharing behavior; (ii) the structure of the platform's optimal inspection policy; and (iii) the impact of fake news on the society's learning environment.

■ SB12

M-Cozumel

Telecommunications

Contributed Session

Chair: Ruben Rodriguez, Universidad del Norte, Km.5 Vía Puerto Colombia, Barranquilla, 080001, Colombia

1 - Network Planning of Broadband Wireless Networks
Ramesh Bollapragada, Professor, San Francisco State University, San Francisco, CA, United States

We discuss network planning for broadband converged voice, data and video networks for Broadband Wireless Service Providers. The network planning methodology is implemented in 4 phases: scenario planning, cluster analysis to identify pockets of demand, hub configuration planning (RF design), end-to-end economic analysis of networks and network architecture design. Decision Support tools are implemented to model the above four phases of planning.

2 - Quality of Service Provision in Dynamic WDM Optical Networks with Wavelength Continuity Constraints
Nicolás Jara, Universidad Técnica Federico Santa María, Valparaíso, Chile, Hermann Pempelfort, Jesenia Salazar, Reinaldo Vallejos

A crucial issue in optical networks is to provide some end-to-end quality of service (QoS) to all the users, notwithstanding the existence of many classes of users. QoS means, here, a maximal user blocking probability. Despite these remarks, the usual wavelength dimensioning approaches in optical networks with wavelength continuity constraints do not consider this situation. This circumstance drives to dimension more network resources than needed. Consequently, we present here two strategies to obtain a closer gap between the offered QoS and the one demanded, generating network cost savings.

3 - Flexible Network Design Utilizing Non Strict Modeling Approaches
Fabion Kauker, Product Architect, 3-GIS, Decatur, AL, United States

By testing a modelling approach that utilizes minimal rules and constraints against an explicit exhaustive mixed integer programming method the research presents an alternative approach. Trade offs of time, effort, compliance, configuration and usability are considered and analyzed. By utilizing approaches from Hedge et al. 2015, Ljubi et al. 2006, and Teitz et al. 1963 much of the traditionally manual process can be automated. Further we demonstrate that a hybrid approach can enhance the productivity and usability of network planning software for telecommunications.

4 - Implementing the System Optimal (SO) Solution for the Discrete Network Design Problem (DNDP) Subject to User Equilibrium (UE) Conditions
Ruben Rodriguez, Universidad del Norte, Km.5 Vía Puerto Colombia, Barranquilla, Colombia, Guisselle Garcia

This research proposes a Decision Support System (DSS) for the DNDP (DSS-DNDP) that sequentially solves two mathematical models, instead of the well-known bi-level model. First, the selection of improvement strategies was performed with an SO traffic assignment model. Then, the User Equilibrium Modified model (UEM) is used to compute the optimal mechanisms to implement in the network so that the users will adopt the SO solution, while respecting the UE constraints. For this method, a Branch-and-Bound algorithm was implemented for the SO, whereas a novel Frank-and-Wolfe-based algorithm, for the UEM. Numerical results show that this method has an acceptable solution quality and solution time.

Monday, 9:00am - 10:30am

■ MA01

JW Tulum A

Recent Advances in Midwest Applied Probability

General Session

Chair: Chang-Han Rhee, Northwestern University, Chicago, IL, 60613, United States

1 - Accelerating Nonconvex Learning via Replica Exchange Langevin Diffusion
Yi Chen, Northwestern University, Evanston, IL, United States

Langevin diffusion is a powerful method for nonconvex optimization, which enables the escape from local minima by injecting noise into the gradient. In particular, the temperature parameter controlling the noise level gives rise to a tradeoff between "global exploration" and "local exploitation", which correspond to high and low temperatures. To attain the advantages of both regimes, we propose to use replica exchange, which swaps between two Langevin diffusions with different temperatures. Such an acceleration effect allows us to faster approach the global minima. Furthermore, by discretizing the replica exchange Langevin diffusion, we obtain a discrete-time algorithm.

2 - Sample Path Large Deviations Levy Processes and Random Walks with Regularly Varying Increments in Multiple Dimensions
Zhe Su, Northwestern University, Evanston, IL, United States, Chang-Han Rhee

In many applications, it has been observed that there is a structural difference in the way system-wide rare events arise when the underlying uncertainties are heavy-tailed (compared to the better-understood light-tailed counterparts). Roughly speaking, in heavy-tailed settings, the system-wide rare events arise because of the catastrophic failure of a small number of components (catastrophe principle). In this talk, we establish the sample path large deviations for random walks and Levy processes with multi-dimensional regularly varying increment distributions and rigorously characterize the catastrophe principle in the most general setting considered in the heavy-tail literature.

3 - Space-filling Design for Nonlinear Models
Chang-Han Rhee, Northwestern University, Chicago, IL, 60613, United States, Enlu Zhou, Peng Qiu

Traditional space-filling designs for computer experiments aim to fill the parameter space with design points that are as "uniform" as possible. However, the resulting design points may be non-uniform in the model output space failing to provide a reliable representation of the output manifold, and becoming highly inefficient or even misleading in case the computer experiments are non-linear. In this talk, we propose and analyze an iterative algorithm that fills in the model output manifold uniformly—rather than the parameter space uniformly—so that one could obtain a reliable understanding of the model behaviors with the minimal number of design points.

■ MA02

JW Tulum B

Bargaining & Decision Making Methods

General Session

Chair: Gerardo Manuell, Instituto Tecnológico Autónomo de México (ITAM), Cerro el Vigilante, Mexico City, Mexico

1 - The Maximum Probability Negotiation: A New Method in Cooperative Games Theory
Gerardo Manuell, Instituto Tecnológico Autónomo de México (ITAM), Cerro el Vigilante, Mexico City, Mexico, Luis V. Montiel

Two of the most well-known solutions in Cooperative Games Theory are Shapley Value and the Core of the game. However, both of these methods do not always provide implementable negotiation strategies for real life scenarios. Therefore, we have developed a new method that aims to compensate these shortcomings under a new rationale: to find the payment distribution that maximize the probability of closing a deal. To do this, we use a multidimensional simulation tool called JDSIM to take a representative sample of the Core and determine the accumulated empirical functions of the payments of each player. Then, we define the Occurrence Probability Function and solve for the Maximum Probability Negotiation.

2 - Exploring Truth Sets of Joint Distributions to Assist Efficient Elicitation of Information
Luis V. Montiel, Instituto Tecnológico Autónomo de México (ITAM), Mexico

A methodology is presented to partition the space of the uncertainties to favor or eliminate dominant alternatives. We start by generating a random collection of discrete joint probability distributions subject to a specified information set, which can be expressed as a set of linear constraints. Hence, if the distribution of the uncertainty is not completely characterized, the optimal alternative may not be unique. By sampling this set we can understand the structure of dominance and develop questions that when answered reduce the set of optimal alternatives.

3 - A Model to Estimate the Probability of Winning the USA Presidential Elections
Edgar López, Instituto Tecnologico Autonomo de Mexico, Ciudad de Mexico, Mexico, Luis V. Montiel

This work proposes a method to optimize the distribution of the electoral polls along the 50 states of The United States of America and the District of Columbia. In the previous election it has been clear that the Electoral College is key on the final outcome. Hence, this work proposes an approximation to the mechanics impose by the Electoral College, and can be used to optimize the recollection of information provided by the polls. Previous models assume independence among states; however, it might exist at different levels of correlation. Hence, our model relaxes the assumption of independence. We use copulas mix with a vector simulation method called JDSIM to implement the model and present results.

■ MA03

JW Tulum C

Data Science for Healthcare

General Session/Practice Session

Chair: Quinlan Buchlak, MD, PhD, The University of Notre Dame, Sydney, Australia

Co-Chair: Nazanin Esmaili, University of Technology Sydney, University of Pittsburgh, Boston, MA, 02134, United States

1 - Development and Validation of Models to Predict Outcomes Associated with Polypharmacy and Potentially Inappropriate Medications in Elderly Patients
Quinlan Buchlak, MD, PhD, The University of Notre Dame, Sydney, Australia, Nazanin Esmaili

We examined PP and PIM exposure in the elderly and predicted healthcare costs and service utilization. MBS and PBS data was analyzed with LR. 293,244 patients were included.52% were exposed to &gt4 drugs per week. 43.28% were exposed to ≥1 PIMs. Benzodiazepines, NSAIDs, CVS drugs and antidepressants were prevalent PIMs. Models predicted high costs (AUC=0.75) and service utilization (AUC=0.87). High PP increased a patient's likelihood of receiving services in hospital, while moderate PP reduced it. Patients in the top cost quintile were 12 times more likely to receive services in hospital. PP and PIM exposure is associated with high costs and a high likelihood of receiving services in hospital.

2 - Data Science Strategies for Clinical Management of Multiple Sclerosis
Samuele Fiorini, PhD, University of Genoa, Genoa, Italy

An ongoing collaboration between the University of Genoa and the Italian Multiple Sclerosis Society (AISM), is designing a data-driven approach to achieve a timely, low cost and patient-centered management of Multiple Sclerosis (MS). More than 850 subjects are followed by three AISM rehabilitation centers in northern Italy. Every four months each subject completes a set of different Patient Centered Outcomes related to the most relevant domains for MS (e.g. mobility, fatigue, cognitive performances, emotional status, quality of life). On such temporal data, the study developed a machine learning model that predicts the disease evolution at the next time point, reaching an accuracy of 82.6%.

3 - Optimizing Interventions Across the HIV Continuum of Care: Process Improvement Analysis
Margaret L. Brandeau, Stanford University, Stanford, CA, United States, Michael Fairley, Geoffrey Barrow

We examine the care process at a hospital-based HIV clinic in Kingston, Jamaica. We show how HIV care can be improved by viewing the patient care process as a production process and applying methods of process improvement analysis. We perform qualitative analysis to identify key areas for process improvement. We develop a stochastic model of the care process and a model for optimal investment of a fixed budget among interventions aimed at improving the process. We use the model to determine the optimal investment among interventions that the clinic could invest in.

4 - The Optimal Frequency for Type 2 Diabetes Screening
Chou-Chun Wu, University of Southern California, Los Angeles, CA, United States, Sze-chuan Suen

High BMI may raise the risk for acquiring type 2 diabetes, but current guidelines do not provide BMI-category-specific screening frequency recommendations by age and prior testing history. We aim to determine the optimal screening policy with the above factors using a Partially Observable Markov Decision Process. We assume the physician has an estimate of the likelihood the patient is healthy, prediabetic, or diabetic at each period and updates his beliefs about the patient's health given progression trends and observed test results. We find that the current recommended screening policy is suboptimal, and high-risk individuals should be screened roughly every six months between ages 45 and 85.

■ MA04

JW Tulum F

Operations Management I

Contributed Session

Chair: Juliana Sagawa, Federal University of São Carlos, São Carlos, Brazil.

1 - The Behavior-dependent Pricing under Servicizing
Tina Arabian, PhD Candidate, Lazaridis School of Business and Economics, Wilfrid Laurier University, Waterloo, ON, Canada, Mojtaba Araghi, Hamid Noori

Servicizing business model, under which a firm sells the use or functionality of a product rather than the product itself, might yield product misuse when customers have less incentive to care for the asset. We develop a behavior-dependent pricing model under which customers are charged not only on the amount of usage, but also the usage behavior. We show that adopting this pricing model can result in a win-win-win outcome where it can simultaneously increase the firm's profits, decrease its environmental impact and increase consumer welfare compared to the behavior-independent pricing.

2 - A State Feedback Controller for Production Control
Juliana K Sagawa, Federal University of São Carlos, São Carlos, Brazil, Gašper Muši

A closed-loop model to control a multi-product multi-station production system is proposed. The goal is to adjust the processing frequency of the stations (manipulated variables) in order to keep the buffer levels of the system (control variables) at the desired references, even in the presence of disturbances, which leads to short throughput times. In the full state feedback approach, all the buffer levels and the interrelation among them are considered to tune the controller. Thus, the reactions are based on global rather than local information, which minimizes delays and provides a more effective response. The model provides prescriptive capacity adjustments for production control.

■ MA05

JW Tulum G

Vehicle Routing Problems

Contributed Session

Chair: David Alvarez Martinez, Universidad de Los Andes, Cra 1 Este No 19A- 40, Bogota, Colombia

1 - Efficiency of Sparse Sets of Routes in the Cyclic Inventory Routing Problem with Split Deliveries
Luca Bertazzi, University of Brescia, Brescia, Italy, Geoffrey A. Chua, Demetrio Laganà, Rosario Paradiso

We study the Cyclic Inventory Routing Problem with split deliveries. A product is shipped from a supplier to a set of customers over an infinite time horizon. The problem is to determine a periodic shipping policy that minimizes the sum of routing and inventory costs. We show how to choose sparse yet efficient sets of routes, hence achieving the best tight worst-case performance bound known for this problem. These sets of routes, together with additional sets, allow us to have solutions with very good average performance in a large set of instances.

2 - Multi-objective Two-echelon Location-routing Problem From a Smart City Perspective
Fernando Sandoya, ESPOL, Guayaquil, Ecuador

We present a two-echelon, multi-product, Location-Routing Problem formulation from a efficient planning city perspective, for the optimization of five objective functions, two of them related to pollutant emissions minimization. Additionally, it is demonstrated that the use of city distribution centers (CDCs), compared to direct shipping, is a better strategy for a congested city in Latin America. Initial experimental results using an exhaustive search alternative prove an 8- 23% reduction of carbon monoxide (CO) emissions, a 6-22% reduction of carbon dioxide (CO2) emissions and an 8-17% reduction in shipping costs, given an initial investment in CDCs.

3 - A Genetic Algorithm for the Fuel Consumption Heterogeneous Fleet Vehicle Routing Problem with Two-Dimensional Loading Constraints

David Álvarez-Martínez, Universidad de Los Andes, Bogota, Colombia, Luis M. Escobar-Falcón, John W. Escobar, Mauricio Granada-Echeverri

This study integrates the Vehicle Routing Problem with a heterogeneous fleet and the two-dimensional Container Loading Problem, with the goal of reducing fuel consumption based on distance, the vehicles assigned, loading patterns and the weight of the cargo. A specialized Genetic Algorithm is presented to solve the routing, keeping its main characteristic: its easy implementation. Meanwhile, the cargo loading constraint is validated through a GRASP algorithm. A computational study is presented using the classical instances, showing the savings achieved in fuel consumption. The algorithm was also adapted to minimize only distance, getting a good performance and improving some solutions.

4 - Matheuristic Algorithm for the Dynamic Problem of Location and Dispatch of Medical Emergency Vehicles

John Escobar, Pontificia Universidad Javeriana Cali, Cali, Colombia, Juan Camilo Paz, Cesar Marin

This work considers the Dynamic Problem of Locating and Dispatching Emergency Medical Vehicles (PDLDVE). In this work, a matheuristic algorithm is proposed addressing the three problems: location, dispatch and relocation. The problem of location is mathematically formulated with a vertex approach which is oriented towards the maximum coverage; the dispatch problem is solved through a heuristic based on the preparedness index for multiple servers; and, finally, the relocation problem is approached in two stages.

■ MA06

JW Tulum H

Models for Service Supply Chains

General Session

Chair: Harihara Prasad Natarajan, University of Miami, University of Miami, Coral Gables, FL, 33124-9145, United States

1 - Overhaul Service Management with Rotable Inventory

Murat Erkoc, University of Miami, Hialeah, FL, 33015, United States

We study optimal service strategies for a maintenance-repair-overhaul (MRO) company with random job arrivals and service times. An arriving job is an equipment that requires maintenance and overhaul. The MRO company maintains an inventory of retables so as to offer its customers exchange equipment during the time of service. While the exchange service improves the service provider's revenues, it incurs significant costs due to ownership of exchange equipment. Using multi-server queuing models, we investigate the optimal inventory policies and the value of the exchange services.

2 - Offering Free Services in Healthcare Supply Chain

Gang Li, Bentley University, Management Department, Waltham, MA, 02452-4705, United States, Vikrant Vaze, Omkar D. Palsule-Desai, Nagesh Gavirneni

In a healthcare supply chain that consists of paying customers, hospitals, and doctors, is it possible that free services to the poor are a joint optimal decision for all the three parties even if each care only maximizing their own benefits? We developed an analytical model to analyze motivations and key decisions in the healthcare supply chain when determining whether to offer free services.

3 - Planning Availability for a Product Category

Harihara Prasad Natarajan, University of Miami, Dept. of Management School of Business Coral Gables, FL, 33124-9145, United States

We study a single-period inventory planning problem for a category of substitutable products. This is an important practical problem facing category managers who have to maintain high service levels for constantly expanding product catalogs. We formulate the problem as a stochastic optimization model that minimizes the total stocking cost subject to service level requirements, which consist of targets for inventory availability through the selling season. Recognizing the difficulty of solving this problem, we propose an optimization-based method and applied this model to randomly-generated numerical instances and data from a re-seller of IT products. We observe that the approach is robust to changes in a variety of problem parameters and yields solutions very quickly, outperforming enumeration-based alternative approaches and suggesting savings in inventory costs.

4 - From Local to Regional Healthcare Logistics Network: Challenges, Opportunities and Lessons Learned

Ana María Anaya-Arenas, ESG-UQAM, Montréal, QC, Canada Ana María Anaya-Arenas, Centre Interuniversitaire de Recherche sur les Réseaux d'Entreprise, La Logistique et Le Transport - CIRRELT, Montreal, QC, Canada, Valérie Bélanger, Angel Ruiz

This study is inspired by the context of the Integrated Centre of Healthcare and Social Services - Chaudière-Appalaches (CISSS-CA) in Quebec (CA). The Ministry of Health and Social Services is creating regional clusters to optimise healthcare operations, and the CISSS-CA needs to review its network. We study three structures, including the required routing schedule to deliver and collect the materials, with various frequencies and time frames. 1) A decentralised structure to portray the current network and its needs. 2) A centralised network with a single location. 3) A two-echelon distribution network. The advantages and challenges of these structures will be discussed.

■ MA07

M-Maya VI

Tutorial: The JuMP Ecosystem for Mathematical Optimization

Tutorial Session

Chair: Andres D. Gonzalez, The University of Oklahoma, Norman, OK

1 - The JuMP Ecosystem for Mathematical Optimization

Juan Pablo Vielma, Massachusetts Institute of Technology, E62-561, 100 Main Street, Cambridge, MA, 02142, United States

JuMP is a multi-award-winning domain-specific language for mathematical optimization. JuMP has already been successfully used in academic and industrial problems related to marketing, causal inference, daily fantasy sports, optimal control of aerial drones, machine learning, school bus routing, sustainable power systems expansion, and decarbonization of electrical networks. The JuMP ecosystem gives access to a wide range of highly-effective commercial and open-source optimization tools in a natural syntax that requires only a basic knowledge of mathematical optimization. JuMP provides this access with a performance that matches or exceeds those of commercial and open-source alternatives, as well as unparalleled versatility and extensibility allowed by the advanced features of the Julia programming language. In particular, JuMP and its infrastructure was used to develop the solver Pajarito.jl, which is currently the state-of-the-art for the mixed-integer conic optimization problems. In this tutorial, we begin with basic syntax and features of JuMP and associated packages assuming no previous knowledge of JuMP and only an elementary knowledge of mathematical optimization. We then cover more advanced features, give performance tips, and cover the recent improvements to JuMP. Finally, we demo some state-of-the-art features, including showing how various packages in the rich Julia ecosystem can be seamlessly combined to provide simple solutions to complicated problems in the optimal control of aerial drones.

■ MA08

M-Maya VII

Health Care II

Contributed Session/Practice Session

Chair: Aineth Torres-Ruiz, Accenture, Lago Alberto 320, KMDH1A-PH1, Anáhuac I Sección, C, 11320, Mexico

1 - Quantification of Precancerous Colonic Neoplasia Dynamics

Mahboubeh Madadi, Louisiana Tech University, Ruston, LA, United States, Ali Farahani

Accurately predicting the growth of adenomas is essential for understanding the post-colonoscopy risk of CRC. In particular, there are likely differences in colonic neoplasia progression with age, gender, and colon location. The goal of this study is to quantify the individual dynamics of colonic neoplasia development by patient's age, colon location, and colonoscopy history.

2 - Importance of Healthcare IT Adoption in Developing Hospital-Supplier Trust Through IT Capabilities

Santanu Mandal, Associate Professor, Amrita Vishwa Vidyapeetham University, Coimbatore, India

The current investigation explores the influence of healthcare IT adoption by hospitals in the development of sensing, learning, coordinating and integrating IT capabilities. Furthermore, it explores the importance of these IT capabilities on hospital supplier trust. Perceptual responses were gathered from general and special hospitals in India and PLS were used to test the hypotheses. Findings suggest healthcare IT adoption as a prominent enabler for sensing, learning, coordinating and integrating IT capabilities. Furthermore, sensing, learning and coordinating IT capabilities positively contribute to hospital-supplier trust.

3 - Visual Efficiency Analysis of Healthcare Units in Mexican Municipalities

Aineth Torres-Ruiz, Accenture, Anáhuac I Sección, C, Mexico

We integrated multiple data sources on healthcare indicators and resources available at public clinics throughout Mexico. The purpose of the study was 1. To demonstrate the relevancy of using data visualization tools to discover trends and resource efficiency opportunities. 2. To provide a useful comparison between care units that would allow the prioritization of resource allocation. We used data envelopment analysis to compare the efficiency of different health care units with a focus on emergency areas and the attention to children and women. The resulting efficiencies were mapped out for different municipalities across the country.

■ MA09

M-Maya VIII

Systems Analysis via Data Analytics

Contributed Session

Chair: Peng Zhu, Nanjing University of Science and Technology, School of Economics and Management, 200 Xiaolingwei Street, Nanjing, 210094, China

1 - Text and Visual Analytics for Uncovering Knowledge a Systems Engineering Case Study

Araceli Zavala, Stevens Institute of Technology, Hoboken, NJ, United States, Jose Emmanuel Ramirez-Marquez, Nicole Hutchison

System engineers experience, skills, and knowledge are paramount to the successful development of engineered systems. As such, this research explores interview transcripts of 451 systems engineers and their roles in their respective organizations. Through the use of text analysis and visual analytics, our approach highlights the areas in which interviewees consistently agreed on specific topics of systems engineering (e.g., effectiveness, mentoring, experiences, etc.), and illustrate knowledge sharing among system engineers.

2 - Dynamic Balanced Scorecard Model for the Management of Service Companies

Valverde Ayala Giovana, Universidada Nacional Mayor de San Marcos, Surco, Peru, Rivas Peña Marcos

The organizations that will become relevant in the future will be those that discover how to take advantage of the enthusiasm and learning capacity of people at all levels of the organization. Business social systems are dynamic, and System Dynamics appears for their treatment. The proposal developed in the present work is a Dynamic Balanced Scorecard model to manage service companies, integrating the Balanced Scorecard model, the Systemic Thinking and the Systems Dynamics methodology to analyze the medium and long term effects of business decisions.

3 - How to Improve Measuring Techniques for the Cumulative Elevation Gain upon Road Cycling

Maren Martens, Landshut University, Landshut, Germany

To prepare for competitions cyclists gather much data about their training units, e.g., about distance, speed, cadence, heart rate, power, and cumulative elevation gain (EG). However, measuring devices do not always work reliably for these factors, in particular accurate measurement of the EG is difficult. Nowadays the EG is measured by GPS or barometric pressure and is dependent of steady connections to satellites or steady changes in the barometric pressure such that different meters deliver quite different quantities - not only depending on the measuring method. We present ideas on how to support meters to deliver more reliable quantities for the EG by using statistics and mathematical methods.

4 - The Influence of Regulatory Focus and Reinforcement on the Promotion Framework Effect of Mobile Application Purchase Intention of the Elderly

Peng Zhu, Nanjing University of Science and Technology, Nanjing, China

Based on the framing effect theory, we studied the moderating role of reinforcement learning and the regulatory focus of the elderly on the relationship between the promotion framework of mobile application and the elderly's response. In the context of positive evaluation of reinforcement learning, the loss-reduction promotion will bring higher perceived value and anticipated regret than the profit-increase promotion; while in the context of negative evaluation of reinforcement learning, the influence difference of these two promotion frameworks disappears.

■ MA10

M-Acapulco

Metaheuristics: Industrial and Real Applications

Emerging Topic: Emerging Metaheuristics

Emerging Topic Session/Practice Session

Chair: Eduardo Pardo, Universidad Rey Juan Carlos, Madrid, Spain

Co-Chair: Edgar Possani, ITAM, Mexico City, 01080, Mexico

1 - Heuristics to Improve the Energy Production

Eduardo G. Pardo, Universidad Politécnica de Madrid, Madrid, Spain, Francisco Serradilla, Jaime Blanco

The production of energy in the industry is an optimization problem related to a combination of a set of input parameters in a factory. Those parameters determine the total amount of energy produced by the factory. In this work we deal with this problem by first modeling the factory with an artificial neural network and, secondly, optimizing the input values to satisfy the optimization of the objective function (either reduce the consumption of the factory while producing the same energy or produce as much energy as possible). We propose a Memetic Algorithm in order to optimize the previous objective function

2 - Relinked Variable Neighborhood Search for a Bi-objective Traveling Purchaser Problem with Deliveries

Pamela J. Palomo-Martínez, Universidad de Monterrey, San Pedro Garza García, Mexico, M. Angélica Salazar-Aguilar

The Bi-objective Traveling Purchaser Problem with Deliveries is a variant of the well-known Traveling Purchaser Problem in which the purchased products are delivered to a set of customers in order to satisfy their demand. The objective of the problem is to minimize the sum of the waiting time of the customers and the sum of the traveling and the purchasing costs, simultaneously. A Relinked Variable Neighborhood Search is proposed for approximating Pareto fronts for a large set of instances of the problem.

3 - Scheduling of Operating Rooms Considering Delays, Overtime and Cancellations

Guillermo Latorre-Núñez, Universidad del Bío-Bío, Concepción, Chile, Armin Lüer-Villagra

The operating rooms are the most expensive resource in a hospital. Delays, overtime and cancellations must be considered during the scheduling of the operating rooms. The scheduling of surgeries is extremely difficult, which requires to develop support tools for the programmer. We study the problem of surgery scheduling, minimizing the costs of delays, extra time and the cancellation of surgeries. We propose a robust approach to address the problem and a computationally efficient metaheuristic. The results show that it is possible to obtain different schedules assuming different levels of risk.

4 - Comparison of Trajectory Based Metaheuristics for the Electric Vehicle Routing Problem

Rodrigo Linfati, Universidad del Bio-Bio, Concepcion, Chile

The Electric Vehicle Routing Problem is a variant of the classical VRP problem with battery charge/discharge constraints. This problem can be evaluated by the objective function of the minimal total distance, or by the minimal pollution cost (cost of greenhouse emissions + cost of fuel + cost of travel times). In this paper, we present the design and implementation of efficient trajectory-based metaheuristics (simulated annealing, tabu search, variable neighborhood search). The performance of the proposed algorithms has evaluated by considering benchmark instances adapted from the literature comparing the solution quality and execution time.

5 - Home Health Care Services in Mexico: A Proposal Using Metaheuristics

Julia Isabel Serrato-Fonseca, Tecnologico de Monterrey, Escuela de Ingeniería y Ciencias, Mexico, Jaime Mora-Vargas, Angel Ruiz

Home Healthcare Services (HHS) emerged for the necessity of personalized medical assistance for patients that, because of their respective medical or physical condition, cannot leave their homes. As these services mean implies an important amount of human, money and equipment resources for the governments, there has been a recent increase in HHS optimization models. Nevertheless, as far as we know, this models are barely applied in a Mexican context. "El médico en tu casa", Mexico City official home healthcare program started on 2014 was replicated after in diverse municipalities in 12 different states. The program had the main purpose of visiting periodically and as needed, vulnerable population that could not travel to hospitals because of medical reasons, such as older adults, people with different abilities, prostrate patients, high risk pregnant women, pregnant women without prenatal care and terminally ill. Nevertheless, lately, the program has been focusing in older adults, which would correspond to a target of 22,900 people benefited at Mexico City.

■ MA11

M-Mexico

Finance - Risk Management

Contributed Session

Chair: Rei Yamamoto, Keio University, Yokohama, Japan

1 - Effect of Firm Age in Credit Scoring Model for the Loans to the Self-employed

Norio Hibiki, Professor, Keio University, Yokohama, Japan, Kenzo Ogi, Yuichi Utsumi

We propose the firm age is utilized for the self-employed in the credit scoring model, and analyze the correlation between firm age and default rate calculated using loans to the more than 680 thousand Japanese self-employed from 2007 to 2014. We show that the default rate can be expressed by a density function of the Weibull distribution or a piecewise-linear function of firm ages with three ranges; up to three, four to twenty-five and over twenty-six years. We formulate the logistic regression model with financial variables and the function value of firm ages. We find that the accuracy ratio rises by about nine percent for the model with each function, and the model can be effectively used in practice.

2 - An Efficient Equity Investing Model Using Smart Beta Based on Market Phase Information

Rei Yamamoto, Keio University, Yokohama, Japan

Recently, smart beta has become popular and its ETFs are now sold by asset management companies and we can easily conduct factor investing by using low-cost smart beta ETFs. We propose a market phase classification method based on market directions and cross-sectional volatility to explain the return of smart beta indices and a conditional mean-absolute deviation model to use the characteristics of these return. Empirical analyses show that our proposed model achieves better performance than both the market index and a normal mean-absolute deviation model used in global markets.

■ MA12

M-Cozumel

Energy Systems and Location Problems

Contributed Session

Chair: Jim Ostrowski, University of Tennessee, Knoxville, TN, 37934, United States

1 - Exact Solution Approaches to Competitive Hub Location Problem

Richa Tiwari, IIM Ahmedabad, Ahmedabad, India

In this paper, we study the hub location problem in the presence of competition caused by the presence of already existing airlines in the network. For this, we model the market share captured by the entrant airline as a proportional gravity based attraction function. This leads to a non-linear integer program, for which we propose several customised exact methods. From our extensive computational experiments using two of the publicly available datasets namely Civil Aeronautical Board (CAB) & Australian Post (AP), we suggest the method which performs the best in terms of computation times.

2 - An Exact Algorithm for a Territory Design Problem with p-center Based Dispersion Minimization

M. Gabriela Sandoval, Universidad de las Américas Puebla, San Andrés Cholula, Mexico, Juan A Diaz, Roger Z. Rios-Mercado

Territory design deals with the discrete assignment of geographical units into territories with restrictions defined by planning criteria. We present an iterative algorithm that successively improves the lower bound of an integer programming model with the objective of minimizing a p-center dispersion measure until the exact solution is found. This is done by testing candidate distance values with subproblems that validate if it is possible to find solutions with at most p territories. The proposed algorithm performs significantly faster than existing approaches.

3 - Water-Energy Infrastructure Value Chains: A Resilience-Interdependency Assessment using System Dynamics Simulation

Fuzhan Nasiri, Concordia University, Montreal, QC, Canada

Water and energy infrastructure are interdependent. Water is supplied for cooling of thermal power plants and electricity is needed for water treatment and distribution. This nexus could aggravate the resiliency of these infrastructure systems at the time and locations with water scarcity. A system dynamics simulation approach is proposed to assess the resiliency of these infrastructure systems subject to droughts and with the presence of interdependencies.

4 - Recent Advances in MILP Formulations for the Unit Commitment Problem

Jim Ostrowski, University of Tennessee, Knoxville, TN, United States

This talk presents recent work on MILP formulations for the unit commitment problem (UC). UC is that of deciding which power generators to schedule to meet anticipated energy demand, and is of critical importance in the operation of power systems. We review existing MILP formulations along with novel formulations made by combining various ideas from the literature and present a comprehensive computational study of said formulations. In addition, we provide reference implementations of the reviewed formulations in the Pyomo modeling language, along with a library of UC test instances.

Monday, 11:00am - 11:50am

■ Plenary

JW Tulum A

Frontiers of Integer Programming

Plenary Session

1 - Frontiers of Integer Programming

Natashia Boland, Georgia Institute of Technology, Ferst Drive, Atlanta, GA, 30332, United States

Optimization problems in which some or all of the variables are constrained to take integer values are applicable in a many fields, ranging from medicine and healthcare to banking and finance to environmental management and conservation. Over recent decades, exact algorithms for their solution have become faster and more efficient, culminating in a variety of commercial software packages and public domain codes that provide exceptional capability for solving practical problems to optimality. This has opened up new frontiers. Many decision makers, in practice, consider multiple, competing objectives. In medicine, radiation oncologists seek to minimize the damage to a critical organ while maximizing the damage to a cancerous tumor. In environmental management, the health of populations of competing, threatened species must be maximized. Leveraging the power of exact integer programming solvers, algorithms that compute the optimal trade-off curve, also known as the Pareto frontier, for integer programming problems with multiple objectives, have been developed in recent years. These greatly enhance what optimization can offer the decision-maker, giving them a complete picture of the options available to them, and allowing them to exercise their experience and expertise in selecting the solution to implement. The astonishing capabilities of exact solvers has only increased the appetite of practitioners to solve ever-larger problems, which challenges the state-of-the-art. These solver capabilities have been achieved by decades of research enhancing the “divide-and-conquer” branch-and-bound method that lies at the heart of all exact solvers. Yet one key element of this method has remained largely untouched since it was first presented in the 1960’s: the branching rule, by which the solution space is divided. Recent work has shown that for problems with decomposable structure, new branching rules, developed to exploit that structure, can have dramatic effects on the performance of the branch-and-bound method. In this talk, we will discuss both these developments, at the frontiers of integer programming research, and, in the process, identify further research opportunities for the field.

Monday, 1:30pm - 3:00pm

■ MB01

JW Tulum A

Resource Management in Large-Scale Stochastic Systems

General Session

Chair: Paul David Feigin, Technion, New York, NY

1 - Synergy via Redundancy: Boosting Service Capacity with Adaptive Replication

Samarth Gupta, Carnegie Mellon University, Pittsburgh, PA, United States

The maximum possible throughput (rate of task completion) of a multi-server system is typically the sum of the service rates of individual servers. Recent works show that task replication can boost the throughput, in particular, if the service time has high variability. Thus, redundancy can be used to create synergy among servers such that their overall throughput is greater than the sum of individual servers. This paper seeks to find the fundamental limit of this capacity boost achieved by task replication. The optimal adaptive replication policy can be found using a Markov Decision Process (MDP) framework, but the MDP is hard to solve in general. We propose two myopic policies, MaxRate, and AdaRep that gradually add replicas only when needed. To quantify the optimality gap of these policies, we also derive an upper bound on the service capacity.

2 - Erlang-S: A Data-Based Model of Servers in Queueing Networks

Paul David Feigin, Jacobs Technion-Cornell Institute, New York, NY, 10044, United State, Paul David Feigin, Technion - Israel Institute of Technology, Haifa, Israel, David Azriel, Avishai Mandelbaum

Classical queueing theory has typically focused on customers, and server availability has been taken for granted. However, data accessibility and the emergence of complex service systems, for example, call centers, reveals the need to stochastically model the complex behavior of servers. In this work, we propose a new model that accommodates such behavior; we call it Erlang-S, where "S" stands for servers. Our model assumes a pool of present servers, some of whom are available to serve customers from the queue while others are not, and the process of becoming available or unavailable is modeled explicitly. Our focus here is on applying the model to real systems, specifically call centers. Erlang-S differs from the Erlang-A model, which has been commonly used for modeling call centers: the latter model assumes that all agents who are present are, in fact, available for service.

■ MB02

JW Tulum B

Multi-Criteria Decision Making

Contributed Session

Chair: Cindy Ortega Romero, Universidad Nacional de Colombia, Antioquia, Colombia.

1 - Ranking US Airlines - A Multi-Attribute Decision Making Approach

Aman Gupta, Associate Professor, Embry-Riddle Aeronautical University - WorldWide, Louisville, KY, United States, Robert Walton

This research presents a multi-attribute decision-making approach to assess the competitiveness of airlines in the United States. The performance measures are considered under five competitiveness dimensions including, cost, price, service quality, management, and productivity. Input from airline decision makers was used to assign weights to the performance measures. Different methods were applied to solve the multi-attribute decision making model. The competitiveness of ten US airlines were ranked based on these methods and compared.

2 - Non Ionized Ammonia Monitoring in Intensive Aquaculture Systems Based on a Priorities Assessment Methodology

José J. Carbajal Hernández, Research Professor, Center for Computer Research, Gustavo A. Madero, Mexico City, Mexico, Luis P. Sánchez Fernández

Aquaculture systems have proved been a good alternative for generating aquatic resources. The main problem in those systems is the monitoring of highly toxic compounds that can disestablish and pollute the habitat, reducing production rates. This research, propose to create a mathematical tool for analyzing and monitoring of non-ionized ammonia (NIA) in freshwater ponds. Using the Analytical Hierarchy Process theory, an assessment model is developed in order to provide an indicator about the NIA interaction in the system. Water quality parameters such as pH, temperature and total ammonia are studied. The model operation has been tested showing a good performance in experimental real tanks.

3 - Fuzzy-AHP-TOPSIS Decision Making Tool to Support Selection of Enhanced Oil Recovery Treatments

Cindy Ortega Romero, Universidad Nacional de Colombia, Antioquia, Colombia, Yris Olaya Morales, Juan Manuel Mejía Cárdenas

Selecting an Enhanced Oil Recovery (EOR) treatment is a specific decision for each field, and it should be economical, geological, environmental and socially viable. Then, an EOR strategy decision is a tough process that depends on multiple expert opinions, complex analysis, and quantitative factors evaluation. Therefore, results are greatly influenced by human factors, increasing the uncertainty and the failure probability. This research proposes a decision support tool to evaluate EOR treatments. The decision support tool combines Analytic Hierarchy Process (AHP), Fuzzy Logic (FL), and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS).

■ MB03

JW Tulum C

Feature Selection

General Session

Chair: Silvia Casado, University of Burgos, Burgos, Spain

Co-Chair: Joaquin Pacheco, University of Burgos, Burgos, Spain

1 - Feature Selection in Data Envelopment Analysis

Sandra Benítez-Peña, Universidad de Sevilla, Sevilla, Spain, Peter Bogetoft, Dolores Romero-Morales

In this talk we present an integrative approach to Feature Selection in Data Envelopment Analysis (DEA) for Benchmarking. Here, the DEA model is enriched with zero-one decision variables modelling the selection of features, yielding a Mixed Integer Nonlinear Programming formulation. Numerical results will be presented using data from Electricity Distribution System Operators. Such results highlight the advantages that our single-model approach provide to the user, in terms of making the choice of the number of features, as well as modelling their costs and their nature.

2 - Feature Selection and Bi-objective Optimization in Finance

Joaquin Pacheco, University of Burgos, Burgos, Spain, Silvia Casado, Laura Nunez

In this work, different classification models are combined and analyzed with multi-objective optmization techniques. Specifically, an ad-hoc method has been designed for the problem of selecting variables with the objective of minimizing the number of selected variables and maximizing the prescriptive capacity. This method is based on taboo search. This method is compared with an adaptation of the NSGA-II algorithm. The methods are combined with classification models, and apply to different problems in the field of finnaces and more specifically in insurance and investment.

3 - Improving Diagnosis of Diseases in Elderly People

Joaquin Pacheco, University of Burgos, Burgos, Spain, Silvia Casado, Olalla Saiz

In this paper we analyze different classical models for the diagnosis of certain diseases in elderly people (mainly Diabetes and Alzheimers), such as Discriminant Analysis, Vector Support or Logistic Regression machines. These methods are combined with different muti-objective combinatorial optimization strategies. The aim is to find models of robust diagnoses with a relatively small set of variables.

■ MB04

JW Tulum F

Operations Management II

Contributed Session

Chair: Eve Rosenzweig, Emory University, Goizueta Business School, Atlanta, GA, 30322-2710, United States

1 - Mergers Between On-demand Platforms: The Impact on Consumer Surplus and Labor Welfare

Tao Lu, Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands, Xiaogang Lin, Xin Wang

We analyze a game-theoretical model in which customers choose between platforms based on prices and expected waiting times, and agents base decisions about which platform to work for on wages and the probability of getting jobs. While a merger reduces competition, customers may benefit from a merger due to the risk-pooling effect and reduced waiting times; moreover, this benefit may spill over to the labor force via cross-side network externalities. We further establish that a win-win-win outcome, in which merging firms, customers and agents are all better off, can always be achieved if the merged platform commits to certain ratios between prices and wages.

2 - Tapping Into Science; University Research Alliances, Technological Breadth, and New Product Development
Simcha Jong, Leiden University, Leiden, Netherlands, Kremena S. Slavova

When does involvement in university research communities boost R&D performance? Building on insights into learning within collaborations with universities, we investigate contingencies under which firms benefit of such collaborations. We conjecture that firms reap greater benefits from reaching out to university science when firms pursue more exploratory rather than exploitative innovations. We also contend that such gains are stronger for firms with capabilities in a broader set of technological fields. Our analysis uses a panel dataset of 220 US biotechnology firms over the period 2003-10. Our results from estimating negative binomial models provide support to our contentions.

3 - Employee Feedback, National Culture, and Performance: A Longitudinal Analysis
Eve Rosenzweig, Emory University, Atlanta, GA, United States, Carrie Queenan

Providing employees with feedback can lead to improvements in service operations. However, different types of feedback (e.g., individual or group), across different countries, may ultimately impact performance in different ways. We examine this idea by analyzing multi-year, multi-country data from a leading hotelier. Our results highlight important aspects of employee feedback to consider in managing global service operations.

■ MB05

JW Tulum G

Last Mile Operations

General Session

Chair: Julian E. Pachon, Amazon Last Mile Logistics, Navitaire Incorporated, Austin, TX, 78732, United States

1 - Geocode Learning - Challenges and Approaches
George Forman, Senior Machine Learning Scientist, Amazon, Seattle, WA, United States

Amazon Last Mile attempts to learn an accurate delivery geocode for each address using GPS estimates from past deliveries. The prior method was based on the idea of a centroid, but is biased away from buildings. We developed a novel ML method that learns to geocode from a training set. It includes two kinds of information fusion: ingesting additional event types, as well as leveraging map information, where available. The ML method reduces the P95 distance to the building by over 54% compared with the prior method. This substantially boosts driver experience and reduces delivery errors.

2 - Package Level Forecasting
Karthik Konduri, Senior Research Scientist, Amazon, Seattle, WA, United States

Container planning provides a detailed plan for sorting (also referred to as induct) packages so that packages can subsequently be staged and dispatched on delivery routes. Container planner requires a list of all packages as input, however, not all packages are known when container planner is run (~85%) because they are still in various stages of order fulfillment. In this talk, we will present a new package level arrival prediction system, that leverages upstream fulfillment and execution data and ML algorithms, to provide a view of all packages that will be inducted.

3 - Large Scale Last Mile Operations
Julian Pachon, PhD, Amazon, Austin, TX, United States

Last Mile Delivery is the movement of good from a retailer's transportation hub to its final destination - a business or consumer's home. The rapid growth of e-commerce has elevated the role of the Last Mile. First, the number of packages that are delivered on a daily basis has increased at double digit rates over the past few years, requiring that the science and technology is able to scale fast. Second, innovation, which was once seen just as a way of driving down the cost of delivery, is now viewed as an opportunity to make more aggressive delivery offerings to compete or surpass the competitors. We will highlight fundamental changes in retail that have impacted Last Mile and discuss the cornerstones of an efficient and scalable last mile operation.

■ MB06

JW Tulum H

Supply Chain Design for New Products

General Session

Chair: Sreekumar R. Bhaskaran, Southern Methodist University, Southern Methodist University, Dallas, TX, 75275, United States,

1 - Sequential Product Development and Introduction by Cash-constrained Start-ups
Sreekumar R. Bhaskaran, Southern Methodist University, Cox School of Business, Dallas, TX, 75275, United States, Sinan Erzurumlu, Karthik Ramachandran

We study the trade-off between revenues that an on-hand product generates for R&D funding and the cannibalization effect it has on future products for a startup. We characterize the optimal introduction timing of the on-hand product as a function of the financial resource constraints, the interdependence between these sequential products and the cost of development.

2 - Financial Cross Ownership and Information Dissemination in a Supply-Chain
Shamir Noam, Tel Aviv University, Yossi Aviv

Financial cross-ownership describes a situation in which one company invests in its rival. We study the effect of this investment on the production decisions and information acquisition policy in a supply-chain comprised of two competing retailers sourcing from a mutual supplier. We show that financial cross-ownership provides stronger incentives to acquire demand information — an outcome that can also increase the consumer surplus. We discuss the policy implications of our findings.

3 - Knowledge Transfer from a Radical New Product Development Project to an Existing Product Improvement Project
Cheryl Gaimon, Georgia Institute of Technology, Scheller College of Business, 800 West Peachtree Street NW, Atlanta, GA, 30308, United States, Wenli Xiao

The successful introduction of a radical new product is fraught with challenges including technical uncertainty and time-based competition. To avert risk, a firm may decide to transfer a portion of the knowledge developed for the radical product to improve a product already in the market. While the value of the existing product improves, the loss in proprietary knowledge reduces the market potential of the radical product. We analyze the knowledge transfer decision in relation to the ability of the existing product improvement team to integrate and benefit from the knowledge transfer.

■ MB07

M-Maya VI

Tutorial: Practical Guidelines for Solving Difficult Mixed Integer Programs, Version 2.0

Tutorial Session

Chair: Eduardo Moreno, Universidad Adolfo Ibanez, Santiago, Chile.

1 - Practical Guidelines for Solving Difficult Mixed Integer Programs, Version 2.0
Alexandra M. Newman, Colorado School of Mines, 1500 Illinois St, Golden, CO, 80401, United States, Ed Klotz

The paper "Practical Guidelines for Solving Difficult Mixed Integer Programs" by Klotz and Newman was written in 2012, and significant parts of that material first appeared in 2007. Since then, mixed-integer solvers have evolved significantly. Two of the three models the paper describes were unsolvable at the time, but some solvers handle them easily, as of the last five years. This tutorial will provide an update to the guidelines. We will consider additional functionality in the solvers and examine a new set of challenging models.

■ MB08

M-Maya VII

Health Care III

Contributed Session/Practice Session

Chair: Jaime M. Bustos, Universidad de La Frontera, F Salazar 01145, Temuco, Chile

1 - Gaining Reliable Insight into Schizophrenia Patient-Individual Response by Using Convex Optimization and Cross-Validation
Andreas Brieden, Chair of Statistics, UniBW Munchen, Neubiberg, Germany

While for various deseases bio markers are known for patient-individual outcome prediction of a medication, the situation is worse for schizophrenia. This talk reports on a successful purely data-analytic approach to determine reliable parameters for outcome prediction within a non-interventional clinical study. The first main ingredient is an algorithmic idea that was developed within the EURO 2013 excellence in practice award winning project. By means of convex optimization subgroups of homogeneous schizophrenia patients are identified whose response rates significantly differ. Second, the strength of the approach is shown by means of stratified cross-validation.

2 - Promoting Health Information Technology for Healthcare Quality: The Spillover Effects in Hospital Referral Regions
Youngsok Bang, Chinese University of Hong Kong, Shatin, Hong Kong, Yongjin Park, Juhee Kwon

Using the large-scale U.S. panel data of 1,965 hospitals in 232 health referral regions, we investigate the spillover effects of health information technology (HIT) adoption on healthcare quality. We find that a hospital's readmission rate is reduced by HIT adoptions of neighboring hospitals in the same referral region. Such spillover effects become greater along with the focal hospital's own adoption. We further investigate how spillover effects vary with HRRs' different market structures and hospitals' meaningful-use status. Our findings offer theoretical and managerial insights for both healthcare researchers and practitioners.

3 - Priorization Policies for the Operating Rooms at the Public Hospital of Puerto Montt-chile
Jaime M Bustos, Faculty, Universidad de La Frontera, Temuco, Chile, Jose Luis Toro, Martha T. Ramirez-Valdivia

We analyze several policies to priorize elective and urgency patients in a public hospital in Chile using a simulation modeling approach. Results are validated using actual data from the hospital. The expected impact of different configurations and operating strategies of the clinical system are evaluated for commonly used outcome measures. The study provides key insights of relations among critical variables and performance of the operating rooms system.

4 - A Multicriteria Prioritization Framework to Improve Patients' Access to Healthcare Services
Angel Ruiz, Universite Laval, Quebec, QC, Canada.

Waiting lists management and appropriate patients' prioritization can play an important role in diminishing undesirable outcomes, such as patients' injury or mortality. We propose a general and integrated framework able to prioritize patients in complex dynamic systems, considering multiple decisional criteria, both medical staff and patients' opinions, risks, uncertainties and incomplete information. The framework encompasses a three-step decision system which includes (1) a multi criteria decision-making tool to structure and define the stakeholders' goals and objectives, (2) a patients' evaluation phase where the situation of each patient is assessed with respect to each criterion by a group of experts to obtain an individual score, and (3) an optimization model to schedule the patients' access to services in such a way that the global system utility is maximized. This presentation will review the foundations of this framework and will explain how it is currently adapted and applied to several healthcare's services contexts.

■ MB09

M-Maya VIII

Analytics for Human Resources

Contributed Session

Chair: Jonatán Edward Rojas Polo, Pontificia Universidad Católica de Perú, Lima, Peru

MV to TC04 - Institutional Research on Career Service Using Big Data Analytics
Chun-Ting Lee, Asia University, Taichung, Taiwan, Roger Gung, Brick Tsai

An Institutional Research Decision Support System to help students career planning and to support administrators course/resource planning will be presented. Internal data across differenet organization and external job related data gathered were integrated. AI-based algorithms were developed to guide strudents course and career planning based on job trends and availability.

2 - Comparative Analysis on Effectiveness of Classroom and Internet-based teaching: Management Science and Statistics
Mahmut Sonmez, Associate Professor in Practice, University of Texas at San Antonio, San Antonio, TX, United States

Teaching quantitative methods and statistics in an online course has its advantages and disadvantages. This paper first looks at the factors and reasons why students prefer to take online management science and statistics courses. Then, the paper provides insights and comparisons on the effectiveness of classroom and internet based teaching of both management science and statistics courses.

3 - Predictive Model of the Professional Success of Graduates of Industrial Engineering of a Peruvian University
Jonatán Edward Rojas Polo, Pontificia Universidad Católica del Perú, Lima, Peru, Cesar Corrales Riveros, Wilmer Atoche Diaz

This research aims to predict the professional situation of graduates in industrial engineering from the time they graduated until the next 3 years, based on the variables of the first and second preprofessional practice. Those variables analyzed are the business line of the company, number of employees, department, time period and if they were companies cataloged as best place to work.

MV to TC04 -Answering the Talent Demand - the Matching Between Syllabi and Recruiting Notices
Chun-Ting Lee, Asia University, Taichung, Taiwan, Ting-Ying Yang, Yi-Jia Chung, Grace Lin, Jia-Nian Zheng, Jeffrey Tsai

This paper considers the level of correspondence between the contents taught in the university and the skills needed in the recruitment posts. Data are collected from two different sources. One is from the course syllabi of the Asia University, and another one is from the job posts on the website of the largest job bank in Taiwan. By using text-mining technique, two keywords lists are generated and linked together. Through the link between the two keywords lists, the gap of the talent demand between the university and job market can be found and investigated. Implication of findings from this paper can help university to adjust their course contents and directions to keep up with the job market.

■ MB10

M-Acapulco

Resource Management in Project Scheduling

Emerging Topic: Emerging Scheduling

Emerging Topic Session

Chair: Norbert Trautmann, University of Bern, Bern, 3012, Switzerland

1 - A Novel MILP Formulation for the Resource-constrained Project Scheduling Problem with Multiple Modes
Norbert Trautmann, University of Bern, FM Quantitative Methoden, Bern, 3012, Switzerland

We propose a novel MILP formulation for the resource-constrained project scheduling problem with multiple modes MRCPSP based on variables representing the assignment of the project activities to individual resource units and the sequential relationships between activities that are assigned to at least one identical resource unit. The model exhibits advantageous performance for instances with long activity durations. sequential relationships between activities that are assigned to at least one identical resource unit. The model exhibits advantageous performance for instances with long activity durations.

2 - Bi-objective Integrated Multi-skilled Workforce and Resource-constrained Project Scheduling Problem with Makespan and Net Present Value Criteria
J. Reyes Angulo-Cedeño, Tecnológico de Monterrey, Guadalajara, Mexico, Juan Gaytán, Jaime Mora, Cipriano Santos

A MIP model has been formulated to solve instances of an integrated case of the Multi-Skilled Workforce Scheduling Problem and the Resource Constrained Project Scheduling Problem. Simultaneously minimizing makespan and maximizing the net present value of cash flows of the project, exact solutions of small-sized instances of the problem have been obtained using the -constraint method and the software combination GAMS-Gurobi. Predictive schedules corresponding to each of the efficient points from the Pareto Front were also obtained; they are of practical importance since staff members are optimally assigned to execute project activities by using specific required skills.

■ MB11

M-Mexico

Electricity Market Design

Emerging Topic: Emerging Energy

Emerging Topic Session

Chair: Alfredo Garcia, Texas A&M University, College Station, TX, 77845-8987, United States

1 - Hydro Challenges: Externalities, Operational Interdependencies and Systemic Valuation

Richard Hochstetler, PhD, Instituto Acende Brasil, Sao Paulo, Brazil

Market mechanisms for power systems with a large share of hydropower producers must be apt to deal with externalities, operational interdependencies and decision-making based on systemic valuation. The two-settlement system - usually employed in electricity spot markets - does not address these issues adequately, giving rise to inefficiencies and hindering market stability. Two alternatives are explored to deal with these challenges. The first is an adaptation of the two-settlement system based on the Coasean principle. And the second is the augmentation of the market to enable the sale of specially designed financial instruments (Financial Storage Rights).

2 - Flexibility Premiums in Electricity Markets

Alfredo Garcia, Texas A&M University, 4776 Stonebriar Circle, College Station, TX, 77845-8987, United States

We consider the evidence of persistent premiums between day-ahead and real-time markets in ERCOT. Our analysis suggests these premiums are not related to load forecast error but rather are highly correlated with residual demand. A highly stylized model of settlement markets with non-convexities in production costs is used to argue such premiums are related to the cost of flexible operation.

■ MB12

M-Cozumel

Bilevel Programming

Emerging Topic: Emerging Global Optimization

Emerging Topic Session

Chair: Viacheslav V. Kalashnikov, Tecnologico de Monterrey, (ITESM), Campus Monterrey, Ave Eugenio Garza Sada 2501 Sur, Monterrey, Nuevo Leon, 64849, Mexico

1 - Analyzing Different Bilevel Solutions for a Humanitarian Logistics Problem

José Fernando Camacho-Vallejo, Professor and Researcher, Universidad Autónoma de Nuevo León (UANL), San Nicolás de los Garza, Nuevo León, Mexico, Edith Salinas de León

In this talk, a bilevel programming model applied to humanitarian logistics is discussed. In the upper level, a federal organization makes the decision of distributing the budget for natural disasters. Then, the state government decides how to employ those resources: where to locate distribution centers and how to distribute the aid for minimizing operating costs response time. The lower level of the problem herein studied considers two objective functions, simultaneously. Hence, for a fixed leader's decision, the follower's reaction consists of a set of efficient solutions. Four well-known solutions are considered to make the analysis (optimistic, pessimistic, deceiving, and rewarding).

2 - Bilevel Optimal Control Solving Natural Gas Cash-Out Problems

Yosefat Nava-Alemán, PhD Student, Tecnologico de Monterrey, Monterrey, Mexico, Viacheslav V. Kalashnikov

We formulate the natural gas cash-out model as a bilevel optimal control problem. The single-level reformulation guarantees that its local optimal solution corresponds to a local optimal solution of the bilevel problem. To do that, we find an approach to compute a general derivative of the lower level value function and the pure state constraints at the upper level. The binary variable at the lower level prevents one from using common regularity conditions. We develop a general maximum principle, which is likely to be non-degenerate, in order to find the optimality conditions to the cash-out problem. This work allows one to deduce practical recommendations to both gas shippers and pipelines.

3 - Bilevel Programming Solving the Problem of Preferred Boarding Groups

Edgar Camacho-Esparza, PhD Student, Tecnologico de Monterrey, Campus Estado de México, Estado de México, Mexico, Nataliya I. Kalashnykova, Viacheslav V. Kalashnikov

A bilevel program is studied where the upper-level decisions are made by an airline's management governing the proportion of preferred boarding passes (PBP) and their price. The passengers seek the Nash equilibrium at the lower level of the model by maximizing their payoff functions thus generating a Markov chain's transition matrix. The steady-state probabilities of the chain go to the upper level as the powers of the pertinent classes into which the passengers are partitioned. The existence of solutions to the proposed bilevel program was established and simple numerical experiments conducted. Hence, practical recommendations about the optimal portions of PBPs and their prices are available.

4 - Cournot and Stackelberg Equilibrium in Mixed Duopoly Models with Cost-Reducing R&D

Nancy Solís-García, PhD Student, Universidad Autonoma de, Nuevo Leon (UANL), San Nicolas de los Garza, Mexico, Nataliya I. Kalashnykova

We investigate the role of Research and Development (R&D) subsidy in Cournot and Stackelberg mixed duopoly models with a public firm maximizing domestic social surplus and a private company searching to maximize its own profit. First, we establish the existence and uniqueness results for the Cournot scheme and propose the agent 's classification as strong or weak according to the agent's optimal reaction function properties at the Cournot equilibrium. Then we examine a desirable role (either leader or follower) of both firms in the Stackelberg scheme and compare the profits and domestic social surplus and the production volumes in each type of such equilibrium.

Monday, 3:30pm - 4:20pm

■ Keynote

JW Tulum E

Keynote: Advances in Exact Algorithms for Vehicle Routing

Keynote Session

Chair: Erick Moreno-Centeno, Texas A&M University, Industrial and Systems Engineering, College Station, TX, 77843-3131, United States

1 - Advances in Exact Algorithms for Vehicle Routing

Eduardo Uchoa, Universidade Federal Fluminense, Niteroi, RJ, Brazil

The Vehicle Routing Problem (VRP) is among the most widely studied problems in the fields of operations research and combinatorial optimization. Its relevance stems from its direct application in the real world systems that distribute goods and provide services, vital to the modern economies. Reflecting the large variety of conditions present in those systems, the VRP literature is spread into dozens of variants. For example, there are variants that consider time windows, multiple depots, mixed vehicle fleet, split deliveries, pickups and deliveries, precedences, etc. The currently best exact VRP algorithms are based on the combination of column generation and cut separation, in the so called Branch-Cut-and-Price (BCP) algorithms. This talk surveys significant recent contributions by several authors. In particular, it presents the concept of cuts with limited-memory (Pecin et al. 2014), a technique that represented a breakthrough on some of the most classical VRP variants, allowing the optimal solution of instances with up to a few hundreds points. The talk also presents the ongoing efforts for creating the first effective generic exact VRP algorithms. They should be suited to many distinct variants and still have a good performance.

Monday, 4:30pm - 6:00pm

■ MC02

JW Tulum B

Data Envelopment Analysis

Contributed Session

Chair: Sebastián Lozano, University of Seville, Escuela Superior de Ingenieros, Seville, 41011, Spain

1 - An Application of Multi-criteria Data Envelopment Analysis to Nonmotorized Transports
Fernando Augusto Silva Marins, UNESP, Guaratinguetá-SP, Brazil, Aneirson Francisco da Silva, Erica Guimarães, Elen Yanina Rodríguez, Cristiane Maria Defalque

The weak discrimination power and an unrealistic weight distribution presented by DEA models remain a major challenge and there are models developed with the aim of improving this performance. This paper applies a new Tri Objective Multiple Criteria DEA (TriO MCDEA) model, which is based on Goal Programming, with and without super efficiency concepts, to a real-world application. The results show that TriO MCDEA model provides a better discrimination of DMUs, and it provides a weight dispersion that is statistically equal to that obtained by the others well known MCDEA Models.

2 - Potential-based Efficiency Assessment
Sebastián Lozano, Professor, University of Seville, Seville, Spain

Based on an analogy with the vector field potential in Physics, the efficiency potential function assigns to each operating point a scalar value so that any input reduction or output increase leads to a reduction in the efficiency potential. Therefore, maximizing the reduction in the efficiency potential can be used as a criterion to project an operating unit onto the efficient frontier and to compute the corresponding efficiency score. Moreover, the proposed approach can be extended to interval and multiperiod data as well as to multistage systems.

■ MC03

JW Tulum C

Analytics, Data Mining and the Internet of Things (IoT)

Contributed Session

Chair: Changsoo Lee, Gangneung-Wonju University

1 - A Wrapper Approach to Improving Prediction in Small Data
Riyaz Sikora, Associate Professor, University of Texas - Arlington, Arlington, TX, United States

Although a lot of research is devoted to the field of Big Data, relatively little attention is paid to the problem of small data analytics. In this study we present a wrapper approach to improve the prediction accuracy of traditional machine learning algorithms when the available data is relatively small.

2 - Iot Real-time Data Quality Measurement Architecture
Dongwoo Lee, GTOne, Seoul, Korea, Republic of, Sangyub Lee, Seongwoo Hwangbo, Jinwoo Lee, Sunho Kim, Changsoo Lee, Alejandro Mate, Juan Carlos Trujillo

We propose a framework that can measure real-time data quality so that IoT data can be used with confidence. Data profiling methods for measuring general data quality are well known, but IoT data quality measurement methods considering the characteristics of real-time data such as real-time, volatility, and time-based data aren't. We first defined the error cause that can occur due to the real-time characteristics. We have also defined how to measure IoT data quality to detect real-time data errors from various perspectives. We introduce this method as "IoT data profiling" and it consists of three kinds of criteria, Single Signal Indicator, Multi Signals Indicator, and Structural Quality Indicator.

3 - Tailoring Data Quality Management Processes Suitable for Smart Connected Product Operations
Sunho Kim, Professor, Myongji University, Yongin, Gyeonggi-do, Korea, Republic of, Changsoo Lee, Dongwoo Lee, Sangyub Lee, Jinwoo Lee, Ricardo Perez del Castillo, Ismael Caballero, Taegi Lim, Hyunbin Chung, Giho Lee

This paper proposes a framework of data quality management to improve the quality of IoT data. This framework is developed by tailoring to the IoT environment the process reference model for data quality management defined in ISO 8000-61. First, characteristics of IoT and types of IoT data are defined. Second, the scope of smart connected product (SCP) operations is determined, and the processes of SCP operations are newly defined. The relationship among SCP operation processes and the structure of the processes and data flows in the technology stack of SCP operations are also described. Finally, the SCP operation processes are integrated with the processe reference model defined in ISO 8000-61.

4 - Input and Output Work Products of Data Quality Management Processes in IoT Environment
Changsoo Lee, Gangneung-Wonju University, Wonju, Korea, Republic of, Sunho Kim, Dongwoo Lee, Jinwoo Lee, Sangyub Lee, Ismael Caballero, Ricardo Pérez del Castillo, Alejandro Mate

The successful operation of smart product with connectivity function depends on the operation by combination of software and hardware for IoT environment. For example of communication in smart connected products operations, both functions in hardware and software should work properly. Data quality management processes has the role of improving data quality created through Internet of Things environment considering hardware and software functions. This paper presents the input and output work products of data quality management processes in terms of smart connected products operations under IoT. Work products can be used to check the achievement of data quality management processes.

■ MC04

JW Tulum F

Operations Management III

Contributed Session

Chair: Karim Perez Martinez, HEC

1 - Modeling an Emergency Service System in which Cross-Trained Fire-Medics Respond to Medical Calls and Fire Incidents
Cheng Hua, Yale University, New Haven, CT, United States

We consider a productivity enhancing emergency services approach, which we call the fire-medic system, in which cross-trained fire-medics respond to emergency medical incidents and fire calls. We develop an approximation model that involves solving two 2-state problems rather than a 3-state problem. Our model shows small error rates when compared to the exact model. We apply our method to the fire-medic system used by the Saint Paul, MN Fire Department and compare it to a traditional system. The comparison shows the clear benefits of the fire-medic system. The method also shows a close agreement to the actual mean response times, with the maximum error of 1.8%.

2 - A Model for Planning the Production of Multi-Product Orders in Flexible Deadlines Settings
Cristian D. Palma, Universidad del Desarrollo, Concepcion, Chile

Most of the time, customers place production orders that include different products. Current optimization models for production planning aggregate different orders and translate them into product demand constraints to be met in specific periods according to the order deadlines. We show a model that explicitly considers production orders instead of products, and provides the flexibility of completing orders before their deadlines, allowing a more flexible use of resources. The model is used to plan the production in a sawmill, and both the model formulation and its benefits are discussed.

3 - Price Competition for Multiple Bundles Considering Consumers' Willingness to Pay
Juan Pérez, Associate Professor, Universidad de Los Andes, Chile, Santiago, Chile, Héctor López-Ospina, Álvaro Flores

We analyze price competition among firms selling multiple bundles and we consider consumers' willingness to pay WP. Constrained Multinomial Logit is used to represent consumers' choices, this makes possible to set a pricing game among firms considering consumers' demand. It has been studied that pricing has a strong relationship with WP. Our results indicate that: (a) the price equilibrium is set at a lower level of prices as WP is lower, (b) the lower the WP the more difficult are for firms to take advantage from cost efficiency in terms of profit and (c) two firms with different base market share, will have lower differences in profit and market share at equilibrium as WP is bigger.

4 - Logic-based Benders Reformulations for Integrated Process Configuration and Production Planning Problems
Karim Perez Martinez, HEC Montreal, Montreal, QC, Canada, Yossiri Adulyasak, Raf Jans

This paper addresses production planning problems where products of different types can be produced simultaneously according to a specific process configuration or pattern. The problem consists of determining the configurations to be used and the production level of each configuration to fulfill the demand at the minimum total cost, which typically includes setup costs, inventory holding or overproduction costs. We propose logic-based Benders reformulations and algorithms to optimally solve this problem in different industrial contexts. The proposed methods outperform the benchmark approaches in the tested problems.

■ MC05

JW Tulum G

Network Routing Problems

Contributed Session

Chair: Athena Alimirzaei, The University of Texas at Dallas, Plano, TX, 75093, United States

1 - Cycles, Pricing, and Pivots

Jacques Desrosiers, Hec Montreal & Gerad, Montreal, QC, Canada

All directed cycles necessary to reach an optimal flow solution are observed on the residual network. Each allows for positive flow and forms a direction. A degenerate pivot occurs when the cycle does not exist. The concepts of paths and cycles can be transferred to LPs and necessary and sufficient optimality conditions are expressed on the residual problem. We propose a family of algorithms with non-degenerate pivots and show that the local search heuristics for routing problems, such as 2-opt, 3-opt, swap, relocate, etc. are directed cycles on the residual network.

2 - A Multiple Vehicle Routing Problem with Delivery and Pick-up Points Focused on a Tourism Case

Iris Abril Martínez Salazar, UANL, San Nicolas de los Garza, Mexico, Pedro Inés Loera Martínez

In this work, we present a multiple vehicle routing problem with delivery and pick-up points focused on a tourism case, we consider a set of m vehicles, which should move a set of n tourists among various tourist attractions, each vehicle has a passenger capacity. Each tourist starts and ends the tour at his hotel within limit time. Also, each person establishes a priority list of points which he wants to visit. The objective function consists in maximizing the profit of tourist with the minimum benefit considering the visited points and penalties. We present a mathematical model and a heuristic procedure.

3 - The Travelling Salesman Problem with Stochastic and Correlated Customers

Pascal L. Wissink, University of Edinburgh, Edinburgh, United Kingdom, Jamal Ouenniche

We propose a copula-based approach to model dependencies between the customer presences of the travelling salesman problem with stochastic customers. This results in a new stochastic combinatorial optimisation problem, called the correlated probabilistic travelling salesman problem (CPTSP). Our formulation only requires marginal probabilities describing the stochastic presence of each customer, and a correlation matrix describing the pairwise dependence between customers. We demonstrate that a good solution for the independent problem does not necessarily coincide with a good solution for the CPTSP.

4 - Solving a Complex Transportation Problem Using Integer Linear Programming

Athena Alimirzaei, Clinical Assistant Professor, The University of Texas at Dallas, Richardson, TX, United States, Monica Brussolo

Minimizing total transportation cost is not a trivial task; however, most companies use a limited approach, producing suboptimal results. This case focuses on an everyday problem for the transportation industry and its optimization. ABC Construction Company is looking to hire a transportation company to design the best plan in order to ship an assortment of machines required for a construction project at the optimal cost and on time. This case illustrates this problem by balancing supply and demand, minimizing the total transportation cost, and receiving the machines on time. Integer programming and Excel Solver were the tools used to model this problem.

■ MC06

JW Tulum H

Logistics and Scheduling Issues in Healthcare

General Session/Practice Session

Chair: Burak Eksioglu, Clemson University, Clemson, SC, United States

1 - Simulation-Optimization of the Material Handling in a Health Care Facility

Sandra D. Eksioglu, Clemson University, 277C Freeman Hall, Department of Industrial Engineering, Clemson, SC, 29634, United States, Tugce Isik, Amogh Bhosekar, Robert William Allen

We collaborate with Greenville Memorial Hospital (GMH) which uses Automated Guided Vehicles (AGV) to perform tasks, such as moving surgical instruments, drugs, linen, etc. We propose a simulation model that optimizes the use of AGVs for the delivery of surgical cases, provided the physical limitations and business rules of GMH. We use travel time and task completion time as performance measures. Our work integrates data analysis with system simulation and optimization. The data analysis provides distributions of travel times, AGV utilization and AGV movement patterns in the current system. We proposed two strategies to improve the movement of AGVs, (a) redesign of the paths taken by AGVs; (b) adjust the number of AGVs used daily based on the volume of surgical cases. The sensitivity analysis indicate that these strategies improve the performance measures identified. The implementation of the proposed solution results in significant reduction in congestion, travel times, task completion times and increased in utilization of AGVs.

2 - Personalized Physician Recommender with Re-ranking

Hongxun Jiang, Renmin University of China, Zhongguancun Street, Beijing, 100872, China

Big-data nourishes smarter services while detailed consideration promotes satisfying ones. State-of-the-art literature has put efforts excessively on accuracy, especially in physician recommenders. This causes few “superstars” dominate in recommendations. It produces not only a long waiting time bores patients, but make themselves exhausted as well. Diversity in some literature helps but not eliminates overloads. This paper proposes a novel metric called workload caps the times a physician recommended. After supervised learning of semantics, we present a mix integer programming to re-rank the results, with subject to the workload constraints, as well as an objective to maximize the accuracy. Considering this computation-consuming large-scale integer programming, we supposed a greedy heuristic to find near-optimal solutions. The experimental results prove the greedy-based algorithm out-performances the CPLEX-based one in the computational time in all circumstances, while the similar scores in accuracy.

3 - Evaluating Appointment Postponement in Scheduling Patients at a Diagnostic Clinic

Burak Eksioglu, Clemson University, Department of Industrial Engineering, Clemson, SC, 29634, United States, Mahsa Kiani, Tugce Isik, Alexandria Thomas

In today’s healthcare systems, the increase in demand for appointments combined with a shortage of physicians has led to challenges for clinics to give timely appointments to patients. We investigate the application of a postponement policy in accepting appointment requests at a diagnostic clinic. The clinic receives appointment requests from outpatients, inpatients and emergency patients. Currently, these requests for appointments are handled on arrival. This causes some high priority outpatients to be referred while some of the capacity reserved for inpatients go unused. We propose postponing the decision regarding acceptance or referral of an outpatient for a reasonable amount of time. We formulate this system as a two-stage stochastic optimization problem and apply the sample average approximation (SAA) approach due to the large size of the state and action space. The results indicate that applying postponement leads to significant cost savings and better capacity utilization.

■ MC07

M-Maya VI

Tutorial: Stochastic Failure Models for Network Analysis

Emerging Topic: Tutorial

Emerging Topic Session

1 - Stochastic Failure Models for Network Analysis

Javiera Barrera, Adolfo Ibáñez University, Penalolen, Chile

Risk-awareness in the design and operation of networks need to systematically consider the performance of the network and consider investment to extend it to face the new challenge to provide their service. In general networks are subject to a trade-off between a low probability of unavailability of the service they provide and the very high cost associated with the impossibility of providing service in that event. Providers, users and regulators wish to understand how to better operate and redesign these networks, so researcher have developed techniques to evaluate their performance and study their stability. To analyze network failures attention must be paid to three important aspects: first to choose a failure model that is complex enough to capture the interaction between components but, at the same time simple to calibrate with the available information; second study the performance, this means that given a model we need to develop methodology to compute the performance of the network, and third to compare network designs and chose according to a budget constraint those which perform better. In this tutorial we will discuss new failure models that are appearing to capture dependence in components and how to estimate performance metrics considering simulation techniques. We will finish with some comment on the network design problem.

■ MC09

M-Maya VIII

Dynamic Systems

Contributed Session

Chair: Mona Ghandi, Washington State University, School of Design + Construction Washington St, Pullman, WA, 99164, United States

1 - Punctuality Measurement in European Rail Freight Collaboration: Empirical Interoperability Analyses in the Rhine-Alpine Corridor
Monika Maria Moehring, Technical University Middle Hesse, Friedberg, Germany, Christoph Geiss, Christiane Warnecke, Inga Haus

The Rhine-Alpine Rail Corridor connects major Dutch and Belgian ports with Genoa, Italy. Organized by RFC Rhine-Alpine, this study scrutinizes downstream punctuality measurement among six of the major players on the strategic axis. It exemplifies the varied use of key performance indicators in different stakeholders in the intermodal transport chain including shippers, logistics service providers, terminals, and infrastructure managers. The study suggests a harmonization of data formats for real-time punctuality records as well as the use of Industry 4.0 technologies.

2 - Stochastic Dynamic Scheduling for EV Sharing Service
Zihao Jiao, Beijing Institute of Technology, Beijing, China, Yanzi Zhang

Considering the trade-off between short-term allocation expenses and scheduling cost, An operator of an EV-sharing system must consider strategic decisions like the number of EVs and the fleet repositioning problem. meanwhile, the charging demand and travel demand are always stochastic in the EV sharing system. In this paper, a dynamic programming model is proposed on an infinite time horizon, which cannot be solved in a reasonable time. By solving a simple case, we get the mechanics of the model and the repositioning rule. A Q-learning approximation is proposed for obtaining a near-optimal solution in infinite horizon dynamic programming. Finally, management sights are presented in a case study.

3 - Adaptive Architecture and Internet of Things
Mona Ghandi, Assistant Professor of Architecture, Washington State University, Pullman, WA, United States

Advancements in information technology offer incredible new possibilities for innovation in architecture. By integrating active sensors and merging physical spaces with information systems, we can create smart environment. Such spaces can make our lives more convenient, expand the range of freedom and comfort in our lives, and improve well-being of the occupants through embedded flexibility and responsiveness. This paper investigates the role of data systems, sensory network, internet of things, reconfigurable structures, and interactive systems of control in making sustainable user-oriented adaptive environments.

■ MC10

M-Acapulco

Topics in Scheduling

Emerging Topic: Emerging Scheduling

Emerging Topic Session

Chair: Roberto Tavares Neto, Brazil

1 - Unrelated Parallel Machine Scheduling under Uncertainty via Robust Optimization
Pedro Munari, PhD., Federal University of Sao Carlos, Sao Carlos, Brazil, Jonathan De La Vega, Alfredo Moreno, Reinaldo Morabito

We describe how the robust optimization paradigm can be useful to model and solve the Unrelated Parallel Machine Scheduling Problem (UPMSP) with sequence- and machine-dependent setup times and job due-date constraints. We present two new robust optimization models, considering uncertain job processing and machine setup times that belong to a budgeted uncertainty set. The results of computational experiments indicate the importance of incorporating uncertainties into the problem, as it produces schedules with high chances of being more robust and effective in practice.

2 - An Application of the Grey Wolf Optimization Approach to Flowshop Scheduling Problems
Roberto Tavares, Professor, Federal University of Sao Carlos, Sao Carlos - SP, Sao Carlos, 13565-905, Brazil, Arthur Beltrame Canciglieri, Leandro dos Santos Coelho

This paper considers solving flowshop scheduling problems (FSPs) based on a global optimization procedure called Grey Wolf Optimizer (GWO). The GWO is a bio-inspired metaheuristic algorithm that proposes a multi-agent system which mimics the leadership hierarchy and hunting mechanism of grey wolves in nature. During the simulation, alpha, beta, and delta wolves estimate the possible position of the prey. The pack is led by the alphas, followed by the beta which is the subordinate wolves that responsible for assisting the alpha in decision making. The beta reinforces the alpha's commands throughout the pack and gives feedback to the alpha. Meanwhile, the lowest ranking of gray wolves are called omega which commonly plays the role of scapegoat. In our case, a modified version of the classical GWO to continuous optimization was set to solve the FSP benchmark problems proposed by Taillard in 1993. Simulation results showed that the tested GWO approach is effective and efficient for solving FSPs.

3 - Combinatorial Scheduling for Adaptive Machine Learning in Cyber-Security
Nourhan Sakr, Columbia University, New York, NY, 10463, United States, Ojas Parekh, Cynthia Phillips, Vladlena Powers, Cliff Stein

Cyber-attacks are an international concern, as high-profile breaches endanger the global economy, network infrastructures or even individual security. In light of constant technical innovation, the evolution of online criminals and their engagement in a continuous game with security experts are not likely to stop. Our work leverages combinatorial scheduling to design budgeted defense strategies against evolving adversaries. We study two related problems in cyber-security: adaptive URL classification and PLADD, a cybersecurity game for Moving Target Defense strategies. We show equivalence between both models and then present both in the language of combinatorial scheduling. We then give algorithms and analyses for several variants of the problem, including a DP algorithm for the two-machine case, a proof of NP-hardness for the general case, an analysis of an IP formulation and finally use real data to design several algorithms that return approximately optimal solutions.

4 - Integrated Permutation Flowshop and Vehicle Routing Problem: Exact and Heuristics Approaches
Roberto Tavares, Federal University of Sao Carlos, s/n, Sao Carlos - SP, Sao Carlos, 13565-905, Brazil, Caio Tomazella, Marcelo Nagano

The integration between production and distribution is an essential issue for industries that produce products with a short lifespan. This paper focuses on an Integrated production-distribution problem composed by a flowshop environment integrated with a vehicle routing problem. This paper uses two approaches to address this problem: a MIP formulation and an IG algorithm. In our algorithm, a two-stage NEH-based algorithm with five different sorting rules is integrated to the IG. On our experiments, it was possible to validate the both approaches. The experimentation considering four different problem sizes shows that the IG algorithm yields results with a 0.12% deviation from the optimal. A Tukey's HSD test indicates the Minimal Delivery Distance as a better way to initialize the algorithm.

■ MC11

M-Mexico

Energy Operations

General Session

Chair: Erick Moreno-Centeno, Texas A&M University, College Station, TX

1 - A Micro-based Model for World Oil Market
Enrique Ter Horst, PhD, Uniandes SM, Bogata, Colombia

In this paper, we study the supply-demand drivers of the price of oil over the last two decades. We address the problem of endogeneity using a novel SVAR approach, which allows us to incorporate technological restrictions that occur at the micro level in the production of crude oil to solve the identification problem in a reduced-form regression analysis that seeks to disentangle the drivers of oil prices. We explore the relationships between oil prices, rig counts, oil production and an index of world economic activity, and provide results for a heterogeneous set of countries. We find that when oil prices peaked in mid-2008 reaching almost US$150 compared to US$14 in 1998, a large proportion of the price move can be explained through a purely demand and supply factors.

2 - Transmission-Line Switching for Load Shed Prevention via an Accelerated Linear Programming Approximation of AC Power Flows

Erick Moreno-Centeno, Texas A&M University, Industrial and Systems Engineering, College Station, TX, 77843-3131, United States, W. Eric Brown

Topology control has garnered recent consideration for its value in leveraging the flexibility of the power system. However, using even the latest technology, the AC optimal transmission switching (ACOTS) problem remains intractable. As such, most research addressing optimal topology control is based on the DCOPF, which has been shown to be particularly inaccurate for transmission switching decisions in the AC power system. This paper accelerates an existing mixed-integer linear power flow model that has been shown to be very accurate in approximating AC power flows. The aim of the new model is to identify transmission switching candidates to prevent load shed caused by contingency events. The methodology was tested on the IEEE 118-bus test case system and presents promising results. The model proposed herein was found to almost always identify AC optimal switching actions while dramatically reducing the necessary solution time in comparison with the base model.

■ MC12

M-Cozumel

Global Optimization and Learning

Emerging Topic: Emerging Global Optimization

Emerging Topic Session

Chair: Andres Gomez, University of Pittsburgh, Pittsburgh, PA, 15217, United States

1 - Rank-one Convexifications for Sparse Regression

Andres Gomez, University of Pittsburgh, Pittsburgh, PA, United States, Alper Atamturk

Sparse regression models are increasingly prevalent due to their ease of interpretability and superior out-of-sample performance. However, the exact model of sparse regression with an L0 constraint restricting the support of the estimators is a challenging non-convex optimization problem. In this paper, we derive new strong convex relaxations for sparse regression. These relaxations are based on the ideal (convex-hull) formulations for rank-one quadratic terms with indicator variables. The proposed rank-one strengthening can be interpreted as an unbiased, non-convex sparsity-inducing regularizer, which dynamically adjusts its penalty according to the shape of the error function.

2 - An Optimal Accelerated Stochastic Gradient Method

Mert Gurbuzbalaban, Rutgers University, Piscataway, NJ, United States

We study the problem of minimizing a strongly convex and smooth function when we have noisy estimates of its gradient. We propose a novel multistage accelerated algorithm that is universally optimal in the sense that it achieves the optimal rate both in the deterministic and stochastic case and operates without knowledge of noise characteristics.

Tuesday, 9:00am - 10:30am

■ TA01

JW Tulum A

Sustainable Supply Chain Management

General Session

Chair: Tarkan Tan, Eindhoven University of Technology, Eindhoven, 5612AZ, Netherlands

1 - Would You Be Willing to Wait – Consumer Preference for Green Last-Mile Home Delivery for e-commerce

Josue Velazquez-Martinez, Massachusetts Institute of Technology, Cambridge, MA, United States, Karla Gamez-Perez, Jan C Fransoo

E-commerce has substantially increased transport emissions, specifically when consumers request fast shipping. Can emissions be reduced by driving consumer behavior? We conducted a field study with a large retail company in Mexico, with 1000 surveys during home delivery and 400 consumer decisions at the moment of the purchase. Our results show that 50% of consumers are willing to wait up to 6 additional days for their delivery when given understandable environmental information and this implies reductions up to 25% of transportation CO2 emissions.

2 - Simulation-optimization Model to Define Shipment Pooling Strategies in Last Mile Distribution

Andres Munoz-Villamizar, Universidad de La Sabana Andres Munoz-Villamizar, Massachusetts Institute of Technology, Cambridge, MA, United States, Josue Velazquez-Martinez, Karla Gamez-Perez

Strategies, such as reducing routing distance using optimization models, have been the most popular approaches to enhance the efficiency of the delivery process and to reduce its environmental burden. In this context, we present a simulation-optimization approach to define shipment pooling and consolidation strategies after including customers' extension of delivery time slots. Our approach allows companies to optimize fleet utilization and inventory and reduce CO2 emissions during last-mile delivery incorporating. We illustrate our approach with the largest retail company in Mexico. Our results show savings up to 15% of CO2 emissions in transportation.

3 - Where to Exert Carbon Emissions Abatement Efforts in a Supply Chain?

Tarkan Tan, Eindhoven University of Technology, School of Industrial Engineering, Den Dolech 2 Paviljoen F-07, Eindhoven, 5612AZ, Netherlands, Yann Bouchery, Astrid Koomen

We consider the problem of how firms can take into account the dynamics of supply chain interactions when "greenifying" their operations. A model is introduced which firms can use in defining the right optimization problem and system boundaries when they want to exert abatement effort by considering the supply chain wide effect of abatement options. Our model, which is applied at a chemical company, can help in determining which impact certain decisions of a focal company have on other firms' emissions in the supply chain and the resulting total footprint of the product.

4 - Net-Metered Distributed Renewable Energy: A Peril for Utilities?

Jayashankar M. Swaminathan, University of North Carolina - Chapel Hill, Kenan-Flagler Business School, Operations, Chapel Hill, NC, 27599-3490, United States, Nur Sunar

Our paper studies the implications of such "distributed renewable energy" for utility profits and social welfare under net metering that has sparked heated debates in practice. We prove that when the equilibrium wholesale price is sufficiently sensitive to the changes in the wholesale demand, there exists a critical market reliance level above which the net-metered distributed generation strictly improves the utility's expected profit. Our analysis also suggests that under certain conditions, it can be favorable for utilities to motivate their customers to adopt distributed renewable energy technology as increased adoption strictly improves the utility profitability.

5 - Environmental Matches and Gaps in the Logistics Service Provider-Shipper Interface

S.M. Mehdi Jourabchi, Wilfrid Laurier University, Waterloo, ON, Canada, D. Marc Kilgour, Michael Haughton, Mojtaba Araghi

We develop an economic model to analyze the environmental decisions of a logistics service provider (supplier) and a shipper (buyer). Our game-theoretic analysis examines the impacts of consumers' environmental preferences, green regulations, and the shipper's share of green investment on their environmental decisions. We characterize the parties' emissions target decisions depending on the parties' negotiation power in making the joint environmental decision of the product logistics. We further explicate the matches and gaps between the parties' environmental targets and discuss the conditions influencing their choices in the supply chain.

■ TA02

JW Tulum B

Using Stochastic Programming to Solve Real-world Problems

General Session/Practice Session

Chair: David Morton, Northwestern University, Evanston, IL, 60208, United States

1 - Optimization of Option Exercise Policies in Incomplete Markets with Quadratic Hedging

Nicola Secomandi, Carnegie Mellon University, Tepper School of Business, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States

Quadratic hedging is a practically appealing approach for approximately replicating the random payoff of European options in incomplete markets. This work broadens this methodology to the case of Bermudan options, for which an exercise policy needs to be optimized. The resulting optimal option exercise policies are in general time inconsistent. Time consistent option exercise policies can be optimized recursively. The proposed approach is relevant to both financial and, upon further development in some cases, real options.

2 - Stochastic Optimal Design and Operation of a River Basin
Alexandra M Newman, Colorado School of Mines, 1500 Illinois St, Golden, CO, 80401, United, Andy Burrow, David Morton, Mandy Hering

As populations and economies grow in regions with changing climates, water demand can quickly grow beyond what natural supply can sustain. Such shortages, along the Lower South Platte River in northeastern Colorado, are mitigated via a three-step approach: (1) create flow data scenarios which represent a wide array of hydroclimatic outcomes; (2) use an existing simulation model to process these scenarios in order to locate excess supply and unmet demand both spatially and temporally; and (3) minimize the cost of mitigating identified shortages using a new, multi-period, two-stage stochastic optimization model which designs reservoir storage (e.g., reservoir location, size, type, and operation) over a 50-year time horizon. Results indicate that unmet demand associated with historical and seasonally shifted scenarios can be mitigated completely while demand associated with reduced-mean scenarios can be mitigated, on average, 90% of the time over the entire horizon.

3 - Understanding Investment Policies in Defined Contribution Pension Funds
Daniel Duque Villarreal, Northwestern University, 2145 Sheridan Road, Evanston, IL, 60208, United States, David Morton, Bernardo Kulnig Pagnoncelli

Defined contribution (DC) pension plans have been gaining ground in the last 10-20 years as the preferred system for countries and other private or public agencies. The central question to DC plans is how to invest the money in order to reach the participant's retirement goals. Given the financial illiteracy of the general population, it is common to offer a default policy for members who do not actively make investment choices. Using data from the Chilean system, we discuss an investment model with fixed contribution rate and compare the results with the default policy under a wide variety of objectives. Our results indicate that the default policy has a good overall performance, but specific closed-loop policies have an impact in the expected shortfall at retirement.

4 - Distributionally Robust Stochastic Dual Dynamic Programming
David Morton, Northwestern University, IEMS Department, 2145 Sheridan Road, Evanston, IL, 60208, United States

We consider a multi-stage stochastic linear program, which lends itself to solution by stochastic dual dynamic programming. In this context, we focus on a distributionally robust variant of the model, inspired by work of Philpott, de Matos, and Kapelevich (2017). Here, the specific realizations in each stage are fixed, and distributional robustness is with respect to the probability mass function governing those realizations. We describe a computationally tractable variant of SDDP to handle this model.

■ TA03

JW Tulum C

Marketing

Contributed Session

Chair: Jingjie Su, University of Texas at Arlington, Arlington, TX, 76019, United States

1 - The Influence of Positive and Negative Word of Mouth on Consumer Exit Barriers
Ye Cao, Tongji University, Shanghai, China

This study is aimed to help company conducts customer retention through word of mouth. The data for empirical analysis were collected from 352 consumers in Shanghai to study the impact of positive and negative word-of-mouth on exit barriers of consumers.It finds that positive online word-of-mouth has a positive impact on monetary exit barriers,social exit barriers, service loss exit barriers and convenience exit barriers. And negative online word-of-mouth has a negative impact on monetary exit barriers and convenience exit barriers. Key Words: Internet word of mouth; transfer obstacles; Car-sharing;

2 - The Influence of Motivational Language Use in Video Commercials on Virality
Tim Tolkmitt, TU Dortmund, Dortmund, Germany

Based on McClelland's theory of needs I hypothesize that motivational language can either harm or support virality depending on the specific need addressed. With a unique dataset of 614 commercial videos of 177 young companies, combining data from Crunchbase, YouTube, Google Trends, a survey and extensive manual coding, video transcripts are analyzed with LIWC2015. The results show, that McClelland's needs are articulated significantly more than in natural language use. While achievement has a positive impact on virality, power shows a negative impact and affiliation doesn't show significant results. The effects are moderated by the evaluability of the product attributes prior to purchase.

3 - Information Overload and Interaction Overload: An Empirical Model
Tingting He, Saint Anselm College, Manchester, NH, United States

Despite the profound research on the information overload syndrome, there has rarely been research that empirically identifies information overload and interaction overload as separate causes of the syndrome. As a novel approach, our empirical research with survey data identifies information overload and interaction overload separately, and measures their impacts on the information overload syndrome. Our results indicate that information overload and interaction overload may be estimated separately, and each of them may contribute significantly yet differently to the information overload syndrome. Based on our results,

4 - Consumer Return Policies and Supply Chain Contract
Jingjie Su, University of Texas at Arlington, Arlington, TX, 76019, United States, Narayan Janakiraman, Kay-Yut Chen

We study the link between consumer return policies and supply chain contracts in a dyad supplier-retailer supply chain. We model the return policy as a mean to transfer some of the product value risks from the consumer to the retailer, and consider further risk sharing between the retailer and the supply through either the buyback or the revenue sharing contract. An analytic analysis shows that a restocking fee based return policy can influence both the choice of, and the parameters used, in the supply chain contract.

■ TA04

JW Tulum F

Sustainable Operations

Contributed Session

Chair: Michi Nishihara, Osaka University, Graduate School of Economics, 1-7, Machikaneyama, Osaka, 560-0043, Japan

1 - Pricing and Cancellation Scheme Design in a Servicizing Business Model
Hamed Vafa Arani, Rotterdam School of Management, Erasmus University Rotterdam, Rotterdam, Netherlands, Erwin Van der Laan, Morteza Pourakbar

Servicizing is a circular business model in which a service provider (SP) provides a product as a service instead of selling it to the customers. In this study, motivated by common business models, we consider an SP which offers a pay-per-use scheme to customers who are heterogeneous in terms of their usage valuation or frequency. SPs also indicate a threshold before which it is costly for the customers to cancel the contract. The purpose of this study is to design and analyze a contract, including the pay-per-use price and the cancellation threshold, to maximize the SP's revenue.

2 - On the Range Anxiety for Electric Vehicles: An Empirical Investigation
Sang Won Kim, CUHK Business School, Shatin, Hong Kong, Ho-Yin Mak, Marcelo Olivares, Ying Rong

Electric vehicles are an important technology for curbing the carbon footprint of road transportation. Despite substantial government incentives, mass adoption has yet to happen in major auto markets. Among the major shortcomings of EVs on the market are limited driving range and long recharging time, creating psychological concerns to drivers called range anxiety and making them reluctant to adopt EVs. Although the range anxiety is quite well-recognized, it has not been adequately quantified, quite possibly due to the lack of quality data. In this work, we propose a novel way to quantify the drivers' range anxiety on EVs by use of a dataset from a car sharing platform.

3 - A Three-Objective Stochastic Location-Inventory-Routing Model for Coffee Waste-Based Biofuel Supply Chain
Yasel Costa, Fundacion Zaragoza Logistics Center (ESG50985993), Zaragoza, Spain, Marcela Morales, William Sarache

Biofuels generated from agricultural waste have been proposed as a potential solution for the mitigation of climate change. This topic involves complex mathematical modeling tasks such as feedstock characteristics, biorefinery location and capacity setting. This study presents a multi-objective stochastic Mixed-Integer Non-Linear Programming model to design a sustainable supply chain from multiple coffee residues. The model incorporates the uncertainty in availability of coffee residues and also proposes a dynamic capacity setting into integrated formulation of location, inventory and routing decisions, analyzing its effects in terms economic, environmental, and social goals.

4 - Preemptive Competition between Two Firms with Different Time Discounts and Investment Costs
Michi Nishihara, Osaka University, Osaka, Japan

I investigate preemptive competition between two asymmetric firms in the game theoretic real options framework. I assume that one firm has a higher time discount and a lower investment cost than the other firm. I show that in equilibrium the order of the two firms' investments depends on characteristics of the market. Indeed, in the market with weaker preemptive competition, higher volatility, and lower growth rate, the firm with a high discount rate and a low cost is more likely to invest earlier than the firm with a low discount rate and a high cost.

■ TA05

JW Tulum G

Transportation and Logistics Applications

Contributed Session

Chair: Aura Jalal-Osorio, Federal University of Sao Carlos, Washington Luís, Sao Carlos, 13565090, Brazil

1- Sustainability and Productivity: Optimizing Timber Extraction on a Stand With Dynamic Programming and Forest Simulation Tools
Mario C. Lopez-Loces, Universidad Autonoma de Nuevo Leon, San Nicolas de los Garza NL, Mexico, Roger Z. Rios-Mercado, Oscar A. Aguirre-Calderon, Jose Gonzalez-Velarde

In this work, we present a dynamic programming algorithm, embedded with a forest growth simulator to solve the Stand Level Optimization Problem. The model considers minimum remaining stock constraints during each cut. During the experimentation, a series of tests were carried out to reduce the computational time cost, which allowed us to evaluate larger instances of the problem, and to adjust the values of the parameters, through sensitivity analysis, to improve the volume of harvested wood at the end of the planning period.

2 - The Robust Capacitated Facility Location Problem
Marco Caserta, IE University, Madrid, Spain

We present robust formulations for the capacitated facility location problems under demand uncertainty, both for the single-source and the multi-source variants. Robustness is defined over different uncertainty sets, i.e., the box, ellipsoidal, and polyhedral uncertainty sets. For each of these variants, we define the robust counterparts and we compare the results obtained through an extensive computational study. We test he effect of using different support sets and analyze the performance of each robust variant using scenario curves and price of robustness, among other measures.

3 - Location and Transport Problem in a Pharmaceutical Distribution Network
Aura Jalal-Osorio, Federal University of São Carlos, São Carlos, Brazil, Eli Toso, Reinaldo Morabito

This work proposes a multiproduct, multi-period, and multimodal mathematical formulation integrating location and transportation decisions for a pharmaceutical distribution network. The model considers product features, such as cold chain transport, as well as characteristics of the Brazilian tax on goods movement (ICMS). Computational experiments with real-life data from a multinational pharmaceutical company show that the proposed model is effective to support the integration of decisions.

■ TA06

JW Tulum H

Supply Chain Management I

Contributed Session

Chair: Raphael Oger, IMT Mines Albi, Campus Jarlard, Albi, 81000, France

1 - Role of Big Data Analytics Infrastructure Capabilities in SC Resilience Development: An Empirical Exploration
Santanu Mandal, Associate Professor, Amrita Vishwa Vidyapeetham University, Coimbatore, India

Influence of BDA infrastructure capabilities in the development of SC resilience remains unexplored. Furthermore, the inter-relationships among these BDA infrastructure flexibility capabilities remains unexplored. Hence in this study we explore these two research gaps. Data were collected from 176 analytics professionals engaged in SC management through an online survey. The collected responses were then analysed using partial least squares in SmartPLS 2.0. M3. Results suggested BDA connectivity, BDA compatibility and BDA modularity as prominent enablers of SC resilience. Furthermore, the study found BDA modularity as prominent enablers of BDA connectivity and BDA compatibility.

2 - Understanding Institutional Theory in Supply Chain Evolution and Future
Chaher Alzaman, Concordia University, Montreal, QC, Canada

In the last 100 years, the supply chain went from a set of diverse operations owned and sometimes managed by one organization to a network of many organizations working together to produce and deliver a given product. The move from a vertically owned supply chain to supply disintegration brought flexibility and cost-effectiveness but at the expense of operational controls (mainly quality, lead-time, and delivery). Looking at the evolution of the supply more deeply, we can trace analogies to institutional theory. Mainly, we focus on the role of informal institutions, the importance of the transaction cost, and the enablement of trial and error in the evolution and future of the supply chain.

3 - Strategic Supply Chain Planning and Risk Management: towards an Event-Driven Decision Support System and Decision-Making Process
Raphael Oger, PhD Candidate, ISYE School, Georgia Institute of Technology, Atlanta, GA, United States, IMT Mines Albi, Albi, France, Matthieu Lauras, Benoit Montreuil, Frédérick Benaben

Strategic supply chain planning and risk management are inseparable nowadays. The ability to consider risks is essential to maintain business performance. However, collecting and processing the information to support the decision-making process is time-consuming, which results in a limited set of considered risks and opportunities. Therefore, a computerized decision support system has been designed to automate the discovery and evaluation of supply chain alternatives. It opens avenues for implementing event-driven decision-making processes in a hyperconnected world.

■ TA07

M-Maya VI

Tutorial: A Few Links between Mathematical Optimization and Data Science

Tutorial Session

Chair: Ivan Contreras, Concordia University, Montreal, QC, Canada.

1 - A Few Links Between Mathematical Optimization and Data Science
Emilio Carrizosa, Universidad de Sevilla, Sevilla, Spain

Mathematical Optimization is omnipresent in Data Science tasks such as dimensionality reduction and visualization, classification and regression. The type of Mathematical Optimization tools is wide, including nonlinear (convex or not) and mixed integer programming, in many cases of large scale. Some recent examples will be presented, mostly around the topic of Cost-sensitive Constrained Classification and Regression Models, based on (randomized) trees or Support Vector Machines.

■ TA09

M-Maya VIII

Novel Analytics Applications

General Session

Chair: Freeman Marvin, Innovative Decisions, Inc., Broad Run, VA, 20137, United States

1 - Building a Targeted Portfolio of Soybean Varieties
Emilia Silebi, Kromite, LLC, Churchville, PA, United States

It's important for those making crop planting decisions to make good use of their land by planting a stable portfolio of high-performing varieties. Kromite developed a tool that leverages experimental data to evaluate variety performance in locations beyond normal trialing sites. Weather, soil, and phenotypic data are all used to predict product performance in these new locations, allowing for a comprehensive evaluation of varieties near commercialization. The tool uses predictive models to generate performance data for varieties. This generated performance data is used to create high performing, stable portfolios of varieties in target markets based on user-defined constraints of location, target product profile, portfolio size, minimum allocation, and specific required varieties. The portfolio of varieties identifies each variety used and the percentage of the portfolio assigned to a variety. The user can also customize their own portfolio of varieties and compare its performance to the optimized portfolio produced by the tool. This presentation will describe the optimization models employed by the tool and include a demonstration of the tool.

2 - In the Face of Uncertainty: Interactive Simulations in Support of Decision-Making
Shaun Doheney, ProbabilityManagement.org, Stafford, VA, 22554, United States, Sam Savage

This presentation will demonstrate how to model, roll up, and visualize operational and sustainability risks in native Excel or other computer environments that support arrays. This sort of modeling is particularly applicable in risk analysis, readiness analysis, project/program/portfolio analysis, and just about any decision-making process where there is uncertainty involved. Examples covered in this presentation will include scenario-based portfolio planning, operational readiness forecasting, and infrastructure risk. Companion models to our presentation are available at https://www.probabilitymanagement.org/models.

3 - The Politics of Analytics – When the Math is Not the Problem
Zahir Balaporia, FICO, Green Bay, WI, 54313, United States

"Trust in God, everyone else bring data" is an old saying that implies convincing others to follow a particular course of action is possible as long as you've armed yourself with enough data. But when it comes to implementing a change based on analytics, data or statistics or even an optimal solution are rarely sufficient. Success often requires navigating through the political landscape in order to reach your intended destination. This talk will cover 5 strategies with supporting examples for effective advocacy under even the most challenging conditions. Ultimately, your political skills are (unfortunately?) just as crucial as your analytical skills when deploying a solution.

4 - Applications of Bayesian Networks for Army Condition-based Maintenance (CBM)
David Aebischer, United States Army CECOM, Nashville,TN, United States

Condition-based Maintenance (CBM) implementations offer unique opportunities to manage uncertainty in combat conditions. The basic premise of a CBM program is to use off-platform data to predict impending failures in time to enable proactively "managed", or planned, repairs instead of reactive repairs – thereby reducing equipment downtime and, in many cases, limiting the extent of equipment damage. The success of a CBM is based on cost – the ratio of implementation cost to cost savings – and availability. The Return on Investment (ROI) aspect, and those equations, are relatively straightforward in industrial settings where costs are generally tangible, continuous production is an imperative, and the CBM-managed components meet established cost and criticality thresholds. Costs and availability are intertwined; cost savings are a function of availability. But combat equipment presents different variables and greater uncertainty due to different descriptions of cost and availability and the relationship between the two. While consumables such as fuel and repair parts are still a significant cost driver, the primary currency in combat is readiness. The case supporting a CBM implementation decision, then, is weaker where Return on Investment (ROI) is lower or where the combination of tangible and intangible benefits is less obvious. The top-level challenge then is always to find ways to reduce sustainment costs without compromising readiness and while maintaining acceptable readiness rates. In general, CBM implementation requires CBM-enabled equipment, to include sensor, sensor-fusion, source collection, user interface devices, and all associated connections and cabling. Many Army legacy systems are not equipped with built-in sensors – not CBM-enabled - and even systems that are sensor-enabled may not be recording data that is sensitive to specific predictive tasks. It can be cost-prohibitive to equip those systems with all the necessary source collection, sensor, and sensor-fusion capability and there is not built-in reasoning system with which to establish what variables are most sensitive to the CBM target. The functional challenge is then to develop and implement a hybrid sensor and reasoning system to support CBM tasks without adding significant cost and logistics burden. The Simple Management Network Protocol (SNMP) is an application-layer protocol used to monitor and manage network devices and their functions. SNMP ubiquitous on Army networking equipment. As such, SNMP can be used as a built-in sensor and source collection asset for CBM. SNMP is feature-rich – providing data on myriad network and system variables and providing multiple configuration tools for network managers. Bayesian networks (BN) are uniquely suited to discover causal structure from data. The knowledge engineering processes associated with BNs provides a path to building fully-parameterized causal models. This paper and presentation will show relevant research on implementing BNs for SNMP and will show the potential for using BNs to learn from current and historical SNMP data to create and agent for deploying SNMP as a CBM sensor.

■ TA10

M-Acapulco

Novel Scheduling Models and Algorithms

Emerging Topic: Emerging Scheduling

Emerging Topic Session

Chair: Debora Ronconi,

1 - On the Special Class of the Job Sequencing and Tool Switches Problem Where All Jobs Require at Most Two Tools
Horacio Hideki Yanasse, Universidade Federal de São Paulo, São José dos Campos, 12227-010, Brazil

In this work, we address the job sequencing and tool switches problem when all the jobs require at most two tools. We show that this special case of the problem is NP-hard and we identify a particular class of instances that can be solved in polynomial time. We believe that the results presented in this work are inspiring and helpful in developing new and improved methods for solving other cases of the problem.

2 - Scheduling Models for a Product-mold-machine Problem
Nelson Troncoso, Depto. de Ingeniería Industrial, Facultad de Ingeniería, Universidad de Santiago, Chile, Chile, Pedro Piñeyro, Héctor Cancela, Óscar C. Vásquez, Joaquín Velázquez

This paper addresses a problem related to the manufacturing process of tires, plastic, ceramics and glass, where several molds are placed in machines to obtain the final product. The production system includes setup times; product processing times; and identical parallel machines with limited number of positions for molds. We show that the problem is NP-complete in the strong sense and propose two different mathematical programming models to minimize the makespan. We discuss their characteristics and performance by means of some numerical examples.

3 - A Filtered Beam Search Method for the Flowshop Scheduling Problem Minimizing the Earliness and Tardiness Penalties and the Waiting Time of the Jobs
Débora Ronconi, University of Sao Paulo, Av. Prof. Almeida Prado, 128, Sao Paulo, Brazil, Ernesto G. Birgin, José E Ferreira

This work addresses the minimization of the absolute deviation of job completion times from a common due date in a flowshop scheduling problem. Besides this main objective, the minimization of the waiting time of the jobs in the production environment is also considered. A mixed integer programming model for this problem is proposed and, due to its complexity, heuristic approaches are developed. A list-scheduling algorithm for the approached problem is introduced. Moreover, a filtered beam search method that explores specific characteristics of the considered environment is proposed. Numerical experiments show that the presented methods can be successfully applied to this problem.MB

■ TA11

M-Mexico

Game Theory I

Contributed Session

Chair: José G. Flores-Muñiz, Universidad Autónoma de Nuevo León, San Nicolás de los Garza, Mexico.

1 - Strategic Inventories in a Supply Chain with Downstream Cournot Duopoly
Xiaowei Hu, University of Wisconsin - Milwaukee, Milwaukee, WI, United States

We present a two-period game-theoretic supply chain model, in which a singular manufacturer supplies products to a pair of identical Cournot duopolistic retailers. We show that the strategic inventory carried out by the retailers under dynamic contract is Pareto-dominating for the manufacturer, retailers, consumers, the channel, and the society as well. We also find that retailer's strategic inventory, however, can be eliminated when the manufacturer commits wholesale contract or inventory holding cost is too high. In comparing the cases with and without downstream competition, we also show that the downstream Cournot duopoly undermines the profits for the retailers, but benefits all others.

2 - Profit-Sharing and Efficient Time Allocation
Miguel Vargas, Research Professor, Santiago de Cali University, Cali, Colombia

Agents are endowed with time, which in turn is invested in projects that generate profit. A mechanism divides the profit generated between these agents, depending on the allocation of time as well as the profit made by every project.

We study mechanisms that incentivize agents to contribute their time to a level that results in the maximal aggregate profit at the Nash equilibrium (efficiency). Our main finding involves the characterization of all mechanisms that satisfy efficiency. We characterize the class of mechanisms that are monotone in the payoffs of the agents with respect to technological improvements, the addition of time to agents, and mechanisms that are resistant to group manipulations.

3 - Consistent Conjectural Variations Equilibrium in a Financial Model
José G. Flores-Muñiz, Ph.D. Student, Universidad Autonoma de Nuevo Leon (UANL), San Nicolas de los Garza, Mexico, Nataliya I. Kalashnykova, Viacheslav V. Kalashnikov

A general multi-sector, multi-instrument model of financial flows and prices is considered and modeled as a multi-leader-multi-follower Stackelberg game. In the upper level, each sector makes conjectures of its influence on the price of each instrument, while in the lower level, these sectors determine the values of instruments held as assets and as liabilities. In both levels, the sectors search to minimize the risk while at the same time maximizing the value of its asset holdings and minimizing the value of its liabilities. The existence of a solution for the lower level is shown while conditions for the uniqueness of the lower level solution and the existence of an upper-level solution are given.

■ TA12

M-Cozumel

Optimal Network Design

Contributed Session

Chair: Alfredo Moreno, Universidade Federal de Sao Carlos, 135 rua Ray Wesley Herrick, Sao Carlos, Brazil

1 - A Network Optimization Approach for Flood Risk Mitigation in Coastal Cities Facing Climate-Change-Induced Sea Level Rise
Donald J. Jenkins, PhD Candidate, University of Massachusetts - Boston, Boston, MA, United States, Foad Mahdavi Pajouh, Paul Kirshen

Incomplete climate change knowledge is presenting decision-makers in coastal cities with challenges to protect their cities in a deeply uncertain situation. This research extends existing flood cost-benefit optimization research by modelling a coastal region lacking an existing flood mitigation infrastructure with an at-risk network grid to evaluate optimal cost-benefit strategies. Expected flood costs are included using a loss function that samples a range of sea level scenarios, while investment costs are for overall infrastructure development. The problem is modeled as a large-scale mathematical program that optimizes for the minimal overall expected costs.

2 - Solution Methods for the Multi-crew Scheduling and Routing Problem in Road Restoration
Alfredo Moreno, Federal University of Sao Carlos, Sao Carlos, Brazil, Pedro Munari, Douglas Alem, Michel Gendreau

This talk introduces solution methods based on decomposition to solve the heterogeneous multi-crew scheduling and routing problem in road restoration. The problem consists of finding the schedule and route of heterogeneous crews that perform the restoration of damaged nodes in a network affected by extreme events. Computational experiments show that the proposed solution methods are able to obtain good-quality solutions to realistically sized instances.

Tuesday, 11:00am - 11:50am

■ Plenary

JW Tulum E

The Applications, Mathematics, and Algorithms of Two-Player Optimization Problems

Emerging Topic: Plenary

Emerging Topic Session

1 - The Applications, Mathematics, and Algorithms of Two-Player Optimization Problems
J. Cole Smith, Clemson University, Clemson, SC, 29634, United States

The optimization fields of bilevel programming, interdiction, and robust optimization have become vital areas of study over the past few decades. Problems in these fields typically involve two players making decisions in turn, where each player's actions affect each other's objectives and/or resources. These models increasingly important relevance in protecting critical infrastructure, determining vulnerabilities in complex systems, and analyzing how systems can be designed to achieve desired outcomes for the players. This lecture will discuss some of the applications that inspired developments in these areas, and will contrast the models used to represent the different games. Despite the variations in algorithms designed to solve these models, there are many commonalities as well. This talk will discuss, in a lightly technical manner, the commonalities of these approaches and how advances in one research area benefits the development of algorithms in the other areas. Finally, I will discuss some emerging research areas and opportunities for future research in this field.

Tuesday, 1:30pm - 3:00pm

■ TB01

JW Tulum A

Simulation Optimization

General Session

Chair: Zelda B Zabinsky, University of Washington, Seattle, WA, 98195-2650, United States

1 - Gradient-Based Simulation Maximum Likelihood Estimation for Stochastic Models
Michael Fu, University of Maryland-College Park, Robert H. Smith School of Business, Van Munching Hall, College Park, MD, 20742, United States, Yijie Peng, Bernd Heidergott, Henry Lam

The usual setting for maximum likelihood estimation assumes that the likelihood function can be explicitly calculated, often in closed form but at least numerically. We consider a setting where this is difficult, if not impossible, because the output is generated by a complex stochastic model, e.g., a large queueing network. We propose a gradient-based simulated maximum likelihood estimation approach for this setting. We demonstrate how our approach can handle various types of model structures and illustrate the potential of the proposed approach with numerical results.

2 - Optimal Computing Budget Allocation with Sensitivity Information
Jian-Qiang Hu, Fudan University, Shanghai, China, Tianxiang Wang, Chun-Hung Chen

In this work, we consider the problem of OCBA under the scenario in which simulation generates not only system performances but also performance sensitivities. We develop the optimal allocation policies and also show that the probability of selecting the best design will increase with additional sensitivity information.

3 - Enhancing Stochastic Search with Surrogate Models and the Shrinking Ball Method
Qi Zhang, Stony Brook University, SUNY, Department of Mathematics and Statistics, Stony Brook, NY, 11794-3600, United States, Jiaqiao Hu

We propose a random search algorithm for solving Lipschitz continuous simulation optimization problems. The algorithm samples candidate solutions from a parameterized probability distribution and estimates the performance of the sampled points using the shrinking ball method. A distinctive feature of the algorithm is that it fully retains the previous simulation information and incorporates an approximation architecture to allow the use of low-variance knowledge of the objective function in searching for improved solutions. We present globally convergence results for the algorithm and provide numerical examples to illustrate its performance.

4 - Probabilistic Branch and Bound for Deep Learning
Zelda B Zabinsky, University of Washington, Industrial and Systems Engineering, Seattle, WA, 98195-2650, United States, TingYu Ho, Seksan Kiatsupaibul

Deep learning is recognized as a global optimization problem, yet the stochastic gradient algorithm, one of the popular methods for training deep learning, is designed for convex functions. Probabilistic branch-and-bound (PBnB), an algorithm that is designed to identify a subset of the feasible region that contains near-optimal solutions to non-convex problems, has finite-time statistical analyses that quantify the solution quality. In this research, we combine PBnB and stochastic gradient applied to deep learning to work forward determining an optimality gap (perhaps with confidence intervals) and providing insights into the sensitivity analysis and randomly selected initial solution.

5 - A New Approach to Large Scale Bayesian Optimization
Giulia Pedrielli, Arizona State University, Tempe, AZ, 85281, United States

A challenge in Bayesian Optimization is the ability to scale to large dimensions. A successful approach in the literature has been to identify the effective dimensionality of the problem or exploit the additive structure of the response function. The resulting algorithms work on manifolds or additive processes. In our approach, we complement this literature for those cases where the effective dimensionality may be hard to retrieve or still too high, or additive structures may be intractable to estimate. We recursively optimize our original function over sets of complementary lower dimensional subspaces. This results in the novel Subspace COmmunication for OPtimization (SCOOP) algorithm, which enables intelligent information sharing among subspaces such subsapces are simultaneously moved towards promising locations. The experiments show that the accuracy of SCOOP rivals state-of-the-art global optimization techniques, while being several orders of magnitude faster and having better scalability against the problem dimensionality.

■ TB02

JW Tulum B

Stochastic Integer Programming: Theory and Applications

General Session

Chair: Ricardo Fukasawa, University of Waterloo, Waterloo, ON, N2L 3G1, Canada

1 - An Affine Bounding Method for Two-stage Stochastic Integer Programs
Gustavo Angulo, Pontificia Universidad Católica de Chile, Macul, Santiago, 7820436, Chile, Merve Bodur, Diego A. Moran

For two-stage stochastic programs with mixed-integer recourse, we propose a decomposition method akin to Benders' decomposition. To approximate the second-stage value function, we iteratively partition the first-stage feasible set with affine lower-bounding functions derived from a Lagrangian relaxation, which is shown to be exact at the vertices of each element of the partition.

2 - Some Recent Advances in Multistage Programming with Mixed Integer Recourse: Tight Cuts and Convergence Analysis
Andy Sun, Georgia Institute of Technology, Atlanta, GA, 30332-0205, United States

In this talk, we present some recent work on multistage programming with mixed integer recourse, including a class of tight cuts, the Lagrangian cuts, for multistage stochastic programming with binary state variables, and related convergence analysis. We will also touch upon extensions to nonlinear constraints.

3 - A Risk-averse Ultimate Pit Problem
Bernardo Kulnig Pagnoncelli, Universidad Adolfo Ibanez, Diagonal Las Torres 2640 Penalolen Of. 533-C, Santiago, 7910000, Chile, Gianpiero Canessa, Eduardo Moreno

In this talk, I will discuss the classical ultimate pit problem that appears in mine planning. We consider ore grade uncertainty and discuss different ways of measuring risk in the objective function. We list a set of desirable properties and show that the entropic risk measure is the only one that satisfies those properties. We propose an algorithm to solve risk-averse ultimate pit mining problems with the entropic risk measure and apply our methodology to one toy problem and one realistic mine.

4 - Improvements on an Exact Algorithm for the Chance-constrained Vehicle Routing Problem
Ricardo Fukasawa, University of Waterloo, 200 University Ave West, Waterloo, ON, N2L 3G1, Canada, James Luedtke, Fernando Santos

The chance-constrained vehicle routing problem (VRP) is a variation of the classical VRP, where demands are considered as random variables and the goal is to design a set of minimum cost routes such that each route's capacity is satisfied with high probability. In a recent work, we developed an exact algorithm based on a branch-and-cut-and-price formulation using deterministic knaspack approximations of the chance-constrained knapsack. In this work we investigate the effect of considering different knapsack approximations in an attempt to solve the problem better.

■ TB03

JW Tulum C

Artificial Intelligence

Contributed Session

Chair: Anahita Khojandi, University of Tennessee, 521 Tickle Building, Knoxville, TN, 37996, United States

1 - The Analysis of ML/AI Intervention Points in the Software Development Process
Brett Josephson, Assistant Professor, George Mason University, Fairfax, VA, United States, Steven I. Lee

We explore two use cases for data analytics in software development efforts. Specifically, we highlighted the potential for modern data analytical approaches across two major components of the software development process: (1) code defect prediction and (2) project estimates. First, we developed a system to automatically process code files and output code complexity metrics along with an algorithm that calculates defect probability. An assortment of models was tested, including Neural Nets, Support Vector Machines, Gaussian Mixtures, and Ensembles. Second, for project predictions, we turned to the Software Benchmarking Standards Group Data Repository (v10) of completed software projects.

2 - Solving Multi-objective Optimization Problems Using a Contribution Hypervolume-based Multi-objective Evolutionary Algorithm
Edgar Manoatl Lopez, Mutuo Financiera, Mexico, Jesus Fernández, Carlos Hernandez Castellanos

The hypervolume-based selection mechanism is one of the most promising schemes for creating MOEAs. However, the main disadvantages of these techniques are that it distributes the solutions around the knee of the Pareto front and its exact computation is very expensive. Therefore it causes that certain MOEAs cannot properly find well-distributed solutions along the Pareto front when solving MOPs with irregular shapes. We proposed a new hypervolume-based selection mechanism, which adopts the use of an angle distance. This improvement makes the hypervolume-based selection mechanism to be more efficient than contribution hypervolume-based method. Our approach shows to be a good optimizer.

3 - Real-Time Sensor Anomaly Detection and Identification in Automated Vehicles
Anahita Khojandi, University of Tennessee, Knoxville, TN, United States, Franco Van Wyk, Yiyang Wang, Neda Masoud

Anomalous sensor readings caused by either malicious cyber attacks or faulty vehicle sensors can result in disruptive consequences for connected and automated vehicles (CAVs). We developed a real-time anomaly detection approach by combining a deep learning method, namely convolutional neural network (CNN), with a well-established anomaly detection method, Kalman filtering with a chi-square detector, to detect and identify anomalous behavior in CAVs. Our numerical experiments demonstrate a high performance in both detection of anomalies and identification of their sources.

■ TB04

JW Tulum F

Project Management

Contributed Session

Chair: Yurui Zhang, Tianjin University, Tianjin, 300072, China

1 - To Renegotiate or Not in Global Infrastructure Projects? The Impact of Loss Aversion

Zhuo Feng, Assistant Professor, Dalian University of Technology, Dalian, China, Qiaochu He, Yiwen Zhang

A growing number of governments in developing economies are attracting foreign firms to build and operate the infrastructure projects for them. Since the initial contract between the host government and the foreign firm is based on forecasted demand, the host government may request renegotiation to adjust it after demand uncertainty is resolved. In consideration of the foreign firm's loss aversion behavior, we take the perspective of the host government to study how to request renegotiation and how to design the initial contract in anticipation of renegotiation.

2 - To Enforce or not to Enforce: An Empirical Study of Antecedents and Constraints on Contract Enforcement

Hongjiang Yao, Tianjin University, Tianjin, China, Yongqiang Chen, Bo Du, Yurui Zhang

Abundant evidence shows that contract violation often occurs in an inter-organizational exchange, yet little literature has addressed the question of responses to contract violations (i.e., contract enforcement). This study empirically explores the effects of trust on contract enforcement and investigates the mediating role of relationship continuity and the moderating role of contract complexity. The findings contribute to contract theory by providing a thorough understanding of antecedents of contract enforcement and also provide a more nuanced perspective on the relationship between trust and contract which has been a heated debate on whether they are substitution or complementary.

3 - Contract Enforcement in Projects: The Role of Contract Violation, Relationship Quality and Environment Uncertainty from A Systematic Perspective

Yurui Zhang, Master, Tianjin University, Tianjin, China

Contracts are of great importance in managing projects and maintaining relationships. However, no matter how well contracts are designed, they are often breached by parties. Using data from Chinese construction industry, this study explores the effects of contract violation and relationship quality directly and interactively and the moderating role of environment uncertainty to draw a holistic picture of contract enforcement from a systematic perspective. The findings provide a deeper understanding of contract enforcement and new insights into contract governance, which contribute to explain the hot debate on the relation of contract governance and relationship governance.

■ TB05

JW Tulum G

Transportation-Freight

Contributed Session

Chair: Nursen Aydin, University of Warwick, Scarman Road, Coventry, CV4 7AL, United Kingdom

1 - A Complex Networks Approach Towards Characterizing the European Hinterland Transport Network as a Multimodal System

Camill Harter, Erasmus University Rotterdam, Rotterdam, Netherlands, Otto Koppius, Rob A. Zuidwijk

The European hinterland container transport network is a complex multimodal network comprising subnetworks formed by transport modes barge, rail, and truck. The understanding of how modes are intertwined on a Europe-wide scale and how they jointly deploy an intermodal system is however limited. We find clusters of cities based on their role in enabling an integrated intermodal system and analyze their connectivity and centrality under different levels of intermodality. We show that multimodal hub cities are most important for a functioning system, but unimodal and remote cities benefit the most from it. We use a unique dataset containing all intermodal services scheduled in Europe from 2016-2019.

2 - Estimation of Disaggregated Freight Flows via a Real-Valued Genetic Algorithm

Javier Rubio-Herrero, Assistant Professor of Industrial Engineering, St. Mary's University, One Camino Santa Maria, San Antonio, TX, 78228, United States, Jesus Munuzuri

We introduce a method for estimating product-by-product commodity flows when they are not readily available and only aggregated data per origin-destination (OD) pair are provided. By using a doubly-constrained gravity model, we aim at finding an OD matrix of aggregated flows that is as similar as possible to the available data. The calibration of the model takes place via a genetic algorithm. We apply this method directly to the case of estimating the disaggregated flows of ten different products among the fifteen regions of peninsular Spain between 2007 and 2016.

3 - Models for Determining Container Seaport Hinterlands

Alejandro Francisco Mac Cawley, Pontificia Universidad Catolica de Chile, Santiago, Chile, Luz A. Florez, Ricardo Giesen, Javier Vega

This work proposes and compares three methodologies to delimit the port hinterlands and applies them to six South America's ports. The three methodologies are: first, Euclidean distances; second, the travel distance considering existing road network in the region and third, a cost function that accounts not just for the travel distance, but also for the fuel costs expressed as a function of load, speed, road network slopes, travel times and other parameters. We analyzed the effect of: fuel cost, port cost and congestion, on the hinterlands of the ports. Finally, we apply the methodologies to 6 ports in South America and 4 destinations. Results show significant differences between the 3 methods.

4 - Speed Optimization in Liner Shipping in the Presence of Uncertain Service Times and Time Windows at Ports

Nursen Aydin, University of Warwick, Coventry, United Kingdom, Habin Lee

Recent studies in maritime shipping have concentrated on environmental impacts of ships. In this regard, fuel is considered as one of the important factors. In particular, the sailing speed of the vessels affects the fuel consumption directly. In this study, we consider a speed optimization problem in liner shipping, which is characterized by stochastic port times. The objective is to minimize the total fuel consumption while maintaining the schedule reliability. We develop a dynamic programming model to provide approximate solutions. Our numerical study using real data from a European liner company indicates that the speed policy obtained by the proposed model performs significantly well.

■ TB06

JW Tulum H

Supply Chain Management II

Contributed Session

Chair: Lina Simeonova, University of Kent, 34 Hollands Avenue, Folkestone, CT19 6PN, United Kingdom

1 - Trust 4.0 - How Sensors Replace Trust in Buyer-Supplier Relationships - Or Do They?

Katharina Badenhausen, PhD Candidate, Erasmus University, Rotterdam, Netherlands, Merieke Stevens

Recently, companies have begun to install sensors on their supplier's production machinery in order to predict and prevent machine breakdowns. This results in real-time access to sensitive supplier data. The appeal of access to continuous data is clear. Less straightforward is how such far-going visibility is managed between organizations. In a multiple-case study, we examine how the adoption of such sensors influences - or is influenced by - trust within a buyer-supplier relationship.

2 - Determination of a Cost Structure for the Trucking Industry

Abel González, Universidad Autónoma de Nuevo León, Monterrey, Mexico, Miguel Mata

The absence of a proper cost structure in small and medium trucking companies in Mexico result in utility losses since there are some operational factors not considered in the initial rate offered to clients. With a thorough analysis of all the variables involved, the transportation companies can have full visibility of the resources spend in a freight service. Every factor around the operation of a service, is subjected to a scientific research, then calculated using modern and exact technological platforms.

3 - An Integrated Mixed Method Approach for Decision Making in a Multi-facility Supply Chain: A Real Life Case from the UK Steel Industry

Lina Simeonova, Senior Logistics Analyst, University of Kent, Canterbury, United Kingdom, Niaz Wassan

This research presents an integrated approach to Supply Chain Management applied to the case of the largest steel stockholder in the UK. The purpose is to identify the most efficient supply chain route to satisfying customer orders. We estimate all costs associated with order processing and apply our heuristic method to determine the optimal route along the supply chain. Implementing this methodology shows significant savings for the company and reveals some interesting practical implications for improving operational efficiency, and some important strategic insights.

■ TB07

M-Maya VI

Tutorial: OR in Energy Planning: Modeling Strategies, Solving Techniques and Practical Aspects

Emerging Topic: Tutorial

Emerging Topic Session

Chair: Chiaro Lo Prete, Penn State, United States

1 - OR in Energy Planning: Modeling Strategies, Solving Techniques and Practical Aspects

Andre Luiz Diniz, Eletrobras Cepel, Rio de Janiero, Brazil

Energy planning is a fertile field for the application of operations research techniques and mathematical programming tools. There are a lot of interesting problems, ranging from long-term planning to day-ahead or intra-day scheduling tools. Despite the improvement in commercial packages to solve LP, MILP or MINLP problems, extensive expertise is still required to model, decompose and solve such problems in an efficient way, in order to derive tools that provide implementable results as closest as possible to reality, in reasonable CPU times. One of the main challenges in these types of problems is how to handle uncertainty. In the past, this issue was mainly addressed in long-term problems, with the application of stochastic programming techniques such as SDDP to represent uncertainty in some crucial input variables such as hydro inflows to reservoirs. In modern power systems, the large increase in intermittent generation has forced unit commitment and short-term scheduling tools to also address this issue, leading to different ways to model here and now/wait and see decisions, and favoring the application of alternative techniques such as robust optimization. In addition, the modeling of hourly operation aspects in long-term planning tools is becoming more and more important, posing a big challenge in handling the trade-off between accuracy in system representation and computational time. Besides providing an overview of decomposition techniques and solving strategies to tackle power generation planning and scheduling problems, this talk also briefly discusses alternative approaches to model different aspects of system operation, such as power flows in the electrical network, dynamic thermal unit commitment characteristics and nonconvex/time linking constraints for the operation of hydro and pumped storage plants, always with a look at practical applications in large-scale systems.

TB08

M-Maya VII

Network Reliability

General Session

Chair: Javiera Barrera, Univ. Adolfo Ibanez, Penalolen, 7941169, Chile

1 - Heterogeneous Node-technology Selection for Reducing the Impact of Shared-risk Attacks on Networks Topologies

Yasmany Prieto, PhD Student, Universidad de Concepción, Concepción, 4070386, Chile, Jorge E. Pezoa, Silvia E. Restrepo

Several practical reasons have lead to deploying highly homogeneous data networks. Unfortunately, such homogeneity induces shared risks, where a correlated attack/failure may entirely disrupt the network. To reduce the impact of correlated events, we propose to take advantage of different technologies and optimally specify networks with heterogeneous nodes, which do not share risks and can communicate. Two search algorithms were designed to find the optimal set of technologies. Results show that network designers are capable of yielding heterogeneous and more resilient networks.

2 - The Impact of Geographical Failures and its Dependencies in the Operation and Planning of Electricity Networks

Javiera Barrera, Associate Professor, Universidad Adolfo Ibáñez, Santiago, 7941169, Chile, Pauline Beaupuits, Eduardo Moreno, Rodrigo Moreno

Geographic failures, such as earthquakes, confront power grids to high cost scenarios that have low probability, that cannot be ignored. In particular, most of these scenarios have a strong geographical dependency between its failures. In our model transmission lines can be affected by failure scenarios generated using an earthquake generation model. We to study how it affects the design and operation decision of an electrical network using a stochastic two-stage optimization model. We evaluate this model using a test network artificially located in the north of Chile, and confronted to historical earthquakes scenarios. We show that the inclusion of these geographical failures scenarios is relevant, because they change the investment and operation decisions considerably. We also benchmark these results with other classical methodologies for this problem. We also show that ignoring this geometrical dependency between failures can lead to suboptimal decisions. Joint work with P. Beaupuits, E. Moreno and R. Moreno.

3 - Reliability Analysis for an k-out-of n Repairable System with Multiple Adapted Vacation Policy and Disasters

George C. Mytalas, CUNY, New York, NY, United States

This paper analyzes a k-out-of-n repairable system with one repairman who takes vacations under the Multiple Adaptive Vacation policy, the duration of which follows a general distribution. The working time of each component is an exponentially distributed random variable and the repair time of each failed component is governed by an arbitrary distribution. Additionally we consider also that system suffers from disasters. Under these assumptions, several important reliability measures such as the availability, the rate of occurrence of failures, and the mean time to first failure of the system are derived by employing the supplementary variable technique and the Laplace transform.

4 - Optimizing Power System Stability in Severe Emergencies

Bryan Arguello, Sandia National Laboratories, Albuquerque, NM, 87111, United States, Matthew Hoffman, April Zwerneman

We present a novel NLP formulation for stability control of a power transmission system following a severe emergency disabling many components (e.g., geomagnetically induced current). Like the Transient Stability-Constrained Emergency Control (TSEC) problem, decision variables represent possible emergency controls, and constraints include a differential algebraic equation (DAE) describing dynamics. However, we eschew the typical economic objectives and conservative path constraints of TSEC for the severe emergency problem; instead, maintaining stability is paramount and temporary excursions outside normal operating margins are acceptable if they lead to better stability margin.

■ TB09

M-Maya VIII

Military Applications

Contributed Session/Practice Session

Chair: Michael Bendersky, Ben Gurion University of the Negev, 52 Golomb St Holon, Holon, 58102, Israel

1 - Scheduling Maritime Search-and-Rescue Operations under Uncertain Data

Eugene Levner, Professor, Holon Institute of Technology, 52, Golomb St., Holon, 5810201, Israel, Boris Kriheli

Assume that search operations at sea are to be scheduled after a submarine accident. The problem is to detect the submarine location in shortest possible time. Smart inspection sensors on board of aerial and marine search vehicles are imperfect and provide data with overlooking and false-alarm errors. We suggest a fast algorithm that finds an almost-optimal quasi-periodic solution with a predetermined detection error. The algorithm extends the Matula (1964) periodic search scheduling algorithm.

2 - The Profiling Game in Border Crossings

Arieh Gavious, Professor, ONO Academic College, Kiryat Ono, Israel

Developing an effective screening in border crossings is a difficult task. We study whether profiling is indeed helpful and how it should be used. We offer a sequential game-model with three players: a defender, who decides on a screening process, an attacker, who recruited a passenger as a violator, and the recruited violator. We will study different variants of the game to understand the extremely challenging social and strategic questions regarding the controversy over the need of profiling.

3 - Static Kalman Filtering for Artillery Firing Shift

Michael Bendersky, Ben Gurion University of the Negev, Beersheba, Israel, Yisrael Parmet

Firing Shift is the shifting of artillery fire from one target to another with the application of corrections determined from the adjustment on the first target to the initial firing data for the second. Shift applications are of great importance in the operation of ground forces as a whole. Applying a linear model for artillery fire accuracies - the parameters of which are easily obtainable from extant Firing Tables - we propose a new algorithm for making the shift, based on a static EKF. It assumes concurrent fire adjustments on multiple registration targets. The proposed firing-shift by multiple registrations is a novel, non-traditional application of the filter.

4 - Drone Applications and Analytics in Operations Management

Soumyadeb Chowdhury, Lecturer Information and Communication Technology, Aston University, Birmingham, United Kingdom, Oscar Rodriguez-Espindola, Lewis Mackenzie

Unmanned aerial vehicles, commonly known as drones, have found their use in various business organisations and domain. The primary aim of the paper is to understand the potential of drone applications in operations management and humanitarian logistics with the aid of four distinct use-cases. The critical analysis of the use-cases will help to develop a readiness framework to build capabilities necessary for the deployment of drones. Additionally, the paper will present an overview of different types of analytics relevant to make sense of the heterogeneous and multimedia data collected by drones.

■ TB10

M-Acapulco

Heuristics and Exact Approaches for Complex Scheduling Problems in Smart Manufacturing

Emerging Topic: Emerging Scheduling

Emerging Topic Session

Chair: Taha Arbaoui, University of Technology of Troyes, France

Co-Chair: Farouk Yalaoui, University of Technology of Troyes, University of Technology of Troyes, Troyes, 10000, France

1 - A Effective Simulated Annealing for the Unrelated Parallel Scheduling Problem with Machine and Sequence-dependent Setup Times

Taha Arbaoui, UTT, Troyes, France

In this paper a Simulated Annealing approach (SA) is presented to solve the unrelated parallel machine with sequence and machine-dependent setup time. The construction phase of GRASP is proposed to construct the initial solution. At each iteration a new candidate solution is generated according to one of the three movements: swap inter machine, swap intra machine and insertion inter machine. VND isused to improve the new solution and to increase the convergence speed of SA, we evaluate and compare the proposed algorithm to the best methods from the literature, experiments show that our approach outperforms the literature methods in most of the tested benchmark instances.

2 - Theoretical and Computational Analysis of Workload Balancing Problem in Parallel Machine Environment

Yassine Ouazene, Troyes, 10004, France, Farouk Yalaoui

This paper considers the problem of assigning a set of N jobs to a set of M machines (or resources) as equally as possible, i.e. to find a schedule that minimizes the workload imbalance. We are interested on the theoretical and computational analysis of the different performance measures adopted in the literature: maximum completion time, difference between maximum and minimum completion times and the Normalized Sum of Square for Workload Deviations. We establish in this study the theoretical correlation between (Cmax - Cmin) and NSSWD criteria. Based on this theoretical relationship, we propose a new mathematical model to provide the optimal solutions of the benchmark instances proposed by Schwerdfeger and Walter (2018).

3 - A Bucket Indexed Formulation for Parallel Machine Scheduling Problem

Luana Mesquita Carrilho, PUC-Rio, Rio de Janeiro, Brazil, Tiago Andrade, Silvio Hamacher

Machine scheduling is a decision-making process that plays an important role in most manufacturing and service industries. This paper tackles a nonpreemptive identical parallel machine scheduling problem considering release dates, deadlines, precedences, eligibility, and machine availability constraints. To solve this problem, a mixed-integer linear programming model is proposed, based in a bucket-indexed formulation. The proposed formulation reduces the solution time for the tested instances compared to a time-indexed formulation as a benchmark.

■ TB11

M-Mexico

Game Theory II

Contributed Session

Chair: Jian-Jun Shu, Nanyang Technological University, 50 Nanyang Avenue, Singapore, 639798, Singapore

1 - Mixed Oligopoly: Analysis of Consistent Equilibria

Gabriela R. Huarachi-Benavídez, PhD Student, Universidad Autonoma de Nuevo Leon (UANL), San Nicolas de los Garza, Mexico, José G. Flores-Muñiz, Nataliya I. Kalashnykova, Viacheslav V. Kalashnikov

We study a model of mixed oligopoly with conjectured variations equilibrium (CVE), in which one of the agents maximizes a convex combination of its net profit with the domestic social surplus. The agents make conjectures about the price variations after their production outputs variations. The notion of interior equilibrium is introduced by developing a consistency criterion for the conjectures, and the existence theorem for the interior equilibrium (which is CVE with consistent conjectures) is proven. Under some additional assumptions, three different types of equilibrium (Cournot, CVE and Perfect Competition) are compared and the optimal value for the combination parameter is computed.

2 - Delivery Times and Penalties

Damian Emilio Gibaja Romero, UPAEP, Puebla, Mexico, Miguel Josué Heredia Roldan

We analyze an interaction between a retailer and a wholesaler, where the first is an intermediary of the wholesaler, in a market where the last does not stand, since operation's costs in the retailer's market are higher than the benefits. Thus, it is possible that the wholesaler may prioritize other customers' requisitions to the detriment of the retailer's benefits. Hence, confidence is necessary to sustain the relationship between both agents. We analyze equilibrium prices in two scenarios, one where the retailer trusts on the wholesaler, and one where not. We model distrust via a penalty, that decreases the retailer's benefit at equilibrium, while prices in the wholesaler's market increases.

3 - Turning the Unfavorable into the Favorable

Jian-Jun SHU, Nanyang Technological University, Singapore, Singapore

Game theory is a research topic of transcribing one specific decision-making process into a game-like situation to facilitate analysis and hence to result in a rational strategy. The Parrondo's paradox is a very special complement to contemporary game theory. It describes a counterintuitive phenomenon where two individually losing games could be combined in producing a winning expectation. The paper shows that other possible paradoxical effects can be produced by manipulating the parameters in the probability space. The issues associated with the paradox are discussed and the potential application of the paradox is addressed.

■ TB12

M-Cozumel

Advances in Models and Algorithms

Contributed Session

Chair: Michal Mankowski, King Abdullah University of Science and Technology, Thuwal 23955, Jeddah, Saudi Arabia

1 - Validity and Impact of Relaxing Some Binary Variables in MIP Formulations

Oliver Avalos Rosales, Universidad Autónoma de Coahuila, Saltillo, Mexico, Yajaira Cardona

Mathematical models with binary variables are used in a large variety of combinatorial problems. Models for the same problem are usually compared according to their linear relaxation values, their time to obtain optimal solutions and their size. A common extended idea about the size is that reducing the number of binary variables will improve the performance of the model. In this paper we describe three cases where at least two sets of binary variables are used in a model and one of them can be relaxed because its relation with the other variables. By experimental comparison on state of the art models we show that reducing the number of binary variables by this kind of relaxation might not be the best choice.

2 - Advantages of Using an Interior Point Algorithm in Cutting Planes and Column Generation

Jacek Gondzio, Professor, Edinburgh University, Edinburgh, United Kingdom

Advantages of interior point methods (IPMs) applied in the context of cutting planes/column generation will be discussed. Some of the many false views of the combinatorial optimization community on interior point methods used within such schemes will be addressed and corrected. In particular, IPMs can warm-start and deliver a natural stabilization when restricted master problems are solved. They guarantee fast convergence, measured with merely a few master iterations needed to localize the solution. Examples from applications in civil engineering and robust routing will be given.

3 - A Binary Programming Model for the Quasi-polyomino Tiling Problem

Marcos O. Rodrigues, USP, Rua Cezar Ricomi, 190, São Carlos, 13560510, Brazil, Franklina Toledo

In this paper, we study the quasi-polyomino tiling problem. The problem consists of checking if a set of items described by quasi-polyominoes can cover a board described by a quasi-polyomino. We developed a binary programming model for the problem and conducted computational experiments to evaluate it using instances from the literature. The model outperfomed the state-of-the-art model for most instances and obtained a solution for instances with up to 47 distinct items using rotations and flips.

4 - Extension of Dynamic Programming for Multi-stage Combinatorial Optimization

Michal Mankowski, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia, Mikhail Moshkov

We propose an extension of the dynamic programming for combinatorial optimization which allows sequential optimization of elements relative to different cost functions. This framework uses so-called circuits without repetitions that represent the sets of elements. We study algorithms for the multi-stage optimization. Problems such as convex polygon triangulation, optimal binary search tree, or one-dimensional clustering were tested. We evaluated the number of operations required by the algorithms and considered results of experiments.

Tuesday, 3:30pm - 4:20pm

■ Keynote

JW Tulum E

Keynote: Revisiting Some Location/Routing Problems

Emerging Topic: Keynote

Emerging Topic Session

1 - Revisiting Some Location/routing Problems

Elena Fernandez, University of Cadiz, Puerto Real - Cadiz, Spain

Location/routing problems (LRPs) is the term generally used to refer to a large family of problems, combining location and routing decisions, which have become classical in combinatorial optimization. In practice, this family contains problems, which, depending on the modeling assumptions, can be of very diverse nature. Aspects that may affect substantially the characteristics of the resulting LRP include, in addition to the type of network where the problem is stated, the placement and features of the demand that has to be served, or potential specific requirements on the service facilities or the service routes. In this talk we mainly focus on two such aspects, namely whether service demand is placed at the nodes or the edges of the network, and whether or not all users with demand have to be served. Alternative techniques are discussed, leading to improved formulations or solution algorithms for some LRPs.

Tuesday, 4:30pm - 6:00pm

■ TC01

JW Tulum A

Simulation Analysis

General Session

Chair: John W Fowler, Arizona State University, Tempe, AZ, 85287-4706, United States

Co-Chair: Lars Moench, University of Hagen, Hagen, 58097, Germany

1 - Simulation Testbeds for Semiconductor Manufacturing

John W Fowler, Arizona State University, Supply Chain Managament, Tempe, AZ, 85287-4706, United States, Lars Moench

In this presentation, we will discuss simulation testbeds for wafer fabrication facilities, as well as a recently developed simulation testbed for semiconductor manufacturing supply chains. We will discuss the role of the testbeds along with some details about their history and where to access them.

2 - Optimization of Prehospital Care Based on Agents, UNAM System

Sebastián A. Horta, Universidad Nacional Autónoma de México, Mexico City, Mexico, Esther Segura, Jesús Salinas, Daniel A. Alonso

The prehospital care system of Ciudad Universitaria in the south of Mexico City has five ambulances, classified as advanced and basic, to attend emergency calls. The emergency calls are classified in trauma and clinica. Our proposal is to optimize the service level by minimizing the arrival time at the accident site taking into consideration different parameters such as distance, emergency type, ambulance type and the time of use of the ambulance is estimated until it is free and this time varies depending on the emergency type. The theory of agents with the support of the Anylogic program is used as a methodology in our case to simulate different scenarios and find the optimal location.

3 - Multiobjective Emergency Room Capacity Planning Using Simulation and Response Surface Methodology

Felipe Baesler, Universidad del Desarrollo, Concepción, Chile, Linsay Alvarez

This paper presents the results of a real life emergency room case study in Chile that was modelled using discrete event simulation. The objective was to find the best combination of human and physical resources that are necessary for an expansion of 40% in demand, maintaining the current patient's waiting time. Four different objectives were considered in the analysis using a goal programming optimization model. This model was used in combination with response surface methodology to perform an optimization iterative process and determine the best combination of resources.

4 - A Simulation-based Study to Optimize Bed Placement of Oncology Patients and Medicine Patients in a Large Academic Community Hospital System

Tze Chao Chiam, Director Health Systems Optimization, Christiana Care Health System, Newark, DE, United States, Stephen Hoover

In this study, we aimed to improve cohorting of patients receiving cancer treatment in the oncology unit by "swapping" the unit with a medicine unit. Due to stochastics involved in patient flow, we used Discrete-Event Simulation to predict the impact of the swap through three scenarios. One scenario was chosen for implementation. Analysis post-implementation adjusted for seasonality effects showed positive outcomes e.g., increased volume of oncology patients with active chemotherapy treatment cohorted on the oncology unit and a decreased number of closed beds on both units.

■ TC02

JW Tulum B

Applications of OR Under Uncertainty

General Session

Chair: Camilo H. Gomez, Universidad de los Andes, Bogota, Colombia

Co-Chair: Andrés González, University of Oklahoma, Norman, OK, United States

1 - Towards a Stochastic Programming Library for Infrastructure Risk Management

Camilo H. Gomez, Universidad de los Andes, Cra 1 Este, 19-40, Bogota, Colombia

OR-based methodologies have become popular in infrastructure risk management, addressing problems of mitigation, preparedness, response, and recovery of interconnected systems exposed to hazards. We study how decisions in these different phases can be integrated as part of a strategic risk management framework, considering the role of multiple stakeholders with diverging interests. We integrate stochastic and multi-criteria optimization strategies to provide evidence that supports decision- and policy-making for critical infrastructure systems.

2 - Distributing Hazardous Materials after the Occurrence of a Disaster

Gina Galindo, Universidad del Norte, KM5 Antigua via a Puerto Colombia, Puerto Colombia, Colombia, Ana Bedoya, Ruben Yie

This research addresses the problem of transporting hazardous materials (e.g. fuel) and locating their distribution centers upon the occurrence of a disaster. Such hazardous material poses a risk to the affected population, but is required as part of the response and recovery activities of the disaster management. The objective is to minimize: (i) response time, and (ii) risk, while maximizing the coverage and equity of the response to the demand points.

3 - Implementation of a Routing Algorithm for Kiwi Campus, a Human-robot Delivery Colombian Startup

Jorge Huertas, 1Center for Optimization and Applied Probability (COPA) - Industrial Engineering Department, Universidad de los Andes, Bogotá, Colombia; Santiago Pineda, Alix C. Gutiérrez, David A. Martínez

The Colombian delivery startup Kiwi Campus uses autonomously driven robots to deliver their customers' orders. Therefore, its logistic operations rely on deploying its fleet with the right routing algorithm. In this context, the vehicle routing problem (VRP) becomes relevant to guarantee a competitive level of service in the delivery market. Over the years, many scholars have devised hard-to-implement methodologies in order to find efficient VRP solutions to specific situations using expensive commercial solver licenses. The small startup does not gather the characteristics devised in the literature, nor the money to afford the needed licenses. In this work, we create a heuristic routing algorithm to assign sets of orders to the startup workers (kiwers), who carry them towards the robots, which ultimately deliver the orders to the clients. We validate the proposed heuristic using real historical data to simulate delivery operations and visualize the solution given by our algorithm

■ TC03

JW Tulum C

Forecasting

Contributed Session

Chair: Eric Enkele Longomo, University of Portsmouth, Yorke Street, Southsea, Portsmouth, PO5 4EL, United Kingdom

1 - Service Forecasting Using Specialized Software (delfos) Applied to Oil and Gas Industry

Luana M. Carrilho, Tecgraf, Rio de Janeiro, Brazil, Pedro Henrique M. Sousa, Marcos V. Nobrega, Luiza F. Andrade, Marcos V. Silva, Hudson R. Assis, Bruno L. Mariani

Oil and Gas exploration operations success relies on a robust resource planning, for both materials and services. Those are made feasible throughout specialized contracts planned by a set of technical, financial and logistics requirements. In this context, it was developed a specialized software that allows both deterministic and stochastic quantities evaluating in order to support the proposed operational schedule. Through the deterministic module, it is possible to identify potential service lines overhead or non-availability. With the stochastic module can be derived a service level analysis, that results in all procurement parameters.

2 - Predictive Model for Complaint Income Calls in a Contact Center in a Latin American Bank

Renzo A Benavente, Pontificia Universidad Catolica del Peru, Lima, Peru, Jonatan Rojas, Miguel Rodriguez

This research aims to predict incoming reclaims calls at the contact center of a Latin American bank. Significant variables that influence the number of calls entered in the period 2015 to 2018 were identified. Then the data was trained in this period with models Random Forest, Time Series, Neural Network and then the one with the best fit was chosen. With the chosen model, the months January and February of 2019 were projected, which then, when compared with the real data, had a MAPE of 4%. Comparing with the previous method of prediction that the bank had, it saved 8% in personnel costs in these 2 months of validation.

3 - Application of Machine Learning to Identify Diseases in Cocoa Crops

David E. Puentes Garzon, Universidad Industrial de Santander, Bucaramanga, Colombia, Henry Lamos Díaz, Diego A. Zarate Caicedo

Crop productivity is affected by different factors as climatic conditions, soil characteristics and the propagation of diseases. In the case of cocoa crops, Monilia (Moniliophthrora rorei) and “Escoba de bruja” (Moniliophthora perniciosa) are some of the diseases that alter its productivity, for these reasons, this work proposes a classification model based on machine learning to determine the variables that establish the presence of a disease. Support Vector Machines (SVM), regression trees, stepwise linear regression and Random Forest are considered, where SVM has the best performance with an accuracy = 0.85, whereas cocoa variety and humidity determine the presence or absence of a disease.

4 - Real-time Prediction of the Optimal Configuration of an Intelligent Gateline System Using Queueing Theory

Eric Enkele Longomo, Research Fellow in Applied Operational Research, University of Portsmouth, Portsmouth, United Kingdom

This work develops and operationally demonstrates -using queuing theory and combinatorial optimization, a gateline that is capable of automatically self-reconfiguring to maximise peak and average throughput and prevent trains station overcrowding. The technology identifies flows of people within the station environment, and learn to predict crowds before they arrive at the gateline. The technology will allow each gate to be configured to be inflow or outflow to deliver reliability and capacity improvements and give the passengers the best experience possible.

■ TC04

JW Tulum F

Intelligent Transportation Systems

General Session

Chair: Sundaravalli Narayanaswami, Indian Institute of Management Ahmedabad, Ahmedabad, 380015, India

1 - An Efficient Heuristic for Demand Estimation of HSR Services Based on Scheduling Aspects

Sundaravalli Narayanaswami, Indian Institute of Management Ahmedabad, Vastrapur, Ahmedabad, 380015, India

The major metro cities have grown to a very large size; however the connectivity between these cities is restricted. As the country is vast, long distance rapid travel between cities is done through airways and not through surface transport. The fastest train between Ahmedabad and Mumbai takes 6 hours 40 minutes to travel a distance of 481 km which translates to an average speed of about 72 kmph, which is significantly slower by global standards. Rapid logistics forms a significant portion of any operations, it can potentially boost the productivity of the country. Thus, there is a need to upgrade the conventional intercitymode of commute. As HSR is a green field initiative in India, public endorsement is extremely vital. Based on sheduling aspects, we develop a heuristic to estimate demand for the HSR services between Mumbai and Ahmedabad.

■ TC05

JW Tulum G

Network Optimization

Contributed Session

Chair: Yezekael Hayel, Avignon University

1 - Optimizacion De Infraestructuras De Red: Hacia Una Metodologia Integral Para La Toma De Decisiones

Tania Turrubiates-López, Profesor - Investigador, Instituto Tecnológico Superior de Álamo Temapache, Álamo Temapache, Mexico, Vanesa Landero-Nájera, David J. Ríos-Soria

La optimización estructural, tiene importancia práctica en el diseño o rediseño de infraestructuras de red para facilitar o dificultar procesos que se llevan a cabo en ellas. Se presenta una metodología para desarrollar una herramienta de toma de decisiones para realizar el diseño o la adecuación de una infraestructura de red, considerando la función que debe realizar esa infraestructura, el desempeño deseado y los costos asociados a la construcción o la adecuación. El procedimiento de optimización irá modificando el grafo de manera que se alcancen valores de las propiedades estructurales que facilitarán o dificultarán el proceso respetando un presupuesto o minimizando el costo.

2 - Supply Chain Competitive Network Equilibrium of Ridesourcing Market

Ni Linglin, Zhejiang University of Finance & Economics, Dongfang College, Hangzhou, China

LATE CANCELLATION

This paper proposes the competitive network equilibrium model of ride-sourcing market (RSM) based on the non-cooperative game theory. The model assumes that each ride-sourcing enterprise (RSE) and individual drivers seek to maximize profits, while customers seek utility maximization. Monotonicity of equilibrium optima and parameters’ sensitivity are analyzed, and some insights for the government and RSEs are gained. The results of several numerical examples verify the flexibility of the model of RSM and demonstrate the validity of the algorithm in solving the problem.

3 - Hub Network Design with Flexible Routing

Luiza Bernardes Real, Instituto Federal de Minas Gerais, Formiga, Brazil, Ivan Contreras, Jean François Cordeau, Ricardo Saraiva de Camargo, Gilberto de Miranda

We present a hub network design problem in which routing decisions are considered. The routes are flexible in the sense that each route may contain a mix of non-hub and hub nodes. We assume that commodity transfers can only be done at hubs and transportation costs are flow-dependent. We describe a mathematical model and two matheuristics to solve the problem. Computational experiments using benchmark instances are presented.

4 - Incentive Design for Electric Vehicles in Urban Networks as Coupled Bilevel Problems with Equilibrium Constraints

Yezekael Hayel, Avignon University, Avignon, France, Benoit Sohet, Olivier Beaude, Alban Jeandin

Electric Vehicles (EV) impact urban systems both when driving (e.g., noise and pollution reduction) and charging. Therefore, there is a need to design incentive mechanisms to foster customer engagement. A congestion game approach is adopted, with multiple classes: EV and Gasoline Vehicles. The latter game is nonseparable as it depends on the global charging need of all EV. Both temporal and energy operating costs are considered and thus driving and charging decisions are coupled. Coupled bilevel problems with equilibrium constaints are proposed and optimal tolls are computed in order to minimize an environmental cost on a simple network topology.

■ TC07

M-Maya VI

Tutorial: Models and Decomposition Methods for Large-Scale Network Optimization

Tutorial Session

Chair: Antonio Mauttone, Montevideo, Uruguay.

1 - Models and Decomposition Methods for Large-Scale Network Optimization

Ivan Contreras, Concordia University, Montreal, QC, Canada

Network optimization problems lie at the hearth of network design planning in transportation and telecommunications systems. This talk focuses on a challenging class of problems referred as general network design which offers a unified view of integrated facility location and network design. Their main difficulty stems from the inherent interrelation between two levels of the decision process. The first level considers design decisions such as the selection of nodes to locate facilities and the activation of links to connect nodes. The second level considers tactical decisions such as the assignment of nodes to facilities and the routing of flows through the network. We present an overview of some of the most prominent mathematical programming formulations that have been used in combination with decomposition methods to develop state-of-the-art exact solution algorithms capable of solving large-scale instances of three important classes of problems involving both linear and nonlinear cost functions: hub network design, multi-level facility location, and multi-commodity network design. We highlight the connections between Lagrangean relaxation, Dantzig-Wolfe decomposition, Benders decomposition, and related primal relaxations in the context of such problems. We also point out to several algorithmic refinements that have been used to accelerate the convergence of such decomposition methods. Practical implementation guidelines to improve their overall performance are discussed.

■ TC09

M-Maya VIII

New Research on Innovation Management

General Session

Chair: Zhijian Cui, University of Science and Technology of China, Hefei, 010000, China

1 - Reward Structure for Crowdfunding Campaigns

Manpreet Singh Hora, Georgia Institute of Technology, Scheller College of Business, Atlanta, GA, 30308, United States, Param Pal Singh Chhabra, Karthik Ramachandran

Crowdfunding enables entrepreneurs to seek capital in small amounts from the marketplace to fund their inventions. A creator makes several decisions while designing a reward-based crowdfunding campaign. This study investigates the effect of these structural decisions on the performance of a reward-based crowdfunding campaign.

2 - Diversification as a Cure for R&D Over-investment

Zhijian Cui, University of Science and Technology of China

This study empirically examines how firms' resource allocation strategy (focus vs. diversify) overcomes the organizational inertia arising from the over-investment into R&D. In particular, we consider two dimensions on which the resources are diversified: innovation objective and knowledge source. Our results show that diversification in innovation objectives and knowledge sources could lead to a higher optimal R&D investment level and weaken both the positive and dysfunctional effects of R&D investment on innovation performance.

3 - Employment Analysis Based on Panel Data in the Background of Industry 4.0

Rongyan Zhou, CentraleSupélec, Université Paris-Saclay, Gif-sur-Yvette, France, Julie Stal-Le Cardinal

The paper reviewes the predictions and analysis about employment from various institutions and scholars in the context of Industry 4.0 as well as analyzes the relationship of Industry 4.0 investments and new jobs created by industry 4.0 investments by panel data for four regions using the data of the Trendeo database and speculate on the reasons for the consequence. Through the analysis, we consider that the EU is facing the greatest technical unemployment pressure among the four regions, followed by NAFTA, then EA and SAARC. However, it should also be noted that with the arrival of the Industry 4.0 era, the amount of Industry 4.0 investments in SAARC has shown a downward trend.

■ TC10

M-Acapulco

Scheduling I

Contributed Session

Chair: Nelson Troncoso, Universidad de Santiago de Chile, Santiago, Chile.

1 - A Model with Modified Clearing Function for Joint Optimizing Production Planning and Preventive Maintenance

Liya Wang, Shanghai Jiao Tong University, Shanghai, China

In recent years, the clearing function is proposed to model the non-linear lead time of production planning. In this paper, a variable of the reliability of the facility is introduced into the clearing function and the nonlinear relationship between the workload and preventive maintenance on the lead time is reconstructed. Based on the modified clearing function, a joint optimization model of the production planning and preventive maintenance is established to minimize the total production and maintenance cost by considering the impact of maintenance on the production planning. It is verified that model has lower total cost than existing models by numerical experiments.

2 - A Flexible Integer Linear Programming Formulation for a Class of Bus Driver Rostering Problems

Kenny Cárdenas-Parra, Researcher and Student of Industrial Engineering, Integra S.A., Pereira, Colombia
Kenny Cárdenas-Parra, Researcher and Student of Industrial Engineering, Technological University of Pereira (UTP), Pereira, Colombia, César A. Marín-Moreno, Rubén I. Bolaños, Luis M. Escobar-Falcón, Mauricio Granada-Echeverri

This work presents a novel integer linear programming formulation to solve an operation planning problem in public transport. It is flexible, and it works by adding or removing specific constraints. The proposed model is a generic version of the Bus Driver Rostering Problem, which has a considerable amount of issues, mostly due to the complexity of the personnel management and their assignment of the daily duty. The main issues taken into account in the model are the specific work conditions, labor regulations for each country, companies' internal policies and available staff. In the literature, it was observed that there is a lack of general mathematical models representing this class of problems.

3 - Scheduling Models for a Product-Mold-Machine Problem

Nelson Troncoso, Universidad de Santiago de Chile, Santiago, Chile, Héctor Cancela, Pedro Piñeyro, Óscar C. Vásquez, Joaquín Velásquez

This paper addresses a problem related to the manufacturing process of tires, plastic, ceramics and glass, where several molds are placed in machines to obtain the final product. The production system includes setup times; product processing times; and identical parallel machines with limited number of positions for molds. We show that the problem is NP-complete in the strong sense and propose two different mathematical programming models to minimize the makespan. We discuss their characteristics and performance by means of some numerical examples.

■ TC11

M-Mexico

Energy Session II

General Session

Chair: Chiara Lo Prete, The Pennsylvania State University, State College, PA

1 - Large-scale Stochastic Programming in the Colombian Electrical Power Network

Carlos Murillo-Sanchez, Universidad Nacional de Colombia, Manizales, Colombia, J.E. Zuluaga Orozco, M.P. Buitrago-Villada

Recently, the colombian congress issued a law that promotes investment in renewable energy sources, and several projects have been registered with UPME (Mines and Energy Planning Unit of the Ministry of Mines and Energy) that intend to use the incentives provided in that law. Of particular interest are the projects that target the north-eastern region in Colombia, which is where most of the wind power potential is located. While a small pilot plant has been operational for several years now near Puerto Colombia in the Guajira Department, due to its small size it has not had much impact on the operation of the colombian transmission system. This is set to change, however, as the new projects become operational in the next few years. These new projects will stress the existing transmission and generation system in the following ways: 1) The variability of wind power must be evened out by other generators in the system in order to maintain the system frequency. The colombian system is already hampered by the fact that it exhibits a rather steep load ramp-up at sunset due to illumination loads; these ramps so far have been tackled by the fast-ramping capability of hydro units, but this effort must be coordinated and anticipated. With additional wind power in the generation mix, it is estimated that the required ramping capacity in the system will increase substantially. 2) The need for spinning operating reserve in the system will also increase as the penetration of wind power grows in order to maintain operational security. The problems are compounded when the local characteristics of wind power are taken into account. For example, since all of the wind power potential is concentrated in a relative small geographic area, the variability of the wind power in Colombia cannot be expected to even-out thanks to geographical averaging. Also, wind speed tends to decrease in the afternoon, and that, together with any photovoltaic penetration, means that traditional generation must bear an even steeper ramp at sunset. These issues have profound implications for any long-term planning of the expansion of the system. The ramping adequacy of the system must be warranted looking into the future. Now, some long term planning models incorporate factors to insure adequacy of different kinds, but these factor must be estimated first. To this end, this work utilized a modified version of MATPOWER's Operation Scheduling Tool (MOST) to assess the need of ramping capability as a function of wind power penetration in Colombia. MOST is a stochastic operations planner for generation and transmission systems that considers system security and stochasticity of renewable energy sources, together with storage modeling and dispatching. It has been termed as "one of the most complete" such planners. However, it was necessary to adapt it to the specific colombian case, which due to its hydro-centric features, requires the modeling of chained-hydro plants, among other issues. As part of a project developed for the colombian Ministry of Energy and Mines, the modified MOST tool was used to quantify the spinning and ramping reserves as a function of future wind power penetration. Existing wind speed time series measured hourly at the locations of interest by IDEAM (Instituto de Estudios Ambientales) were used to characterize the statistics of wind power and these in turn were used to produce synthetic scenarios for the stochastic optimization. Water availabiliy was also modeled after historic data, capturing its monthly variation. The operation for a full year was simulated using sixteen "typical" days, clustered from a full year's worth of water availability data, hourly demand data, and several year's worth of wind speed data. These typical days were then used to compute a daily operating schedule with the modified MOST tool, yielding not only the operating schedule but the necessary quantities of ramping and spinning reserve by region. This was repeated for several hypothetical wind power penetration values and thus the dependency of spinning and ramping reserve quantities on the amount of wind power penetration was established.

2 - Capacity Markets Versus Energy-only Markets: A Comparison under Wind Energy Penetration

Chiara Lo Prete, The Pennsylvania State University, State College, PA, United States, Cody Hohl

We compare two electricity market designs (a capacity market followed by a energy market and an energy-only market) under varying levels of wind energy penetration. A modified version of the IEEE 36-bus NPCC network, with an emphasis on New York and New England, provides a test system for our analysis. Simulations of power market outcomes are evaluated in terms of a diverse set of metrics emphasizing revenue sufficiency, flexibility, and sustainability.

■ TC12

M-Cozumel

New Trends in Optimization

Contributed Session

Chair: Guillermo Cabrera-Guerrero, Pontificia Universidad Católica de Valparaiso, Av Brasil 2241, Valparaiso, United States

1 - Why Optimization?

Pano Santos, Technical Content Manager, Gurobi Optimization, Beaverton, OR, United States

In this session, we discuss Industry 4.0 and the importance of mathematical optimization to maximize operational efficiency and to manage complexity through automation of number crunching for decision making. We discuss evolution and applicability of mathematical optimization and its impact on solving challenging, high impact, and high value problems. We provide an example of combining mathematical optimization and machine learning.

2 - Advanced Heuristics with Gurobi

Daniel G Espinoza, PhD, Gurobi Optimization LLC, Beaverton, OR, United States

This talk covers one capability of MIP that is often overlooked: itsability to find and subsequently improve good quality solutions to exceedingly difficult problems. In particular, we will focus on techniques for using the Gurobi MIP solver as a heuristic, and a discussion on what makes a model more amenable to optimization, and common techniques to use MIP in local-improvement-type of heuristics.

3 - A Dynamic Scheduling Problem on a Single Machine with Sequence-dependent Setup Times

Jobish Vallikavungal Devassia, Post-doctoral Researcher, Tecnológico de Monterrey, Monterrey, Mexico, Francisco Román Ángel Bello Acosta

This work is dealing with a single machine scheduling problem on the dynamic context. Sequence-dependent setup time and release time are the major constraints involved. The unknown release time, prior to the scheduling, leads to the dynamic nature of the problem. To solve the problem, a periodic re-optimization approach is proposed. For the re-optimization, an iterative insert-improvement strategy is implemented.

4 - Local Search Algorithms for the Bi-Objective Beam Angle Selection Problem

Guillermo Cabrera-Guerrero, Pontificia Universidad Católica de Valparaiso, Valparaiso, Chile, Carolina Lagos, Gustavo Gatica, Jose Miguel Rubio

Due to the inherent trade-offs between tumour irradiation and sparing of organs at risk, problems arising in radiation therapy should be modelled as multi-objective ones. However, the beam angle optimisation problem has been mainly addressed from a single objective point of view and, therefore, only a little attention has been paid to its multi-objective counterpart. In this study, we consider four different MO local search algorithms: the well-known Pareto Local Search and three variants of it, namely random PLS, judgement-function-guided PLS and dominance-guided PLS. Obtained results confirm the ability of PLS-based algorithms to address this problem.

Wednesday, 8:00am - 9:30am

■ WA01

JW Tulum A

Simulation Applications

Contributed Session

Chair: John W Fowler, Arizona State University, P.O. Box 874706, Supply Chain Managament, Tempe, AZ, 85287-4706, United States

1 - Applying Simulation to Fisheries Management

Pall Jensson, Reykjavik University, Reykjavik, Iceland

In this paper, we apply simulation to introduce and integrate the concept of substitutability of economic resources into a traditional bio-economic model of fisheries. The results show that fishery management, which bases decisions solely on traditional bio-economic models that ignore the dynamics and consequences of the operational decision processes, may show results that that are in contradiction to the objective of the intended management scheme

2 - Exploring Dependencies across Multiple Online Social Network Platforms
Hwang Kim, Chinese University of Hong Kong, Shatin, Hong Kong, Vithala R. Rao

This study investigates the interplay among multiple social networking platforms. To do so, we propose an integrated visit model that accommodates communicating activities across multiple network platforms. We test the models using data from two social network gaming platforms. We find that the interdependence across social network platforms stems only from friends who are overlapped in both the concerning network platforms. Finally, our simulation study shows how the firms can manage networks by discovering asymmetric spillover effects across the network platforms due to different proportions of overlapping and non-overlapping friends.

3 - Resiliency Analysis Method and Tool for IoT in Emergency Planning
Gabriel Wainer, Carleton University, Ottawa, ON, Canada, Cristina Ruiz-Martin

We present the results of advanced simulation methods for providing connectivity, security and productivity in emergency situations. Our method allows analyzing the resilience of these kind of systems combining Network Theory, Agent Based Modeling and Discrete Event System Specifications. Model reuse is improved, as one can redefine parts of it (i.e., connections) while keeping the rest unchanged (i.e., behavior). A formal definition of our architecture allows the components to be updated easily. We released a prototype to study the resilience of an existing system based on IoT solutions. We will discuss the methodology, the development process, the prototype and sample simulation results.

■ WA02

JW Tulum B

Simulation in Policy Evaluation

Contributed Session

Chair: John W. Fowler, Arizona State University, Supply Chain Managament, Tempe, AZ, 85287-4706, United States

1 - A Simulation Framework for Infrastructure Interdependency Modeling and the Analysis of Design Solutions
Nicolas Eduardo Gomez Jacome, Professor, Corporación Universitaria Americana, Calle 72 Carrera 41c – 64, Barranquilla, 80020, Colombia, Guisselle Adriana Garcia Llinas

As society becomes more dependent on complex and critical infrastructures networks, research on integrated models for the design of interdependent infrastructures is developed more frequently. Network and simulation tools have been widely used to analyze the behavior of individual and interdependent infrastructures systems, but this research traditionally sacrifices stochasticity for optimality or the reverse. This paper proposes the development of a simulation framework that complements deterministic optimization with the stochastic and more accurate evaluation of design solutions. A semi real case of Barranquilla, Colombia is used to illustrate the approach and show its advantages.

2 - Mobile App Upgrading Decisions across App Versions
Seoungwoo Lee, Assistant Professor of Marketing, A.B. Freeman, School of Business, Tulane University, New Orleans, LA, United States, Jie Zhang, Michel Wedel

This study examines upgrading decisions of mobile apps in conjunction with their versioning decisions and identifies opportunities to improve app publishers' profits and the app distribution platform's revenue using data we collected from over 500 apps. We find that upgrading one version of an app increases its demand while decreasing the demand for the other version, if it is available. We also find a contemporaneous cannibalization effect between the free and paid versions. We conduct policy simulations to examine the soundness of certain current practices and to identify opportunities to improve app publishers' profits, the app distribution platform's revenue, and the eco-system payoff.

3 - Development of Cluster Mappping and Social Progress Index' Decision Analysis Methodologies for Mexican States and Municipalities
Pablo Nuño, UPAEP, Puebla, Mexico, Richard Bryden, Jaime Garcia, Martha Cabanas, Miguel Ángel Garcia

This paper describes the creation and development of Sintonía (Institute for collaboration and Competitiveness for a New Mexico) at UPAEP University in alliance with Harvard's Institute for Strategy and Competitiveness at Harvard Business School. We have developed decision analysis methodologies for economic and social development for México, such as a cluster mapping for all the states in México and the Social Progress Index for each municipality in the country, to help in defining private and public economic and social policies for governments, enterprises, universities, and non-profit organizations.

■ WA03

JW Tulum C

Interface on Operations, Data, and Management

Contributed Session

Chair: Sangahn Kim, Siena College, Loudonville, NY

1 - Mixed Penalized Likelihood for Monitoring Grouped High-dimensional Processes
Sangahn Kim, Siena College, Loudonville, NY, United States, Mehmet Turkoz

In high-dimensional processes, a large number of process parameters or quality characteristics are found to be featured through their dependencies and relevance. The features that have similar characteristics or behaviors in the process operation can be categorized into multiple groups. Thus, when the process changed in a few quality characteristics, it is highly probable that the process shift would occur in a few relevant groups. This research proposes a new method to monitor the high-dimensional process via mixed penalized likelihood when the grouped structure in the behavior of the process is observed.

■ WA04

JW Tulum F

Business Applications

Contributed Session

Chair: Katsuya Hihara, Tokyo Metropolitan University / University of Tokyo, 2-31-13-204 Ogikubo Suginamiku, Tokyo, 167-0051, Japan

1 - Blcokchain-Based Supply Chain Finance Innovation
Ko-Yang Wang, Chair Professor, Asia University, Wufeng, Taiwan, Grace Lin, Han-Chao Lee

In this talk, we will discuss new opportunities for supply chain finance. An innovative business model for supply chain finance based on a third-party blockchain-based platform will be presented. A smart contract design for crowd-funding and a mechanism that uses transaction information with protection will also be discussed.

2 - Spotlight on the Average Joes: Managing and Improving Employee Performance
Nilofar Varzgani, Assistant Professor, Business Systems & Analytics, La Salle University, Philadelphia, PA, United States

We present research geared towards improving operations management using data analytic techniques to identify trouble areas and recommend improvement strategy. Our focus is on companies that struggle with improving employee performance. Lack of understanding of employee performance drivers, particularly from a motivational aspect prevent the company from achieving this goal. We analyze a model that puts the focus on the middle performers of the normal curve. We adopt a three-step performance evaluation and improvement strategy that is driven by regression analysis to define, identify and replicate star performers.

3 - Process of Delivery of Online Sales in Urban Areas
Natalia Espitia-Pereira, Universidad Nacional de Colombia, Medellín, Colombia, Carlos Alberto Gonzalez-Calderon, John Jairo Posada Henao

This research seeks to analyze the process of delivery of online sales and get in the same way to obtain information about mobility and freight, which is a problem that is at the beginning of the investigation and which is not There are figures that show the problem, it is intended to estimate an economic model that allows to show the effect. This is an analysis in a case study for Medellin and its metropolitan area, involving both buyers and sellers online through survey forms where you can identify the variables that influence the problem and their causality relationships.

4 - Analysis of Airport and Airline Relationship with a Third Party Tourism Promotion
Katsuya Hihara, Tokyo Metropolitan University / University of Tokyo, Tokyo, Japan

By revenue sharing model under uncertainty, we included Destination Management Organizations, DMOs, into airport and airline vertical relationship to analyze the impact of revenue sharing with DMO on welfare level. If DMO and airport, both seeking welfare maximization, coordinate with each other perfectly with revenue sharing's demand boosting effects, airport ends up in fully sharing its revenue with DMO. If DMO and airport, seeking profit maximizations, bargain with each other about sharing level, the result could be evenly divided among the three.

■ WA05

JW Tulum G

Logistics

Contributed Session

Chair: Leila Hajibabai, State University of New York at Stony Brook, Department of Civil Engineering, 2433 Computer Science, Stony Brook, NY, 11794, United States

1 - On an Algorithm Engineering System for Full Supply Chain Management in Manufacturing Industry

Wenlian Lu, Professor, Fudan University, Shanghai, China, Yaoting Huang, Boyu Chen, Zhong-Xiao Jin, Ren Zheng

Increasing application of AI and IoT technology in supply chain management arises such challenges in optimization and programming algorithms that should run through the full supply chain. In this work, we establish an algorithm engineering system that comprises of diverse optimization and programming modules fulfilling demands in hierarchical time-scales, including assignment, routing and scheduling of short-term, prediction, risk-warning and planning of medium term, and allocation and layout of long-term. And a hyper-heuristic scheme is utilized to integrate these modules to customize algorithms for real-world application in the Shanghai Automotive Industry Corporation.

2 - A Tabu Search Algorithm for Solving a Green Logistics Bi-Objective Bi-Level Problem

Lilian Lopez, Facultad de Ciencias Fisico-Matemáticas, UANL, San Nicolás de los Garza, Mexico

Consider a company that distributes commodities over a selected set of customers and a manufacturer company that produces the commodities demanded by the customers. The distributor company has two objectives: the maximization of the profit gained by the distribution process and the minimization of CO2 emissions. The manufacturer company aims to minimize its manufacturing and shipping costs. This situation is modeled as a bi-level programming problem with two objectives in the upper level and a single objective in the lower level. A tabu search algorithm is designed for approximating the Pareto frontier. Numerical experimentation shows the efficiency of the proposed methodology.

3 - Correlated Storage Assignment in Semi automated Warehouses

Masoud Mirzaei, Erasmus University - Rotterdam, Rotterdam, Netherlands

Order picking, as the most critical operation in the warehouses, requires a lot of costly activities. The aim of this paper is to minimize the total inbound and outbound effort using the data available on the customer demand. We clusters correlated products in the customer demand an assign the clusters to storage zones. At the same time, we aim to disperse the products in multiple clusters to increase the accessibility from each pick station. Additionally, we dynamically assign replenishment and newly introduced products such that correlation and dispersion is maintained. We show this model reduces the total replenishment and order picking time compared to conventional assignment policies.

4 - Optimal Design of Electric Vehicle Charging Facilities and Power Dispatch under Mixed-traffic Equilibrium

Leila Hajibabai, State University of New York at Stony Brook, Department of Civil Engineering, 2433 Computer Science, Stony Brook, NY, 11794, United States, Roksana Asadi, Ali Hajbabaie

This study presents the integrated power distribution and transportation network design for electric vehicle infrastructure planning with the underlying mixed-traffic equilibrium. The objective is to minimize the total cost of power distribution network operation, charging facility deployment, and transportation. The proposed bi-level problem is converted into an equivalent single-level model and solved using a column and constraint generation technique. Numerical experiments confirm the quality of the solutions by the proposed methodology.

■ WA06

JW Tulum H

Disruption Management

Contributed Session

Chair: Nancy Arellano-Arriaga, Autonomous University of Nuevo Leon, Calle V 232, Ampl. Morelos, Saltillo, 25017, Mexico

1 - Incentive Design for the Last Mile Problem in Post-Disaster Power Restoration

Geoffrey Bryan Ang Chua, Nanyang Technological University, Singapore, Singapore, Fang Liu, Di Yin

The last mile in power restoration after a disaster is considered a challenge in many countries facing natural disasters. The problem arises because power companies prioritize restoration for more profitable establishments over less profitable small households. We formulate the power company's problem as a Markov decision process to determine the optimal restoration efforts as a function of time since disaster and of restoration reward. We also propose how a regulator can alter the reward structure so as to incentivize restoration efforts that lead to improved social welfare.

2 - Latency and Distance: Two Evolutive Heuristics and Some Comparatives

Nancy A. Arellano-Arriaga, Autonomous University of Nuevo Leon, Monterrey, Mexico
Nancy A. Arellano-Arriaga, University of Malaga, Malaga, Spain, Julian Molina, Iris Martinez-Salazar, Elisa Schaeffer, Ada Alvarez

By minimizing latency and distance, we study the inclusion of the client in the decision making from a vehicle routing perspective. In this talk, we introduce a bi-objective problem which considers a fleet of k uncapacitated vehicles to visit a set of clients waiting for a service, while simultaneously minimizing the total travel distance of the fleet while and the total waiting time of the clients to be visited. We call this problem as k-Minimum Latency-Distance Problem (k-MLDP), and in this talk we present two novel heuristic approaches to approximate its Pareto fronts by exploiting the structure of the problem and obtaining good quality results.

■ WA07

M-Maya VI

Tutorial: Chronic Decision Management; The Past, the Present, and the Future

Tutorial Session

Chair: Angel Ruiz, Université Laval, Quebec, QC, Canada.

1 - Chronic Decision Management; The Past, the Present, and the Future

Mariel Sofia Lavieri, University of Michigan, Department of Industrial and Operations Eng., 1205 Beal Avenue, Room 2715, Ann Arbor, MI, 48109-2117, United States

Chronic disease management often involves sequential decisions that have long-term implications. Those decisions are based on high dimensional information, which pose a problem for traditional modeling paradigms. In some instances, the disease dynamics might not be known, but instead are learned as new information becomes available. In this tutorial I describe some of the ongoing research modeling medical decisions of patients with chronic conditions. Model conception and validation is described, as well as the role of multidisciplinary collaborations in ensuring practical impact of this type of work. I conclude this tutorial with a discussion of future research directions in the field.

■ WA08

M-Maya VII

Health Care IV

Contributed Session/Practice Session

Chair: YeongLing Helio Yang, San Diego State University, Info & Decision Syst/College of Business Administration, San Diego, CA, 92182-8234, United States

1 - Studying Socioeconomic Characteristics of a Population and Healthcare Outcomes

Leily Farrokhvar, West Virginia University, Morgantown, WV, United States

We explore the association between a population's socioeconomic characteristics and patients' medical procedures outcomes. We use unsupervised machine learning technics to classify the patients and study the characteristics of patients within each group. Then, we propose predictive models to be incorporated in a healthcare decision support tool. The results enable better regional planning and more efficient allocation of a healthcare system's resources based on demographic characteristics of the population it serves.

2 - Autonomous Vehicles for Sterile Campus Transport among Operating Theatres: Applied Research in Large-Scale Clinical Scenarios

Monika Maria Moehring, Dr., Technical University Middle Hesse, Friedberg, Germany, Jessica Mohr

This study scrutinizes the potential of Industry 4.0 technologies in complex clinical operations. It exemplifies the introduction of autonomous transport of sterile materials among on-campus operating theatres of one of the largest German University hospitals. Consequently, a generic methodological cycle for applied innovation in the clinical sector is proposed.

3 - Assessing the Shortage Drug Manufacturers in the United States
YeongLing Yang, Professor, San Diego State University, San Diego, CA, United States

This research investigates the United States drug shortage issue from the supply chain perspective. Financial and operational data of the shortage drug manufacturers are analyzed during the peak of the shortages in the United States from 2005 to 2011. First-tier customers and suppliers of their respective supply chains are evaluated. Internal production problem and material sourcing are identified as main causes of supply disruptions.

■ WA10

M-Acapulco

Scheduling II

Contributed Session

Chair: Gislaine Mara Melega, UFSCar - Universidade Federal de São Carlos, 2265 Cristovao Colombo Street, Sao Paulo, Brazil

1 - Chemo Smartbook 2.0: Optimizing Chemotherapy Scheduling with Constraint Programming
Leah Weber, BC Cancer Research Centre, Vancouver, BC, United States, Tony Chang, Sophie Clyne-Salley

Chemotherapy scheduling is a challenging problem due to the substantial heterogeneity of patient treatment requirements as well as the need for timely interdepartmental coordination between nursing and pharmacy. We propose a constraint programming model that seeks to maximize patient throughput while balancing staff workloads and considering patient time preferences. This model is currently being incorporated into a decision-support web application known as Chemo SmartBook 2.0, which offers improved flexibility and usability over the current application. Chemo SmartBook 2.0 is planned to go-live in all six British Columbia regional cancer centres starting the summer of 2019.

2 - A Relax-and-Fix with Fix-and-Optimize Heuristic Applied to Job Sequencing and Tool Switching Problem
Horácio Hideki Yanasse, UNIFESP, São José dos Campos, Brazil, Tiago Tiburcio Silva, Antônio Augusto Chaves

The Job Sequencing and Tool Switching Problem consists in determining a sequence to process a set of jobs in a machine, such that the total number of tool switches is minimized. In this study, we propose a new multicommodity flow mathematical formulation for this problem whose linear relaxation provides a better lower bound to the optimal solution value compared to those provided by previous models of the literature. We propose a combined relax-and-fix and fix-and-optimize heuristic using the new formulation. The limited computational test results indicate that this is a promising approach.

3 - Optimization of Single and Parallel Batch Processing Machines
Ibrahim Muter, University of Bath, Bath, United Kingdom

In this paper, we tackle both single and parallel batch processing machine scheduling problems with the objective of minimizing makespan. The analysis of these problems unveils a strong relationship between the objectives of the parallel batch processing machine problem and the single machine counterpart. We propose a reformulation of the parallel machine problem and an exact algorithm for its solution. In the first part of the proposed algorithm, we solve the single machine problem by a column-and-cut generation algorithm. The second part employs a search mechanism to find the minimum makespan for the parallel machine problem, which entails the solution of the reformation by column generation.

■ WA11

M-Mexico

Environment, Energy, and Natural Resources

Contributed Session

Chair: Fouad El Ouardighi, PhD, ESSEC Business School, Avenue B Hirsch BP 105, Cergy Pontoise, 95021, France

1 - Urban Land Use and Transportation Planning for Climate Change Mitigation: A Theoretical Framework
Benjamin D. Leibowicz, Assistant Professor, University of Texas-Austin, Austin, TX, United States

Cities produce 75% of global GHG emissions from energy use, and their share is increasing due to rapid urbanization. This paper derives analytical insights into urban land use and transportation planning for climate change mitigation by formulating a social planner's utility maximization problem. Results provide theoretical support for policies that encourage compact urban forms and mode shifts from private automobiles to public transit on sustainability grounds. In addition, they demonstrate how urban mitigation strategies in the residential and transportation sectors are closely intertwined, thereby offering a strong argument for integrated land use and transportation planning.

2 - A Self-Organizing Deep and Transfer Learning Framework for Modeling Wind Turbines
Xin Liu, City University of Hong Kong, Hong Kong, Zijun Zhang

This paper proposes a self-organizing deep and transfer learning (SODTL) framework for efficiently modeling a population of wind turbines from a data-driven perspective. A typical data-driven modeling problem, reconstructing the feature space of wind turbines, is considered. The SODTL introduces a self-organizing mechanism for adaptively determining structures of deep networks and integrates the transfer learning principle to more effectively model wind turbines with heterogeneous characteristics captured. Computational results validated that the SODTL outperforms benchmarking models in developing wind turbine models from the data-driven perspective.

3 - Economic and Environmental Impacts of Vertical and Horizontal Competition and Integration
Fouad El Ouardighi, Professor, ESSEC Business School, Cergy Pontoise, 95021, France, Jeung Eun Sim, Bowon Kim

We explore the economic and environmental impacts of market structures (competition or integration at vertical and horizontal levels). We consider a bilateral duopoly consisting of two manufacturers and two retailers in which each manufacturer offers a wholesale price contract to the respective retailer.

■ WA12

M-Cozumel

Continuous Optimization

Contributed Session

Chair: Mehdi Toloo, Technical University of Ostrava, Czech Republic, VŠB-TU Ostrava, Faculty of Economics,, Sokolská tr. 33., Ostrava, 701 21, Czech Republic

1 - Identification in Noncoercive Variational Inequalities
Akhtar A. Khan, Professor and Researcher, Rochester Institute of Technology, Rochester, NY, United States

This talk will focus on a parameter identification problem in noncoercive variational inequalities. We will use regularization, penalization, and smoothing for the inverse problem. Convergence analysis and numerical examples will be presented.

2 - Some Extensions of Antipodal-Type Theorems
Lilia Alanís-López, Professor and Researcher, Universidad Autónoma de Nuevo León (UANL), San Nicolás de los Garza, Mexico, Viacheslav V. Kalashnikov, Dolf Talman, Nataliya I. Kalashnykova

The Brouwer fixed-point theorem was published in 1909 and its extensions for various settings formed powerful tools in the optimization theory and applications. The classical fixed-point theorems are mainly established for mappings defined on convex sets. However, in real-life problems, the domains need not be convex. We outline how we extend the antipodal theorems to more general domains and for multi-valued mappings as well. We provide preliminary definitions and basic properties used for the extensions of the antipodal and fixed-point theorems. An extended procedure for approximating zero is described, thus forming the paper's main result for multi-valued mappings and star-shaped domains.

3 - Non-negativity Constraints in Robust Optimization
Mehdi Toloo, Technical University of Ostrava, Czech Republic, Ostrava, Czech Republic, Emmanuel Kwasi Mensah

The current robust optimization approaches model robust counterparts (RC) to prescribed uncertainty sets for general solutions to corresponding uncertain optimization problems. This study suggests some alternative RC with nonnegative decision variables with the aim of removing redundant constraints, and auxiliary decision variables and decreasing the required computations in practical problems with nonnegative decision variables. Our approach is also extended to the robust Data Envelopment Analysis (DEA). A real data is taken to validate the new simplified approach. Based on the obtained results, our new approach reduces the computational burden required to solve DEA problems.

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