■ SA04

North Bldg 122A

Joint Session OPT/Practice Curated: Theory and Applications of MIP

Sponsored: Optimization/Integer and Discrete Optimization

Sponsored Session

Chair: Haochen Luo, Texas A&M University, College Station, TX, 77843-3131, United States

1 - A Bounded Formulation for the School Bus Scheduling Problem
Liwei Zeng, Northwestern University, 2145 Sheridan Road, IEMS Department, Evanston, IL, 60208, United States, Karen Smilowitz, Sunil Chopra

This paper proposes a new formulation for the school bus scheduling problem (SBSP) which optimizes starting times for schools and associated bus routes to minimize transportation cost. Specifically, the problem determines the minimum number of buses required to complete all bus routes under the constraint that routes for the same school must arrive within a set time window before that school starts. We present a new integer linear programming (ILP) formulation for this problem which is based on a time-indexed formulation. We develop a randomized rounding algorithm based on the linear relaxation of the ILP that yields near-optimal solutions for large-scale problem instances.

2 - Integer Programming for Learning Directed Acyclic Graphs
Hasan Manzour, University of Washington, Seattle, WA, United States, Simge K. Á. Kyavuz, Ali Shojaie

Bayesian Networks (BNs) are probabilistic graphical models that represent causal relationships among a set of random variables in the form of a Directed Acyclic Graph (DAG). We study the problem of DAG structural learning of a BN from observational data where the underlying causal mechanism in the network is linear. We propose a new optimization model for this learning problem and discuss the statistical implications of L1 versus L0 penalty in our model. The computational results, tested on both synthetic and real datasets, demonstrate that the proposed model is computationally more efficient to learn the optimal DAG when compared with the existing mathematical models in the literature.

3 - An MIP Approach to Finding Optimum Search Schemes for Approximate String Matching
Haochen Luo, Texas A&M University, 3131 TAMU, College Station, TX, 77843-3131, United States, Kiavash Kianfar, Christopher Pockrandt, Bahman Torkamandi, Knut Reinert

Finding approximate occurrences of a pattern in a text using a full-text index is a central problem in bioinformatics. Use of search schemes (partitioning the pattern and searching the pieces in certain orders with given bounds on errors) can yield significant speed-ups. However, finding optimal search schemes is a difficult combinatorial optimization problem. Here for the first time, we propose a mixed integer program (MIP) capable to solve this optimization problem for Hamming distance with given number of pieces. Our experiments show that the optimal search schemes found by our MIP significantly (up to 35 times) improve the performance of search in index upon previous ad-hoc solutions.

■ SA05

North Bldg 122B

Joint Session OPT/Practice Curated: Sparse Semidefinite Programs with Machine Learning Applications

Sponsored: Optimization/Linear and Conic Optimization

Sponsored Session

Chair: Somayeh Sojoudi, University of California, Berkeley, Berkeley, CA, 94703, United States

Co-Chair: Richard Zhang, UC Berkeley, Berkeley, CA, 94709, United States

1 - Empirical Bayes Estimation of Parametric Gaussian Priors
Martin Skovgaard Andersen, Technical University of Denmark, Asmussens Allé, Kgs. Lyngby, 2800, Denmark

In Gaussian linear models, a maximum a posteriori estimate of a set of unknown parameters depends on a prior distribution that is typically unknown. Assuming that this prior is Gaussian with a structured or sparse precision matrix, we investigate the use of empirical Bayes estimation to estimate the prior directly from data. We also propose a method to solve the resulting estimation problem, which is a nonlinear semidefinite optimization problem, and demonstrate the usefulness of the approach with some numerical examples.

2 - SDP Formulations for Fairness in Unsupervised Learning
Mahbod Olfat, PhD Student, University of California-Berkeley, 1433 Dwight Way, Unit C, Berkeley, CA, 94702, United States, Anil Aswani

Though there is a growing body of literature on fairness for supervised learning, the problem of incorporating fairness into unsupervised learning has been less well-studied. This paper studies fairness applied to PCA. We first present a definition of fairness for dimensionality reduction, which can be interpreted as saying that a reduction is fair if information about a protected class cannot be inferred from the dimensionality-reduced data points. Next, we develop convex optimization formulations that can improve the fairness (with respect to our definition) of PCA and kernel PCA. These formulations are SDP's, and we demonstrate the effectiveness of our formulations using several datasets.

3 - Linear-time Algorithm for Learning Large-scale Sparse Graphical Models
Richard Zhang, UC Berkeley, 621 Sutardja Dai Hall, University of California, Berkeley, CA, 94709, United States, Salar Fattahi, Somayeh Sojoudi

The sparse inverse covariance estimation problem is commonly solved using an l1-regularized Gaussian maximum likelihood estimator known as "graphical lasso". This talk describes a Newton-CG algorithm to efficiently solve graphical lasso for large datasets. Assuming that the thresholded sample covariance matrix is sparse with a sparse Cholesky factorization, we prove that the algorithm converges to an ?-accurate solution in O(n log(1/?)) time and O(n) memory. The algorithm is highly efficient in practice: we solve graphical lasso problems with as many as 200,000 variables to 7-9 digits of accuracy in less than an hour on a standard laptop computer running MATLAB.

4 - Control-theoretic Analysis of Smoothness for Stability-certified Reinforcement Learning
Ming Jin, UC Berkeley, Cory 406, Berkeley, CA, 94720, United States

It is critical to obtain stability certificate before deploying RL in real-world mission-critical systems. This work justifies smoothness as an important property for stability-certified RL from a control-theoretic perspective. The smoothness margin can be obtained by solving a feasibility problem based on SDP for both linear and nonlinear dynamical systems, and it does not need to access the exact parameters of the learned controllers. Numerical evaluation on nonlinear and decentralized frequency control for large-scale power grids is demonstrated using (deep) neural-network policies. The study opens up new opportunities for robust Lipschitz continuous policy learning.

■ SA10

North Bldg 125A

Joint Session MSOM/Practice Curated:Empirical and Analytical Research to Improve Humanitarian Service Delivery

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Mahyar Eftekhar, Arizona State University, Tempe, AZ, 85287, United States

1 - What Drives Humanitarian Organizations' Donation Income? An Empirical Investigation
Iman Parsa, Arizona State University, Mahyar Eftekhar, Charles J. Corbett

For their survival, humanitarian organizations greatly depend on donations they receive. We empirically study how different factors impact individual donations and government grants that medium and large humanitarian organizations ?receive to see whether, and how, they can adopt policies to attract more donations. These factors include elements related to organizations' internal operations, such as program spending ratio and transparency, as well as external factors, like media exposure.

2 - A Field Study of Charitable Giving Reveals that Reciprocity Decays over Time
Amanda Chuan, University of Pennsylvania, Philadelphia, PA, United States, Judd Kessler, Katherine MIlkman

We examine how reciprocity changes over time using a large field study. We analyze data from a hospital system on 18,000 donation requests to former patients in the four months following their first hospital visit. We exploit quasi-experimental variation in solicitation timing and find that an extra 30-day delay between the provision of medical care and a donation solicitation decreases the likelihood of a donation by 30%. Our findings have important implications for models of economic behavior, which currently fail to incorporate reciprocity's sensitivity to time. The fact that reciprocal behavior decays rapidly also suggests the importance of capitalizing quickly on quid pro quo opportunities.

3 - Communities in the Crossfire: How Companies Can Do Well by Doing Good
Andres Fernando Jola-Sanchez, Texas A&M University, College Station, TX, United States, Alfonso J. Pedraza-Martinez

We study how social investments in conflict zones affect firms' operational performance. Social investments can improve the well-being of communities in war-torn areas, but how do firms benefit from making these investments? We collect data from all the oil firms in Colombia and examine a law that compelled a group of these firms to spend 1% of their budget on social investmentsùthe Colombian civil war is rampant in oil regions. We find this group obtains higher operating margins compared to the group the law did not affect. By influencing workforce, sourcing and logistics processes, social investments reduce the frequency of disruptions affecting firms in conflict zones.?

4 - Supply Management for Rapid-onset Disasters: Effects of Supply, Demand, and Budget Uncertainty
Mahyar Eftekhar, Arizona State University, BA 433, Main Campus, P.O. Box 874706, Tempe, AZ, 85287, United States, Jing-Sheng Jeannette Song, Scott Webster

To fulfill beneficiaries' demands, humanitarian organizations should design a cost-efficient and time-effective procurement policy. We consider and analyze two common supply management policies: pre-positioning and local-purchasing. Our analysis takes demand, supply, and budget uncertainties into account.

5 - Do Optimization Models for Humanitarian Operations Need a Paradigm Shift
Harwin de Vries, INSEAD, Boulevard de Constance, Fontainebleau, 77210, France, Luk N. Van Wassenhove

Optimization approaches for planning and routing of humanitarian field operations have been studied a lot. Yet, their adoption in practice seems absent. Based on interviews, literature, and modeling results, we discuss the applicability and cost-effectiveness of such approaches and identify areas where future research is needed.

■ SA12

North Bldg 126A

Joint Session OR Frontiers/Practice Curated: Novel Applications of Operations Research

Emerging Topic: OR Frontiers

Emerging Topic Session

Chair: Srinivas Bollapragada, GE Global Research Center, Niskayuna, NY, 12309, United States

1 - Optimal Scheduling of Field Resources for Power Plant Outages
Rajeev Namboothiri, GE Global Research, John F. Welch Technology Centre, Plot # 122, EPIP Phase 2,, Bangalore, 560066, India, Srinivas Bollapragada, Babu Narayanan, Guillaume Camard, Ahmed Khattab

Power plants around the world require field resources to carry out maintenance outages. A host of complex constraints restrict the eligibility and availability of a field resource to perform a maintenance task. We developed a Field Resource Scheduling algorithm minimizing the total cost associated with field services while meeting all the real-world constraints. Using exhaustive preprocessing, an intelligently designed cost function, and a novel approach that iteratively solves a series of linear programs, we achieve the optimal solution within a few minutes. GE Power has been using this tool in the Middle East Africa region, resulting in operational cost savings of millions of dollars.

2 - Optimizing Maintenance Operations at GE Wind Sites
Rajesh Tyagi, GE Global Research Center, 1 Research Circle, Niskayuna, NY, 12309, United States, Nitish Umang

GE Renewable, a leading producer of wind turbines, also sells service agreements to guarantee their operating availability at wind sites. These sites have up to 200 turbines, with outstanding maintenance work for a subset of turbines at any given time. We present a Digital Plan of the Day (DPOD) system that has been developed to optimize the maintenance operations to determine which turbines will have maintenance performed that day and develops a schedule for each crew. DPOD has so far been implemented at over 50 wind farms in North America.

3 - Rail Network Operations Optimization
Srinivas Bollapragada, Chief Scientist, GE Global Research Center, 1 Research Circle, K1-4A50A, Niskayuna, NY, 12309, United States

Each of the seven major railroads (called Class 1 railroads) in North America owns over 20,000 miles of track and runs over 1000 trains per day. Moving freight on such complex networks requires meticulous planning and execution. Multiple opportunities exist to realize large savings from improving railroad operations. For example, increasing the average speed of freight trains by one mile per hour saves a Class 1 railroad around $200 million per year. Improving terminal (rail yard) operations and decreasing fuel consumed by locomotives also result in similar sized savings. We will describe some of our work on developing algorithms to improve operations of rail networks.

4 - Rail Network Operations Optimization
Srinivas Bollapragada, PhD, Chief Scientist, GE Global Research Center, Niskayuna, NY, USA.

Each of the seven major railroads (called Class 1 railroads) in North America owns over 20,000 miles of track and runs over 1000 trains per day. Moving freight on such complex networks requires meticulous planning and execution. Multiple opportunities exist to realize large savings from improving railroad operations. For example, increasing the average speed of freight trains by one mile per hour saves a Class 1 railroad around $200 million per year. Improving terminal (rail yard) operations and decreasing fuel consumed by locomotives also result in similar sized savings. We will describe some of our work on developing algorithms to improve operations of rail networks.

■ SA22

North Bldg 130

Joint Session RMP/Practice Curated: Interface between RM and Market Analytics

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Ang Li, PROS, Inc., Houston, TX, 77002, United States

1 - Spot Scheduling for Cable Networks
Xin Ma, Turner Broadcasting System, Inc., 1050 Techwood Dr NW, Atlanta, GA, 30318, United States, J. Antonio Carbajal

Spot scheduling is a media planning process in which TV commercials are placed into buckets of commercial airtime for airing. In this presentation, we provide some background information of media planning, and review different types of deals, constraints, and requirements involved in this process. Then we introduce the spot scheduling problem, and discuss how we decompose it in a multi-stage optimization framework that realizes spot prioritization and best use of Turner's commercial airtime.

2 - A Probabilistic Modeling Framework to Optimize Volume Pricing Settings
Jose Luis P. Arreola, Home Depot (Blacklocus), Austin, TX, United States, Joseph Nipko

We optimize volume pricing settings in terms of tier quantity (Qi) and discount (di) over retail price in order to perform constrained optimization on performance metrics such as Margin, Revenue and Unit Sellthrough. Our inference approach is based on probabilistic modeling of the order size distribution of similar products, under an observed array of (Qi, di) settings. Further, our methodology allows for the overlaying of product-specific context parameters in a modular way. We apply our approach to three different groups of construction material products and we conduct market price tests on them. We observe that our framework predicts directionally correct revenue and margin lift estimates.

3 - DP Based Efficient Frontier in Revenue Management
Wei Wang, PROS Inc, 3100 Main St, Suite #900, Houston, TX, 77002, United States, Fangzhou Sun, Darius Walczak, Subhash C. Sarin

In this paper, we consider jointly optimizing expected profit contribution and resource utilization for revenue management problems. In particular we use a constrained Markov decision process-based approach to find the corresponding efficient frontier.

4 - Predicting Users' Forecast Influences via Machine Learning
Ang Li, PROS, Inc., 3100 Main Street, Suite #900, Houston, TX, 77002, United States, Stephanie Zipkin

Airline RM analysts spend a significant amount of time monitoring and influencing forecasted demand. In this innovation study, we developed several supervised learning models to predict demand influences based on historical data. In particular, we derived features which mimic a variety of influence criteria and rules the analysts apply through surveying domain experts. Our numerical experiments show that a medium-complexity decision tree model reliably predicts user influences with low error rate. We discuss how the RM system may be augmented with our model, and outline our next steps of study.

■ SA23

North Bldg 131A

Joint Session FSS/Practice Curated: Financial Engineering Applications

Sponsored: Finance

Sponsored Session

Chair: Justin Sirignano, University of Illinois at Urbana-Champaign, Irvine, CA, 92617, United States

Co-Chair: Alexandra Chronopoulou, University of Illinois, Urbana-Champaign, Urbana, IL

1 - Optimal Kernel Estimation of Spot Volatility of Stochastic Differential Equations
Jose E. Figueroa-Lopez, Washington University-St Louis, One Brookings Drive, St Louis, MO, 63130, United States

A feasible method of bandwidth and kernel selection for spot volatility kernel estimators is proposed, under some mild conditions on the volatility process, which not only cover classical Brownian motion driven dynamics but also some processes driven by long-memory fractional Brownian motions. The optimal selection of the kernel function is also investigated. For Brownian Motion type volatilities, the optimal kernel turns out to be an exponential function, while, for fractional Brownian motion type volatilities, numerical results to compute the optimal kernel are devised. Simulation studies further confirm the good performance of the proposed methods. This is based on joint work with Cheng Li.

2 - Delta-hedging in Fractional Volatility Models
Alexandra Chronopoulou, University of Illinois, Urbana-Champaign, 104 South Mathews Avenue, 117 Transportation Building, Urbana, IL, 61801, United States, Qi Zhao

In this talk, we propose a delta-hedging strategy for a long memory stochastic volatility model (LMSV). This is a model in which the volatility is driven by a fractional Ornstein-Uhlenbeck process with long-memory parameter H. We compute the so-called hedging bias, i.e. the difference between the Black-Scholes delta and the LMSV delta as a function of H, and we determine when a European-type option is over-hedged or under-hedged. Finally, we apply our approach to SP 500 data.

3 - Mean Field Analysis of Neural Networks in Machine Learning
Alexandra Chronopoulou, University of Illinois, Urbana-Champaign, 104 South Mathews Avenue, 117 Transportation Building, Urbana, IL, 61801, United States, Justin Sirignano, University of Illinois at Urbana-Champaign, Irvine, CA, USA.

Neural network models in machine learning have revolutionized fields such as image, text, and speech recognition. There's also growing interest in using neural networks for applications in science, engineering, medicine, and finance. Despite their immense success in practice, there is limited mathematical understanding of neural networks. We mathematically study neural networks in the asymptotic regime of simultaneously (A) large network sizes and (B) large numbers of stochastic gradient descent training iterations. We rigorously prove that the neural network satisfies a Law of Large Numbers (LLN) and a Central Limit Theorem (CLT). The LLN is the solution of a nonlinear partial differential equation while the CLT satisfies a stochastic partial differential equation.

4 - Deep Learning in Asset Pricing
Markus Pelger, Stanford University, 312 Huang Engineering Center, 475 Via Ortega, Stanford, CA, 94305, United States

We estimate a general non-linear asset pricing model and optimal portfolios with a deep-neural network applied to all U.S. equity data combined with all relevant macroeconomic and firm-specific information. No-Arbitrage Pricing theory implies that the conditional expectation of the discounted excess returns are zero under the risk-neutral probability. Our data-driven approach estimates the stochastic discount factor that explains all asset prices from this basic assumption. Our model allows us to identify the key factors for asset prices, find mis-pricing of stocks and generate the optimal portfolio with the highest Sharpe ratio.

■ SA29

North Bldg 221B

Joint Session TSL/Urb/Practice Curated: Activity Modeling and Applications in Urban Transport

Sponsored: TSL/Urban Transportation

Sponsored Session

Chair: Jee Eun Kang, University at Buffalo, Buffalo, NY, 14260, United States

1 - Strategic Public Parking Locations with Routing Considerations of Individual Autonomous Vehicles
Somayeh Dejbord, University at Buffalo, Tonawanda, NY, United States

Use of personal Autonomous vehicles (AV) will lead to increased Vehicle-Miles-Traveled (VMT) particularly due to empty trips. While a decision maker makes the parking location decision (public), the decision of using the parking is made by individual private AV owners, households. A location siting model uses flow-based demand data as an input but the actual decision of using parking is made individually with finer details such as what household members' daily itineraries are. We develop a methodology to approximate input data for the location model using data available to the decision maker.

2 - Integrating Augmented Reality, Gamification and Social Interactions in Mobile Apps to Influence Short- and Long-term Travel Decisions
Yuntao Guo, Purdue University, West Lafayette, IN, United States, Srinivas Peeta, Shubham Agrawal, Irina Benedyk, Mohammad Miralinaghi

This study develops a framework that integrates augmented reality (AR), gamification and social interactions through mobile apps to influence short- and long-term travel decisions by using a popular location-based AR gaming app, Pok mon GO, as a case study. A survey was designed and implemented to evaluate impacts of the integrated mobile apps on travel decisions using participants with different levels of familiarity and experience with Pok mon GO. Descriptive statistics and econometric model estimation results illustrate that such integrated mobile apps can be leveraged for implementing behavioral intervention strategies to influence travel decisions of subpopulations of travelers.

3 - Household Activity and Travel Patterns with Shared Autonomous Vehicles
Marjan Mosslemi, University of California-Irvine, Irvine, CA, United States, R. Jayakrishnan

Access to shared autonomous vehicles can create new opportunities for performing daily activities and will change traveler behavior. We explore the potential impacts by modifying the constraints of the Household Activity Pattern Problem (HAPP). The new constraints include two new specifications of the supply environment (shared mobility and driverless vehicles) and reflect following new opportunities: more vehicle resources than personal vehicles, possibility to perform activities in-vehicle, some activities that can travel.

■ SA41

North Bldg 226C

Joint Session DAS/Practice Curated: Risk and Decision Analytics

Sponsored: Decision Analysis

Sponsored Session

Chair: Sayanti Mukhopadhyay, PhD, Purdue University, West Lafayette, IN, 47907, United States

1 - Optimizing Inspection Routes in Pipe Networks
Thomas Ying-Jeh Chen, University of Michigan, Ann Arbor, MI, 48105, United States, Connor Riley, Pascal Van Hentenryck, Seth Guikema

The inspection of aging water distribution pipes is a vital process for utilities to aid better decision making for risk-based management. To facilitate cost-efficient deployment of inspection robotics, a process that finds high risk pipe while accounting for the tool limitations is needed. We formulate the problem as an integer program, and explore a variety of methods to identify optimal routes: branch and bound, constraint generation, breadth-first search, depth-first search, and depth-first search with pruning. While only three factors are used to characterize tool limitations, the formulation can be extended to include technology-specific complexities in real world applications.

2 - Optimizing Design for Hybrid Renewable Energy Systems Under Long-range Uncertainties
Ramin Giahi, Iowa State University, Ames, IA, 50010, United States

Understanding the potential for new applications and different environments under which a system will operate is important in engineering design. This presentation focuses on design with long-range uncertainty. We identify and model significant uncertainties that will impact the use and lifespan of a system. This research explores designing a hybrid renewable energy system design while taking into account long-range uncertainties of 20 years.

3 - Modeling the Impact of Natural Hazards on the Serviceability of Infrastructure Systems: A Bayesian Approach
Jin-Zhu Yu, Vanderbilt University, Nashville, TN, United States, Mackenzie G. Whitman, Hiba Baroud

The ability to make accurate predictions of failure or recovery measures for infrastructure systems is often hindered by the lack of data and uncertainty of hazards. To address this challenge, this study presents a framework that incorporates a Bayesian updating mechanism of network component fragility into the evaluation of the overall serviceability of an infrastructure network under multiple hazard scenarios. This framework allows for better understanding of the subsequent performance of the individual components and the entire network as new data becomes available. A case study of a water distribution network is presented to illustrate the framework.

4 - Multi-stage Prediction for Zero-inflated Hurricane Induced Power Outages
Sara Shashaani, University of Michigan, Ann Arbor, MI, 48105, United States, Seth Guikema, Chengwei Zhai, Jordan V. Pino, Steven M. Quiring

Predictive models on hurricane power outages can be built via statistical learning

methods that use past hurricanes data to capture the effects of several climatological and environmental variables on the power systems. Classical data minim methods and accuracy metrics are misleading for datasets with the majority of their response variables being zero. To deal with the zero-inflation in the power outage datasets, we develop and validate a 3-stage framework for three historic hurricanes and predict the outages of three recent hurricanes in the central Gulf region. The results show improvement over the traditional approaches.

5 - Impact of Climate Model Uncertainties in Projecting Long Term Regional Energy Demand

Sayanti Mukherjee, Purdue University, West Lafayette, IN, United States, Panteha Alipour, Roshanak Nateghi

The uncertainties in projecting long-term energy demands are not only associated with stochasticity in future socio-economic conditions, population changes or technology infusion, but also with climate projections as provided by the General Circulation Models (GCMs). Uncertainties attributed to climate projections mostly arise from the structure and processes within the GCMs, leading to projection divergence across the models. The purpose of this study is to provide an assessment of how the divergence in climate projections influence the long-term regional energy demand projections. The proposed framework will help the stakeholders in risk-informed long-term utility planning.

■ SA44

North Bldg 227C

Joint Session ENRE/Practice Curated: Data Analytics for Power Systems

Sponsored: Energy, Natural Res & the Environment/Electricity

Sponsored Session

Chair: Ming Jin, UC Berkeley, Berkeley, CA, 94720, United States

Co-Chair: Javad Lavaei, University of California, UC, Berkeley, CA, United States

1 - Data Driven Power Flow Analysis in Distribution Grids with Incomplete System Information

Yang Weng, Arizona State University, 551 E. Tyler Mall, ERC 563, Engineering Research Center (ERC), Tempe, AZ, 85281, United States, Jiafan Yu, Ram Rajagopal

The increasing integration of distributed energy resources calls for new monitoring and operational planning tools to ensure stability and sustainability in distribution grids. One idea is to use existing tools in transmission grids and some primary distribution grids. However, they usually depend on the knowledge of the system model. To solve the modeling problem, we propose a support vector regression (SVR) approach to reveal the mapping rules between different variables and recover useful variables based on physical understanding and data mining. We illustrate the advantages of using the SVR model over traditional regression method which finds line parameters in distribution grids.

2 - Real-time Prediction of the Duration of Distribution System Outages

Baosen Zhang, University of Washington, Seattle, WA, United States, Aaron Jaech, Mari Ostendorf, Daniel Kirschen

This paper addresses the problem of predicting duration of unplanned power outages, using historical outage records to train a series of neural network predictors. The initial duration prediction is made based on environmental factors, and it is updated based on incoming field reports using natural language processing to automatically analyze the text. Experiments using 15 years of outage records show good initial results and improved performance leveraging text. Case studies show that the language processing identifies phrases that point to outage causes and repair steps.

3 - Data-driven Learning Methods for Detecting and Mitigating Load Redistribution Attacks

Lalitha Sankar, Arizona State University, 551 E. Tyler Mall, Tempe, AZ, 85281, United States

The electric power grid is a critical cyber-physical infrastructure that is vulnerable to data injection attacks. We present data-driven detection techniques against a wide class of cyberattacks that maliciously redistribute loads by modifying measurements including nearest neighbor, SVM, and neural networks. The detectors are both trained and tested using publicly available PJM zonal load data. Mapping the dataset to the IEEE 30-bus system, the efficacy of the detectors, designed in a semi-supervised manner with labeled non-anomalous historical data, is tested with both attacked and non-anomalous data. We show that all three detectors designed are very accurate.

■ SA49

North Bldg 230

Joint Session ENRE/Practice Curated:Advanced Analytics in Oil & Gas Production and Exploration

Sponsored: Energy, Natural Res & the Environment/Natural Resources Petrochemicals

Sponsored Session

Chair: Damian Burch, ExxonMobil Upstream Research Company, Houston, TX, United States

1 - Bayesian Modeling and Decision Making for a Well System

Rujian Chen, Massachusetts Institute of Technology

We are interested in modeling a large off-shore oil well system with complex multi-phase fluid flows. Previous optimization-based learning methods failed to capture the high uncertainty in the system arising from noisy and missing measurements. In this work, we adopt a Bayesian framework to infer system parameters as well as characterize their uncertainty. We use a Gaussian process to model the flow simulation and develop an approximate model with a tractable inference method. We use synthetic to data show the fidelity of the approximate model and use Bayesian model validation techniques to show the predictive accuracy of the model. Finally, we develop new experiment design approach which brings time and cost savings compared to previously used empirical methods.

2 - The Effect of Technology on Importance of Geologic Parameters for Shale Well Productivity: Cross-Play Analysis

Svetlana Ikonnikova, University of Texas at Austin, Austin, TX, United States, Katie Smye, Scott Hamlin, Robin Dommisse, Frank Male

This study of Haynesville, Fayetteville, and Marcellus shale plays explores the role of geologic parameters versus completion technology? Applied machine learning methods (random forest and model-based recursive partitioning) reveal the set of variables, which explain individual well productivity. The analysis focuses on exceptionally good wells in geologically mediocre, e.g. ductile, areas to understand whether “poor rock quality can be compensated by completions and be economical. We find that good “outliers exist, with productivity being statistically explained by technology-related changes, such as optimized completions (and field experience) making “poor zones economic.

3 - Transdimensional Full Waveform Inversion Using a Hamiltonian Formulation

Mrinal K. Sen, University of Texas at Austin

Abstract not available.

4 - Data-driven Methods for Well Connectivity

Damian Burch, PhD, ExxonMobil Upstream Research Company, 22 S. Peaceful Canyon Circle, The Woodlands, TX, 77381, United States, Akash Mittal, Tripti Kumari

Making the best development and production decisions in the oil & gas industry requires a detailed understanding of subsurface flow paths. Most critically, we need to understand if and how pressure from injection wells might affect nearby producer wells. Unfortunately, this information usually cannot be directly imaged, so indirect methods are required to infer subsurface flow paths from sparse surface measurements. In this talk, we will discuss methods that combine simple physical models with data-analytic algorithms for detecting and quantifying well connectivity.

5 - Real-time Solution of a Pursuit-Evasion Game for Ice Management

Matthew W. Harris, ExxonMobil Upstream Research, Magnolia, TX, United States

Ice management systems provide a rational basis for risk-based decisions, and they involve estimating the probability of an ice impact and associated time. A differential pursuit-evasion game perspective provides conservative estimates for miss distance and time. Such problems are generally difficult to solve since the direct methods of optimal control do not apply. However, the state space can be partitioned to identify closed-form solutions or a reduced set of algebraic equations. It so happens that the degenerate solution types admit closed-form solutions while regular solution types do not. Examples of each are shown.

■ SA50

North Bldg 231A

Joint Session Practice/Practice Curated:Editor’s Cut #1: Cybersecurity, Elections, Transportation, Agribusiness

Sponsored: INFORMS Section on Practice (formerly CPMS)

Sponsored Session

Chair: Carrie Beam, University of Arkansas, Walnut Creek, CA, 94596, United States

1 - Moderator - Editor's Cut #1 (Cybersecurity, Elections, Transportation, Agribusiness)

Robin Lougee, IBM Research, IBM TJ Watson Research Center, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States

This panel will cover the Cybersecurity, Elections, Transportation, and Agribusiness issues of Editor's Cut. Come learn more about the case studies, videos, and other journal articles available free, online

Panelists

Scott Nestler, University of Notre Dame, 51344 Pebble Beach Court, Granger, IN, 46530, United States
Alan Erera, Georgia Institute of Technology, School of Industrial & Systems Eng, Atlanta, GA, 30332-0205, United States
Saurabh Bansal, Penn State University, 405 Business Building, State College, PA, 16801, United States
Sam Ransbotham, Boston College, Fulton Hall 460A, 140 Commonwealth Avenue, Chestnut Hill, MA, 02467, United States

■ SA58

West Bldg 101C

Joint Session HAS/Practice Curated: Healthcare Analytics I

Sponsored: Health Applications

Sponsored Session

Chair: Ozden Onur Dalgic, Massachusetts General Hospital/ Harvard Medical School, Boston, MA, 02114, United States

1 - Predicting the Risk of Critical Events in ALS Disease Using Data Analytics

Ozden Onur Dalgic, Harvard Medical School, Boston, MA, United States, Osman Ozaltin, F. Safa Erenay, Kalyan Pasupathy, Mustafa Y. Sir, Brian Crum

ALS is a neuro-degenerative disease causing continuous decay of motor neurons and muscle atrophy. Patients suffer from losing their abilities to speak, eat, move and. Due to having no permanent treatment, ALS eventually affects all abilities but disease progression shows a great variability. Using medical records of over 500 patients from Mayo Clinic, we analyse the ALS progression pathways, and estimate risks of losing abilities and needing medical interventions (e.g., feeding/breathing tube). We then develop a natural history model to to predict the risk of critical events (e.g., using wheelchair) over the course of the disease.

2 - Using Partially Observable Markov Decision Processes to Improve Alzheimers Disease Screening

Saeideh Mirghorbani, University of Alabama, Tuscaloosa, AL, 35401, United States, Sharif Melouk, John Mittenthal

Family history, genetics, Down syndrome, head injury, high cholesterol levels, high blood pressure, and diabetes are some of the factors that place individuals at a higher risk of developing Alzheimer's disease (AD). To manage this risk and its complications, persons more susceptible to AD should be regularly screened. To determine an optimal screening plan, we develop a finite horizon, partially observable Markov decision process model for individuals transitioning through different stages of AD. The model aims to maximize the Quality Adjusted Life Years (QALY) for an individual.

3 - The Role of Big Data in System Dynamics Modeling

Hamed Kianmehr, Binghamton University, Binghamton, NY, 13905, United States, Nasim S. Sabounchi, Lina Begdache

Our objective in this research is to use big data techniques to enhance system dynamics (SD) modeling regarding the relationship between diet and mental health. We apply our approach to study the relationship between diet and mental health. We estimate the parameters of the system dynamics model by applying some novel big data techniques on a large data set. Then, we feed the calibration parameters in SD models with the new estimations using big data analytics. Big data techniques and SD models can contribute to investigating the causal relationships between nutrition and mental health. The future achievement will enable big data analytics to assist other modeling techniques in the healthcare domain.

4 - Developing Predictive Models for Parkinson's Disease by Analyzing an Imbalanced Dataset

Saeed Piri, University of Oregon, 434 Lillis Business Complex, Eugene, OR, 97403, United States

Parkinson's disease (PD) is a neurodegenerative disorder that affects about one million Americans. In this study, we develop diagnostic models, which use only demographic, lab, and clinical events data. To develop these models, we analyzed a large size imbalanced data. To enhance our models' accuracy, we applied synthetic informative minority oversampling (SIMO) algorithm and extended it to machine learning techniques such as decision tree, logistic regression, and neural network. Finally, we developed an ensemble model by applying confidence margin ensemble approach.

■ SA59

West Bldg 102A

Joint Session HAS/Practice Curated: Empirical Research in Health Care

Sponsored: Health Applications

Sponsored Session

Chair: Daniel Ding, BC, Canada

1 - Workload, Predictive Accuracy, and the Value of Algorithm-enabled Process Innovation: The Case of Sepsis Alerts

Mehmet U. Ayvaci, University of Texas at Dallas, Richardson, TX, United States, Idris Adjerid, Ozalp Ozer

Predictive algorithms have an increasingly important role in supporting the day-to-day operations of businesses. This paper studies how and when algorithm-enabled process innovation (AEPI) creates value, particularly in the context of changing operational environments and the behavioral responses to algorithmic predictions. We contextualize the broad research problem into the implementation of an alert system in a hospital for early identification and treatment of sepsis. We leverage a rich set of clinical and nonclinical data and econometric approaches to examine the relationship between sepsis AEPI and patient mortality.

2 - Impact of Discharge Policies on Emergency Department Overcrowding

Arshya Feizi, Boston University, 595 Commonwealth Avenue, Boston, MA, 02215, United States, Jillian Berry Jaeker

In a hospital "boarding" occurs when emergency department (ED) patients are stabilized but cannot be admitted to their appropriate wards for further treatment, if required, due to issues such as insufficient capacity in the receiving unit. We investigate how discharge policies may impact ED overcrowding and patient boarding.

3 - How to Improve MRI Hospital Waiting Time – An Empirical Analysis of Geographical Resource Pooling

Yangzi Jiang, Northwestern University, 4174 Kellogg Global Hub, 2211 Campus Drive,, Evanston, IL, 60208, United States, Jan A. Van Mieghem, Hossein Abouee Mehrizi

Significant mismatches between demand and capacity in MRI hospitals in Ontario Canada leads to prolonged waiting time which inspired our research of when and to what extend to implement pooling. Using patient-level data gathered from 72 MRI hospitals over 5 years, we conducted an empirical analysis using regional pooling to achieve over 20% wait-time reduction. This research provided the basis for strategic hospital decisions. ?

4 - Do Financial Incentives Change Length-of-stay Performance in Emergency Departments? A Retrospective Study of the Pay-for-performance Program in Metro Vancouver

Yichuan Ding, University of British Columbia, University of British Columbia, 6333 Larkin Drive, Vancouver, BC, V6T 1C3, Canada, Yuren Wang, Eric Park, Garth Hunte

We study whether and how a province-wide P4P program affected ED patient disposition timing. The P4P program provided financial compensation to enrolled hospitals for each ED patient visit that met a certain LOS target. We examined, in 4 EDs, whether the LOS distribution had a discontinuous density near the LOS targets specified by the program, which suggests that patient dispositions may have been completed in order to meet the LOS targets. Our findings provide evidence of organizational responses to P4P incentives and suggest that the P4P program can benefit patients by reducing access blocks, but may also lead to unintended outcomes, such as higher return and admission rates.

■ SA60

West Bldg 102B

Joint Session HAS/Practice Curated: Data and Models in Healthcare Analytics

Sponsored: Health Applications

Sponsored Session

Chair: Joel Goh, NUS Business School, 119245, Singapore

Co-Chair: Shasha Han, National University of Singapore, National University of Singapore, Singapore, Singapore

1 - The Analytics of Bed Shortages: Coherent Metric, Prediction and Optimization

Jingui Xie, University of Science and Technology of China, School of Management, 96 Jinzhai Road, Hefei, 230026, China, Gar Goei Loke, Melvyn Sim, Shao Wei Lam

In practice, healthcare managers often use bed occupancy rates (BOR) as a metric to understand bed utilization, which is insufficient in capturing the risk of bed

shortages. Based on the riskiness index of Aumann and Serrano (2008), we propose the entropic bed shortage metric, which captures more facets of bed shortage risk than traditional metrics such as the occupancy rate, the probability of shortages and expected shortages. We also propose optimization models to control the risk of bed shortages and plan for bed capacity via this metric. These models have linear program re-formulations which can be solved efficiently on a large scale.

2 - Cost-effectiveness Analysis of Clinical Management Strategies for Undifferentiated Febrile Illness in the Era of Responsible Antibiotic Use

Zhenhuan Zhang, University of Minnesota, Minneapolis, MN, 55414, United States, Diana Maria Negoescu, Claudia Munoz-Zanzi

Febrile illnesses such as dengue, leptospirosis and scrub typhus have similar symptoms and are often difficult to differentiate without diagnostic tests. If not treated appropriately, patients could experience serious complications. The question of what diagnostic test to use and when to administer antibiotic treatment to avoid misuse of scarce resources and ensure best possible health outcomes remains an open problem. We construct a Markov model of febrile illness progression to assess the cost-effectiveness of fifteen clinical management strategies for diagnosing and treating acute undifferentiated febrile illness in Thailand under different attitudes towards antibiotic misuse.

3 - Data Driven Personalized Treatment Planning for Chronic Diseases

Christof Naumzik, ETH Zurich, Zurich, Switzerland, Stefan Feuerriegel

Medical research has found the progression of chronic diseases to transition between different clinical phases (e.g. acute and stable). These trajectory phases are relevant for clinical practice, since they serve as the basis for providing care and nursing. Yet their correct identification is challenging, as symptoms are only stochastically related to them. We formalize a hidden Markov model with latent states matching the trajectory phases as defined by the Corbin-Strauss trajectory framework. A copula approach is implemented to handle multivariate observations (e.g. pain and disability).

4 - A Robust Approach to Study Multiple Treatments: Hierarchical Contrast-specific Propensity Score

Shasha Han, NUS Business School, National University of Singapore, NUS Business School, Biz 2 Building B1, 1 Business Link, Singapore, Singapore, Joel Goh, Fanwen Meng, Donald Rubin

The worldwide rise in number of patients with diabetes and the consequent secondary complications is afflicting human population globally. To study the multiple medications treatment effect for diabetes, we propose a hierarchical contrast-specific propensity score(CSPS) approach. One merit of the approach is that it is robust to misspecification of the functional form of CSPS. The results from diabetes data in Singapore corroborates our theoretical findings. Due to such robustness, the hierarchical CSPS could be influential in causal inference for multiple treatments. Also, the approach charts one of the paths towards personalized medication in healthcare.

■ SA64

West Bldg 104A

Joint Session DM/AI/pratice Curated: Urban Big Data Analytics and Mining

Sponsored: Data Mining

Sponsored Session

Chair: Xun Zhou, University of Iowa, Iowa City, Iowa

1 - Predicting Urban Dispersal Events: A Two-stage Framework Through Survival Analysis

Amin Vahedian Khezerlou, University of Iowa, IA, United States

In this work, we focus on predicting unexpected dispersal of people in urban setting, based on taxi pick-up records. Unlike regular taxi pick-up patterns, which are highly regular and predictable, the irregular dispersal events do not follow an obvious pattern and are challenging to predict. Such predictions can be used to better plan public safety and traffic management, as well as business profit. We propose a supervised learning framework which takes advantage of survival analysis to infer the event time, and also predict the event volume. We use a public dataset of taxi records for evaluations. We outperform baseline methods by a significant margin.

2 - Multi-Frequency Convolutional LSTM for Crime Prediction

Maryam Rahmani Moghaddam, Univeristy of Iowa, Iowa City, IA, United States

The crime prediction problem aims at predicting the location and time of the future crimes. This problem is challenging due to the spatial and temporal sparsity of the crimes. In this work, we propose a Multi-Frequency Convolutional LSTM model, which is an ensemble of multiple convolutional lstm models trained by subsets of historical data with varying sampling intervals to capture the multi-frequency patterns of crimes. The combined output of these models using a convolutional neural network is further combined with the historical map through a spatial regression. We test our model on 5 years (Feb 2015-Feb 2017) of burglaries (23797 reports) in Portland, Oregon provided by the Portland Police Bureau and evaluate the PAI and PEI. We compare the proposed model with baseline methods static-map and Self-Exciting Point Process.

3 - A Holistic Solution for Connected Smart City with Good Environmental Health, Traffic and Energy

Sheela Siddappa, Bosch, Bengaluru, India

Traffic Management is very important aspect towards smart city. As a solution towards smart city, this work concentrates on multiple aspects like 1) IOT based systems adapting Deep Learning and Machine Learning Techniques to accurately identify vehicles that violate traffic rules 2) Estimate the probability of a parking space being available in a locality 45 mins in advance and update with time 3) Estimate the impact of traffic realignment on the environment and iterate accordingly. Overall the solution aims towards a connected city and bring a balance between the environmental health and comfort towards traffic movement and rules in a holistic view.

■ SA69

West Bldg 106A

Joint Session QSR/Practice Curated: Data Analytics in Healthcare Applications

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Dongping Du, Texas Tech University, Lubbock, TX, 79409, United States

1 - Network-based Analysis of Multivariate Sensory Data for Real-time Monitoring of Cardiac Patients

Chen Kan, University of Texas at Arlington, Arlington, TX, United States

In this paper, a new network model is developed to integrate multivariate sensory data forreal-time detection of abnormal cardiac patterns. Each cycle of the high-dimensionalsignal is mapped as a weighted network. Structural variations among networks arecharacterized by optimal network alignment, which are then incorporated into anexponentially weighted moving average control chart for in-situ monitoring. Experimentalresults show that the proposed network model effectively and efficiently capturesincipient changes of cardiac activity for the early identification of disease patterns

2 - Atrial Fibrillation Source Identification Using Multinomial Distribution and Maximum Likelihood Estimation

Dongping Du, Texas Tech University, 2500 Broadway, P.O. Box 43061, Lubbock, TX, 79409, United States, Amirhossein Koneshloo

Atrial Fibrillation (AF) is the most common sustained cardiac rhythm disorder. Identifying AF triggers is essential for efficient treatment design. However, due to the uncertainty and randomness associated with electrical wave propagation, determining the trigger locations is challenging. In this study, we develop a robust probabilistic method to track the electrical wave conduction in AF in the presence of uncertainty. The method provides confidence regions that successfully capture AF sources. The confidence bounds can be valuable references for AF ablation design and planning.

3 - A Mixed Effects Multi-task Learning Model for Parkinson's Disease Monitoring Using Smartphones

Hyunsoo Yoon, Arizona State University, 699 S. Mill Ave, Tempe, AZ, United States, Jing Li

Built-in sensors in smartphones can conveniently collect the activities of PD patients. The cost-effectiveness of this method allows patient conditions to be assessed frequently for more effective treatment. However, due to patient heterogeneity, patient-specific models are needed but face the challenge of limited data regarding the Unified PD rating Scale representing disease severity. We propose a multi-task learning approach, MEMTL, which can utilize both general population and patient-specific patterns to improve prediction performance. The unique features of MEMTL include detection of early signs of PD and accurate prediction of PD progression.

4 - Subspace Learning and Representation of Dynamic Coordination Pattern Across Multiple Joints During Movement for Chronic Ankle Instability

Shaodi Qian, Northeastern University, Boston, MA, 02115, United States, Sheng-Che Yen, Eric Folmar, Chun-An Chou

Ankle sprains and instability are major public health concerns. Up to 70% of individuals don't fully recover from a single ankle sprain and develop chronic ankle instability (CAI). The diagnosis of CAI is usually based on self-report rather than objective biomechanical measures. In this study, we propose a new analytics method to identify discriminative patterns in the coordination among bilateral hip, knee, and ankle joints between individuals with CAI and health cohorts. A subspace learning algorithm is developed to estimate the multi-joint coordination patterns. The computational results show >80% classification accuracy with the identified patterns using a SVM classifier.

■ SA75

West Bldg 212B

Joint Session MAS/Practice Curated: Cybersecurity Analysis and Applications I

Joint Session

Chair: Paul L. Goethals, United States Military Academy, West Point, NY, 10996, United States

1 - Quantum Correlation Sets and the Limits of Quantum Communication
Travis Russell, PhD, Army Cyber Institute, West Point, NY, 10996, United States

A quantum correlation is a kind of probability distribution that can be achieved with quantum technology but cannot be achieved by classical probabilistic means. The study of quantum correlations goes back to debates between Albert Einstein and his contemporaries during the formative years of quantum mechanics, yet there are many questions about quantum correlations that remain unanswered to this day. In this talk, we introduce the idea of quantum correlations and discuss some connections with positive semidefinite programming, operator algebras and cyber security.

2 - Cyber Attacks Models Based on Weighted Rooted Trees
Elie Alhajjar, Army Cyber Institute, West Point, NY, 10996, United States

In recent years, Agnarsson et al. defined a rooted tree model for cyber-security systems based on defense-in-depth and layered-security approaches, as many systems do. In the model, the concepts of penetration cost and acquisition gain are introduced and decision and optimization problems are formulated. In this talk, we look at the problem of storing targets via the intuition that high-value targets should be deeper in the system and outer layers should have higher penetration costs. Moreover, we address the possibility of repositioning targets periodically and how it affects the dynamics of the network.

3 - Locating Arrays: A New Experimental Design for Complex Engineered Systems
Violet Syrotiuk, PhD, Arizona State University, Tempe, AZ, United States

Screening experiments are used to identify significant factors and interactions on a response. Traditional experimental designs for screening in complex engineered systems requires either restricting the factors considered, which automatically restricts the interactions, or restricting interest to main effects, which fails to consider interactions. To address this problem we propose a locating array (LA) as a screening design. LAs exhibit logarithmic growth in the number of factors allowing an order of magnitude more factors in experimentation than traditional approaches. We apply an LA for screening responses in an experiment on w-iLab.t, a wireless network testbed in Belgium.

4 - Modeling in Cyberspace: Accounting for the Human Dimension
Paul L. Goethals, United States Military Academy, 66-B Schofield Place, West Point, NY, 10996, United States, Natalie Scala

It is now widely recognized that a large number of our cybersecurity vulnerabilities are attributed to human error of some kind. The models that account for the human dimension, however, are somewhat sparse in the cyberspace literature. This talk will outline some of the existing research lines of effort and discuss potential opportunities for future research in this area.

■ SB02

North Bldg 121B

Joint Session OPT/Practice Curated: Optimization under Uncertainty in Energy and the Environment

Sponsored: Optimization/Optimization Under Uncertainty

Sponsored Session

Chair: Sarah G. Nurre, University of Arkansas, Walnut Creek, CA, 94596, United States

1 - Resilient Transmission Hardening Planning in a High Renewable Penetration Erra
Ali Bagheri, Oklahoma State University, Stillwater, OK, 74075, United States, Chaoyue Zhao, Feng Qiu, Jianhui Wang

Transmission system hardening is a practice to improve system resilience against possible disruptions. In a power system with a very high penetration of renewable energy, the system hardening will be further complicated by the uncertainty of renewable energy. We study the transmission line hardening planning problem in the context of probabilistic power flows injected by the high penetration of renewable energy. We assume that the information of renewable energy is incomplete. A data-driven two-stage stochastic model is formulated by considering the joint worst-case wind output distribution and transmission line contingencies.

2 - An Integrated Two-level Inventory Problem: Applications to Battery Management in Electric Vehicle and Drone Swap Stations
Amin Asadi, University of Arkansas, 4207 Bell Engineering Center, 800 W. Dickson Street, Fayetteville, AR, 72701, United States, Sarah G. Nurre

We examine the new class of stochastic two-level integrated inventory problems (TOLIPs) with applications in drone and electric vehicle (EV) battery management. In the TOLIP, we model how first-level battery charge with battery charging, discharging, and replacement actions impact the deterioration and necessary actions for second-level battery capacity. In the context of a battery swap station, we formulate the TOLIP using a Markov Decision Process model with an uncertain demand for swaps. We perform computational experiments to derive optimal policies and deduce insights.

3 - Stochastic Multi-Objective Water Allocation with Hedging Rule
Ming (Arthur) Yang, The Ohio State University, Columbus, OH, United States, Guzin Bayraksan

The problem of water shortage is usually caused by uneven distribution of rainfall, increasing water demand, or other environmental and human factors. In this study, we develop a mathematical model that applies hedging rules under inflow and demand uncertainties to provide an optimal strategy in managing and operating reservoirs. Hedging rules determine different rationing levels between users at certain trigger volumes of reservoirs during droughts. We develop time series models for the uncertain inflows and demands and model the problem as a multistage stochastic mixed integer program with multiple objectives. We present numerical results on a real-world multi-reservoir system.

4 - Industrial Demand Response in Electricity Markets
Golbon Zakeri, University of Auckland, Dept of Eng Science, Private Bag 92019, Auckland, New Zealand

We will present a single stage optimization problem faced by a large industrial consumer of electricity who is capable responding to price, and also capable of offering interruptible load reserves. We will then extend our model to a multistage setting and report some computational results.

■ SB22

North Bldg 130

Joint Session RMP/Practice Curated: Data Science in Online Platforms

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Ruben Lobel, Airbnb, San Francisco, CA, 94103, United States

Co-Chair: Carlos Abad, Airbnb, San Francisco, CA, 94103, United States

1 - Supply-side Incentives Allocation at Lyft
Davide Crapis, Lyft, San Francisco, CA, United States

Lyft runs a number of programs to engage drivers when and where supply is most needed. The aim is to align supply and demand, provide better service levels for passengers and increased earnings for drivers. Scientists work on optimizing these programs using machine learning, optimization algorithms, and continuous experimentation. We give an overview of different incentives programs and the technical problems they pose. We then present in more detail some of the techniques used to compute optimal allocations.

2 - Zillow Instant Offers with Human-in-the-loop Machine-learning
David E. Fagnan, Senior Manager, Applied Science, Zillow Group, Seattle, WA, United States, Fan Cao, Sebastian Wickenburg, Emily Gill, Krishna Rao

We give an overview of recent data science challenges at Zillow. In particular, we focus on Zillow Instant Offers, a new home-selling option for homeowners who want a certain and predictable sale on their timeline. Our system tries to balance offer quality, offer timeliness, and risk in the presence of potential selection bias. With this focus, we discuss our learnings around making decisions under uncertainty including examples such as how much to pay for a house, predicting housing liquidity through days on market, and how much a pool is worth. We discuss progress on these problems and how we combine the use of human judgement with machine-learning algorithms in a human-in-the-loop system.

■ SB26

North Bldg 132A

Joint Session OR/Practice Curated: Doing Good with Good OR

Emerging Topic: Doing Good with Good OR

Emerging Topic Session

Chair: Mehmet U.S. Ayvaci, University of Texas at Dallas, 800 W Campbell Rd, Sm33, Richardson, TX, 75080-3021, United States

Co-Chair: Gemma Berenguer, Purdue University, 1020 Happy Hollow Rd, West Lafayette, IN, 47906, United States

1 - Influence Maximization for HIV Prevention among Homeless Youth

Bryan Wilder, University of Southern California, Los Angeles, CA, United States

HIV among homeless youth is a pressing health challenge; hence, local agencies conduct HIV prevention interventions. Selected youth are trained as peer leaders and disseminate prevention-related information through their social network. Choosing influential peer leaders is a difficult optimization problem. Together with local agencies, we developed and deployed novel optimization techniques which reached over twice the youth as previous methods.

2 - Inconvenience, Liquidity Constraints and the Adoption of Off-Grid Lighting Solutions

Bhavani Shanker Uppari, INSEAD, 1 Ayer Rajah Avenue, Singapore, 138676, Singapore, Serguie Netessine, Ioana Popescu, Rowan Clarke

One-fifth of humankind living in poverty does not have access to electricity. An off-grid lighting model that is becoming prominent in impoverished countries is rechargeable bulb technology. We examine, both theoretically and empirically, the impact of liquidity constraints and recharge inconvenience on the usage of rechargeable bulbs. Our analysis has implications for both firm-level operational decisions and government-level policy decisions.

3 - Improving the Chilean College Admissions System

Ignacio Rios, Stanford University, Stanford, CA, 94305, United States

We designed and implemented a new white-box algorithm that solves the matching of students to universities, unifying the admission tracks and improving the allocation of around 2,500 students each year since it was fully implemented. In addition, our solution reduced dramatically the computational time, allowing the evaluation of other policies and the implementation of new changes to the Chilean college admissions system.

4 - How and When Should Students Get to School? Equity-Driven Optimization for Boston Public Schools

Sebastien Martin, Massachusetts Institute of Technology, Cambridge, MA, 02139, United States, Arthur Delarue

We collaborated with Boston Public Schools to develop and apply optimization algorithms for school bus routing and bell time assignment, resulting in a $4+ million yearly educational reinvestment in a district where 75% of students are economically disadvantaged and the unanimous approval of the first equity-driven start time policy in almost thirty years by the Boston School Committee.

■ SB27

North Bldg 132B

Joint Session Education/Practice Curated: INFORMS Case Competition

Sponsored: Education (INFORMED)

Sponsored Session

Chair: Palaniappa Krishnan, University of Delaware, Newark, DE, 19716-2130, United States

1 - You Can't Take It with You

Coleen R. Wilder, Valparaiso University, 353 Sheffield Drive, Valparaiso, IN, 46383, United States, Sailu Li

The theme of this two-part case study is erroneous retirement planning experienced by two protagonists at different stages in their lives. A common retirement goal presented to many financial advisors is that people want to maintain their current lifestyles. For older clients, advisors are typically confronted with the task of explaining why their clients have insufficient funds and for younger clients, they are challenged with the task of convincing them to save more today for tomorrow. This case study provides a concrete example for students to visualize the impact of the time value of money. Students will often nod their heads to the idea that a dollar today is not worth the same tomorrow. They also will nod to the fact that a loaf of bread costs more today than it did yesterday. It does not actually register, however, until they see it evolve year by year over an extended period of time. Advanced Excel functions that may be used include FV, PV, PMT, NORMINV, VLOOKUP, Scenario Manager, Data Table, and Goal Seek.

2- Supply Chain Coordination and Contracts in the Sharing EconomyùA Case Study at Cargo

Maxime Cohen, NYU Stern, New York, NY, 10012, United States, Daniel Guetta, Wenqiang Xiao

This case study presents a modern approach to supply chain contracts. Supply chain coordination and supply chain contracts are central parts of almost every operations management (OM) core course. Traditionally, the main motivational example used in this context is video rentals. In the late 1990s, Blockbuster LLC revamped their business model and successfully implemented supply chain contracts. This is indeed an excellent example, but it is becoming increasingly outdated, and the vast majority of millennial students find it difficult to relate to this application. With this motivation in mind, we decided to revisit the topics of supply chain coordination and supply chain contracts in the context of the sharing economy. This case study is written in collaboration with Cargo, an innovative startup that recently raised $7.3 million in seed funding, and illustrates how supply chain contracts can be applied in two-sided markets. Cargo sources goods from suppliers to provide a platform for gig economy drivers (e.g., Uber and Lyft) to run small convenience stores out of their vehicles. Consequently, Cargo needs to optimize its supply chain with both its drivers and its suppliers. Inspired by Cargo's operations, we generate datasets that illustrate the benefits of supply chain coordination and contracts, and allow students to experience the use of these techniques in a real-world business problem. This case study can be used at the undergraduate, MBA, and graduate levels for 1-3 sessions. In particular, instructors of an OM core or a supply chain elective course could use this case to discuss the following topics: (i) a novel OM application in the sharing economy, (ii) supply chain centralization, (iii) supply chain contracts (wholesale price, revenue sharing, and buyback), and (iv) the benefits of data-driven demand forecasting.

■ SB28

North Bldg 221A

Joint Session RAS/Practice Curated: Railway Applications Section Student Paper Competition

Sponsored: Railway Applications

Sponsored Session

Chair: Steven Harrod, Technical University of Denmark, Kgs. Lyngby, 2800, Denmark

1 - Railway Applications Section Student Paper Competition

Steven Harrod

Awards for the 2018 Railway Applications Section Student Paper Competitions will be presented, along with presentations by the finalists. Winners are announced at the conference, or a few weeks before at the earliest.

3 - Marketplace Experimental Design at Airbnb

Ruben Lobel, Airbnb, 888 Brannan St, 3rd Floor - Airbnb, San Francisco, CA, 94103, United States, David Holtz, Bar Ifrach, Sinan Aral

Online A/B tests rely on the assumption that responses on treatment and control units are independent. However, experiments in online marketplaces such as Airbnb can be biased when listings in the treatment group affect the listings in the control group. We propose a method to reduce this bias by identifying a network of marketplace substitution and applying a clustering algorithm on this network. By delivering the experiment on clusters of listings, we hope to detect the true impact of our models, without sacrificing too much in the experiment's sample size. We demonstrate the use of this method with a pricing experiment, measuring the trade-off between bias reduction and statistical power.

4 - An Overview of Uber's Surge Pricing Mechanism

Hamid Nazerzadeh, USC Marshall School of Business, Bridge Memorial Hall - BRI 401B, 3670 Trousdale Parkway, Los Angeles, CA, 90089, United States

Uber is running one of the largest marketplaces in the world that matches millions of riders and drivers together. One of the key features of Uber's marketplace is dynamic pricing, so called surge pricing, that aims to balance the demand for trips and the supply of available cars. The surge pricing also motivates drivers to relocate to parts of the city with higher demand. In this talk, I'll discuss the design of the new generation of surge mechanisms that aim to increase the marketplace efficiency.

■ SB41

North Bldg 226C

Joint Session DAS/Practice Curated: Decision Analysis Practice Award Competition

Sponsored: Decision Analysis

Sponsored Session

Chair: Saurabh Bansal, Penn State University, State College, PA, 16801, United States

Co-Chair: Michael C. Runge, USGS Patuxent Wildlife Research Center, 12100 Beech Forest Rd, Laurel, MD, 20708, United States

Co-Chair: Michael Fitch, Chevron, San Ramon, CA, 9458, United States

1 - Modeling the Value of Agents in Supply Chains of Malaria Rapid Diagnostic Test Kits with Decision Analysis

Jarrod D. Goentzel, Massachusetts Institute of Technology, 77 Massachusetts Avenue, E38-650, Cambridge, MA, 02139, United States, Gilberto Montibeller, Corinne Carland

Malaria poses one of the greatest challenges to global health. Accurate diagnosis, with rapid diagnostic tests (RDTs), is critical because presumptive treatment of malaria wastes resources and increases the risk of drug resistance. In this project, we developed a value model for the agents along the RDT kit supply chain in Uganda. The model, based on multi-attribute value theory, enables an understanding of the motivations of each agent in the supply chain. The analysis identified a new package of incentives that proved to be robust against the variation of relevance of agents in the chain.

2 - New Methods for Improved Decision Making in Unconventional Field Development

Andrew Beck, University of Texas-Austin, Austin, TX, 78757, United States, J. Eric Bickel

We developed a decision support tool for Statoil's US Onshore portfolio. This tool includes an asset valuation model and price and production uncertainty models. Because of high dimensionality, finding an optimal dynamic development schedule based on learning is difficult. We combined the Least Squares Monte Carlo algorithm with forward simulation to replicate an annual cycle of drilling, learning, and adaptation. By finding the set of alternatives that yields the highest net present value, the user ends up with an expected NPV for the asset, and a recommended year 1 development plan.

3 - Safer Skies in Spain

David Rios Insua, ICMAT-CSIC and Royal Academy of Sciences, Nicolas Cabrera 13, Madrid, 28049, Spain, Javier Gómez, C sar Alfaro, Verónica Elvira, Pablos Hernández-Coronado, Fran Bernal

As required by the International Civil Aviation Organization, nations must develop a so-called State Safety Program (SSP) to promote a proactive approach to safety oversight and management at country level. SSPs support strategic decision-making and resource allocation to areas with higher aviation safety risks. The Spanish Aviation Safety and Security Agency (AESA) developed a novel methodology with full use of numerous Decision and Data Sciences methods and implemented it in an R-based tool. This has allowed AESA to better support its safety decision making and attain considerable savings.

■ SB44

North Bldg 227C

Joint Session ENRE/Practice Curated: Optimization Methods for Power Systems

Sponsored: Energy, Natural Res & the Environment/Electricity

Sponsored Session

Chair: Cedric Josz

Co-Chair: Somayeh Sojoudi, University of California, Berkeley, Berkeley, CA, 94703, United States

1 - Learning Solutions to Optimal Power Flow: An Active Set Approach

Line Roald, University of Wisconsin-Madison, Madison, WI, United States, Sidhant Misra, Yee Sian Ng

Power systems optimization involves solving similar optimization problems over and over and over again, with slightly varying input parameters. We consider the problem of directly learning the optimal solution as a function of the input parameters. Our learning framework is based on identifying the relevant set of active constraints, which we discover using our proposed streaming algorithm with performance guarantees. Applying the algorithm to the optimal power flow problem with renewable energy, we establish that the number of active sets is typically small for OPF problems, and discuss theoretical and practical implications for power systems operation.

2 - Improving Bound Tightening with Quadratic Reformulation Method Applied on Optimal Power Flow

Hadrien Godard, Rte, Paris, France

Optimality-based and reduced-costs bound tightening are classic methods using convex relaxations. For the OPF problem, the Quadratic Reformulation method gives an efficient relaxation, leading to sharp lower bounds, and interior-points methods compute good feasible solutions. We strengthen bound tightening using those sharp bounds, and present computational results on OPF instances up to a thousand nodes.

3 - Tight Piecewise Convex Relaxations for Global Optimization of Optimal Power Flow

Harsha Nagarajan, Los Alamos National Laboratory, NM, United States, Mowen Lu, Russell Bent, Sandra D. Eksioglu, Kaarthik Sundar

In recent years, there has been an increasing interest in developing convex relaxations for ACOPF, which are often tight in practice. We further improve the quality of these relaxations by employing convex-hull characterizations for multilinear functions and develop tight piecewise convex relaxations. We also provide useful polyhedral results of these relaxations. Using these tight relaxations, we develop an adaptive, multivariate partitioning algorithm with bound tightening that progressively improves these relaxations, thus converging to the global optimal solution. Computational results show that our novel algorithm reduces the best-known optimality gaps of the Nesta ACOPF cases.

4 - Conic Optimization for Robust State Estimation: Deterministic Bounds and Statistical Analysis

Igor Molybog, University of California, Berkeley, Berkeley, CA, United States, Ramtin Madani, Javad Lavaei

This project is concerned with the robust electric power system state estimation problem, where the goal is to find the unknown state of a system modeled by nonconvex quadratic equations based on unreliable data. We propose two techniques based on conic optimization to address this problem. We analyze the techniques in both deterministic and stochastic (Gaussian) settings by deriving bounds on the number of bad measurements the algorithms can tolerate without producing a nonzero estimation error. The efficacy of the developed methods is demonstrated on synthetic data and the European power grid.

■ SB49

North Bldg 230

Joint Session ENRE/Practice Curated:Data Analytics and Renewables in Oil & Gas Production

Sponsored: Energy, Natural Res & the Environment/Natural Resources Petrochemicals

Sponsored Session

Chair: Sam Aminfard, University of Texas at Austin, Austin, TX, United States

1 - Electrifying Oil and Gas Wells With Renewable Energy

Sam Aminfard, University of Texas at Austin

Renewable sources such as solar energy can be utilized to power remote electrified well site control systems and to minimize emissions of greenhouse gases. To assess the viability of powering well sites with renewable energy, we first developed a tool to calculate time-varying power loads of electrified well site control systems. We then utilized a transient energy flow model to evaluate the solar power generation and energy storage needed to reliably meet the estimated power loads using on local energy resource availability. Finally, we assessed the feasibility of potential renewable energy and storage options with a life-of-operation economic study.

2 - Modeling Microgrids at Well Fields

Sam Johnson, University of Texas at Austin, Austin, TX, 78756, United States, Jon La Follett

High penetrations of renewable energy generation could increase downward pressure on electricity prices, which in turn could drive cogeneration plants to seek out alternative profit schemes. Likewise, regulations restricting emissions could motivate industrial electricity consumers to explore alternative power generation options. To identify an optimal operation strategy for facilities facing this predicament, a modeling framework was developed and applied to an existing microgrid. The reliability and resilience of on-site renewable energy generation and integrated energy storage were explored.

3 - Toward a Global Assessment Framework for Oil and Gas Sector GHG Emissions

Adam Brandt, Stanford University, Mohammad S. Masnadi, Jeffrey Rutherford

As the threat of global climate change increases, regulatory limits on the oil and gas industry is becoming more stringent, and long-term emissions reductions look increasingly likely. A particular challenge to addressing oil and gas emissions using current regulatory mechanisms (standards or taxes) is that the industry is profoundly global in nature and crude oil products can cross multiple jurisdictions before reaching consumers. Also, emissions data availability in the global oil industry is generally poor, with many of the data required to estimate emissions being considered proprietary or strategic in nature by companies and thus held closely to

operators. We describe an effort to address these issues by developing a combined open-source GHG modeling platform that is data-rich and based on engineering fundamentals. We also describe recent efforts to compile global data sources into the first comprehensive picture of global oil sector emissions, with an emphasis on data and analytical challenges.

■ SB50

North Bldg 231A

Joint Session Practice/Practice Curated Editor's Cut #2: Human Trafficking, Crowdsourcing, Retail

Sponsored: Practice Curated Track

Sponsored Session

Chair: Carrie Beam, University of Arkansas, Walnut Creek, CA, 94596, United States

1 - Moderator, Editor's Cut Panel #2 (Human Trafficking, Crowdsourcing, Retail)

Renata Alexandra Konrad, Worcester Polytechnic Institute, School of Business, 100 Institute Road, Worcester, MA, 01609, United States

This panel will cover the Human Trafficking, Crowdsourcing, and Retail issues of Editor's Cut. Come learn more about the case studies, videos, and other journal articles available free, online.

Panelists

Renata Alexandra Konrad, Worcester Polytechnic Institute, School of Business, 100 Institute Road, Worcester, MA, 01609, United States

Paul R. Messinger, University of Alberta, Faculty of Business, 3-20e Faculty Of Business Bldg, Edmonton, AB, T6G 2R6, Canada

Richard G. McGrath, United States Naval Academy, 572C Holloway Rd, Annapolis, MD, 21402, United States

Eric Johnson, Vanderbilt, Nashville, TN, United States

■ SB52

North Bldg 231C

Joint Session Award/Practice Curated: Social Media Analytics Best Student Paper Competition

Emerging Topic: Social Media Analytics

Emerging Topic Session

Chair: Julie Zhang, University of Massachusetts, Lowell, Operations and Information Systems, Lowell, MA, United States

1 - Detecting Influence Campaigns in Social Networks Using the Ising Model

Nicolas Guenon des Mesnards, Massachusetts Institute of Technology, Cambridge, MA, USA, .

We consider the problem of identifying coordinated influence campaigns conducted by automated agents or bots in a social network. We study several different Twitter datasets which contain such campaigns and find that the bots exhibit heterophony - they interact more with humans than with each other. We use this observation to develop a probability model for the network structure and bot labels based on the Ising model from statistical physics. We present a method to find the maximum likelihood assignment of bot labels by solving a minimum cut problem. Our algorithm allows for the simultaneous detection of multiple bots that are potentially engaging in a coordinated influence campaign, in contrast to other methods that identify bots one at a time. We find that our algorithm is able to more accurately find bots than existing methods when compared to a human labeled ground truth. We also look at the content posted by the bots we identify and find that they seem to have a coordinated agenda.

2 - Detecting Changes in Dynamic Events over Networks

Shuang Li, Georgia Institute of Technology, Atlanta, GA, United States

Large volume of networked streaming event data are becoming increasingly available in a wide variety of applications, such as social network analysis, Internet traffic monitoring and healthcare analytics. How to promptly detect changes in these dynamic systems using these streaming event data? In this paper, we propose a novel change-point detection framework for multi-dimensional event data over networks and cast the problem into sequential hypothesis test. We show that our method can achieve weak signal detection by aggregating local statistics over time and networks. Finally, we demonstrate the good performance of our algorithm on numerical examples and real-world datasets from twitter and Memetracker.

3 - How do Sales Responses to Various User-generated-content? A Panel VAR Analysis based on Twitch, YouTube and Steam Data

Shuang Li, Georgia Institute of Technology, Atlanta, GA, United States

Twitch.tv (Amazon owned), having over 15 million daily active users, owning over 43 percent of game video content market and ranking 4th in in peak US internet traffic, is the biggest live stream platform now. The unique features of live stream video platforms include timely broadcasting and interpersonal interaction, large scale user base and democratized content genre distribution. Given these unique features, Twitch has been more and more popular among various marketers across different industries as a new form of marketing channel which have timely impacts and high efficiency. Meanwhile, pre-recorded video platforms like YouTube is also largely used as an effective marketing channel. Thus, it is unclear that which platform as better marketing efficiency. Additionally, compared with traditional user-generated-content (UGC) like reviews, it is unclear that whether user-generated video contents about a product on two platforms are associated with the product's reputation in terms of reviews- the traditional form of user generated content. To explore these two concerns, we merge a unique dataset including game sales and profile data from the largest online game distribution platform- Steam, game related data from YouTube and Twitch and conduct a comprehensive Panel VAR analysis. We provide both empirical and theoretical implications based on summarized finding patterns and illustrate contributions of this study.

4 - Opinion Dynamics with Stubborn Agents

David S. Hunter, Massachusetts Institute of Technology, Cambridge, MA, United States

We consider the problem of optimizing the placement of stubborn agents in a social network in order to maximally impact population opinions. We assume individuals in a directed social network each have a latent opinion that evolves over time in response to social media posts by their neighbors. The individuals randomly communicate noisy versions of their latent opinion to their neighbors. Each individual updates his opinion using a time-varying update rule that has him become more stubborn with time and be less affected by new posts. The dynamic update rule is a novel component of our model and reects realistic behaviors observed in many psychological studies. We show that in the presence of stubborn agents with immutable opinions and under fairly general conditions on the stubbornness rate of the individuals, the opinions converge to an equilibrium determined by a linear system. We give an interesting electrical network interpretation of the equilibrium. We also use this equilibrium to present a simple closed form expression for harmonic influence centrality, which is a function that quanties how much a node can affect the mean opinion in a network. We develop a discrete optimization formulation for the problem of maximally shifting opinions in a network by targeting nodes with stubborn agents. We show that this is an optimization problem with a monotone and submodular objective, allowing us to utilize a greedy algorithm. Finally, we show that a small number of stubborn agents can non-trivially influence a large population using simulated networks.

■ SB57

West Bldg 101B

Joint Session HAS/Practice Curated: Experiments in Health Care Operations

Sponsored: Health Applications

Sponsored Session

Chair: Hummy Song, Philadelphia, PA, 19104, United States

1 - The Effects of Occupancy Information Hurdles and Physician Admission Decision Noise on Hospital Unit Utilization

Song-Hee Kim, University of Southern California, Los Angeles, CA, United States, Jordan D. Tong, Carol Peden

Hospital units usually have high demand that exceeds their capacity, requiring physicians to make admission decisions. Under reasonable conditions, the optimal admission policy should depend on the arriving patient's severity and the occupancy upon a patient's arrival. In practice, the occupancy is not always readily accessible and there may exist occupancy information hurdles. We recruit physicians and MTurk workers to study how occupancy information hurdles may systematically affect admission decision behavior. We also examine how random error (in the policy selection and policy execution) may drive predictable biases of over- or under-occupied units depending on the system parameters.

2 - Priority & Predictability: The Differential Effects of Emergent and Scheduled Hospital Admissions

Jillian Berry Jaeker, Boston University, 595 Commonwealth Avenue, Room 657A, Boston, MA, 02215, United States

Using experimental and patient-level data, this study focuses on the impact of incoming patient admission type (scheduled or emergent) on the probability of admission and LOS, and the moderating effect of high workload. We also provide a counterfactual analysis of the possible savings achieved through higher predictability in demand.

3 - Shared Medical Appointments – An Innovative Approach to Healthcare Delivery
Nazli Sonmez, London Business School, Regent's Park, London, NW1SN, United Kingdom, Kamalini Ramdas, Ryan W. Buell

We examine shared medical appointments (SMAs) as a substitute for regular one-on-one appointments. Under this innovative approach, a group of patients with similar chronic conditions meet with a doctor simultaneously. We conduct a randomized controlled trial at the Aravind Eye Hospital's Glaucoma Clinic, in Pondicherry, India to assess the effectiveness of shared medical appointments versus traditional one-on-one appointments for glaucoma. Preliminary results obtained with the data suggest that the knowledge and satisfaction level of patients who attend shared medical appointments is significantly higher than that of patients who attend one-on-one appointments.

4 - Optimal Newborn Screening Algorithm for Cystic Fibrosis
Seyedehsaloumeh Sadeghzadeh, Virginia Institute of Technology Blacksburg, VA, 24060, United States, Hussein El Hajj, Ebru Korular Bish, Douglas R. Bish

Cystic fibrosis (CF) is one of the most prevalent genetic disorders in the United States. Newborn screening for CF allows for early diagnosis, and can improve health outcomes, whereas a delayed diagnosis may result in severe symptoms or fatality. All 50 states of the United States perform newborn screening for CF, starting with a bio-marker test, followed by a genetic test for newborns with elevated bio-marker levels. We develop a stochastic optimization model to determine an optimal bio-marker threshold and set of CF mutations to be tested, in order to minimize the expected misclassification cost. Our case study shows that the optimal combination can substantially reduce the misclassification cost.

■ SB59

West Bldg 102A

Joint Session HAS/Practice Curated: HIV Prevention, Testing, and Treatment

Sponsored: Health Applications

Sponsored Session

Chair: Pooyan Kazemian, Harvard Medical School, Boston, MA, 02114, United States

1 - Optimal Scale-up of HIV Treatment Programs in Resource-limited Settings Under Supply Uncertainty
Sameer Mehta, PhD Student, UT Dallas, TX, United States, Sarang Deo, Charles J. Corbett

In this paper, we study the challenge of scaling-up HIV treatment programs faced by clinics in sub-Saharan Africa. The key trade-off underlying this allocation is between the marginal health benefit obtained by initiating an untreated patient on treatment and that obtained by avoiding treatment interruption of a treated patient. We cast the clinic's problem as a stochastic dynamic program and provide a partial characterization of the optimal policy, which consists of dynamic prioritization of patient segments and is characterized by state-dependent thresholds.

2 - Treatment Optimization of Using Darunavir Versus Lopinavir in a Resource Limited Setting with an Unknown Price Ceiling
Jennifer Campbell, Clinton Health Access Initiative, P.O. Box 51071 Ridgeway, Lusaka, Zambia, Marta Prescott, Paul Domanico

The analysis quantifies the value of second-line HIV drugs in complex market settings by addressing treatment sequencing, clinical efficiencies, programmatic heterogeneity and nuanced market paradigms in resource limited countries. The model estimates patient outcomes linked to probabilities of transitioning to different HIV treatment and health states in the medium and long term. The model uses country and region-specific data and clinical outcomes from published sources. Costs and impact, including secondary infections, are included. This work is shared with Ministries of Health and helps set treatment policy priorities, clinical trainings, and procurement for second line treatment.

3 - The Cost-effectiveness of HIV Pre-exposure Prophylaxis (PrEP) in High-risk Groups in India
Pooyan Kazemian, Harvard Medical School, 100 Cambridge St, 1695, Boston, MA, 02114, United States, Sydney Costantini, A. David Paltiel, Kenneth A. Freedberg

We leveraged a detailed microsimulation model of HIV prevention and treatment to evaluate the cost-effectiveness of HIV pre-exposure prophylaxis (PrEP) and regular HIV testing for two high-risk groups in India: adult men who have sex with men (MSM) and people who inject drugs (PWID). We conducted sensitivity analysis on multiple parameters related to PrEP and assessed different HIV testing frequencies. Results suggest that a PrEP strategy targeted to these high-risk groups can be cost-effective in India.

4 - Surveillance and Control in Networked Disease Dynamics with Individual Response
Ceyhun Eksin, Assistant Professor, Texas A&M Univesity, 3131 TAMU, College Station, TX, 77843, United States

Disease spread is a complex system in which the outcome of intervention policies depends on the disease state, network structure and individual behavior. We consider the viewpoint of a policy-maker that aims to minimize the spread of an infectious disease under budget constraints and unknown disease severity. Daily, the policy-maker decides to spend its funds on information collection or on targeted campaigns that change individual behavior. We characterize optimal policies based on the accuracy of the disease estimate and time horizon for simple networks such as a line, star, and ring. Based on these optimal policies, we design an algorithm that approximates the solution in arbitrary networks.

■ SB61

West Bldg 102C

Joint Session HAS/DM/Practice Curated: Predictive Analytics in Clinical Settings

Sponsored: Health Applications

Sponsored Session

Chair: M. Samie Tootooni, Mayo Clinic, Rochester, MN, 55906

1 - Outcome-Driven Personalized Treatment Design for Managing Diabetes
Eva Lee, Georgia Tech, Industrial & Systems Engineering, Ctr for Operations Research in Medicine, Atlanta, GA, 30332-0205, United States

This work is joint with Grady Health Systems and Morehouse School of Medicine. Diabetes affects 422 million people globally, costing over $825 billion per year. In the United States, about 30.3 million live with the illness. Current diabetes management focuses on close monitoring of a patient's blood glucose level, while the clinician experiments with dosing strategy based on clinical guidelines and his (her) own experience. In this work, we describe a model for designing a personalized treatment plan tailored specifically to the patient's unique dose-effect characteristics. Such a plan is more effective and efficient-for both treatment outcome and treatment cost-than current trial-and-error approaches. Implementation results will be discussed.

2 - A Machine Learning Based Personalized Intervention Model to Reduce COPD Readmissions
Sujee Lee, University of Wisconsin-Madison, 402 N. Eau Claire Avenue, Unit 302, Madison, WI, 53705-2820, United States, Philip A. Bain, Jo Goffinet, Christine Baker, Jingshan Li

In this talk, we introduce a machine learning based personalized intervention model to reduce COPD readmissions. Specifically, a machine learning predictive model is trained to predict the readmission risk of a COPD patient based on his/her status at discharge. Using this model, the impact of potential intervention policies is analyzed. Then, the predictive model re-evaluates the risk based on updated information during interventions, and new intervention strategies will be adjusted dynamically.

3 - Mapping Free Text Chief Complaints using an Adaptive Natural Language Processing Approach
Mohammad Samie Tootooni, PhD, Mayo Clinic, Rochester, MN, 55906, United States, Mustafa Y. Sir, Kalyan Pasupathy, Heather Heaton, Casey Clements

We provide a comprehensive structured list to categorize the [free-text] chief complaints. We also developed a heuristic algorithm, equipped with an iterative enhancement procedure to map the recorded chief complaints into the structured list. The data includes all chief complaints recorded at the emergency department of Mayo Clinic in Rochester, MN in 2016 and 2017. Using a bi-level validation process a total sensitivity of 94.2% with specificity of 99.8% and F-score of 94.7% are obtained. The result is reported individually for each main syndrome group as well. In conclusion, the proposed mapping tool can help the field's researchers to incorporate the chief complaints into their models.

■ SB63

West Bldg 103B

Joint Session DM/Practice Curated: Data Analytics and Modeling for Health Informatics and Decision Making

Sponsored: Data Mining

Sponsored Session

Chair: Shouyi Wang, PhD, The University of Texas at Arlington, 500 West First Street, Arlington, TX 76019, Arlington, TX, 76019, United States

1 - Information Loss from Parameter Estimation in Discrete Distributions with an Application in Genetics
Maryam Moghimi, PhD Candidate, The University of Texas at Arlington, Arlington, TX, 76019, United States, Herbert W. Corley

We consider the information loss due to the use of a statistic T(X) to characterize an n-dimensional vector X of random variables representing discrete data. In other words, we compare the probability that a random sample X of size n takes on the value x to the probability that X is x given the statistic satisfies T(X) is T(x). We focus on sufficient statistics to develop a general formula for the Shannon information loss due to this data reduction. Applications of this approach will be discussed, including an example on gene sequencing.

2 - A Chronological Pharmacovigilance Network Analysis Approach for Predicting Adverse Drug Events

Behrooz Davazdahemami, PhD Candidate, Oklahoma State University, Stillwater, OK, 74075, United States, Dursun Delen

In this study, we extend prior research by proposing a chronological network analysis (NA) approach for predicting adverse drug events (ADEs) before the drugs' approval. Combining known drug-ADE associations from the biomedical literature with information about drugs' target proteins for pre-2001 approved drugs, a drug-ADE network was constructed and used as a basis to train machine-learning (ML) models. The models were validated by predicting drug-ADE associations for post-2001 drugs. The promising results (92.9% accuracy, 72.8% sensitivity) achieved by the ensemble ML models shows the incredible power of such models, in combination with NA, for capturing sophisticated drug-ADE patterns.

3 - Hemodynamic Pattern Discovery and Classification with Children Who Stutter Using Functional Near-infrared Spectroscopy

Rahil Hosseini

In this paper, we developed a novel supervised sparse feature learning approach to discover discriminative biomarkers from functional near infrared spectroscopy (fNIRS) brain imaging data recorded during a speech production experiment from 46 children in three groups: children who stutter (n = 16); children who do not stutter (n = 16); and children who recovered from stuttering (n = 14). We made an extensive feature analysis of the cerebral hemodynamics from fNIRS signals and selected a small number of important discriminative features using the proposed sparse feature-learning framework. The discovered set cerebral hemodynamics features are presented as a set of promising biomarkers to elucidate the underlying neurophysiology in children who have recovered or persisted in stuttering and to facilitate future data-driven diagnostics in these children.

4 - A Statistical Network Modeling Approach for Discriminative Brain Network Connectivity Analysis

Shouyi Wang

There are many studies focusing on network detection in multivariate (MV) time-series data. A great deal of focus have been on estimation of brain networks using fMRI, fNIRS and EEG. We propose a sparse weighted directed network (SWDN) estimation approach which can detect the underlying minimum spanning network with maximum likelihood and estimated weights based on linear Gaussian conditional relationship in the multivariate time series. Considering the brain neuro-imaging signals as the multivariate data, we evaluated the performance of the proposed approach using the publicly available fMRI data-set and the results of the similar study which had evaluated popular network estimation approaches on the simulated fMRI data. Moreover, we applied the proposed network construction method as a feature extraction technique from fMRI data to classify the patterns of the Parkinson Disease.

■ SB64

West Bldg 104A

Joint Session DM/AI/Practice Curated: Unstructured Data Mining: Methods and Applications

Sponsored: Data Mining

Sponsored Session

Chair: Chaojiang ôCJ Wu, Drexel University, 3141 Chestnut Street, Philadelphia

1 - Investor's Opinion Divergence and Stock Return Volatility: Evidence from User-generated Content

Yang Li, Drexel University LeBow College of Business, PA, United States

This paper examines the relationship between investors' opinion divergence and stock return volatility using daily user-generated content (UGC) data of 66 most discussed stocks from a social media platforms for investors in the U.S. Our research adds to the emerging body of literature on the impact of UGC on the stock market regarding: (1) novel techniques for systematically measuring sentiment divergence in large-scale UGC data; and (2) uncovering the dynamic interdependence of the relationship between investors' opinion divergence and stock volatilities.

2 - Deep Learning for Predicting Research Topic Trends

Jiangen He, Drexel University College of Computing and Informatics, PA, United States

Text data can be useful for predicting topic trends in the future. The prediction can be beneficial for various applications. In this study, we represent the semantic and structural dynamics of research topics by embedding learning and propose a deep learning model that can capture discriminative features for predicting research topic trends (rising or falling trend). We train and test the model by using scientific publications from PubMed. Our experimental results show that both semantic and structural dynamics of a research topic has predictive features for its future trend.

3 - Breadth, Depth, and Conformity: A Double-Hurdle Model for Review Helpfulness

Chaojiang Wu, Drexel University, 3141 Chestnut Street, Philadelphia, PA, 19107, United States, Feng Mai, Xiaolin Li

Using multi-attribute attitude model as a framework, we show that the helpfulness of a review not only depends on its internal features, but also hinges on its breadth, depth, and content, in relation to other reviews of the product. We construct two novel measures, content entropy and content deviation, and then propose a double-hurdle model to simultaneously estimate the probability of a review being voted and its helpfulness. We show content entropy positively and content deviation negatively related with the helpfulness of a review. We further illustrate that the content deviation moderates the relationship of the numerical rating deviations and helpfulness.

4 - Person Name Disambiguation Based on Profession

Haimonti Dutta, Assistant Professor, University at Buffalo, 325P Jacobs Management Center, Buffalo, NY, 14260, United States

Named Entity Disambiguation (NED) is the task of disambiguating entity mentions in natural language text. In this paper, we present a generative model based on Latent Dirichlet Allocation (LDA) to disambiguate entity mentions occurring in noisy text. Each entity is assumed to have a profession and the representative words are generated from the document in which it is mentioned; words representing a profession are further interpreted for the task of disambiguation. Empirical results presented on a corpus of 14020 historical newspaper articles show that this generative model can obtain reasonable accuracy in the task of person name disambiguation.

■ SB65

West Bldg 104B

Joint Session DM/Practice Curated: Big Data Science

Sponsored: Data Mining

Sponsored Session

Chair: Hongxia Yin, Minnesota State University, Mankato, Mankato, MN, USA

1 - A Simple and Efficient Hybrid Genetic Algorithm for Minimum Sum-of-squares Clustering

Thibaut Vidal, Professor, PUC-Rio, Departamento de Informatica, Rua Marques de Sao Vicente, 225, Rio de Janeiro, 22453-900, Brazil, Daniel Gribel

Minimum sum-of-squares clustering (MSSC) is a widely used clustering model. We introduce an efficient genetic algorithm that uses K-means as a local search in combination with problem-tailored variation operators. The approach is scalable and accurate, outperforming all recent state-of-the-art algorithms for MSSC in terms of solution quality, measured by the depth of local minima. This enhanced accuracy leads to classification results which are significantly closer to the ground truth for overlapping Gaussian-mixture datasets with a large number of features. Improved global optimization methods therefore appear to be essential to better exploit the MSSC model in high dimension.

2 - On the Behavior of the Expectation-maximization Algorithm for Mixture Models

Babak Barazandeh, University of Southern California, Los Angeles, CA, 90007, United States, Meisam Razaviyayn

Finite mixture models are among the most popular statisticalmodels that are widely used in different data science disciplines.Despite their broad applicability, inference under these models typically leads to computationally challenging non-convex problems. While the Expectation-Maximization (EM) is the most popular approach for solving these non-convex problems, the behavior of this algorithm is not well understood for general mixture model inference problems. In this work, we study the equally weighted mixture of two single dimensional Laplacian distributions and show that every local optimum of the population maximum likelihood estimation problem is global optimum.

3 - Fourier Transform Inverse Regression Estimators of the Central Subspaces

Jiaying Weng, University of Kentucky, Lexington, KY, 40503, United States, Xiangrong Yin

We introduce an optimal inverse regression estimator, Fourier transform inverse regression estimator, by optimizing the quadratic discrepancy function using Fourier transforms. We further develop degenerated and robust Fourier transform inverse regression estimators for computational efficiency and robustness, as well as partial Fourier transform inverse regression estimator for predictors consisting both categorical and continuous variables. For sufficient variable selection, we propose shrinkage and sparse group LASSO Fourier transform inverse regression estimators. Furthermore, marginal or conditional hypothesis tests for predictors or dimensions are considered.

4 - An Smoothing Newton Method for SVM Type Models in Data Analysis

Hongxia Yin, Minnesota State University, Mankato, Department of Mathematics and Statistics, 273 Wissink Hall, Mankato, MN, 56001, United States
Hongxia Yin, University of Chinese Academy of Sciences, Beijing, 100190, China

An smoothing Newton method for a few support vector machine (SVM) models in data analysis are given by reformulate their dual problems. We proved the global convergence and local super-linear (or quadratic) convergence of the methods. Numerical tests on problems in UCI illustrate the efficiency and robustness of the algorithm compare to the existing results in literature.

■ SB66

West Bldg 105A

Joint Session AI/Practice Curated: Business Applications of Artificial Intelligence

Sponsored: Artificial Intelligence

Sponsored Session

Chair: Srikar Velichety, The University of Memphis, Memphis, TN

1 - Does Image Semantics Impact Demand on Digital Sharing Platforms? An Empirical Study Using Deep Learning

Vivek Kumar Singh, University of South Florida, Tampa, FL, United States, Utkarsh Shrivastava, Anol Bhattacherjee

The digital sharing platforms such as Airbnb encourage customers to seek cues from textual information and images for making an informed decision. Unlike prior studies that focused on only textual information, we study the impact of semantic scenes (e.g. indoor and outdoor) depicted by the property's images and their position within the listing's webpage on the lodging demand. Our propositions are supported by ideas from theories of signaling and information processing and tested using deep learning and econometric modeling approaches. We found that advances in artificial intelligence can indeed provide insights from images at scale for guiding sellers on the digital platforms.

2 - Seeing the Forest for the Trees: Generating Instrumental Variables with Random Forest for Bias Correction in Statistical Inferences

Mochen Yang, University of Minnesota, Carlson School of Management, 321-19th Avenue South, Minneapolis, MN, 55455, United States

The practice of combining machine learning with econometric analysis has become increasingly prevalent in empirical research. In the first stage, machine learning methods are typically used to create new variables (e.g., predict sentiment from textual data), which are then added into second stage econometric models as covariates. Because the predictions from machine learning models are inevitably imperfect, the subsequent econometric estimations suffer from biases due to measurement error in covariates. In this paper, we discuss a novel approach that mitigates biases by leveraging instrumental variables that are generated from an ensemble machine learning model, such as a Random Forest.

3 - A Graphical Model for Topical Impact Over Time

Zhiya Zuo, University of Iowa, Iowa City, IA, United States, Kang Zhao

After being published, a document, whether it is a research paper or an online post, can make an impact when readers cite, share, or endorse it. Built on supervised topic models, we propose a graphical model to capture the topical impact over time within a corpus of documents. We conducted experiments on papers published in (i) D-Lib Magazine and (ii) The Library Quarterly from 2007 to 2017. Comparing with ToT, we found that our model produced more robust and interpretable results on topical trends over time and. Enabling better understanding and modeling of topical impact over time, this model can be used for the design of social media platforms, and evaluation of scientific contributions and policies.

4 - A Modeling Framework for Bike Rebalancing Problem in Bike Sharing System

Fan Dong, University of Arizona, Tucson, AZ, 85715, United States

Bike sharing systems have been implemented in many major cities to offer a convenient mobility service in which public bicycles are deployed in different stations across the city for shared use. The users can check out a bike from a station nearby, take a short ride, and check in the bike to a station around their destination. As the check in and check out of bikes at different stations are unbalanced during different time periods, the bike imbalance issue constantly occurs. Bike stations tend to be full of bikes or empty because the dynamic and asymmetric spatial and temporal bike usage patterns between stations. To ensure good service quality, bike sharing systems need to make sure all stations have enough available bicycles for check out and empty slots for check in. Therefore, system managers need to make decision in advance to send out trucks to dispatch bikes within different stations to rebalancing the bike stations. There are several key challenges related to the bike rebalancing problem: the determination of stations need to be rebalanced, and the dispatch truck routing optimization. In this paper, we design a general framework for bike sharing systems managers to solve the bike rebalancing problems by following steps. The first step is to design a community detection clustering algorithm to cluster bike stations into different communities based on their bike trip network. The second step is to implement a three layer predicting model to predict the check in and check out of bikes for each station in a future period in order to identify the unbalanced stations in future. The third step is to design rebalancing routing algorithm to rebalancing bike stations within and between communities.

■ SB67

West Bldg 105B

Joint Session ISS/Practice Curated: Digital Innovation, Analytics, and Business Value

Sponsored: Information Systems

Sponsored Session

Chair: Jessica Pye, Arizona State University

1 - Using Swarm Optimization Heuristics for Winner Determination in Combinatorial Auctions

Karthik Kannan, Purdue University, 3315 Webster Street, West Lafayette, IN, 47906, United States, Abhishek Ray

Combinatorial auctions are increasingly being used to allocate bundles of items among interested bidders. However, as the number of bundles increases, it takes exponentially longer to solve for the winners in the auction. In such situations, regular solvers such as IBM CPLEX or AMPL fail to produce the optimal solution either completely due to computational limitations or in reasonable time. We propose an Ant Colony-based algorithm (TrACA) that produces optimal or near-optimal results within specified time. The best value from TrACA is at least as good as best-in-class heuristics in 100 % of the cases. Additionally, to better understand the why deterministic algorithms fail or take too long for approximating winners in such auctions, we analyze empirical hardness of tested instances and use a standard supervised learning method to build a predictive model of TrACA run-times.

2 - On the Networks of Executives and Firm Strategic Entry: Evidence from the US Broadband Industry

Tedi Skiti, Temple University, Philadelphia, PA, 19123, United States, Paul Pavlou

We examine the role of the social and professional networks of the firm's top executives in the firm's geographic entry to new markets. We define networks as social ties (generated by common education and societal activities) and professional ties (generated by common work experiences). Potential entrant firms may have an information asymmetry about the market conditions which might reduce their entry likelihood. Networks may reduce this information asymmetry providing information about competitors and market demand. We combine and utilize firm-level data on broadband deployment in the United States (US) and board member data about their networks and individual characteristics. We find that professional ties mitigate the competitive effects, making entry significantly more likely. We contribute to the limited literature on the role of the network of executives in a firm's strategic entry (before the firm becomes an actual entrant) and the literature on intraorganizational knowledge transfer as the result of individual executives' ties.

3 - When Your Problem Becomes My Problem: The Impact of Airline IT Disruptions on On-Time Performance of Competing Airlines

Brad N. Greenwood, University of Minnesota, 4200 32nd St S, Arlington, VA, 22206, United States, Jennifer Tae, Min-Seok Pang

We study how firm disruptions affect competitor performance in the presence of shared resources. We propose that the impact of disruption is moderated by the routine complexity of both a disrupted firm and a competitor. Our context is the four large IT outages affecting the U.S. airline industry. Competitor flights which originated from, or were inbound to, a disrupted hub experienced significant changes in on-time performance, depending on the routine complexity of the disrupted airline. Performance deteriorated during the disruption of full-service carriers, but improved during that of a low-cost carrier. We also find that this effect is strongly moderated by competitors' routine complexity.

4 - Chat More and Contribute Better: An Empirical Study of a Knowledge-based Community

Christopher M. Forman, Cornell University, Dyson School of Economics, Warren Hall, Ithaca, NY, 14850, United States, Xiaomeng Chen, Michael Kummer

Platform design is important to the success of knowledge-based communities. This paper studies whether a new channel of information exchange can impact the efficiency of users' contributions. To test this hypothesis, we use a policy change implemented on the platform. On 2010 October 15, Stack Overflow launched chat.stackoverflow.com to support real-time communication for users. We leverage the fact that not all users could initiate this communication channel to set up a difference-in-differences (DiD) strategy, that compares the questions of the same users before and after the exogeneous change. We find mixed evidence of the efficacy of the chat rooms on improving knowledge-sharing outcomes.

■ SB69

West Bldg 106A

Joint Session QSR/Practice Curated: Data Science and Analytics for Quality and Reliability Assurance

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Mingyang Li, Tampa, FL, 33647, United States

Co-Chair: Jianguo Wu, Peking University, Haidian District, Beijing

1 - Prescribing Age Replacement Policies with Minimal Repair in Anticipation of Non-stationary Unpunctual Implementation

Shadi Sanoubar, University of Pittsburgh, Pittsburgh, PA, United States, Kai He, Lisa M. Maillart, Oleg A. Prokopyev

We consider the problem faced by a maintenance planner who must prescribe an age-replacement policy in anticipation of the fact that the party implementing the policy may be unpunctual, to a degree that depends on the replacement age itself. Our analytical and numerical results compare the optimal solution and its performance to those when the unpunctual behavior is assumed to be absent or independent of the prescribed replacement time.

2 - Optimal Maintenance Management of the Deteriorating Water and Transportation Infrastructures with Interdependencies

Hung Nguyen, University of South Florida, Tampa, FL, 33613, United States, Noha Abdel-Mottaleb, Shihab Uddin, Qiong Zhang, Qing Lu, He Zhang, Mingyang Li

Due to the co-location and spatial proximity, the deteriorating water infrastructure (WI) and transportation infrastructure (TI) are physically and operationally interdependent/dependent. Most of the existing maintenance works mainly consider WI and TI separately, but neglect the complex interdependency/dependency between WI and TI. We will propose an optimal maintenance decision-making framework by jointly prioritizing and maintaining a large number of co-located WI and TI components (e.g., pipes and roads) at the reduced cost. A case study will demonstrate the cost-effectiveness of the proposed work.

3 - Degradation Modeling and Rul Prediction Using Wiener Process Subject to Multiple Change Points and Unit Heterogeneity

Yuxin Wen, University of Texas-El Paso, 216 W. California Ave, El Paso, TX, 79902, United States, Jianguo Wu, Devashish Das, Bill Tseng

Degradation modeling is critical for health condition monitoring and remaining useful life prediction (RUL). In the paper, we propose a multiple change-point Wiener process as a degradation model. To take into account the between-unit heterogeneity, a fully Bayesian approach is developed where all model parameters are assumed random. At the offline stage, an empirical two-stage process is proposed for model estimation, and a cross-validation approach is adopted for model selection. At the online stage, an exact recursive model updating algorithm is developed for online individual model estimation, and an effective Monte Carlo simulation approach is proposed for RUL prediction.

4 - Monitoring of User-generated Reviews via a Sequential Reverse Joint Sentiment-topic Model

Qiao Liang, Tsinghua University, Beijing, China, Kaibo Wang

User-generated reviews can serve as an efficient tool for evaluating the customer-perceived quality of online products and services. This article proposes a joint control chart for monitoring the quantitative evolution of topics and sentiments in online customer reviews. A sequential model is constructed to convert the temporally correlated review documents to topic and sentiment distributions, which are subsequently used to monitor the topics and topic-specific opinions in an ongoing product and service process. Simulation studies on various data scenarios demonstrate the superior performance of the proposed control chart in terms of both shift detection and diagnosis.

5 - Optimal Design of Reliability Demonstration Tests with Risk-adjusted Costs

Suiyao Chen, University of South Florida, 5017 Patricia Court, Tampa, FL, United States, Lu Lu, Qiong Zhang, Mingyang Li

Conventional optimal design of reliability demonstration tests (RDTs) mainly minimizes the testing costs within a RDT, but neglects its impacts on subsequent reliability assurance activities, such as reliability growth and warranty. This work investigates the influence of RDT design on its subsequent reliability activities and further proposes an optimal RDT design strategy by jointly considering cost components at both design and operational phases in a more holistic manner. A comprehensive case study is given to demonstrate the benefits of the proposed work under different cost scenarios and prior elicitation settings.

■ SB75

West Bldg 212B

Joint Session MAS/Practice Curated: Cybersecurity Analytics and Applications II

Joint Session

Chair: Natalie M. Scala, Towson University, Dept. of e-Business and Technology Management

1 - A Risk Model for Voting Systems at Local Precincts

Natalie M. Scala, Towson University, Dept. of e-Business and Technology Management, 8000 York Road, Towson, MD, 21252, United States, Paul L. Goethals

Cyber, physical, and insider vulnerabilities are threats to the integrity of elections. Most research has predominantly examined cyber threats at the aggregate state level in U.S. elections. Little attention has been paid to insider or human threats, particularly at polling places. This research examines vulnerabilities at polling precincts and develops a risk model, based on Markov chains, to assess total threat. We then identify best practices to mitigate threat and illustrate the application of the model through a case study of a mid-Atlantic state.

2 - Cybersecurity Applications of Blockchain Technology

James Howard, Lead Data Scientist and Service Manager, The Johns Hopkins University, 11100 Johns Hopkins Road, Laurel, MD, 20723, United States

Many are lured to blockchain by the promise of security and privacy in the transaction. However, blockchain security and privacy are mostly a myth. But many applications will still benefit from blockchain technology when reliability and trust are at stake. Cybersecurity is a realm rich with applications as an industry founded on reliability and trust for protecting infrastructure, physical and virtual. This talk will look at the cybersecurity industry and how it can use blockchain to provide better service to clients, public and private.

3 - Defending Against Chained Cyber-attacks by Adversarial Agents: An Optimization Approach

Vivin Paliath, Arizona State University, Tempe, AZ, 85281, United States, Paulo Shakarian

Cyber-adversaries employ a variety of malware and exploits to attack computer systems. Existing paradigms that model such cyber-adversarial behavior do not account for sequential or “chaining of attacks. We take the first steps toward addressing this need thru a framework that allows for the modeling of sequential cyber-attacks, taking into account complex-interdependencies between vulnerabilities and exploits. The framework identifies the overall set of capabilities gained by an attacker through the convergence of a fixed-point operator. We study the problem of determining an optimal defense strategy to block the attacker from gaining certain capabilities.

■ SC01

North Bldg 121A

Joint Session OPT/Practice Curated: Applications of Stochastic Mixed Integer Programming

Sponsored: Optimization/Optimization Under Uncertainty

Sponsored Session

Chair: Haoxiang Yang, Northwestern University, Evanston, IL, 60208, United States

1 - Optimizing Crashing Decisions in a Project Management Problem with Disruptions

Haoxiang Yang, Northwestern University, 2145 Sheridan Road, Room C151, Evanston, IL, 60208, United States, David Morton

We introduce a general type of sequential decision problem under uncertainty, where the uncertainty consists of a small number of disruptions, both the magnitude and the timing of which can be random. We consider a special case: a project crashing problem under a single disruption. When a disruption occurs, the duration of an activity which has not started could change. The magnitude of the activity duration change and the timing of the disruption can be random. We formulate a stochastic mixed integer programming (SMIP) model with second stage a mixed integer program. We propose a learning-based branch-and-bound algorithm and evaluate the computational performance of our approach.

2 - Optimizing Water Network Mitigation Shortage and Distribution Costs Under Node Damage and Demand Uncertainty

Jiangyue Gong, Texas A&M University, College Station, TX, 77840-7140, United States, Lewis Ntaimo, Mark Alan Lawley

Planning for water distribution in a network under unforeseen node damage due to natural hazards and demand uncertainty is challenging. We present a two-stage

stochastic programming model for minimizing weighted water shortage and water distribution cost. The model identifies sectors to pressurize in the first stage and determines the assignment of unpressurized sectors to pressurized sectors for water delivery to satisfy demand in the second stage when the uncertainty is resolved.

3 - Modeling Wildfire Extended Attack Planning using Stochastic Programming

Brittany Segundo, TAMU, 924 Sun Meadows Street, College Station, TX, 77845, United States, Lewis Ntaimo

Wildfires that are not contained after an initial response, called escaped fires, challenge decision-makers due to the high degree of temporal and spatial uncertainty surrounding fire behavior and response. We model the extended attack as a stochastic process and employ probabilistic constraints to limit response to scenarios that are feasible given resource and budgetary constraints. We present an accompanying algorithm that identifies optimal solutions while remaining computationally tractable. These solutions will inform when and how to stage and deploy resources to each fire.

4 - Data-Driven Generator Maintenance and Operations Scheduling under Endogenous Uncertainty

Beste Basciftci, Georgia Institute of Technology, H. Milton Stewart School, 755 Ferst Drive NW, Atlanta, GA, 30332, United States, Shabbir Ahmed, Nagi Gebraeel

In this study, our aim is to effectively model and solve the integrated condition-based maintenance and operations scheduling problem of a fleet of generators. We develop a data-driven optimization framework that explicitly considers the effect of the operations decisions on the generators` degradation levels. Since this problem involves decision-dependent uncertainties, we propose a stochastic formulation that captures the resulting endogeneity. Finally, we present computational experiments demonstrating the significant cost savings and computational benefits of the proposed approach.

■ SC02

North Bldg 121B

Joint Session OPT/Practice Curated: Optimization under Uncertainty: Military and Cybersecurity Applications

Sponsored: Optimization/Optimization Under Uncertainty

Sponsored Session

Chair: Rajesh Ganesan, George Mason University, Fairfax, VA, 22030, United States

1 - Critical Node Analysis and System Identification using a Discrete, General Framework for Dependency Mapping

Les Servi, The MITRE Corporation, M/S M230, 202 Burlington Road, Bedford, MA, 01730-1420, United States, Erica Mason, Damon Frezza

A new mission dependency mapping framework is introduced which models the relationship between an overall mission capability and its dependent component's capability. A new genetic algorithm is presented which identifies the framework's parameters using simulated experiments instead of the time-intensive manual alternative. A second new algorithm is presented that uses these parameters to identify the dependent components that have the greatest impact on the mission outcome. Empirical performance is reported both algorithms.

2 - Resource-enabled Pathfinding with Mandatory Waypoints and Turn Constraints

Doug Altner, MITRE Corporation, 7515 Colshire Drive, M/S H617, McLean, VA, 22102, United States

This presentation introduces a shortest path problem/robot motion planning problem around obstacles in a continuous space in which 1) new paths through obstacles could be created using a limited number of resources and 2) the path must also come within range of a pre-specified sequence of waypoints and satisfy turn constraints. We develop an A*-based heuristic for this problem that incorporates elements from constrained shortest path routing, theta* search, and tour routing. Computational results on over 100 test cases demonstrate our heuristic is a viable solution for this complex problem.

3 - An Approximate Dynamic Programming Approach for the Financial Execution of Department of Defense Weapon System Acquisition Programs

Erich D. Morman, Naval Postgraduate School, 298 Watson Street, Apartment A, Monterey, CA, 93940, United States, Rajesh Ganesan, Karla L. Hoffman

Operating in a "use or lose fiscal environment, weapon system programs return millions-of-dollars each year of unspent funding. These dollars are opportunity costs to program offices representing forgone projects. The inefficiency is due to the institutional use of an inadequate myopic cash allocation policy. Using Q-learning and value function learning, we develop approximate dynamic programming (ADP) approaches to create alternative cash allocation policies. When compared to the myopic policy, our ADP models reveal that between 2% and 7% of funding is at risk of yearly "sweep-upö. The research can help program offices interested in improving overall utilization of their annual budget.

4 - Dynamic Optimization of the Level of Operational Effectiveness of a Cybersecurity Operations Center under Adverse Conditions

Rajesh Ganesan, George Mason University, 4400 University Drive, Engineering Building MSN 4A6, Fairfax, VA, 22030, United States, Ankit Shah

The analysts at a cybersecurity operations center (CSOC) analyze alerts generated by intrusion detection systems. There are many disruptive factors that affect the alert analysis process and as a result, adversely impact the Level of Operational Effectiveness (LOE) of the CSOC. To improve the LOE, additional resources must be called upon to assist with the alert analysis process. In a resource constrained environment, determining when and how many resources to call upon is non-trivial. In this talk, a reinforcement learning (RL) model for optimizing the LOE of a CSOC is presented. Results indicate that the RL model helps in making better decisions compared to ad-hoc practices employed at the CSOCs.

■ SC08

North Bldg 124A

Joint Session OPT/Practice Curated: Network Optimization Models in Routing and Communications

Sponsored: Optimization/Network Optimization

Sponsored Session

Chair: Tachun Lin, Bradley University, Peoria, IL, 61625, United States

1 - Consistent Aircraft Fleeting and Routing among Schedule Periods

Zhili Zhou, United Airlines, 233 S. Wacker Drive, 5th Floor, Chicago, IL, 60606, United States

Commercial airlines invest in international markets, which gain revenues compatible with its domestic counterpart. For international services, airlines change flights and markets in different schedule periods. To reduce the operational burdens, we address the fleet assignment and aircraft routing consistency problem between two schedule periods with the objective to minimize the changes of fleets on served markets and routes. We explore the column-and-row algorithm under a cross-layer network setting for this airline scheduling problem. Preliminary experiment results demonstrate the improvement of scheduling consistency between schedule periods.

2 - On Routing Unmanned Aerial Vehicles for Surveillance and Reconnaissance Activities

Cai Gao, University at Buffalo, Buffalo, NY, 14260, United States, Jose Luis Walteros

We tackle a variation of the Close-enough Traveling Salesman Problem where the salesman is accounted for visiting a node if he traverses a precalculated distance through a circular area surrounding each node. This variation arises in the context of unmanned aerial vehicle (UAV) routing where a UAV collects information form a set of targets, while minimizing detection risks. We provide a mixed-integer formulation and solve it using Benders Decomposition. We enrich our approach by introducing a set of lifting algorithms to strengthen the optimality cuts generated by the proposed decomposition and a k-opt heuristic in the style of the classic Lin-Kernighan algorithm to generate better lower bounds.

3 - 5G Hierarchical Network Slicing with Uncertain Demands

Tachun Lin, Bradley University, 1501 W. Bradley Ave, Bradley Hall 171, Peoria, IL, 61625, United States

Network slicing, a key enabling technology for 5G development, creates concurrently dedicated and independent virtual networks and virtual network services for tenants on a common physical infrastructure platform. Compared with early works targeting single-domain physical infrastructure and demand-driven virtual network construction, we present in this talk multi-domain network slicing jointly with the construction of network functions' forwarding graph. We discuss random tenant choices and the respective resource allocation based on traffic/demand uncertainty under a cross-layer network topology.

4 - A Real-time Relocation Strategy for Station Based Autonomous Electric Vehicle Sharing System

Li Li, PhD Candidate, New York University, New York, NY, United States, Saif Eddin G. Jabari

This paper puts forward a distributed rebalance strategy for station based autonomous electric vehicle sharing system. The max-weight algorithm is adopted and the queue stability of the network is guaranteed. The rebalance decision is made by each station independently, and only local information, e.g. queue length of neighboring stations, is required for decision making. Hence the rebalancing strategy is able to be implemented in real time, regardless of how big the network size is. Another advantage of this algorithm is that it requires no knowledge of the demands, and can achieve the maximum throughput of the whole network.

■ SC11

North Bldg 125B

Joint Session MSOM/Practice Curated: Empirical Topics in iFORM

Sponsored: Manufacturing & Service Oper Mgmt/iFORM

Sponsored Session

Chair: Alex Yang, London Business School, London Business School

Co-Chair: Nitish Jain, London Business School, London, NW1 4SA, United Kingdom

1 - Retailer Initiated Inventory-based Financing

Weiming Zhu, IESE Business School, Avenida Pearson 21, Barcelona, 08034, Spain, Wei Luo

We study a innovative financing scheme in which a large retailer provides short-term financing to a small retailer using the inventory of the small retailer as collateral. We analyze the effectiveness of such financing scheme and explore their impact on operational decisions and contract design.

2 - Buyer Preferred Commodity Price Risk Allocation: A Theoretical and Empirical Investigation of the BMW Supply Chain

Panos Markou, Cambridge Judge Business School, Cambridge, United Kingdom, Daniel S. Corsten, Panos Kouvelis, Danko Turcic

Downstream manufacturers are exposed to volatile commodity prices through their suppliers, and information asymmetry often means that they are disadvantaged in seeing true prices in opaque markets. We formalize a model of BMW's supply chain, generate several predictions of how contracts should be allocated to suppliers under information asymmetry, and test these using a proprietary data set comprising contracting terms from 1,600 suppliers.

3 - Operational Disruptions and the Value of Credible Control Systems

William Schmidt, Cornell University, 314 Sage Hall, Ithaca, NY, 14850, United States, Ananth Raman

Operational disruptions can impact a firm's risk, which manifests in a host of operational issues, including a higher holding cost for inventory, a higher financing cost for capacity expansion, and a higher perception of the firm's risk among its supply chain partners. We empirically examine whether firms can meaningfully reduce the impact on their risk by implementing and credibly attesting to having effective internal control systems.

4 - Supply Chain Network Structure and Environmental Information Disclosure

Marcus A. Bellamy, Rafik B. Hariri Building, 595 Commonwealth Avenue, Boston, MA, 02215, United States, Suvrat Dhanorkar, Ravi Subramanian

Recognizing that supply network structure has implications for a focal firm's ability to access environmental information embedded in its supply network, this paper draws on structural, environmental, and financial data from Bloomberg to test the relationship between a focal firm's supply network structure and its extent of environmental information disclosure.

■ SC12

North Bldg 126A

Joint Session Frontiers/Practice Curated: Statistical Learning and Optimization

Emerging Topic: OR Frontiers

Emerging Topic Session

Chair: Emma Frejinger, Universite de Montreal, Montreal, QC, H3C 3J7, Canada

1 - Learning MILP Resolution Outcomes before Reaching Time-limit

Andrea Lodi, École Polytechnique de Montréal, Montréal, QC, Canada, Martina Fischetti, Giulia Zarpellon

The solution of some MILPs still presents challenges for solvers and may require hours of computations, so that a time-limit is often provided by the user. Nevertheless, it could be useful to get a sense of the optimization trends after only a fraction of the time-limit, and ideally be able to tailor the use of the remaining solution time in a more strategic way. Looking at the evolution of a partial branch-and-bound tree for a MILP, up to a certain fraction of the time-limit, we aim to predict whether the problem will be solved to proven optimality before timing out. We exploit Machine Learning tools, and summarize the progress of a MILP solution process to cast a prediction within a classification framework.

2 - Optimizing Decision Diagrams Size and Bound via Reinforcement Learning

Louis-Martin Rousseau, École Polythechnique de Montréal, Cp 6079 Succ Centre-Ville, Montréal, QC, H3C 3A7, Canada, Quentin Cappart, David Bergman

Decision Diagrams are a recent technology enhancing optimization methods. They can be used in Integer Programming for tightening relaxation bounds. Their performances are highly dependent on the variable ordering chosen. Finding an optimal ordering is NP-complete. Recent research in Machine Learning has also shown that reinforcement learning can be used for solving NP-hard problems. Following this trend, we propose to use a similar approach in order to reduce the size of Decision Diagrams.

3 - Learning Heuristics for the TSP by Policy Gradient

Yossiri Adulyasak, HEC Montréal, 3000 Cote-Sainte-Catherine, Montreal, QC, H3T 2A7, Canada, Michel Deudon, Pierre Cournut, Alexandre Lacoste, Louis-Martin Rousseau

We extend the neural combinatorial optimization framework to solve the traveling salesman problem (TSP). The neural network is trained using reinforcement learning to predict a distribution over city permutations. We designed our own critic to compute a baseline for the tour length which results in more efficient learning. We further enhance the solution approach with the well-known local search heuristic and the approach could outperform a high performance heuristic (OR-Tools). Our approach based on machine learning techniques could learn good heuristics which, once being enhanced with a simple local search, yield promising results.

4 - A Machine Learning Algorithm for Fast Prediction of Solution Descriptions to an ILP

Emma Frejinger, Université de Montréal, FAS, Pavillon Andre-Aisenstadt, Montreal, QC, H3C 3J7, Canada, Eric Larsen, Sébastien Lachapelle, Yoshua Bengio, Simon Lacoste-Julien, Andrea Lodi

We propose a methodology to predict descriptions of solutions to discrete stochastic optimization problems in short computing time. We approximate the solutions based on supervised learning and the training dataset consists of a large number of deterministic problems that have been solved independently (offline). Uncertainty regarding a subset of the inputs is addressed through sampling and aggregation methods. Our application concerns booking decisions of containers on double-stack trains. The results show that deep learning algorithms make predictions high accuracy in milliseconds or less.

■ SC14

North Bldg 126C

Joint Session MSOM/Practice Curated: Empirical OM in Services

Sponsored: Manufacturing & Service Oper Mgmt/Service Operations

Sponsored Session

Chair: Carri Chan, Columbia Business School, New York, NY, 10027, United States

Co-Chair: Fanyin Zheng, Columbia University, New York, NY, 10027, United States

1 - Component Sharing and Recalls: An Empirical Study in the Auto Industry

Kamalini Ramdas, London Business School, A215 Sussex Place, Regent's Park, London, NW1 4SA, United Kingdom

Automakers often share components - such as brakes, engines or outer body panels - across models in their product lines, in any year and across years. We examine how such component sharing impacts product recalls, using US government recalls data and detailed data on automakers' component sharing strategies in the US market.

2 - The Combined Effect of the Information Provision and the Randomized Reward on Patients' Satisfaction

Danqi Luo, Stanford Graduate School of Business, 655 Knight Way, Stanford, CA, 94305, United States, Mohsen Bayati, Erica Plambeck

This work looks at the problem of information provision on wait time in the emergency department. What kind of information schemes should be provided to the low-acuity patients, considering patients' own satisfaction and the waiting externalities on other patients? The effect of varies delay announcement schemes on patients' satisfaction level and pain level will be looked.

3 - The Impact of Primary Care Provider Availability on Patient Care

Hessam Bavafa, Wisconsin School of Business, 4284C Grainger Hall, 975 University Avenue, Madison, WI, 53706, United States, Christian Terwiesch

Emergency room (ER) overcrowding and overuse are significant problems in the United States, and prior studies have shown that a large portion of ER patients could

have been treated by a primary care provider. If this is the case, why do patients spend hours waiting in the ER for a problem that their primary care physician could have addressed? One common answer is that primary care providers are too busy to provide timely appointments, making the ER a more attractive alternative for their patients. In this paper, we use a large dataset from the Veterans Health Administration to shed light on this claim.

4 - Structural Estimation of Intertemporal Externalities on ICU Admission Decisions

Fanyin Zheng, Columbia University, Columbia Business School, 412 Uris Hall, New York, NY, 10027, United States, Carri Chan

Patient care in capacity-constrained hospital units sometimes results in scenarios where the demanded quantity and level for care exceeds immediate availability, which may impact patient outcomes as well as economic outcomes. In this paper, we study the intertemporal externalities on Emergency Department patients' Intensive Care Unit admission decisions. In particular, we study how admitting a patient in the current period affects the system status, and, in turn, its ability in admitting another patient with possibly more severe conditions in the next period. We take the structural estimation approach which allows us to estimate the intertemporal externalities from data.

■ SC50

North Bldg 231A

Joint Session Practice/Practice Curated: Edelman Reprise I

Sponsored: INFORMS Section on Practice (formerly CPMS)

Sponsored Session

Chair: Anne G. Robinson, Verizon Wireless, Basking Ridge, NJ, 07920, United States

Co-Chair: Carrie Beam, University of Arkansas, Walnut Creek, CA, 94596, United States

1 - China National Petroleum

Zuo-Jun Max Shen, University of California Berkeley, 4141 Etcheverry Hall, Mail code 1777, Berkeley, CA, 94720-1777, United States

Abstract not available.

2 - Turner Blazes a Trail for Audience Targeting on Television with Operations Research and Advanced Analytics

J. Antonio Carbajal, Turner Broadcasting System, Inc., Atlanta, GA, USA

Turner has designed and implemented innovative and integrated forecasting and optimization models that power audience targeting solutions disrupting decades-old paradigms and business processes in the media industry, and producing significant sales and advertisement efficiencies for Turner and its clients. Turner is on track to sell 50 percent of its inventory through audience targeting by 2020, representing billions in ad revenue.

3 - Europcar Integrates Forecast, Simulation and Optimization Techniques in a Capacity and Revenue Management System

Europcar, Y, Aruba.

Europcar, the leading European car rental company, partnered with ACT Operations Research to create Opticar, a complex decision support system. Opticar features forecasts, discrete event simulations and optimization techniques providing an integrated approach to revenue and capacity management. Opticar anticipates future demand for Europcar's vehicles fleet, up to six months in advance, improving capacity management. In addition, Opticar enables Europcar to optimize its approach to revenue management and rental pricing, taking into account competitors information, the currently available fleet and expected demand for vehicles. Opticar provides a shared mathematical approach used as a starting point for all daily operations to nine Europcar's corporate countries.

■ SC51

North Bldg 231B

Joint Session OMS/Practice Curated: Applications in Scheduling

Emerging Topic: Project Management and Scheduling, in Memory of Joe Leung,

Emerging Topic Session

Chair: Rodrigo A. Carrasco, Ph.D., Universidad Adolfo Ibáñez, Santiago, Chile

1 - A Scheduling Problem Motivated by Cybersecurity and Adaptive Machine Learning

Nourhan Sakr, Columbia University, New York, NY, 10027, United States, Clifford Stein, Ojas Parekh, Cynthia Phillips, Vladlena Powers

We consider a multiple-machine problem where each machine is associated with its predetermined sequence of jobs. A machine may start a new job if it is given a signal (a "take") to do so. A take is global across all machines. Given a fixed budget of takes, we schedule takes to minimize total idle time. This problem comes from a stochastic-programming exploration of a cybersecurity game. We also find another interpretation that applies this problem to adaptive machine learning. We motivate and define the problem, give some preliminary complexity results, and discuss practical (in)tractability.

2 - The Value of Flexibility in Bottling Operations in the Wine Industry under Sequence Dependent Setup Times

Alejandro Francisco Mac Cawley, Pontificia Universidad Catolica de Chile, Vicuna Mackenna 4860, Santiago, 7820436, Chile, Sergio Maturana, Mauricio Varas

Wineries must optimize their bottling process and deal with many products to be processed, high-demand variability and sequence dependent setup times. Under these conditions, managers must generate scheduling plans. We look at flexible strategies such as the postponement of the labeling of bottled wines; to gain productivity in the process. We study the performance impact of implementing flexible strategies by developing a multi-stage mixed-integer stochastic programming model with full recourse for demand scenarios. Results show benefits of implementing flexible strategies under given capacity of the system, demand variability and setup times.

3 - Scheduling Surgeries with Variable Times: The Value of More Data

Rodrigo A. Carrasco, Diagonal Las Torres 2640, Of. 532, Edicifio C, Santiago, 7941169, Chile

Although operating room scheduling has been studied since the early 60's, dealing with surgery variability has been one of the main difficulties when implementing scheduling tools. In this work we present a way of incorporating such variability by using chance constraints to improve schedule performance. We develop specific constraints, through data analysis of real instances, which improve the schedule, reducing the need for overtime but without affecting the utilization significantly..

4 - Bicriteria Job Scheduling with Split Lots

Rasaratnam Logendran, Professor, Oregon State University, School of Mech lndustrial & Mfgr Engr, Rogers Hall Rm 204, Corvallis, OR, 97331-6001, United States, Ayush R. Aryal

An algorithm, which incorporates tabu search into the framework of path relinking, is presented to solve a job shop scheduling problem, consisting of M = {1,?., m} machines. Each job j e J = {1, ?, n} consists of i(j) ordered operations. During an operation, a job is split or merged into ki(j) split-lots. Each split-lot operation can be performed by a subset of machines in M. The production is discontinuous within a two-week planning horizon. The objective function focuses on minimizing a linear combination of weighted flowtime and weighted tardiness. Three initial solution finding mechanisms are used and their comparative performance in the algorithm is evaluated using various problem instances.

■ SC55

North Bldg 232C

Joint Session Practice Curated/Practice Sports Analytics II

Sponsored: SpORts

Sponsored Session

Chair: Stephen Hill, UNC Wilmington, United States

1 - NFL versus NCAA Football Decision Making Analysis

Stephen Hill, UNC Wilmington, United States

In this work in game win probability models are developed for NFL and NCAA football. These models are compared and then used to evaluate decision making approaches. Additionally, consideration is given to measuring in game win probability volatility.

2 - Real-Time NBA Playoff Elimination

Mark Husted, Colorado School of Mines, 816 20th Street, Golden, CO, 80401, United States, Alexandra M. Newman, Eli Olinick

The NBA is divided into two conferences, each of which is comprised of fifteen teams, and the top eight teams from each conference compete in the playoffs. An integer-programming model determines when a team has been eliminated from the playoffs before the completion of the regular season. There are instances in which teams' winning percentages are tied. Ties are broken using seven independent criteria based on the number of teams tied. The results are published on the RIOT website so fans can follow their favorite teams' playoff standings. We compare the time at which (and day on which) these results are published to the NBA official standings; in many cases, RIOT notifies the public prior to the NBA.

3 - Learning from Success and Failure at the Speed of Formula One
Michael A. Lapré, Vanderbilt University, 401 21st Avenue South, Nashville, TN, 37203, United States, Candace Cravey

KC, Staats and Gino (2013) found that surgeons learn from their own success and from others' failure. Unlike surgery, in Formula One racing, success is rare and competitive. Using data since Formula One started in 1950, we investigate driver learning from own experience and teammates' experience with both success and failure. We find that drivers learn from own success, teammates' success, as well as own car failures. We use characteristics of success to explain observed learning effects.

4 - Maximizing National Hockey League Goal Differential through the Examination of Line Orders and Lengths
William Davis, Student, Slippery Rock University, Slippery Rock, PA, 16057, United States, Jacob Lindey

While graph theory and mathematical predictive measures rarely enter into dialogue with hockey, these are the very concepts that would provide National Hockey League managers with better chances of winning through more efficient ice time. We examine and implement these concepts to manipulate line orders and lengths to maximize goal differential for any given team. In addition, we break down our easy-to-use interface designed for managers.

5 - A Classification and XML Framework for Round Robin Sports Timetabling Problems
Dries Goossens, Ghent University, Tweekerkenstraat 2, Gent, 9000, Belgium, David Van Bulck, Jorn Schonberger, Mario Guajardo

In the sports timetabling literature, most problems assume different constraints and objectives. Often, one specific case study is discussed, with an accompanying solution method. This lack of structure makes it hard to compare problem instances and to assess algorithmic performance. We present a 3-field classification scheme for round-robin sports timetabling problems. For the instance definition and its solution(s), we propose two XML-file-based templates and a C++-library (RobinX) to evaluate both files. We present a web application that should encourage exchanging instances and solutions, and eventually lead to more general insights.

■ SC59

West Bldg 102A

Joint Session HAS/Practice Curated: Stochastic models of Hospital Admission and Discharge Services

Sponsored: Health Applications

Sponsored Session

Chair: Nan Kong, Purdue University, West Lafayette, IN, 47906-2032, United States

Co-Chair: Michelle M. Alvarado, University of Florida, Gainesville, FL, 32611-6595, United States

1 - Stochastic Models for Inpatient Discharge Planning
Maryam Khatami, Texas A&M University, College Station, TX, USA; Michelle M. Alvarado, Nan Kong, Pratik J. Parikh, Mark Lawley.

The inpatient discharge planning problem requires the efficient assignment and sequencing of ready-for-discharge patients to resources. Delay in discharge processes deteriorates patient satisfaction and increases hospital costs. We model and solve the inpatient discharge planning problem as a two-stage stochastic program with uncertain inpatient discharge processing time and bed request times. The objective is to minimize patient dissatisfaction, discharge lateness, and patient boarding. We derive managerial insights by comparing the results of a two-stage stochastic program, the mean value problem, and two heuristics from current practice using simulation modeling.

2 - Missed Opportunities in Preventing Hospital Readmissions: Redesigning Post-discharge Checkup Policie
Xiang Liu, University of Michigan, Ann Arbor, MI, United States, Mariel Lavieri, Jonathan Helm, Ted Skolarus

Hospital readmissions affect hundreds of thousands of patients, placing a tremendous burden on the healthcare system. Post-discharge checkup can reduce readmissions through early detection of conditions. Our work develops optimal checkup plans to monitor patients following hospital discharge using methods including phone calls and office visits. By analyzing the structure of optimal policies, we develop checkup schedules that mitigate 32% more readmissions.

3 - Improving Discharge Process at a University Hospital: A System-theoretic Method
Xiaolei Xie, Tsinghua University, 614 Shunde Building, Beijing, 100084, China, Nan Chen, Zexian Zeng, Xiang Zhong, Maria Brenny-Fitzpatrick, Barbara A. Liegel, Li Zheng, Jingshan Li

This paper introduces a system-theoretic approach to improve inpatient discharge process at a university hospital. The complex hospital discharge process is modeled by a stochastic process with parallel sub-processes, splits, and merges. A system analysis method is introduced to approximate the discharge time and evaluate the mean, variability, and discharge-time performance. It is shown such a method results in a high accuracy in performance evaluation. To improve the discharge process at the university hospital, bottleneck and what-if analyses are carried out and improvement recommendations are discussed.

4 - Admission Planning Problem with Stochastic Length of Stay
Jorge Vera, Universidad Catolica de Chile, Dept. Industrial and System Engineering, Santiago, 7820436, Chile, Ana Celeste Batista, David Pozo

Effective admission planning process can improve inpatient throughput and waiting times. The uncertain in the patient s length of stay complex the admission and may cause bottlenecks and long waiting times in the patient's flow. We study the admission planning problem considering uncertain in the length of stay. Classically length-of-stay is modeled as a sum over a time windows constraint. This makes it very complex to consider uncertainty on this variable. In this work, we developed a new formulation in which the length of stay is on the right hand of the constraint by employing a single binary variable.

■ SC60

West Bldg 102B

Joint Session HAS/Practice Curated: Applications of Operations Research to Organ Transplantation

Sponsored: Health Applications

Sponsored Session

Chair: Mariel Sofia Lavieri, University of Michigan, Ann Arbor, MI, 48109-2117, United States

Co-Chair: Wesley Marrero, University of Michigan, 1205 Beal Ave, Ann Arbor, MI, 48109, United States

1 - Optimizing Kidney Sharing to Reduce Geographic Disparity
Sommer Gentry, US Naval Academy, Mathematics Department, 572-C Holloway Road, Annapolis, MD, 21402, United States, Jack Robinson

We use parametric linear programming to investigate tradeoffs in decreasing geographic disparity in kidney transplants. We optimize the sharing of kidney supply between neighboring Donation Service Areas (DSAs) to make the number of kidneys transplanted per incident waitlist candidate similar among DSAs. We adjust the percentage of kidneys recovered in a particular DSA that must be transplanted in that same DSA, to reduce geographic disparity while limiting disruption to existing transplant programs which might otherwise oppose the plan. Surprisingly, even if DSAs retain 90% of their original supply, we can significantly improve the kidney transplant rates in the most underserved areas.

2 - Achieving Fairness in Allocating Uncertain Resources with Applications to Kidney Transplantation
Sanjay Mehrotra, Northwestern University, Chaithanya Bandi

A novel model for fair allocation of uncertain resources becoming available over time is presented. Demand exceeds supply. Supply distribution is constrained by certain logistical requirements. Our goal is to achieve a fair distribution of supply. Fairness objective is stochastic and fractional. We show that a parametric convex optimization problem can be used to identify an optimal solution. We give parametric tractable re-formulations of our model using polyhedral and conic ambiguity sets, motivated from the concepts of robust queues. Numerical results on the performance of the model using data from the US kidney allocation system, which motivated the problem, will be presented.

3 - Cherrypicking Kidneys and Patients: Incentives in Transplant Centers
Mazhar Arikan, Associate Professor, University of Kansas, Lawrence, KS, United States, Baris Ata, Rodney P. Parker

In 2007 the Centers for Medicare and Medicaid Services implemented a set of regulations for transplant centers called conditions of participation (COP). These rules evaluate transplant centers based on one-year patient and organ survival rates post transplantation. According to the COP, centers performing worse than the COP expectation face losing their certification to transplant. Using actual offer and transplant data, we empirically analyze some potential unintended consequences of these regulations such that more risk averse centers choose healthier patients and higher quality organs to transplant. We also discuss some recommendations to policymakers for improving the COP.

4 - The Health and Economic Impact of Presumed Consent Organ Donation on Patients with End-stage Renal Disease
David W. Hutton, University of Michigan, 1015 Fairmount Drive, Ann Arbor, MI, 48105, United States, Huey-Fen Chen, Hayatt Ali, Wesley Javier Marrero Colon, Neehar Parikh, Mariel Sofia Lavieri

We evaluated the impact of opt-out organ donation policies using a Markov model of end-stage renal disease patients in the US. We evaluated policy increasing donation

rates by 5%, 25%, or 50% versus the status quo. An opt-out, presumed consent policy would save $18.3 billion, and gain 137,029 Quality-Adjusted Life-Years over the lifetime of an open cohort of patients on dialysis and on the waitlist for kidney transplantation. When the presumed consent policy only increased donation by 5%, the cost saved was $4.0 billion, and 29,478 Quality-Adjusted Life-Years were gained. The cost savings were $32.8 billion and 254,515 Quality-Adjusted Life-Years were saved if the policy increased rates by 50%.

■ SC63

West Bldg 103B

Joint Session DM/Practice Curated: Data Analytics of Complex Data and its Applications

Sponsored: Data Mining

Sponsored Session

Chair: Wanlu Gu, University of Arizona, Tucson, AZ, United States

Co-Chair: Neng Fan, University of Arizona, Tucson, AZ, United States

1 - Parametric Approach for Developing Quick Quotes in Fabrication

Ravi Suman, University of Wisconsin-Madison, Madison, WI, 53726, United States, Omar Habib, Ananth Krishnamurthy, Sushanta Sahu

We describe a methodology to develop rapid and accurate quotes for fabrication jobs. First, fabrication hours are estimated using parametric equations and part drawings. Next, multistep regression model is used to minimize the input features, speed up the estimation process, and derive accurate estimates of pre-weld and post-weld operations. Finally, model coefficients, exponents, and hyperparameters are set using training data. Validation studies using industry data shows that the methodology reduces quoting times by 50% while providing estimates that are within acceptable industry range.

2 - A Markov Decision Process to Identify Optimal Policies for Stopping a Trial of Labor

Karen T. Hicklin, University of North Carolina at Chapel Hill, B-24 Hanes Hall, Chapel Hill, NC, 27599-3260, United States, Julie Simmons Ivy

For first time moms the decision to have a cesarean delivery (C-section) can lead to future complications in subsequent pregnancies such as uterine rupture or repeat C-sections. In addition to the health risk associated with C-sections, there is general consensus that the C-section rate in the United States is too high and not associated with a decrease in maternal and neonatal morbidity or mortality. We model the mode of delivery decision using a Markov decision process (MDP). This MDP evaluates when a C-section is optimal as a function of total time spent in labor and the associated rate of complications.

3 - Analysis of Aggregate Data using Phase-type Distribution for Reliability Estimation

Samira Karimi, University of Arkansas, Fayetteville, AR, United States, Haitao Liao

One of the most accessible component reliability data in industry is aggregate lifetime data from fielded systems. While Gamma and Inverse Gaussian have been used in reliability estimation using aggregate data, Phase-type (PH) distribution has not been studied in the related literature. In this work, an expectation-maximization (EM) algorithm is proposed to estimate the parameters of PH distribution based on aggregate data. In addition, a Bayesian alternative is also studied and confidence region for model parameters are provided. A numerical study shows the strength of using PH distribution as an alternative for handling aggregate lifetime data.

4 - Modeling Patient Flow Information with Covariates using Phase-type Distributions

Wanlu Gu, University of Arizona, Tucson, AZ, 85719, United States, Neng Fan

The hospital length-of-stay (LOS) measures the time from admission to discharge. It demonstrates patient flow and plays an important role in health care quality improvement. In this paper, we fit the Coxian phase-type (PH) distributions to the patient flow information collected in Banner University Medical Center Tucson and assess the effects of covariates, including age, gender, admission type etc. The resulting estimated PH distributions can classify patients into different LOS groups and the pattern under each group is identified. The estimated coefficients and the statistical significance of covariate effects will help decision making in healthcare service and sources assignment.

■ SC64

West Bldg 104A

Joint Session DM/Practice Curated: Data Science and Analytics in Health Care III

Sponsored: Data Mining

Sponsored Session

Chair: Hamidreza Ahady Dolatsara, Auburn University, Auburn, AL

1 - Neural Fuzzy-based Unscented Kalman Filter Model for Atrial Fibrillation Onset Prediction

Trung Le, North Dakota State University, Fargo, ND, 58102, United States

Atrial fibrillation is the most common arrhythmia, which increases the risk of stroke by 5 times and potentially leads to embolism. Assessing the risk of developing PAF is important to avoid the risk of death; previous work has only focused on addressing the challenge for predicting the onset of paroxysmal atrial fibrillation (PAF) from the morphological-temporal features of surface electrocardiogram by utilizing machine learning-based techniques. In this paper, we propose a method based on a combination of Kalman filter algorithm and a Neural Fuzzy network to predict PAF onset for 70 patients suffering from PAF.

2 - Quantification of Stroke Risk in Patients with Atrial Fibrillation and Obstructive Sleep Apnea

Rupesh Kumar Agrawal, Research Assistant, Oklahoma State University, Tulsa, OK, 74106, United States, Daniel Tran, Matt Wilkett, Dursun Delen, Bruce Benjamin

Extant research work has established strong correlation in patients with Atrial Fibrillation (A-Fib), the Obstructive Sleep Apnea (OSA) and the increased risk of stroke. CHADS2 and CHA2DS2-VASc scores are used to calculate the risk of stroke based on circulatory and respiratory mechanism. This is a pilot study to quantify stroke risk in patients with A-Fib, OSA, to show that the stroke risk is higher in patients, independent of treatment with anticoagulants used to treat patients with A-Fib. Furthermore, our goal is also to develop human subject clinical trial, based on the knowledge gained from the analytics study to develop a score for OSA as part of the criteria for calculating a risk of stroke

■ SC69

West Bldg 106A

Joint Session QSR/Practice Curated: QSR Student Interaction Session

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Dongping Du, Texas Tech University, Lubbock, TX, 79409, United States

Co-Chair: Raed Al Kontar

1 - QSR Student Interaction Session

Dongping Du, Texas Tech University, 2500 Broadway, P.O. Box 43061, Lubbock, TX, 79409, United States

The Student Interaction Session is designed for QSR student to build their professional network, show up their talents, and learn from invited guests. The session consists of students' introduction, student and guest interactions, and Best Student Poster Competition. Each participant will have 2 minutes to deliver an elevator speech about his/her research interests and accomplishments; Senior QSR members and guests will be invited to interact with attendees and share experience; A panel of judges will select a poster competition winner, which will be announced at the QSR business meeting.

3 - Quantifying the Motivation of Physicians' Continuous Charitable Clinics Choice Online

Han Yang, Beijing Institute of Technology, No.5 Zhongguancun South Street, Haidian Dist, Beijing, 100081, China, Zhijun Yan, Lun Li

Online healthcare communities is a novel channel for physicians to share healthcare knowledge with patients.The services that physicians provide in OHCs consist of paid health services and charitable clinics services, and we have limited knowledge on the motivation of physicians' continuous charitable clinics choice online. We develop a logistic model to examine three types of motivation of physicians' continuous charitable clinics choice, including economic , social image and altruistic motivation. Based on the data from Guahao.com, we find that different types of motivation has different effects on physicians' continuous charitable clinic behavior based on different situations.

■ SC71

West Bldg 106C

Joint Session ICS/Practice Curated: Decomposition Algorithms for Power Grid Optimization

Sponsored: Computing

Sponsored Session

Chair: Deepak Rajan, Lawrence Livermore National Laboratory, Livermore, CA, 94551, United States

1 - Optimizing Power System Restoration using Mixed Integer Linear Programming

Ignacio Aravena, Universite Catholique de Louvain, Voie du Roman Pays 34, Center for Operations Research and Econometri, Louvain-la-Neuve, B-1348, Belgium, Deepak Rajan, Georgios Patsakis, Jennifer Rios, Shmuel S. Oren

We present a novel framework for optimizing power system restoration and black-start allocation as MILPs. First, we build piece-wise linear approximations of power flow equations that account for the regime of excess of reactive power typical during restoration. Then, we propose a specialized integer L-shaped algorithm that decouples the power flow equations from the combinatorial dynamics of the restoration process. The method allows sharing cuts between time periods and formulating feasibility cuts over electrical islands. We present numerical results for modified IEEE test systems and models of the WECC and the Chilean power grids demonstrating the effectiveness of the proposed approach.

2 - Scalable Decomposition for Stochastic Unit Commitment

Jean-Paul Watson, Sandia National Laboratories, 7305 Blue Cypress Avenue NE, Albuquerque, NM, 87113-2065, United States, David L. Woodruff, Bernard Knueven

We discuss recent advances in scenario-based decomposition algorithms for solving realistic, large-scale stochastic unit commitment problems. We focus on mitigating the difficulty of instances with diverse renewables production patterns, which can cause serious degeneration in practical convergence behaviors. Mitigation proceeds through the use of cross-scenario cuts. We will discuss experimental results and newly created openly available benchmarks.

3 - Parallel Temporal Decomposition Method for Long-term Unit Commitment Problems

Kibaek Kim, Argonne National Laboratory, 9700 South Cass Avenue, Building 240, Lemont, IL, 60439, United States, Audun Botterud, Feng Qiu

We consider a long-term unit commitment (UC) for power system production cost modeling. The UC problem is formulated as a large-scale mixed-binary linear programming problem. We present the Lagrangian dual decomposition method that solves the long-term UC by decoupling the long-term horizon into several sub-horizons. We also develop the branch-and-bound method on top of the dual decomposition, which enables to find a global optimal solution. The method has been implemented in an open-source optimization framework DSP that can run in parallel on high-performance computing clusters. In our computational experiments, we show significant reductions in solution time as compared with CPLEX.

4 - ADMM for SCUC: Effects of Market Characteristics and Subproblem Design on Algorithm Performance

Jesse Holzer, Pacific Northwest National Laboratory, 902 Battelle Blvd, Richland, WA, 99354, United States, Feng Pan, Yonghong Chen, Stephen Elbert

Security constrained unit commitment (SCUC) is the computational engine for day ahead wholesale electricity markets. As markets evolve, larger networks and numerous smaller energy resources pose increasing computational challenges for mixed integer programming (MIP) solvers. The alternating direction method of multipliers (ADMM) has been applied to SCUC as a scalable alternative to MIP. ADMM has guaranteed convergence in convex problems, but SCUC is nonconvex. We compare ADMM and MIP on large scale instances, observing that smaller and more numerous resources and larger subsystems tend to improve ADMM convergence but make the subproblems more expensive.

■ SC74

West Bldg 212A

Joint Session MCDM/Practice Curated: MCDM in Practice

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Lorraine Gardiner, Dalton State College

1 - Multi-Objective Delivery Allocation

Jonathon Leverenz, Systems Planning and Analysis, Inc, Alexandria, VA, 22302, United States, Stephanie Diane Brown, Chris Grubb

The Multi-Objective Delivery Allocation problem assigns delivery vehicles to jobs delivering equipment to a set of locations. Each vehicle is assigned a job and each job contains multiple locations. Locations can be assigned to multiple jobs and grouped together in various ways resulting in multiple options for each vehicle. Vehicle-location pairs are assigned a probability representing the chance of a successful delivery. Assignments are made under competing objectives that include cost, location coverage, probability of success, and expected number of completed deliveries. A network-with-gains model is used to make assignments and investigate tradeoffs between the various objectives.

2 - Blockchain's Impact on Digital Supply Chain: Contributions from MCDM

Birsen Karpak, Distinguished Professor, Youngstown State University, One University Plaza, WCBA 3303, Youngstown, OH, 44555, United States, Valerio A. Salomon

Digital Supply Chain (DSC) is about the way how supply chain processes are managed with a wide variety of innovative technologies, e.g. internet of things, big data, cloud computing, among others. Blockchain is the new-comer not explored even in the frameworks offered very recently. This study explores the impact of blockchain on digital supply chain and reports the findings of the implementation of a proposed DSC framework into an industrial real-case. Authors see a potential contribution from multiple criteria decision approaches.

3 - Weighting Criteria for Agriculture Planning: An Application of the Analytical Hierarchy Process

Jay Parsons, University of Nebraska-Lincoln, 103B Filley Hall, P.O. Box 830922, Lincoln, NE, 68583-0922, United States, Kathleen Brooks

A statewide farm financial health survey of Nebraska farmers and ranchers was conducted in 2016 to assess farm and ranch financial stress as a result of low commodity prices. In the survey, producers were asked a series of questions to assess the importance of different factors in their planning process. The analytical hierarchy process is used to identify the importance of the factor criteria for all respondents as a whole and for various segments of the sample population.

4 - Survey on the Practice and Implementation of MCDM

Lorraine R. Gardiner, Dalton State College, Wright School of Business, 650 College Drive, Dalton, GA, 30720, United States

The purpose of the research survey is to document and classify published accounts describing the practice of MCDM. The survey includes peer-reviewed articles that describe the actual use of one or more MCDM methods by decision makers in an organization. The author summarizes results by general problem area, organizational type, decision level, degree of organizational involvement and MCDM method category.

■ SD01

North Bldg 121A

Joint Session OPT/Practice Curated: Applications of Stochastic Programming

Sponsored: Optimization/Optimization Under Uncertainty

Sponsored Session

Chair: Amanda G. Smith, University of Wisconsin-Madison, Madison, WI, 53706, United States

1 - Leveraging Decomposition Methods to Design Robust Policies for Markov Decision Processes

Lauren N. Steimle, University of Michigan, 3261 Bolgos Circle, Ann Arbor, MI, 48105, United States, Brian T. Denton

Markov decision processes (MDPs) are commonly used to derive optimal sequential decision-making policies. However, these policies can underperform if the true model parameters differ from the estimates used in the optimization process. To address this issue, the Multi-model MDP has been proposed as a way to find a policy that performs well with respect to multiple models of the MDP parameters. Finding a policy that maximizes a weighted value across the models can be viewed as a two-stage stochastic program, and leveraging this connection, we develop exact and approximate solution methods that can be used to generate MDP policies that are robust to deviations in model parameters.

2 - Designing Resilient Distribution Systems Under Natural Disasters

Sadra Babaei, Oklahoma State University, 322 Engineering North, Industrial Engineering & Mgmt, Stillwater, OK, 74078, United States

This talk proposes a distributionally robust model for designing a distribution power system to withstand the risk of disruptions imposed by natural disasters. Using the moment information of asset failures, we build an ambiguity set of probability distributions of system contingencies. On the one hand, we consider the stochasticity of natural disasters and provide a less conservative configuration than that by a robust optimization approach. On the other hand, our model considers distributional ambiguity and so is more reliable than stochastic programming. We recast the model as a two-stage robust optimization formulation and solve it using the Column-and-Constraint Generation framework.

3 - Optimizing Flux Bound Change Decisions In Metabolic Engineering

Amanda Smith, University of Wisconsin-Madison, Fitchburg, WI, 53711, United States, James Luedtke

Bilevel mixed-integer programming models are frequently used to solve metabolic engineering problems. However, these models tend to push cells close to infeasibility, and solutions may yield non-viable organisms. To overcome this drawback, we

investigate three new bilevel MIP models that attempt to offer a compromise between desired output and organism viability. First, we introduce a bi-objective top-level problem. We then augment this model by incorporating enzyme kinetics and conclude with a stochastic extension that accounts for uncertainty in cellular behavior.

4 - Distributionally Robust Dual Dynamic Programming
Daniel Duque, Northwestern University, 2145 Sheridan Rd, Evanston, IL, 60208, United States, David Morton

We consider a multi-stage stochastic linear program that lends itself to solution by stochastic dual dynamic programming (SDDP). In this context, we consider a distributionally robust variant of the model with a finite number of realizations in each stage, and distributional robustness is with respect to the probability mass function governing candidate realizations. We describe a computationally tractable variant of SDDP to handle this model using the Wasserstein distance to characterize distributional uncertainty.

■ SD07

North Bldg 123

Joint Session OPT/Practice Curated: Network Analytics: Models and Applications

Sponsored: Optimization/Network Optimization

Sponsored Session

Chair: Jose Luis Walteros, University at Buffalo, SUNY, Buffalo, NY, 14260, United States

1 - An Integer Programming Approach for Vertex Connectivity Interdiction Problems
Demetrios Papazaharias, University at Buffalo, Buffalo, NY, 14260, United States, Jose Luis Walteros

The vertex connectivity interdiction problem entails finding the minimum subset of vertices in an undirected graph whose deletion achieves a desired reduction in the graph's connectivity. In particular, we aim to reduce the size of the largest component to at most k. In this paper, we introduce a 0-1 linear programming model with an extended formulation and cutting planes to strengthen its LP relaxation. We present computational experiments to compare our results to competing formulations as well as highlight interesting results for graphs containing a special structure.

2 - Distance Between Two Random Events in a Network
Ningji Wei, University at Buffalo, SUNY, Buffalo, NY, United States, Jose Luis Walteros, Rajan Batta

We are interested in the shortest distance D of two random events in any given connected network where the lengths of edges are not negligible. We found the closed form formula for its expectation, and any order higher moments. Also found its PDF in closed form. In application, we may encounter the situation that one distribution is under our control, so we also found those statistics for the shortest distance conditioning on one of the events. Further, we analyzed the property of there statistics, and also their computational complexity with respect to the size of the network. Finally, we applied our results on some special type networks.

3 - Optimal Corridor Design in Fragmented Landscapes
Chao Wang, Arizona State University, Tempe, AZ, United States, Jorge A. Sefair

Corridor design is fundamental in conservation planning to mitigate the adverse effects of habitat fragmentation. Current approaches focus on network analysis and landscape features but ignore the likelihood of movement and species mortality. To overcome these challenges, we present a discrete time Markov chain approach that allows us to predict transient and long-term connectivity measures. We also discuss a MIP formulation to find corridors with the highest expected usage to connect a network of fragmented landscapes. We discuss our models using a real case study of human-wildlife conflict.

4 - Studying the Trade-off Between Police Presence and Patrolling in a Road Network
Fatemeh Mousapour, University at Buffalo, Buffalo, NY, 14260, United States, Jose Luis Walteros, Rajan Batta

Patrolling and adequate coverage are two key factors in police patrolproblems respectively to stop, deter and prevent crimes. Our approach integrates some aspects of the traditional orienteering problem within a patrolling model to examine the trade-off between police presence in specific spots and patrolling through a road network.

■ SD08

North Bldg 124A

Joint Session OPT/Practice Curated: Network Design Models and Applications

Sponsored: Optimization/Network Optimization

Sponsored Session

Chair: Navid Matin Moghaddam, Arizona State University, AZ

1 - Large-scale Network Design with Application to Carbon Capture and Storage
Navid Matin Moghaddam, Tempe, AZ, 85281, United States, Jorge A. Sefair

Motivated by the emerging need of climate stabilization, CCS seeks to prevent carbon emissions from entering the atmosphere by capturing, compressing, and transporting CO2 from sources (e.g., oil refineries) to geologic reservoirs (e.g., depleted oil wells) for its long-term storage. To find the least-cost network of pipelines able to transport a target amount of CO2, we propose an optimization model and an exact decomposition algorithm that takes advantage of the optimal solution sparsity and the problem's cost structure. We illustrate the performance of our methods on a set of real instances.

2 - Profit Oriented Fixed-charge Network Design with Elastic Demand
Carlos Armando Zetina, Concordia University, 1455 de Maissonneuve Boulevard West, Montreal, QC, H3G 1M8, Canada, Ivan Contreras, Jean-Francois Cordeau

Networks require significant investments and their infrastructure is built to last over an extended period of time. It is unrealistic to believe that the demand patterns will remain the same during its lifetime. Moreover, demand patterns depend on the resulting network's topology, leading to sub-optimal designs if static estimations are used. We attempt to circumvent this by incorporating elastic demand into a fundamental network design problem. We replace static origin-destination demand estimations with functions of the network characteristics often used to estimate demand. This provides the decision-maker with insights on the effect the design has on demand patterns.

3 - Using Network Optimization to Extend the Transit Opportunity Index for Large-scale Transit Systems
Andres L. Medaglia, Professor, Universidad de los Andes, Cr 1 este Bogota, 111711, Colombia, Claudia D. Bedoya, Olga L. Sarmiento, Daniel A. Rodriguez, Jessica Camacho

The Transit Opportunity Index (TOI) quantifies accessibility and connectivity of a public mass transit system by combining spatial, temporal, and trip coverage metrics. We extended the TOI to allow for connectivity in large-scale transit systems where more than one transfer may be required. In this extended TOI we build a time-space network from the public transit supply and find shortest paths allowing multiple transfers. With the extended TOI, transit planners could adjust transit service to include opportunities and accessibility as design goals and address equity by identifying underserved areas. We illustrate the extended TOI with the public transit network of Bogotß, Colombia.

4 - The Wireless Network Design Problem Subject to Radio Interference
Hugh Medal, Mississippi State University, P.O. Box 9542, Msu, MS, 39762, United States, Will Leonard, Randy K. Buchanan

This paper studies the wireless network design problem, which considers how best to place a set of antennas so that the antennas can send and receive data in a way that maximizes total network throughput. A mixed-integer program was implemented to solve this problem using a Benders-decomposition approach. Maximal independent sets representing antennas' connections to one another were produced dynamically. The goal of this paper is to demonstrate whether utilizing directional antennas instead of omnidirectional antennas affects maximum throughput, as well as what changes occur to maximum throughput based on imposing constraints related to power and channel availability.

■ SD36

North Bldg 224B

Joint Session AAS/Practice Curated: Aviation Applications Section: Awards Finalists

Sponsored: Aviation Applications

Sponsored Session

Chair: Vikrant Vaze, Dartmouth College, 14 Engineering Drive, Murdough Center, Hanover, NH, 03755, United States

1 -Aviation Applications Section: Awards Finalists

■ SD42

North Bldg 227A

Joint Session ISim/Practice Curated: Simulation Modeling Applications

Sponsored: Simulation

Sponsored Session

Chair: Mohammad Dehghanimohammadabadi, Northeastern University, Boston, MA

1 - Estimating the Real Demand in Bike-Sharing Systems

Ashkan Negahban, Pennsylvania State University, 30 E. Swedesford Rd, Malvern, PA, 19355, United States

The objective of the first part of this presentation is to: (1) provide a formal comparison between the distribution of bike-inter pickup times and the underlying (latent) customer inter-arrival time; and, (2) propose an alternative data filtering method to improve demand estimation by preserving the portion of the observed bike inter-pickup times that represent actual customer inter-arrival times. The second part introduces an iterative methodology combining simulation, nonparameteric bootstrapping, and indifference-zone analysis to estimate the true demand in bike-sharing systems when data analysis approaches fail.

2 - Introducing an Efficient Way to Optimize a Simulated Model with Data-table Inputs

Mohammad Dehghanimohammadabadi, Northeastern University, 170 Brookline Avenue, Unit 1025, Boston, MA, 02115, United States

The major goal in simulation-optimization studies is to obtain the most appropriate configuration settings of the model. This could be easily achieved via embedded optimizers in simulation packages such as OptQuest. However, these optimizers fail to optimize the simulation models designed based on data-table inputs. This study extends the boundaries of the existing simulation-optimization tools by incorporating data-tables as a control parameter of the simulation model. This new approach could significantly enhance the applicability of the simulation and reduce efforts to optimize data-table driven simulation models.

3 - An Agent-based Model of Individual Forgetting and Learning Behavior in Epidemics

Kaiming Bi, Kansas State University, 1605 Roof Drive, Manhattan, KS, 66502, United States, Yuyang Chen, Chih-Hang Wu, David Ben-Arieh

We presents two mathematical models, information forgetting curve (IFC) model and memory reception fadingcumulating (MRFC) model, to examine forgetting and learning behaviors of individuals during an epidemic. Both models consider behavior-change information may affect agent emotions and subsequently influence an individual's behavior. IFC model utilizes a forgetting curve to process epidemic information, and MRFC model formulates disease information variations using the It process. An agent-based simulation model also developed to mimic the epidemic prevalence of the 2009 Chicago H1N1.

■ SD47

North Bldg 229A

Joint Session Tutorial/Practice Curated: Machine Learning and Data Mining with Combinatorial Optimization Algorithms

Emerging Topic: Practice Curated Track

Emerging Topic Session

Chair: Scott J. Mason, Clemson University, 273 Freeman Hall, Clemson, SC, 29634, United States

1 - Machine Learning and Data Mining with CombinatorialOptimization Algorithms

Dorit Simona Hochbaum, University of California-Berkeley, Dept of IEOR, 4135 Etcheverry Hall MC 177, Berkeley, CA, 94720-1777, United States

The dominant algorithms for machine learning tasks fall most often in the realm of AI or continuous optimization of intractable problems. This tutorial presents combinatorial algorithms for machine learning, data mining, and image segmentation that, unlike the majority of existing machine learning methods, utilize pairwise similarities. These algorithms are efficient and reduce the classification problem to a network flow problem on a graph. One of these algorithms addresses the problem of finding a cluster that is as dissimilar as possible from the complement, while having as much similarity as possible within the cluster. These two objectives are combined either as a ratio or with linear weights. This problem is a variant of normalized cut, which is intractable. The problem and the polynomial-time algorithm solving it are called HNC. It is demonstrated here, via an extensive empirical study, that incorporating the use of pairwise similarities improves accuracy of classification and clustering. However, a drawback of the use of similarities is the quadratic rate of growth in the size of the data. A methodology called "sparse computation has been devised to address and eliminate this quadratic growth. It is demonstrated that the technique of "sparse computation enables the scalability of similarity-based algorithms to very large-scale data sets while maintaining high levels of accuracy. We demonstrate several applications of variants of HNC for data mining, medical imaging, and image segmentation tasks, including a recent one in which HNC is among the top performing methods in a benchmark for cell identification in calcium imaging movies for neuroscience brain research.

■ SD48

North Bldg 229B

Joint Session ENRE/Practice Curated: Wildland Fire Decision Support I

Sponsored: Energy, Natural Res & the Environment Forestry

Sponsored Session

Chair: Yu Wei, Colorado State University, Fort Collins, CO, 80523, United States

1 - Identify and Present Large Fire Containment Strategies

Yu Wei, Colorado State University, Department of FRWS, Forestry 102, Fort Collins, CO, 80523, United States, Matt Thompson

Catastrophic large wildfire could threat human lives, properties and natural resources. Fire containment involves complicated decisions. We build an OR model to use stochastic fire simulation results to support large fire suppression effort. Instead of selecting only one optimal suppression strategy, our analyses provide a range of "good fire containment strategies based on a wide range of fire situation predictions, manager's risk preferences, resource availability levels, and other management restrictions. Model results lead to alternative suppression solutions that are organized through decision-trees to support fast decisions during a fire event.

2 - A Decision Support System for Dispatching Interagency Hotshot Crews

Erin Belval, Colorado State University, 1472 Campus Delivery, Fort Collins, CO, 80523, United States, Dave E. Calkin, Yu Wei, Crystal S. Stonesifer, Alex Taylor Masarie

Interagency Hotshot Crews (IHCs) are an important wildland fire suppression resource. During the fire season, they drive long distances to respond to ongoing and emerging fires; previous research has indicated that this driving could be reduced. We spent the summer of 2018 working with dispatchers to refine an existing optimization model to produce 1) a real-time dispatching tool and 2) a model that uses historical data to realistically examine the impacts on IHCs of changing various policies. In this presentation we discuss the process of refining the model with dispatching input, the current state of the real-time tool, and some results from the model utilizing historical data.

■ SD50

North Bldg 231A

Joint Session Practice/Practice Curated: Edelman Reprise II

Sponsored: INFORMS Section on Practice (formerly CPMS)

Sponsored Session

Chair: Anne G. Robinson, Verizon Wireless, Basking Ridge, NJ, 07920, United States

Co-Chair: Carrie Beam, University of Arkansas, Fayetteville, AR, 94596, United States

1- Pediatric Heart Network

Eva Lee, Georgia Tech, Industrial & Systems Engineering, Ctr for Operations Research in Medicine, Atlanta, GA, 30332-0205, United States

The Pediatric Heart Network enlisted researchers with the Georgia Institute of Technology to create clinical practice guidelines (CPG) for pre-, intra-, and post-surgical care of patients with congenital heart defects (CHDs), the most common birth defect, impacting nearly 1 million children and 1.4 million adults in the U.S. Substantial variances in surgical practices to treat patients with CHDs among different healthcare centers were reflected in inconsistent surgical outcomes, some of which resulted in negative consequences for patients. By studying the nine leading U.S. pediatric centers, the researchers identified seven significant factors for influencing surgical outcome, and implemented a CPG that enables patients to be removed from breathing apparatuses earlier, lowered the rate of reintubation, and decreased the time patients need to remain in the intensive care unit. These guidelines also realized a cost savings of 27 percent, which translates to $13,500 per patient.

2 - Analytics Makes Inventory Planning A Lights-Out Activity at Intel Corporation

Sean Willems, University of Tennessee, 617 Commodore Lane, Knoxville, TN, 37934, United States

Intel, which employs more than 100,000 people in over 70 countries around the world and has an annual revenue of $60 billion, implemented a fully automated Multi-Echelon Inventory Optimization (MEIO) based inventory target-setting system managing $1 billion daily in finished goods inventory representing over $40B a year in sales. Algorithm-derived inventory targets at Intel are accepted by planners +99.5 percent of the time and have simultaneously driven higher customer service and lower inventory levels resulting in over $1.3B in gross profit since 2014. In addition, customers are delighted: since MEIO was implemented at all of Intel's vendor managed inventory hubs in 2012, customer satisfaction has never been higher and Intel has landed in the top-10 of Gartner's Supply Chain Top-25 every year. Faculty in the department of Business Analytics and Statistics at the University of Tennessee, Knoxville and the supply chain software company Logility also contributed to this project.

■ SD51

North Bldg 231B

Joint Session OMS/Practice Curated: Applied Scheduling

Emerging Topic: Project Management and Scheduling, in Memory of Joe Leung,

Emerging Topic Session

Chair: Zhixin Liu, University of Michigan - Dearborn, 19000 Hubbard Dr, Dearborn, MI, 48126, United States

1 - Scheduling Jobs on Mixed Batching Machines

Guoqiang Fan, Northwestern Polytechnical University, 127 West Youyi Road, Xi'an, SN 29, China, Junqiang Wang

This paper considers a mixed batching model that is different from the parallel-batch and the serial-batch. The mixed batching machine can process at most b jobs simultaneously. The processing time of a batch is the weighted sum of the maximum processing time and the total processing time of the jobs in the batch. The objective is to minimize the makespan. We first prove that the Full Batch Longest Processing Time (FBLPT) algorithm yields an optimal schedule for the problem on a single mixed batching machine. Then we show the NP-hardness of the problem on parallel mixed batching machines. We analyze the worst-case ratio of FBLPT algorithm and a modified-FBLPT algorithm.

2 - Introducing Swing Shifts to Dynamically Respond to Emergency Department Workload Uncertainty

David L. Kaufman, University of Michigan - Dearborn, 19000 Hubbard Drive, Fairlane Center South, Dearborn, MI, 48126, United States, Kalyan Pasupathy, Daniel Cabrera, Mustafa Y. Sir

A fundamental problem of emergency care is matching resources to uncertain patient demands. Staffing allocation decisions require good matching with workloads but also consider the needs of emergency providers at very high risk of burnout. Mayo Clinic Emergency Department recently introduced a "swing shift, which allows physicians to leave early depending on a workload threshold. While popular, swing shifts introduce several challenges: How to design a threshold mechanism? What is the optimal length of the furlough? When should these shifts start and what is their impact? We introduce an effective and tractable data-driven optimization model for a complex stochastic problem.

3 - Maximizing On-time Jobs for the Customer Order Scheduling Problem

Hairong Zhao, Purdue University Northwest, 2200 169 Street, Hammond, IN, 46323, United States

We consider the problem of scheduling multi-task jobs on parallel machines. Each job consists of one or more tasks. Each job has a release date and a due date. A task of a job can be processed by any one of the machines. Multiple machines can process the tasks of a job concurrently. The objective is maximizing the number of on-time jobs. We show that while the general problem is NP-hard, some special cases are solvable. For the general case, we develop some heuristics whose performance is evaluated by experimental results.

4 - Cost Allocation in Rescheduling with Machine Unavailable Period

Zhixin Liu, University of Michigan-Dearborn, 19000 Hubbard Drive, Dearborn, MI, 48126-4100, United States, Liang Lu, Xiangtong Qi

We study a rescheduling problem faced by multiple jobs owners sharing a single machine, where jobs need to be rescheduled, when the machine becomes unavailable for a period. We define a feasible schedule over which cost saving can be achieved by optimal rescheduling, and then formulate a cooperative game for job owners accordingly, to share the cost saving. Given that the optimization problem is computationally intractable, we find several optimal properties and develop an optimal pseudopolynomial time dynamic programming algorithm for rescheduling. We provide a simple closed form core allocation of the total cost saving for all the jobs, and provide the Shapley value of the game in a computable form.

■ SD55

North Bldg 232C

Joint Session Sports/Practice Curated: Sports Analytics III

Sponsored: SpORts

Sponsored Session

Chair: Keith A. Willoughby, University of Saskatchewan, Saskatoon, SK, S7N 5A7, Canada

1 - Ratio Breakers: Analyzing Drafting Strategy in the Canadian Football League

Keith A. Willoughby, University of Saskatchewan, Department of Finance and Mangement Science, Saskatoon, SK, S7N 5A7, Canada, Kent Kostuk

The Canadian Football League (CFL) deploys a "game rule ratio mandating that Canadian athletes comprise at least 21 members of a team's 44-player roster. This regulation requires team management to strategically evaluate Canadian talent in order to assemble competitive rosters. The primary source of Canadian player recruitment is the league's annual draft. We analyze over two decades of draft results and determine a number of insights to guide drafting strategies.

2 - Modeling Extra Inning Decisions in Softball

Kent J. Kostuk, Federated Co-Operatives Limited, 9 Cantlon Crescent, Saskatoon, SK, S7J 2T2, Canada, Keith A. Willoughby

In softball when teams are tied after the regulation 7th inning they continue to play additional innings to determine a winner. In an effort to reduce the number of extra innings, each half inning starts with a runner on 2nd base. A typical defensive philosophy is to always focus on preventing runners from advancing. Alternatively, offensively teams will typically bunt; sacrificing an out in an effort to improve the likelihood of scoring. We will develop a model that will allow us to quantify the efficacy of these classic defensive and offensive strategies.

3 - Understanding the Female/male Velocity Ratio of Olympic Champions in Running, Speed Skating, Swimming and Rowing

Raymond Stefani, California State University, Long Beach, CA, United States

Photographs of male and female Olympic champions taken about 80 years apart show little change in physiology but major changes in the competitive conditions that would increase efficiency. Thus, if both genders are now equally trained and equally efficient, then performance ratios should depend on physiology ratios, which are likely to have changed little. Equations are derived from physiology and physics for which power times efficiency depends on performance, physiology and other factors common to both genders. Assuming equal training and efficiency, the velocity ratio of female/male Olympic champions simplify when populated with kinesiology data from over 2000 athletes in the various types of competition. The velocity ratio for running and speed skating is estimated to be the relative lean-to-weight (LTW) ratio while for swimming and rowing the estimate is the 8/9 power of the relative LTW ratio. The approach appears to be validated in that, for 1992-2016, elite female athletes had 90% of the lean-to-weight ratio that men had and, in fact, their Olympic champions ran, swam and rowed about 90% as fast. For 1980 to 2014, in speed skating, elite female athletes had 92% of the lean-to-weight ratio of men and their Olympic champions skated 92% as fast.

4 - Predictive Power of the (1, a) Method Compared to Traditional Sports Ranking Methods

Baback Vaziri, James Madison University, 2210 Reserve Circle, Unit 203, Rockingham, VA, 22801, United States, Shaunak Dabadghao

Ideally, a ranking method for a sports tournament will be not only fair and comprehensive, but it will also possess strong predictive power. In a recent article, the (1, a) method was proposed as being fair and comprehensive in comparison with other popular sports ranking methods. In this study, we compare the predictive power of the (1, a) method against five (5) popular sports ranking methods for NFL, NHL and NBA seasons from 2001-2015. We also show which values of a are best suited for the (1, a) method to maximize the methods' predictive power based on sport.

5 - Effects of Major League Baseball Manager Attributes on Team Performance

Seong Dae Kim, Associate Professor, University of Tennessee at Chattanooga, Chattanooga, TN, 37403, United States, J.C. Kim

For the 2017 season, an average salary of the top-5 highest-paid managers is a $4.5 M. 4 out of 5 managers are employed with teams located in large cities. Many of them have a lot of experience as a manager and are highly paid. But hiring an experienced manager could be a difficult decision to teams in small markets. Teams may want to consider hiring a more affordable and less experienced but promising young manager to save money to hire good players. To address this problem, this study analyzes data sets about MLB managers using data analytics techniques to explore the effects of the manager's attributes on the team performance. This study will help MLB teams hire a right manager with a tight budget.

■ SD62

West Bldg 103A

Joint Session DM/Practice Curated: Data Science in Social Media & Societal Issues

Sponsored: Data Mining

Sponsored Session

Chair: Mohammad Abdollahi, Wayne State University, 4815 Fourth Street, Room 1067, Detroit, MI, 48202, United States

1 - Annual Report Readability, Timeliness, and Earnings

Yuan Song, Tongji University, Room 1413, Tongji Building A, Siping Rd 1500, Shanghai, 200092, China, Shouyi Wang, Hongwei Wang

This paper studies the associations between earnings and annual report readability and timeliness based on China's capital market. Empirical results indicate that firms with higher earnings are likely to disclose their annual reports earlier in a timely manner and smaller document size; the annual reports of firms with lower earnings are later disclosed and harder to read in a larger file size. The results are consistent with both firms reporting a loss and firms with positive earnings. Additionally, among China's multi-tier capital market system, the annual report readability and timeliness in SHSE are more powerful to explain earnings than in SZMB and SME.

2 - Rethinking Resilience Analytics for Cyber-physical-social Systems

David L. Alderson, Naval Postgraduate School, 1411 Cunningham Road, Monterey, CA, 93943, United States, Daniel Eisenberg, Thomas P. Seager

The concept of `resilience analytics' has been proposed to leverage the promise of big data and associated analytic techniques to improve the resilience of interdependent critical infrastructure systems and the communities supported by them. Given the prevalence of high-profile disasters and advances in data-driven analytic techniques, the temptation to develop resilience analytics without question is almost overwhelming. However, without critical examination of the assumptions and limitations of existing analytics, such efforts may ironically create more brittle cyber-physical-social (CPS) systems from overconfidence, myopia, and/or loss of adaptive or innovative capacity.

3 - A Deep Learning Approach for Travel Time Prediction

Mohammad Abdollahi, Wayne State University, 4815 Fourth Street, Room 1067, Detroit, MI, 48202, United States, Kai Yang

Travel time is a fundamental measure in transportation which its accurate prediction is also crucial to the development of intelligent transportation systems. In this paper, we study travel time prediction for New York cabs using deep learning. First, we extract features (by clustering and other techniques) and combine different datasets such as weather and fastest routes. Then, a deep stacked autoencoder for feature representation is presented. These feature transformation makes the feature space more robust and less prone to overfitting. Finally, we compare the effect of feature extraction on performance of different regressors such as boosted trees, deep belief networks, and etc.

3 - Evaluating Alternative Models for Evaluating the Daily Deployment of Airtankers for Forest Fire Suppression

David L. Martell, University of Toronto, Faculty of Forestry, 33 Willcocks Street, Toronto, ON, M5S 3B3, Canada

Forest fire management agencies often use airtankers to assist with initial attack on fires and as is the case with other emergency response systems, response time is crucial. Each day the regional duty officer must decide where to deploy his or her airtankers to minimize their expected response time given the predicted fire arrival rates. Resolution of the daily airtanker deployment problem calls for the design and control of a complex spatial queueing system with time-dependant arrival rates and complex service processes. We explore the merits of using alternative simplified initial attack process models to evaluate daily airtanker deployment strategies.

■ SD64

West Bldg 104A

Joint Session DM/Practice Curated: Data Science and Analytics in Healthcare II

Sponsored: Data Mining

Sponsored Session

Chair: Dung Hai Nguyen, Mercy Health, 655 Maryville Center Drive, Saint Louis, MO, 63141, United States

1 - Advances in Density-based Gaze Fixation Identification: Optimization for Outlier Sensitivity, and Automated Detection of Density-modulation Parameter

Wen Liu, Worcester Polytechnic Institute, Worcester, MA, United States, Andrew C. Trapp, Soussan Djamabsi

Eye tracking is an increasingly common technology with applications to healthcare. Of great interest in eye-tracking studies are fixations, indicative of attention and awareness. However, eye-tracker imprecision can lead to outlier points, e.g. blinks or other anomalies. We extend our density-based fixation identification optimization formulations to account for outlier sensitivity. As our formulations are parameterized by a key density-modulation parameter, we also discuss machine learning approaches for its automatic detection. We conclude with encouraging computational results.

2 - A Continuous Time Bayesian Network Model for Identifying Patterns of Multiple Chronic Conditions

Syed Hasib Akhter Faruqui, Graduate Research Assistant, University of Texas-San Antonio, San Antonio, TX, 78256, United States, Adel Alaeddini, Carlos A. Jaramillo, Mary Jo Pugh

Emergence of multiple chronic conditions (MCC) adds complexity in managing patient healthcare design, care, and cost. Hence, it is required to have an effective management of MCC that uses real-time decision making in a big data setting. The proposed study uses de-identified data from a large national cohort of patients (N = 608,503) who entered care in the Department of Veterans Affairs, to identify the risk factors that affect the evolution of MCC. A Continuous Time Bayesian Network is used to examine the interactions of patient disease states and identify major dependencies among MCC that can be used to predict the onset of emerging conditions according to patient level risk factors.

■ SD65

West Bldg 104B

Joint Session DM/Practice Curated: Big Data, Text Mining, and E-commerce

Sponsored: Data Mining

Sponsored Session

Chair: Amarpreet Kohli, University of Southern Maine, P.O. B, Portland, ME, 04104, United States

1 - Dynamic Seed Identification and Activation for Influence Maximization

Yerasani Sinjana, Research Scholar, Indian Institute of Technology Kharagpur, Kharagpur, 721302, India, Monalisa Sarma, Manoj Kumar Tiwari

In this paper, we consider a network where a set of nodes are termed as seed nodes at each time interval in scheduling seed activation. Seeds are tactically activated for maximizing the spread of influence on social networks: Given a time period for activation, campaign budget, and a network where a set of nodes can be selected as seeds to propagate information. At each stage, time-dependent partial activation of nodes information is used to track the opinions and awareness of users. Activating different users at different periods of time can be termed as Dynamic Seed Activation Problem and can be rewritten as mixed integer programming. A memetic algorithm is employed for scheduling seed activation.

2 - Putting Prediction into Practice: The Case of Restaurant Hygiene Inspections

Michael Luca, Harvard Business School, Boston, MA, United States, Edward Glaeser, Andrew Hillis, Hyunjin Kim

Partnering with Yelp and the City of Boston, we run an experiment comparing an inspector-curated list of restaurants to inspect (i.e.business-as-usual) to algorithm-created lists based on predictions of which restaurants are most likely to have health code violations. We find that even simple algorithms outperform business-as-usual, identifying 50% more violations per inspection. However, one practical barrier to implementing algorithms is compliance - inspectors were less likely comply with a directive to inspect a restaurant based on the algorithm. The algorithm also has fairness implications. For example, the algorithm-based predictions were more likely to target ethnic restaurants.

3 - Text Analysis for Educational Crowdfunding Success: Comparison between Different Textual Components

Mingyan Xu, Baruch Collge, New York, NY, 10075, United States

Educational crowdfunding is emerging as a salient hit on online platforms. Despite its growing popularity, the antecedents of funding success are far from certain. To help the fundraisers (i.e. teachers) better understand factors affecting funding success and improve their success rate, this study provides an empirical analysis on one large U.S. educational crowdfunding platform. Specifically, it analyzes the impact of the textual features from different components of the project description on funding success and identifies the differences of the impact on different levels of the project economic needs. The implications of the findings for fundraisers have also been discussed.

4 - How User-generated Content Predict Box-office Sales for Different Movie Genres

Pei-Hua Chen, National Chiao Tung University, Hsin-Chu, 300, Taiwan, Chia-Tze Chang

This study explored the factors that affect two kinds of movie-goers: innovators and imitators. For Innovators, we included casts of the movies and various movie attributes to predict box-office sales on opening weekends. In addition to the variables used for innovators, we added user-generated-contents to predict sales

increase for imitators. We analyzed the effects of movie-goer emotions and experiences on box-office sales for different movie genres. The results showed that different movie genres provide different experiences and emotions for movie-goers.

5 - Using Text Mining to Analyze Consumer Brands Sentiments of Smart Watches

Amarpreet Kohli, Associate Professor, University of Southern Maine, P.O.Box 9300, Portland, ME, 04104, United States, Solomon Nkhalamba, Zhenning Xu

Social media has been a significant part of many businesses and organizations. Many firms are utilizing social media platforms to interact with their customers and clients to gauge value of their products and services through diverse stakeholders. The advent of social media platforms such as Twitter and Facebook have provided companies with easier access to collect customer opinions or reviews than the traditional survey methods and focus group approaches. To demonstrate the great potential of social media in unlocking the useful knowledge of market products, this paper uses text mining to analyze consumers' twitter sentiments of smart watches.

■ SD67

West Bldg 105B

Joint Session ISS/Practice Curated: AI and Smart Technologies

Sponsored: Information Systems

Sponsored Session

Chair: Xinxin Li, University of Connecticut, University of Connecticut, Storrs, CT, 06269, United States

1 - Reinforcement Mechanism Design, with Applications to Dynamic Pricing in Sponsored Search Auctions

Michael Zhang, Professor, Chinese University of Hong Kong, Decision Sciences and Managerial Economics, 9th Floor, CYT Building, Shatin, N.T., Hong Kong, Weiran Shen, Binghui Peng, Hanpeng Liu, Ruohan Qian, Yan Hong, Zhi Guo, Zongyao Ding, Pengjun Lu, Pingzhong Tang

We apply reinforcement learning techniques and propose what we call reinforcement mechanism design to tackle the dynamic pricing problem in sponsored search auctions. In contrast to previous works that rely on rationality and common knowledge among the bidders, we take a data-driven approach. We implement our proposed technique at a major search engine: We first train a buyer behavior model with a real bidding data set. We then put forward a reinforcement/MDP (Markov Decision Process)-based algorithm that optimizes reserve prices over time, in a GSP-like auction. Experiments demonstrate that our framework outperforms several strategies currently in use.

2 - The Dynamic Impact of Quantity Restriciton on Backers' Investment Intention

Zhijin Zhou, University of Washington, Foster School of Business, Seattle, WA, 98195, United States, Chaoliang Ma, Yong Tan

We analyze the effect of implementing quantity restriction, a prevalent marketing strategy to promote sales in the off-line market, in the context of crowdfunding. Using a dynamic panel dataset, we start with a preliminary analysis to get insights into backers' basic response patterns. Then, we extend our model and allows for (a) varying parameters to fully capture the underlying dynamics, (b) correlation in the errors that might affect parameter evolving process. Our results suggest that the scarcity of a product increases backers' overall evaluation of the product, while it plays a moderating role in attenuating backers' reliance on peers' action and decreasing their price sensitivity.

3 - A Model of Smart Technologies

Xinxin Li, University of Connecticut, 2100 Hillside Road U-1041, Storrs, CT, 06269, United States, Yuxin Chen, Monic Sun

We study the optimal pricing and design of smart technologies that are based on artificial intelligence (AI) and can learn consumers' preferences over time. Our preliminary analysis suggests that it is not always profitable to increase the smartness of a firm's technology even when doing so does not involve direct costs. The "price in our model can be interpreted as either a direct price that consumers have to pay to the firm or a form of advertising exposure. Correspondingly, our model has implications not only for the pricing and design of smart technologies and their interaction with consumers, but also for platforms on which advertisers aim to target the users of smart technologies.

4 - Too Much of a Good Thing?

Wei Zhou, PhD Student, University of Arizona, Tucson, AZ, 85721, United States, Mingfeng Lin

The importance of reputation online is well established and is especially true for service-oriented markets spanning such as professional services. We explore limits to such claims using a detailed transactional dataset and discuss implications for designing such reputation systems.

■ SD71

West Bldg 106C

Joint Session ICS/Practice Curated: Advances in Computational Stochastic Optimization and Applications

Sponsored: Computing

Sponsored Session

Chair: Harsha Gangammanavar, Southern Methodist University, Dallas, TX, 75275, United States

1 - Monte Carlo Tree Search with Sampled Information Relaxation Dual Bounds

Lina Al-Kanj, Princeton University, Olden Street, Sherrerd Hall, Office 115, Princeton, NJ, 08542, United States, Daniel Jiang, Warren B. Powell

MCTS is a well-known strategy for solving sequential decision problems, particularly in the area of game-play AI. We propose a new technique called Primal-Dual MCTS that utilizes sampled information relaxation (Brown et. al., 2010) bounds on potential actions in order to make tree expansion decisions. The approach shows promise when used to optimize the behavior of a driver navigating a graph while operating on a ride-sharing platform.

2 - Variable Sample-size Stochastic Approximation Scheme for Two-stage Stochastic Economic Dispatch

Wendian Wan, Pennsylvania State University, 351 Leonhard Building, University Park, PA, 16802, United States, Uday Shanbhag, Mort David Webster

This talk introduces the development of variable sample-size stochastic approximation schemes for two-stage stochastic convex programs. Our focus lies in applying this class of schemes towards the solution of a broad class of adaptive stochastic decision-making problems arising in the operation of large-scale power systems. In this talk, we consider the stochastic economic dispatch problem. In such problems, a first-stage dispatch is made contingent on taking a recourse decision when the uncertainty reveals itself. Preliminary numerics reveal that the proposed schemes provide accurate solutions but require far less time than traditional approaches like standard stochastic approximation.

3 - Stochastic Decomposition for Two-stage Stochastic Linear Programs with Random Cost Coefficients

Harsha Gangammanavar, Southern Methodist University, Department of EMIS, P.O. Box 750123, Dallas, TX, 75275, United States, Yifan Liu, Suvrajeet Sen

The Stochastic Decomposition (SD) algorithm has been a computationally proficient tool to tackle real-scale stochastic optimization problems arising in practical applications. In this talk we present new enhancements to this sequential sampling-based algorithm to address two-stage stochastic linear programs with random cost coefficients. We demonstrate their performance through results from our computational experiments.

4 - Simulation-based Hybrid Stochastic Approximation using Common Random Numbers

Marie Chau, Virginia Commonwealth University, 1015 Floyd Avenue, Richmond, VA, 23220, United States, Jong J. Lee, Michael Fu

Common Random Numbers (CRN) is a variance reduction method, which can be used to increase the typical O(n-1/3) convergence rate of gradient-free stochastic approximation (SA) to match the optimal O(n-1/2) convergence rate of gradient-based SA. Secant-Tangents AveRaged (STAR) and adaptive Secant-Tangents AveRaged (aSTAR) simultaneous perturbation SA are hybrid methods, which combine gradient-free and gradient-based SA algorithms. By applying CRN assumptions, STAR and aSTAR can a

■ MA29

North Bldg 221B

Joint Session TSL/Practice Curated: Game-theoretic Applications in Urban Transport

Sponsored: TSL/Urban Transportation

Sponsored Session

Chair: Joseph Y. J. Chow, New York University, New York, NY, 10012, United States

1 - Highway Infrastructure Protection Against Sea Level Rise: Game Theoretical Approaches

ILIA Papakonstantinou, NYU, Brooklyn, NY, 11209, United States

This research investigates the differences between game theoretical approaches among decision makers protecting their infrastructure against sea level rise. We take into account the hydrodynamic interactions, transportation system adaptation to

inundations due to sea level rise, and budget constraints. Both competitive and cooperative games are considered, where each decision maker aims to minimize traffic delays within its territory caused by the network disruptions due to sea level rise. A case study of the San Francisco Bay area for 0.5m sea level rise is used. The results of different games are compared for a range of budgeting scenarios.

2 - A Many-to-many Auction-based Multimodal Network Assignment Game

Theodoros P. Pantelidis, New York University, Brooklyn, NY, United States

Urban transportation networks are multi-dimensional complex systems that serve large numbers of travelers every day. These complex multimodal systems can be considered as multiple smaller networks which are privately owned by transit operators. When considering pricing and capacity decisions, operators take into account only volume flows in their own network and fail to capture the effects of multimodal trips. In this study, we propose an auction-based game theoretic approach, where travelers act as buyers and network edges as market products that belong to a set of sellers, in order to find the optimal allocation that maximizes joint profits.

3 - Modeling On-demand Mobility Service: Competition, Surge Pricing, and Subsidy

Xinwu Qian, Purdue University, 3326 Putnam Street, West Lafayette, IN, 47906, United States, Satish Ukkusuri

The study presents the mathematical model for the competition among stakeholders, riders, and drivers in the market of on-demand mobility service. We consider that the stakeholders propose the surge pricing and subisdy policies to maximize their revenue, riders decide whether or not make the trip based on the perceived travel cost, and the drivers decide whether they will leave/enter the market and the location to pick up riders based on their perceived utility. Our results indicate that market efficiency depends on how drivers value their lost for leaving the market. We also observe that subsidizing occupied and vacant trips are important as a regulation to drivers' selfish behavior.

4 - Modeling Competition of Intermodal Infrastructure Investors Factoring Their Heterogeneity and Maritime Carrier Behavior

Irina Benedyk, Purdue University, 2411 Neil Armstrong Drrive, # 2A, West Lafayette, IN, 47906, United States, Srinivas Peeta

This study develops a game theoretical framework that allows one-to-many relationship between investors and intermodal ports, and factors impacts of maritime carrier competing behavior, and investor heterogeneity (defined as a number of intermodal ports under their control) on the investment decision-making process. A solution algorithm is developed to identify and analyze the Nash equilibrium and demonstrate its applicability using the case study of the Northeast U.S. intermodal ports. The study findings can be used by the public sector to evaluate impacts of policies and incentives on intermodal infrastructure development.

■ MA36

North Bldg 224B

Joint Session AAS/Practice Curated: Airline Crew Management

Sponsored: Aviation Applications

Sponsored Session

Chair: Bruno F. Santos, TU Delft, Delft, 2629 HS, Netherlands

1 - Generating Crew Pairings for Cargo Aviation

Junhong Guo, University of Michigan, Ann Arbor, M I, United States, Amy Cohn

We consider a variation of the airline crew pairing problem in which we focus on the challenges faced by a cargo carrier with predominantly long-haul international flights. The difference in rules and pairing characteristics relative to domestic passenger aviation (e.g. pairings are typically on the order of 15 days) provide both challenges and opportunities. We present heuristics and optimization-based approaches for improving this process.

2 - Dynamic Design of Reserve Crew Pairings for Long Haul Airline Crew

Lennart Scherp, PhD Candidate, Delft University ot Technology, Delft, Netherlands, Richard Janssen, Bruno F. Santos

In this work we propose a new reserve crew pairings generation algorithm. A method is used that iteratively selects a set of pairings and evaluates them based on simulations of roster disruptions to obtain the most efficient set of reserve pairings. The goal is to minimize the effects of disruptions on rosters. Results show improvements of about 5% over the current approach used by a large European airline.

3 - Airline Crew Scheduling with Re-timing and Complex Aircraft Connection Rules

Fredrik Altenstedt, Optimization Expert, Jeppesen, Odinsgatan 9, G÷teborg, SE-411 03, Sweden

This presentation considers finding crew trips covering all flights for an airline given that we may adjust the flight times slightly, commonly known as the pairing problem with retiming. The aircraft routes influence the crew rules, shorter connections are allowed if the crew does not change aircraft. Both re-timings and short connections may require extra aircraft. This is normally prevented using plane count constraints, but these only work for simple connection rules. We give an overview of how we maintain aircraft feasibility for more complex rules by generating aircraft consistency constraints dynamically as well as share our experience from using the system with one of our clients.

4 - Shift Scheduling with Flexible Execution Times and Sequence Dependent Travel

Pouya Barahimi, Oregon State University, Corvallis, OR, 97331, United States, Hector Vergara

We consider the scheduling problem where each task may require multiple workers with different skills. Tasks have fixed duration and can be executed within a given time window. Travel times between tasks are different. The objective is to maximize the reward gained by executing tasks given a limited team of workers. A branch-and-price algorithm and two heuristics are developed to solve instances. A numerical study assessing the effect of inputs on run-time and quality of the solutions obtained is presented. The problem is presented in the context of the airline industry where ground crew located at an airport perform tasks to get flights ready for departure.

5 - Modeling Flight Effort in Air Operations Training Programs

Sergio Rebou as, Technological Institute of Aeronautics, Pra a Marechal Eduardo Gomes, 50, Sao Jose dos Campos, Brazil, Talita Alessandra da Silva, Fernando Teixeira Abrahπo

The flight effort forecasting in pilot training programs is a challenge for civil and military organizations. The mobilization of material and human resources to support air operations is the main factor of impact in their economic health and administrative efforts. The logistic and operational support contracts are based on this forecast, whose inaccuracy would imply significant financial and administrative consequences. This article describes a method to estimate flight effort based on a pilot's training program, integrating the individual instructions, operational and maintenance constraints and historical data, with the objective of maximizing its accuracy.

■ MA45

North Bldg 228A

Joint Session ENRE/Practice Curated: Power Systems Analytics

Sponsored: Energy, Natural Res & the Environment/Electricity

Sponsored Session

Chair: Shmuel S. Oren, University of California-Berkeley, Berkeley, CA, 94720-1777, United States

Co-Chair: Georgios Patsakis, University of California Berkeley, University of California Berkeley, Berkeley, CA, 94702, United States

1 - An Oligopoly Power Market Model in Presence of Strategic Prosumers

Sepehr Ramyar, University of California-Santa Cruz, Santa Cruz, CA, United States, Yihsu Chen

We investigate the formation of wholesale power prices in presence of strategic prosumers and analyze how the unconventional behavior of agents capable of consumption and generation at the same time can impact wholesale power markets. In this study, the price is determined endogenously by strategic prosumers along with other market participants. We study the behavior of prosumers under price-taking assumption and then contrast it with results from Cournot oligopoly with strategic prosumers. We discuss and report the results of price and social surplus implications.

2 - Sequential Pricing and Intermittent Supply in Electricity Markets with Heterogeneous Traders

Derck Koolen, Rotterdam School of Management, Chris Bennekerslaan 29Q, Rotterdam, 3061EB, Netherlands, Wolfgang Ketter, Liangfei Qiu, Alok Gupta

Motivated by the ongoing integration of renewable energy sources, we analyze sequential market pricing in short-term electricity markets with producers operating under heterogeneous constraints. We propose a multi-stage competitive equilibrium model to analyze retailers and heterogeneous producers' optimal sequential trading. The simulated value of flexibility, indicating a first-mover advantage, is validated empirically for different countries.

3 - Comparison of Tools to Address Profound Uncertainty in Power Systems

Evangelia Spyrou, Johns Hopkins University, 3400 N. Charles Street, Geography and Environmental Engineer, Baltimore, MD, 21218, United States, Benjamin Field Hobbs

Many tools have been developed to aid decision making under uncertainty. However, most power system analyses tend to use a single particular tool such as

stochastic programming or robust optimization. Here, we critically review available tools including Robust Decision Making, which is widely used by the climate change adaptation community, and discuss their strengths and weaknesses. We investigate both theoretical properties of the tools and their practical performance through examples drawn from World Bank studies of climate and conflict risks.

4 - A Bound Strengthening Method for Optimal Transmission Switching in Power Systems

Salar Fattahi, University of California-Berkeley, Berkeley, CA, 94702, United States, Javad Lavaei, Alper Atamturk

This paper studies the optimal transmission switching (OTS) problem for power systems. Most of the existing methods for the problem are based on first converting the OTS into a mixed-integer linear program (MILP) or quadratic program (MIQP), and then iteratively solving a series of its convex relaxations. In this work, it is shown that finding the strongest big-M inequalities to be used in an MILP or MIQP formulation of the OTS is NP-hard. Despite the difficulty of obtaining the strongest bounds in general, a simple bound strengthening method is presented to strengthen the convex relaxation of the problem. Remarkable improvements in the performance of the solvers are achieved compared to other methods.

■ MA50

North Bldg 231A

Joint Session Practice/Analytics/Practice Curated: IAAA Winner Reprise: Northwestern University's Marathon Data Visualization Drives Safety

Sponsored: INFORMS Section on Practice (formerly CPMS)

Sponsored Session

Chair: Carrie Beam, University of Arkansas, Walnut Creek, CA, 94596, United States

1 - SAFE (Situational Awareness for Events): A Data Visualization System

Karen Smilowitz, Northwestern University, Industrial Engineering Management Scienc, 2145 Sheridan Road RM D239, Evanston, IL, 60208, United States

Marathons are growing in popularity, requiring significant resources to ensure safety and success. A team from Northwestern University and the Bank of America Chicago Marathon developed a data visualization system that uses analytics to monitor participants and manage resources. The system has been deployed at marathons in Chicago and Houston.

■ MA64

West Bldg 104A

Joint Session DM/Practice Curated: Data Science and Analytics in Healthcare II

Sponsored: Data Mining

Sponsored Session

Chair: Durai Sundaramoorthi, Washington University in Saint Louis, 10352 Conway Road, Saint Louis, MO, 63131, United States

1 - Machine Learning Based Hypoglycemia Recognition from Driving Patterns in Individuals with Diabetes Mellitus

Mathias Kraus, ETH Zuerich, Zuerich, Switzerland, Stefan Feuerriegel, Elgar Fleisch, Tobias Kowatsch, Markus Laimer, Christoph Stettler, Felix Wortmann, Thomas Z ger

Hypoglycemia has consistently been shown to be associated with an increased risk of driving mishaps. As a prevention, we propose to utilize machine learning models to detect and predict hypoglycemia based on driving behavior. We compare data about the driving behavior by tracking individuals with/without hypoglycemic condition. Our preliminary evaluation using a driving simulator confirm the effectiveness of our approach.

2 - Using Machine Learning Techniques to Determine Preterm Birth Risk Factors

Alireza Ebrahimvandi, Virginia Tech, Blacksburg, VA, 24060, United States

Preterm birthùbirth before 37 wksùis a major health issue in the US and its predictors are poorly known. Prior studies applied machine learning techniques to identify variables that can predict preterm. We will use two machine learning techniquesùlasso regression and support vector machinesùon a much larger dataset obtained from Center for Disease Control to identify key predictors of preterm. We expect to improve sensitivity of prediction by using a larger dataset. Improving one percent sensitivity of prediction tests is valuable because every preterm birth costs about $10,000, and 1% decrease in preterm births translates to half a billion dollars saving plus preventing long life deficiencies.

3 - Combining Observational Data and Meta-analysis Results for Evaluating Impact of Behavior Changes on Disability Adjusted Life Years

Ozden F. Gur Ali, Koc University, College of Administrative Sciences, Rumeli Feneri Yolu Sariyer, Istanbul, 34450, Turkey, Angi Ghanem

We introduce a method to combine individual level observational data with meta-analysis results of extant research to evaluate the potential impact of a public health intervention. We show that both pieces of information are needed to get causally defensible models that reflect the local effects, adjust for important individual level covariates, and guard against confounding. We apply the method to provide point and interval estimates of the impact of changes in behaviors like physical exercise, smoking, and diet on disability adjusted life years (DALY) due to prevalence of heart disease and diabetes.

■ MA65

West Bldg 104B

Joint Session APS/Opt-Uncert/Practice Curated: APS Session Uday

Sponsored: Applied Probability

Sponsored Session

Chair: Uday Shanbhag, Pennsylvania State University, University Park, PA, 16803, United States

1 - Randomized Push-pull Method for Optimization on Graphs

Angelia Nedich, ASU, 650 E. Tayler Mall, Goldwater Center, Rm 311, Tempe, AZ, 85281, United States

We consider a randomized push-pull algorithm for distributed optimization on graphs. The method is based on a random asynchronous implementation of push-pull method recently proposed for minimizing the sum of the agents' cost functions in a network that obeys the network connectivity structure. In order to minimize the sum of the cost functions, a new distributed gradient-based method where each node maintains two estimates, namely, an estimate of the optimal decision variable and an estimate of the gradient for the average of the agents' objective functions. We show convergence results for the method over a directed static network.

2 - Estimating Optimality Gaps for Stochastic Optimization via Bootstrap Aggregating

Henry Lam, Columbia University, 500 W. 120th St., New York, NY, 10027, United States, Huajie Qian

We present approaches to estimate the optimality gaps of solutions in stochastic optimization using limited data. Our approaches are based on bootstrap aggregating that can demonstrably improve the tightness-variance tradeoff incurred in existing methods. We present our theories and show numerical effectiveness through some examples.

3 - Asymptotic Results on Two-stage Stochastic Quadratic Programming

Junyi Liu, University of Southern California, 30 Virginia Avenue, Los Angeles, CA, 91107, United States, Suvrajeet Sen

In this talk, we will present stochastic decomposition (SD) algorithms for two-stage stochastic quadratic programming (STQP) problem. Based on their stochastic linear programming (SLP) predecessor, these iterative schemes in SD algorithm approximate the objective function using affine/quadratic minorants and then apply a stochastic proximal mapping to obtain the next iterate. We show that under certain assumptions the proximal mapping applied in SD obey a non-expansive mapping property and study the convergence rate of SD to the optimal solutions.

4 - Smoothing and Acceleration for Stochastic Convex Optimization

Afrooz Jalilzadeh, Pennsylvania State University, 310 Leonhard Building, University Park, PA, 16803, United States, Uday Shanbhag

We consider a class of structured nonsmooth stochastic convex problems. By integrating smoothing, Nesterov acceleration, and increasing batch-sizes, we show that Nesterov's rate of O(1/k) may be recovered while under strong convexity, a linear rate of convergence is attained. We comment on special cases in the convex regime when the problem is either smooth or merely deterministic.

■ MA74

West Bldg 212A

Joint Session MCDM/Practice Curated: Multiobjective Optimization: Theory and Applications

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Margaret M. Wiecek, Clemson University, Clemson, SC, 29634-1907, United States

1 - On Highly Robust Efficient Solutions for Uncertain Multiobjective Linear Programs
Margaret M. Wiecek, Clemson University, Mathematical Sciences Dept, Clemson, SC, 29634-1907, United States

We develop properties of the highly robust efficient (HRE) solutions to uncertain multiobjective linear programs (UMOLPs) with objective-wise uncertainty in the objective function coefficients. A characterization using the cone of improving directions, several bound sets on the HRE set, and a robust counterpart for a class of UMOLPs are provided. A bilevel method for computing the HRE solutions is proposed.

2 - Multiobjective Design of a Fin in a Steady-State Regime
Lakmali Weerasena, University of Tennessee Chattanooga, 615 McCallie Ave, Chattanooga, TN, 37403, United States, Boris Belinskiy, James Hiestandzand.

Removal of waste heat to another material or the environment by convection and radiation is important in everyday life and industrial applications. Extended surfaces are often used to remove heat and such surface extensions for convective heat transfer frequently are called fins. The design of a fin is modeled as bi-objective optimization problem. The efficiency of the fin and its mass are considered as two objective functions and the multi-objective optimization carried out to maximize the efficiency and the minimize the mass simultaneously. The approach is based on a piece-wise constant design of the fin.

3 - Balancing Mission Goals and Maintenance Demands using a Force Structure Model
Chris Grubb, Systems Planning and Analysis, Inc., Alexandria, VA, United States, Stephanie Diane Brown, Jonathon Leverenz, Brian Chen

A Force Structure Model designs a day-to-day schedule for a set of assets to meet mission goals and maintenance demands while satisfying travel, duration, and operational constraints. Tension in the schedule arises from the desire to maximize time allotted for maintenance against the need to provide a sufficient number of assets for missions each day. A network-based model and branch-and-bound algorithm are used to investigate tradeoffs between allocating time for mission goals and maintenance demands. The network model offers more flexibility than existing timetabling methods when designing the schedule and the algorithm is shown to outperform CPLEX for longer, more difficult problems.

4 - Multi-objective Optimization for Political Districting with Explicit Fairness Considerations
Rahul Swamy, Champaign, IL, 61820, United States, Douglas M. King, Sheldon H. Jacobson

Political redistricting is a multi-objective problem with conflicting objectives such as compactness, population balance, etc. While the problem is well-studied, the use of political fairness metrics has been relatively under-explored. In addition, contiguity enforcement within an exact method has been a challenging task. This research presents a multi-objective approach explicitly considering political criteria such as efficiency gap and competitiveness within a branch and cut framework. The results show that compactness does not always ensure political fairness, and vice versa.

■ MA75

West Bldg 212B

Joint Session MAS/Practice Curated: Advanced Analytics for Military Cyber Security, Defense and Readiness

Joint Session

Chair: Nathaniel D. Bastian, PhD, Army Cyber Institute, West Point, NY, 10996, United States

1 - Early Warning Systems for Cyber Security
Isaac Faber, PhD Candidate, Stanford University, 141 Aryshire Farn Ln #113, Stanford, CA, 94305, United States

Through the paradigm of early warning systems, from risk analysis, early-stage cyber attack signals can be generated using machine learning techniques. The past ten years have seen the growth of interest in cybersecurity. As cyber threats become more sophisticated, system defenders must keep pace with better methods of detection and response. Advanced cyber-attacks are a set of discrete, observable steps called a 'kill chain.' Using burgeoning techniques within analytic systems and machine learning, data produced from early kill chain steps can be used to mitigate downstream consequences. An application of ensemble classification using supervised learning techniques is explored.

2 - Bots in Nets: Empirical Analysis of Bot Evidence in Online Social Networks
Ross Schuchard, George Mason University, 4400 University Drive, Fairfax, VA, 22030, United States

Online social networks (OSNs) continue to play an increasing role as a primary source of information in today's society. The emergence of social bots within OSNs to diffuse information at scale has given rise to many efforts to detect bots. While methodologies employed to detect the evolving sophistication of bots continue to improve, much work can be done to characterize the impact of bots on actual communication networks. This study proposes a social network analysis framework to characterize the pervasiveness and relative importance of bots in various OSN conversations.

3 - Fake News: Fearing the End of Truth, a Quantitative Risk Analysis
Travis Trammell, Stanford University, Stanford,, CA, United States

Strategically using information to affect the views of a population is certainly nothing new and dates all the way back to the earliest development of political systems. The speed of distribution and the number of people that can be reached by leveraging the modern information infrastructure is unprecedented. The rapid distribution of fake news can cause contagion, manipulate markets, spark conflict, or fracture strategic relations. Probabilistic Risk Analysis (PRA) can be leveraged to quantitatively describe the risk associated with fake news by examining all relevant factors to evaluate associated probabilities and costs resulting from fake news campaigns.

4 - Saving the Army from Cyberspace: A Strategy to Seize the Initiative Using Big Data
Gregory Bew, U.S. Army Cyber Command, Fort Belvoir, VA, United States

In the information age the defense of the Department of Defense Information Network (DoDIN) is arguably our most mission essential task. Mission command, logistics, medical support, and weapons systems all rely on access to the DoDIN or we will operate in a severely degraded state. In war, that means people will die. To ensure access, Army Cyber Command decided to rely on big data and developed a phased approach to seize initiative, increase confidence, and change our culture to defend our cyber terrain. The results of this approach have created the DoD's largest and most capable cyber big data platform, providing a common environment to develop apps and analytics to help the Army defend the DoDIN.

5 - An Advanced Analytics Framework for Optimizing Army Cyber Mission Force Readiness and Manning
Nathaniel D. Bastian, Operations Research Scientist, Army Cyber Institute, U.S. Military Academy, West Point, NY, 10996, United States, Andrew O. Hall, Christopher B. Fisher

Given the unique expertise required of military personnel to execute the DoD cyber mission, the US Army created the Cyber Branch to establish managed career fields for Army cyber warriors, while providing a force structure with successive opportunities for career development and talent management via leadership and broadening positions, technical training, and advanced education. In order to optimize Cyber Mission Force readiness and manning levels across the Army's operating and generating forces, we proffer the Cyber Force Manning Model (CFMM) to project the optimal number of accessions, promotions and personnel inventory for each cyber specialty across the Army cyber enterprise.

■ MB15

North Bldg 127A

Joint Session MSOM/Practice Curated: Empirical Service Operations

Sponsored: Manufacturing & Service Oper Mgmt/Service Operations

Sponsored Session

Chair: Vinayak Deshpande, The University of North Carolina at Chapel Hill

1 - Improving Customer Compatibility with Operational Transparency
MoonSoo Choi, Harvard Business School, 700 Soldiers Field Road, Wyss House, Boston, MA, 02163, United States, Ryan Buell

Recent research has demonstrated the impact of customer compatibility - the degree of fit between the needs of customers and the capabilities of the operations serving them - on service performance. Companies with more compatible customers receive higher satisfaction scores and exhibit faster growth. However, when marketing their offerings to prospective customers, companies often shroud the operational tradeoffs inherent in their offerings in favor of emphasizing their advantages. Through a large-scale field experiment with a nationwide retail bank, we investigate how providing prospective customers with transparency into an operation's tradeoffs affects acquisition and engagement.

2 - Don't Call Us, We'll Call You: An Empirical Study of Caller Behavior under a Callback Option
Brett Hathaway,The University of North Carolina at Chapel Hill , 1800 Baity Hill Drive #310, Chapel Hill, NC, 27514, United States,, Seyed Emadi, Vinayak Deshpande

Using call center data from a bank, we empirically study callers' decision-making process in the presence of a callback option. We formulate a structural model of their decision-making process, and impute their underlying preferences from the data. Our estimates of their preferences show that they experience almost no discomfort while waiting for a callback, and they incur a high cost of switching from their

offline tasks to answer a callback. We conduct a counterfactual analysis of how various callback policies affect the service quality and system throughput of this call center. Our results indicate that offering callbacks increases service quality without substantially impacting throughput.

3 - At Your Service on the Table: Impact of Tabletop Technology on Restaurant Performance

Fangyun Tan, Southern Methodist University, 6212 Bishop Blvd, Dallas, TX, 75275, United States, Serguei Netessine

We use granular data to examine the impact of a tabletop device that facilitates the order process on the check size and meal duration aspects of restaurant performance. We find that the tabletop technology is likely to improve average sales per check by 2.91% and reduce the meal duration by 9.74%, which increases the sales per minute or sales productivity by approximately 10.77%. Overall, our results indicate great potential for introducing tabletop technology in a large service industry that currently lacks digitalization.

4 - Decision Bias in the News Vendor Problem: Evidence from Airline Flight Scheduling

Vinayak V. Deshpande, University of North Carolina at Chapel Hill, Kenan Flagler Business School, McColl Building, CB #3490, Chapel Hill, NC, 27514, United States, Milind Sohoni, Chandrasekhar Manchiraju

Research in Behavioral Operations Management has documented "Demand Chasing" and "Pull to Center" as two prevalent behavioral biases in the single period newsvendor problem in laboratory experimental settings. Using flight-scheduling data from the US Airline industry, we show that these biases exist even in real world managerial decisions. We also show that these biases exist not only at the individual level, but are also at the firm level.

■ MB16

North Bldg 127B

Joint Session MSOM/Practice Curated: Renewable Energy Operations

Sponsored: Manufacturing & Service Oper Mgmt/Sustainable Operations

Sponsored Session

Chair: Nur Sunar, UNC, Chapel Hill, NC, 27517, United States

1 - Pricing and Information in Short-term Sequential Power Markets with Renewable Energy

Derck Koolen, Erasmus University-Rotterdam, Rotterdam, 3062PA, Netherlands, Derek W. Bunn

Motivated by the ongoing integration of renewable energy sources, we analyze sequential pricing in short-term power markets with a varying technology mix. We propose a multi-stage competitive equilibrium model to analyze retailers and heterogeneous producers' optimal sequential trading, allowing to capture the information transparency effect of large-scale and decentralized production on individual market participants' risk related hedging pressure. Empirical results, comparing the British and Californian market, validate the approach with respect to market specific exogenous operational constraints.

2 - Smart Bike Lanes: A Data-driven Approach

Sheng Liu, University of California, Berkeley, 1731 Spruce St Unit B, Berkeley, CA, 94709, United States, Zuo-Jun Max Shen, Xiang Ji

We develop a bike lane planning model based on the bike trajectory data. We formulate the bike lane planning problem as an integer program to maximize the coverage of cyclists as well as the continuity of bike lanes. We develop a Lagrangian relaxation method to solve the model efficiently by exploiting its structure. We apply the model to Zhuhai city of China using the real trajectory data from a dock-less bike sharing system. The construction plan of our model can benefit tens of thousands of cyclists in Zhuhai and promote cycling as a healthy and sustainable transit mode. We collabrate with the urban planning institution of Zhuhai to implement the model.

3 - Capacity Investment in Wind Farms: The Role of Subsidy Policies

Foad Iravani, University of Washington, Foster School of Business, ISOM Department, Box 353226, Seattle, WA, 98195-3226, United States, Saed Alizamir, Safak Yucel

The U.S. government offers output-based and cost-based subsidies to promote investment in wind farms. We analyze the decision of wind farms to choose one of the two subsidies and study the effect of subsidies on the farms' capacity decisions.

4 - Meeting Corporate Renewable Energy Targets

Selvaprabu Nadarajah, College of Business, University of Illinois at Chicago, 601 South Morgan Street,, UH 2406, Chicago, IL, 60607, United States, Danial Mohseni-Taheri, Alessio Trivella

Several companies have committed to procuring a percentage of their power demand from renewable sources by a future date. We study the dynamic procurement problem to meet this target by purchasing power via virtual power purchase agreements (PPA) and the wholesale spot market, which are two dominant strategies. We analyze the change in procurement cost under different target levels and PPA strike price structures used in practice, as well as, characterize substitution between the strike price and the target level. To assist in computing multi-stage procurement portfolios, we develop a dual reoptimization based approximate dynamic programming policy and present results on realistic instances.

5 - Implications of Independent Renewable Power Producers for Utility Companies

Nur Sunar, UNC, 1604 Village Crossing Drive, Chapel Hill, NC, 27517, United States, Jayashankar M. Swaminathan

It is widely believed that the existence of independent renewable power producers hurts the profitability of utility companies. We identify a prevalent practical setting in which the existence of independent renewable energy producers increases the profitability of utilities. We complement our results with data analysis.

■ MB25

North Bldg 131C

Joint Session Service Science/Practice Curated: NSF Funding Opportunities for Service Science Researchers

Sponsored: Service Science

Sponsored Session

Chair: Alexandra Medina-Borja, PhD, National Science Foundation, Alexandria, VA, 22314, United States

1 - NSF Funding Opportunities for Service Science Researchers

Alexandra Medina-Borja, PhD, National Science Foundation, Alexandria, VA, 22314, United States

Technologies are enabling an era of smart everything while service systems continue to dominate industrialized economies. As the concepts of smartness and service are starting to fuse, modeling of smart engineered systems is becoming challenging. While applying a "service framework to this partnership of humans and machines could help, society is still concerned with machines replacing workers in the service sector. Myriad convergent research opportunities in this new landscape are possible. NSF Program Officers will discuss some funding opportunities at the National Science Foundation, both in terms of the NSF's Ten Big Ideas for Future Investment and research funding for re-skilling the service workforce.

■ MB35

North Bldg 224A

Joint Session AAS/Practice Curated: AAS Best Student Presentation Competition II

Sponsored: Aviation Applications

Sponsored Session

Chair: Susan Hotle, Virginia Polytechnic Institute and State University,

1 - A Game-Theoretic Analysis of the Scaled Airline Preferences Mechanism for Airport Landing Slots

Jackie W. Baek, Massachusetts Institute of Technology, 77 Massachusetts Ave, Bldg E40-103, Cambridge, MA, 02139, United States

As arrival capacities increasingly constrain the air transportation system, there is a need for mechanisms by which airlines can exchange landing slots. Currently, when the number of aircraft is projected to exceed the capacity, flights are allocated slots in a first-scheduled-first-served manner. However, flights have different delay costs and can be assigned more efficiently. We focus on a reallocation mechanism called scaled airline preferences (SAP) and evaluate it on individual rationality, incentive compatibility, and fairness. The flight delay cost functions are scaled where the average unit delay cost by airline is equal and the mechanism minimizes the total scaled delay cost.

2 - Forecasting Airport Transfer Passenger Flow Using Real-Time Data and Machine Learning

Xiaojia Guo, University College London, International Hall, Lansdowne Terrace, London, WC1N 1AS, United Kingdom

Air passengers missing their connection can have a major impact on satisfaction and airline delays. Accurate forecasts of the flow of passengers and their journey times through an airport can help improve the experience of connecting passengers and support airline, airport, and air space punctuality. In collaboration with Heathrow Airport, we utilize real-time data to develop a predictive system based on a regression tree and Copula-based simulations. These real-time predictions can be used to inform target off-block time adjustments and determine resourcing levels at security and immigration.

3 - An Assessment of the Potential Benefits of Dynamic Airline Scheduling

Ahmet Esat Hizir, Massachusetts Institute of Technology, Cambridge, MA, United States,

The commonly used approach to airline schedule design does not enable airlines to effectively adapt to changes in passenger demand and airspace system capacity. This study investigates the potential benefits of a dynamic scheduling approach in which flight frequencies, schedules and aircraft types are finalized closer to the day of operations based on the most current demand information. Our integrated schedule design and fleet assignment model satisfies the passenger demand without inconveniencing passengers, to evaluate the maximum possible benefits of a dynamic scheduling strategy.

■ MB44

North Bldg 227C

Joint Session ENRE/Practice Curated: Applications of Conic Optimization for Energy Systems

Sponsored: Energy, Natural Res & the Environment/Electricity

Sponsored Session

Chair: Ramtin Madani, The University of Texas at Arlington, Arlington, TX, 76015, United States

1 - Multiplier-based Observer Design for Large-scale Lipschitz Systems

Ming Jin, UC Berkeley, Cory 406, Berkeley, CA, 94720, United States

Observer design for nonlinear systems with incomplete state observations is of practical significance. To this end, this study presents a multiplier-based approach that is capable of determining an asymptotically stable observer for a large class of highly nonlinear and large-scale systems. Both the present and the state-of-the art methods are evaluated in a benchmark example and a case study on the dynamic power system state estimation, where the proposed approach exhibits an imperative trade-off between non-conservatism and computational tractability, establishing its viability for real-world large-scale nonlinear systems.

2 - Sequential Convex Relaxation for Optimal Power Flow and Unit Commitment Problems

Ramtin Madani, The University of Texas at Arlington, Arlington, TX, 76015, United States, Fariba Zohrizadeh, Mohsen Kheirandishfard, Adnan Nasir, Edward Quarm

This talk is concerned with the optimal power flow (OPF) and unit commitment (UC) problems. We propose a novel convex relaxation, which transforms non-convex AC power flow equations into convex quadratic inequalities. Additionally, we propose a penalization technique which guarantees the recovery of feasible solutions for the original non-convex problem, under certain assumptions. The proposed penalized convex relaxation scheme can be used sequentially in order to find feasible and near-globally optimal solutions. By solving a few rounds of penalized convex relaxation, fully feasible solutions are obtained for challenging benchmark test cases with as many as 13659 buses.

3 - Convex Relaxation of Bilinear Matrix Inequalities with Applications to Optimal Control Synthesis

Mohsen Kheirandishfard, The University of Texas at Arlington, Arlington, TX, United States, Fariba Zohrizadeh, Muhammad Adil, Ramtin Madani

This talk is concerned with the problem of minimizing a linear objective function subject to a bilinear matrix inequality (BMI) constraint. We introduce a family of convex relaxations which transform BMI optimization problems into polynomial-time solvable surrogates. The efficacy of the proposed convex relaxation methods are demonstrated on benchmark instance of optimal control synthesis problems.

4 - A Mixed-integer Programming Solution to AC Optimal Transmission Switching for Load Shed Prevention

William Eric Brown, Texas A&M University, College Station, TX, United States, Erick Moreno-Centeno

Optimal transmission switching (OTS) has garnered recent consideration for its value in leveraging the flexibility of the power grid. However, solving the AC-OTS problem remains quite difficult in practice. We propose a mixed-integer linear programming (MILP) model for the AC-OTS to maximize post-contingency load shed prevention (LSP). Unlike the widely-used DC-OTS, which is based on the standard DC linearizations (i.e., the DCOPF), our model produces LSP values which are highly correlated with the ACOPF. In thorough computational tests, our approach identifies the AC optimal switch in over 92% of studied instances.

■ MB47

North Bldg 229A

Joint Session Tutorial/Practice Curated: Tabu and Scatter Search: Principles and Practice

Emerging Topic: Practice Curated Track

Emerging Topic Session

Chair: Rong Pan, Arizona State University, School of Computing Informatics & Decison Sys, P.O. Box 878809, Tempe, AZ, 85287-8809, United States

1 - Tabu and Scatter Search: Principles and Practice

Manuel Laguna, University of Colorado, Boulder, CO, United States

This tutorial focuses on the metaheuristics known as tabu search and scatter search. Tabu search has dramatically changed our ability to solve a host of problems in applied science, business, and engineering. The adaptive memory designs of tabu search have provided useful alternatives and supplements to the types of memory embodied in other metaheuristic approaches. We also explore the evolutionary approach called scatter search, which originated from strategies for creating composite decision rules and surrogate constraints. Numerous studies have demonstrated the practical advantages of this approach for solving a diverse array of optimization. Scatter search contrasts with other evolutionary procedures, such as genetic algorithms, by providing unifying principles for joining solutions based on generalized path constructions and by utilizing strategic designs where other approaches resort to randomization. Additional advantages are provided by intensification and diversification mechanisms that exploit adaptive memory, drawing on foundations that link scatter search to tabu search. We show connections between tabu search and scatter search by demonstrating how they can be applied to many optimization problems found in practice. This tutorial also discusses the search strategy called path relinking, relevant to both tabu and scatter search. Features added to both tabu and scatter search by extension of their basic philosophy are captured in the path relinking framework. From a spatial orientation, the process of generating linear combinations of a set of reference solutions (as typically done in scatter search) may be characterized as generating paths between and beyond these solutions, where solutions on such paths also serve as sources for generating additional paths. This leads to a broader conception of the meaning of creating combinations of solutions. By natural extension, such combinations may be conceived to arise by generating paths between and beyond selected solutions in the neighborhood space. Finally, we highlight key ideas and research issues associated with tabu search, scatter search, and path relinking that offer promise of yielding future advances.

■ MB63

West Bldg 103B

Joint Session DM/AI/Practice Curated: From Data to Algorithms: How Ride-sharing Platforms Improve Rider and Driver Experiences?

Sponsored: Data Mining

Sponsored Session

Chair: Helin Zhu, UBER

Co-Chair: Peter Frazier, Cornell University, School of Operations Research, and Information Engineering, Ithaca, NY

1 - Driver Preferences at Uber: Welfare, Flexibility, and Pricing

Peter Frazier, Cornell University, School of Operations Research, and Information Engineering, Ithaca, NY, 14853, United States

The Uber platform lets drivers set preferences for trips going to a destination through its Driver Destination feature. This feature lets drivers avoid deadheading when they need to go home, but also creates gaming opportunities by letting drivers select lucrative long trips. Moreover, when many drivers use this feature, their reduced flexibility causes riders going to unpopular destinations to wait longer on pickups for drivers coming from further away. We study the impact on welfare of this and other similar preference-setting features in two-sided markets. We show that they can decrease welfare when launched without discretion, but improve welfare when combined with appropriate pricing.

2 - Dynamic Pricing and Matching in Ride-hailing Platforms

Helin Zhu, Marketplace Optimization, Uber, 1455 Market Street, 4th Floor, San Francisco, CA, 94103, United States, Chiwei Yan, Dawn Woodard, Nikita Korolko

Advanced matching and dynamic pricing algorithms are the two key levers in ride-hailing platforms. We demonstrate via a stylized model, calibrated with real data,

that the synergy of these two levers can bring significantly more benefits. Specifically, we study a novel matching mechanism called dynamic waiting. We show that pricing and waiting could be jointly optimized in reducing rider and driving waiting times, lowering price volatility, and increasing trip volume and welfare.

3 - Estimating Primary Demand in Bike-sharing Systems
Chong Yang Goh, Massachusetts Institute of Technology-ORC, Cambridge, MA, 02139-4910, United States, Chiwei Yan, Patrick Jaillet

We consider the problem of estimating the primary or first-choice demand for a bike-sharing service using trip and inventory data. To account for choice substitutions, we propose a rank-based demand model that treats each observed trip as the best available option in a latent ranking over origin-destination pairs. We then solve a high dimensional estimation problem using algorithms that (i) find sparse representations of the parameters efficiently, and (ii) constrain trip substitutions spatially according to the bike-share network. Our method is effective in recovering the primary demand and computationally tractable on a city scale, as we demonstrate on a bike-sharing service in Boston.

■ MB64

West Bldg 104A

Joint Session DM/Practice Curated: Data Science and Analytics in Supply Chain

Sponsored: Data Mining

Sponsored Session

Chair: Aihong Wen, Walmart

1 - Reinforce Learning with Counterpetition Strategy in Hotelling Model
Xiaoya Xu, Assistant Professor, Guangdong University Of Finance & Economics, 21 Luntou Road, Guangzhou 510320, Guangdong, P.R. China, Guangzhou, 510320, China

The combination of reinforce learning and game theory is exceptional serviceable for solving complexity problems, we adapt this methodology to the cooperation game in hotelling model. Assuming customers apply their potential game in each stage for maximizing their optimal revenue. Using the reinforce learning, customers can automatically choosing their optimal strategy systematically .

2 - Improving Demand Forecast Accuracy through Partial Aggregation
Vladimir Kovtun, Assistant Professor, Yeshiva University, 500 W. 186th Street, New York, NY, 10033, United States, Avi H. Giloni, Sridhar Seshadri, Hurvich Clifford

We consider a single firm (retailer) that observes demand streams coming from many distinct consumer populations. We assume that each demand stream follows an Autoregressive Moving Average (ARMA) process. We show with examples that by grouping similar ARMA demand streams together and forecasting several partial-aggregate streams the retailer is able to drastically improve its forecast accuracy when compared to grouping all consumer streams together and forecasting a single aggregate ARMA stream. Furthermore we show that little is lost when compared to forecasting all demand streams separately.

3 - Spatial Patterns and Socioeconomic Dimensions of Short-term Shared Accommodations: The Case of Airbnb in Los Angeles and New York City
Avijit Sarkar, Professor, University of Redlands, 1200 E. Colton Avenue, Redlands, CA, 92373, United States, Mehrdad Koohikamali, James B. Pick

This study examines spatiotemporal aspects and socioeconomic dimensions of shared accommodations within the broader context of the sharing economy. Specifically, we examine how socioeconomic attributes of Airbnb hosts moderated by hosts' attitudes towards trust and greener consumption influence participation in the sharing economy. Spatial bias in sharing economy participation rates is examined and policy implications for the supply side of shared accommodations are discussed along with generalizability of results for two major U.S. cities - New York City, NY and Los Angeles CA.

4 - Cognitive Learning with Application to Supply Chains
Seho Kee, Arizona State University, Tempe, AZ, 85044, United States, Ghazal Shams, Mani Janakiram, Mark A. Wilkinson, George Runger

The evolving data-rich environment has enabled making data-driven business decisions. Rather than traditional approaches, more automated, adaptive, and intelligent systems can be developed to expand upon the capabilities of human decision makers. A cognitive computing approach is presented to learn and improve human decision-making in a dynamic, context-aware decision support platform. The proposed system is applied to a real-world use case in supply chain.

5 - Sourcing Model Optimization using a Linear Model in Multi-echelon Distribution Network
Prashant Kaldindi Verma, FleetPride, Inc., 600 E. Las Colinas Blvd #400,, Irving, TX, 75039, United States, Mohit Arora, Homarjun Agrahari, Brian Steinmiller, Ziyu Li

The SKU sourcing policy can have significant impact on the transportation and inventory holding costs. We developed and implemented an optimization model that explicitly deals with vendor contracts, varying pack sizes and demand. The model takes into account the cost of transportation to each location and handling cost specific to location. We will present mathematical model, and financial impact it has had on the organization.

■ MB65

West Bldg 104B

Joint Session DM/Practice Curated: Data Science and Applied Probability

Sponsored: Data Mining

Sponsored Session

Chair: Xu Sun, Columbia University, New York City, NY, 10027, United States

1 - Shepherding the Herd
Ville Satopaa, INSEAD, 140 Avenue Daumesnil, Paris, 75012, France, Jussi Keppo

We analyze multiple agents who forecast an underlying dynamic state based on a stream of public and private signals. Each agent minimizes a convex combination of her forecasting error and deviation from the other agents' forecasts. As a result, the agents exhibit herding behavior - a bias that has been well-recognized in the literature. We first derive and analyze the agents' optimal forecast under different levels of herding. This extends the Kalman filter to applications where herding is an important part of the process. After that we solve a dynamic strategy that allows a social planner to influence the agents' forecasting and this way raise welfare through disclosure of public information.

2 - Determining Optimal Treatment Allocations for Online Experiments with a Fixed Number of Rounds
Balaji PitchaiKannu, Research Scholar, IIT Madras, 236, Bhadra Hostel, IIT Madras, IIT Madras, CHENNAI, 600036, India, Nandan Sudarsanam

In this study, we determine the optimal treatment allocation for experiments that are conducted in batches, in a live setting with a finite horizon. Unlike the traditional online learning problems seen in the multi-armed Bandit setup, our problem statement requires that the entire trial horizon is exhausted in a fixed set of rounds. In this environment, we determine the batch size as well as the ratio of treatments to units for each round. Our optimization seeks to minimize expected cumulative regret, a common metric in online learning. We use a Bayesian framework to model the theoretical means of the alternatives and the noise in the system as Gaussian distributions.

3 - Predicting and Managing Sustainability
Kemal Gursoy, Professor, Rutgers University, 100 Rockafeller Road, Room 5146, Piscataway, NJ, 08854, United States

In order to survive we must learn how to predict and manage the change in our environment and ourselves. This brings an immense challenge of collecting facts and extracting sufficient information from this incoming stream of big data. In this work, we identify some significant challenges in this process and present an adaptive method for managing sustainability.

4 - Many-server Service Systems with Autoregressive Inputs
Xu Sun, Columbia University, New York City, NY, 10027, United States

Motivated by recent studies revealing the presence of significant autocorrelation and overdispersion in arrival data at large call centers. we study a class of queueing systems where customers arrive according to a doubly stochastic Poisson point process whose the intensities are driven by a time-dependent Cox-Ingersoll-Ross (CIR) process. The nonnegativity and autoregressive feature of the CIR process makes it a good candidate for modeling temporary dips and surges in arrivals. We study asymptotic performances such as the queue length and customer delays. The results acknowledge the presence of autoregressive

■ MB66

West Bldg 105A

Joint Session AI/Practice Curated: Healthcare Analytics and Medical Decision-making

Sponsored: Artificial Intelligence

Sponsored Session

Chair: Karthik Srinivasan, University of Arizona, Tucson, AZ, 85719, United States

1 - A Prediction Model for Adverse Events in Hospitalized Patients
Yu-Kai Lin, PhD, Georgia State University, Atlanta, GA, United States, Xiao Fang

Inadequate patient safety is a serious problem in current medical practice. Medical errors cause adverse events (AEs) among patients and lead to increased hospital stays, medical costs, and risk of death. This study develops a novel in-hospital AE prediction method to improve patient safety. We evaluate the predictive performance and practical utility of the proposed method using real-world inpatient data. Our results suggest that the proposed model can better predict and prevent in-hospital AEs than alternative methods.

2 - Study for Out-of-hospital Days in Chinese Cancer Patients
Luwen Huangfu, 1549 N. Santa Rita, Tucson, AZ, 85719, United States

Cancer readmission time interval, or Out-of-Hospital Days (OHD) between two consecutive hospital admissions, has been widely adopted as an important measure of healthcare service. However, there is a paucity of models that focus on OHD and associated risk factors. We aim to utilize OHD that is more than 30 days as the result of cancer patient's personal and medical conditions and treatment costs. We analyze a sample of 635,261 cancer inpatients Electronic Health Records (EHR) from 190 hospitals in China. Using hierarchical linear regression, we show that age, marital status, previous admissions and whether the treating hospital is in the same province as the patient, are significant factors in OHD.

3 - Predicting High Cost Patients at Point of Admission using Network Science
Karthik Srinivasan, University of Arizona, Tucson, AZ, 85721, United States, Sudha Ram, Faiz Currim

Data mining models for high-cost patient encounter prediction at the point-of-admission (HPEPP) in inpatient wards are scarce in literature due to lack of availability of relevant features at such an early stage of treatment. We explore a disease co-occurrence network (DCN) for community formation and structural properties to create new input features for HPEPP models. We propose community membership and high-cost propensity scores as two network based features for HPEPP modeling. We find that our proposed set of features improve performance of prediction models. HPEPP model using our feature set has the potential to reduce overall health care expenditure in US.

■ MB78

West Bldg 213B

Joint Session SOLA/PSOR/Practice Curated: Public Sector Location Applications

Sponsored: Location Analysis

Sponsored Session

Chair: Rajan Batta, University at Buffalo (SUNY), Buffalo, NY, 14260, United States

1 - Prepositioning of Supplies in Domain of Natural Disasters Logistics: A Systematic Review of Operations Research and Management Science Papers
Monir Sabbaghtorkan, University at Buffalo (SUNY), Amherst, NH, United States, Rajan Batta, Qing He

Prepositioning of supplies is an efficient way to improve the post-disaster relief efforts. In this paper, we explore and review OR/MS papers related to this topic to find the gaps and give directions to future researchers in this area. The classifications that are used in this paper are as follow, Authors affiliation, journals contribution, number of papers over the years and type of disaster considered by papers. Moreover, we would present the mathematical model features for each paper, like objective function, decision variables, constraints, solution methodology and etc.

2 - Responding to Medical and Fire Emergencies on a Disrupted Network
Gina Galindo, Universidad del Norte, KM5 Antigua via a Puerto Colombia, Puerto Colombia, Colombia, Juliette Garc a

Events such as heavy rains or extreme snowfall may disrupt roads and affect the response times of critical services such as fire and medical emergencies. This research develops a methodology for effectively allocating medical and fire emergencies to available facilities on a disrupted network. The methodology was applied to a case study in Barranquilla, Colombia. Based on the results, we recommend potential site for locating additional fire and medical facilities.

3 - A Stochastic Programming Model for Emergency Supply Planning Considering Traffic Congestion
Xiaofeng Nie, Texas A&M University, College Station, TX, United States, Qingyi Wang

Traffic congestion delays emergency supply after disasters, but it is seldom considered in the emergency logistics literature. To fill this gap, we propose a traffic congestion incorporated two-stage stochastic programming model that facilitates the planning of supplies pre-positioning and post-disaster transportation. The corresponding mixed-integer nonlinear program is efficiently solved with a generalized Benders decomposition algorithm. A case study on a hurricane threat in the southeastern U.S. shows the superiority of our model and provides managerial insights.

4 - A Bi-Level Combined Facility Location and Network Design Problem in Hazardous Materials Transportation
Xufei Liu, University of South Florida, Tampa, FL, United States, Changhyun Kwon

In this paper, we consider a bi-level optimization problem for hazardous materials transportation to determine facility locations and network design. The leader intends to minimize the total cost of facility costs and exposure risk by restricting the shipment and anticipates the reaction of the followers who want to minimize the transportation costs by choosing the shortest path for shipments. Considering the uncertainty of the number of trucks and exposure risk, we formulate a robust bi-level combined facility location-network design model and propose a cutting plane algorithm.

■ MC06

North Bldg 122C

Joint Session OPT/Practice Curated: Pyomo: Recent Developments and Applications

Sponsored: Optimization/Computational Optimization and Software

Sponsored Session

Chair: John Siirola, Sandia National Laboratories, Albuquerque, NM, 87185, United States

1 - Pyomo.GDP: An Integrated Ecosystem for Generalized Disjunctive Programming Modeling and Optimization
Qi Chen, Carnegie Mellon University, 5000 Forbes Avenue, Department of Chemical Engineering, Pittsburgh, PA, 15213, United States, David Bernal, John Siirola, Ignacio E. Grossmann

In this work, we present new capabilities in Pyomo.GDP. Generalized Disjunctive Programs (GDPs) allow high-level description of optimization problems involving both discrete and continuous decision variables. For difficult problems, we must move beyond classical reformulation approaches. Pyomo.GDP offers automated application of advanced techniques such as disjunctive "basic steps and procedural reformulations. We also introduce a new direct solver for Pyomo.GDP models, GDPopt, which implements the logic-based outer approximation decomposition algorithm. We demonstrate the application of these tools on a set of GDP test problems.

2 - Pyomo.dae: A Framework for Modeling and Solving Dynamic Optimization Problems
Bethany Nicholson, Sandia National Laboratories, P.O. Box 5800, MS 1326, Albuquerque, NM, 87185, United States, John Siirola

Dynamic optimization problems include differential equations as constraints. These problems can be tough to implement and solve because they must be reformulated before being sent to standard optimization solvers. Pyomo.dae is a Pyomo extension for representing differential equations in an optimization modeling context. It includes implementations of several discretization schemes that will automatically convert differential equations to algebraic equations, making the model compatible with generic optimization solvers. In this talk we describe the capabilities of Pyomo.dae and demonstrate the concise model implementations of several complex dynamic optimization problems.

3 - The IDAES Framework: Process Modeling and Optimization in Pyomo
John Siirola, Sandia National Laboratories, P.O. Box 5800, MS 1326, Albuquerque, NM, 87185, Qi Chen, Ignacio E. Grossmann

A cornerstone of the Institute for the Design of Advanced Energy Systems (IDAES) is a modeling and algorithmic framework that addresses the capability gap between state-of-the-art process simulators and general-purpose algebraic modeling languages. The framework, built on Pyomo, provides an extensible process modeling environment that supports optimization-based synthesis, design, control, and uncertainty quantification. This presentation will show how Pyomo was extended into the PSE domain and highlight several case studies.

4 - Mixed-integer Nonlinear Decomposition Toolbox for Pyomo (MindtPy)

David E. Bernal, Carnegie Mellon University, 5000 Forbes Ave., Pittsburgh, PA, 15213, United States, Felicity Gong, Qi Chen, Ignacio E. Grossmann

This work describes a software toolbox developed in Pyomo, a modeling and optimization application in Python, where decomposition methods for solving mixed-integer nonlinear programs (MINLP) are implemented. Decomposition methods for MINLP rely on the iterative solution of mixed-integer linear programs and nonlinear programming; which have had a steady and considerable improvement in the last years. Several decomposition methods, together with recent algorithmic improvements such as primal heuristics and quadratic cuts, are available in MindtPy. We illustrate the application of this toolbox on a set of convex MINLP problems of varying sizes and degrees of difficulty.

■ MC08

North Bldg 124A

Joint Session OPT/Practice Curated: Network Optimization in Power Systems

Sponsored: Optimization/Network Optimization

Sponsored Session

Chair: Adolfo Raphael Escobedo, Arizona State University, Tempe, AZ, 85287-8809

1 - Optimal Portfolio of Power Flow Control Technologies: Topology and Impedance Control

Mostafa Sahraei-Ardakani, University of Utah, 50 South Central Campus Drive, #2110 Merrill Engineering Building, Salt Lake City, UT, 84112, United States

High congestion costs demand for more efficient utilization of the transmission system. Topology and impedance control are two technologies that enable such efficiency gains, through controlling the power flows. As the system operators begin to utilize these tools, it is essential to understand the interdependence between them. This talk presents simulation results that suggest a strong interdependence between topology and impedance control. It is, thus, essential to acknowledge this interdependence, both at the planning and operation stage. Failure to do so will lead to economic inefficiencies that can be avoided through appropriate co-optimization.

2 - Strategic Behavior of Self-scheduling Distributed Energy Resources in Energy and Reserve Co-optimizing Markets

Fatma Selin Yanikara, Boston University, 15 St Marys Street, Room 140, Boston, MA, 02215, United States, Michael C. Caramanis

We study the participation of distribution network connected, self-scheduling Distributed Energy Resources (DERs), such as EVs and wind farms, in energy and reserve markets. Important issues that arise when DERs self-schedule are existence and uniqueness of equilibrium, and strategic behavior. We study the distributed market clearing with self-scheduling DERs in game theory context and characterize the Nash equilibrium under various information availability cases: DERs are either (i)price takers or (ii)have access to local information and can explicitly calculate locational prices. Information aware DERs engage in a Nash game since they know how their own and others' actions impact prices.

3 - Spatiotemporal Marginal Costs in Optimal Operational Planning of Distribution Networks

Panagiotis Andrianesis, Boston University, Boston, MA, United States, Michael C. Caramanis

The rapid growth of Distributed Energy Resources (DERs) presents a major challenge together with a still unexploited opportunity for a radical transformation of the distribution grid. We employ a distribution grid representation that captures the salient features and costs of distribution assets, as well as the complex DER preferences and capabilities, and enables the discovery of short-term dynamic locational marginal costs. We discuss the inherent difficulties of the operational planning optimization problem, and we present results from actual distribution feeders.

4 - Bus-angle Difference Valid Inequalities and Algorithms for DC Power Transmission Expansion Planning

Kyle Skolfield, Arizona State University, Phoenix, AZ, United States, Laura M. Escobar, Adolfo Raphael Escobedo, Ruben Romero

To meet rising demand for electricity under limited budgets, it is necessary to determine the best Transmission Expansion Planning strategies. This problem can be modeled as a large-scale MIP whose solution is intractable. To enable efficient search of the solution space, we derive a class of angular valid inequalities (AVIs) to be incorporated as cutting planes in the root node of the branch-and-bound tree. We design a data-driven scheme guided by solutions to various relaxation models to select the most effective AVIs. We test this scheme's effectiveness via benchmark instances.

■ MC11

North Bldg 125B

Joint Session MSOM/Practice Curated: Empirical Studies in Operations

Sponsored: Manufacturing & Service Oper Mgmt/iFORM

Sponsored Session

Chair: William Schmidt, Cornell University, Ithaca, NY, 14850, United States

1 - Supply Networks: Does Industry Matter

Manpreet Singh Hora, Georgia Institute of Technology, Scheller College of Business, 800 West Peachtree Steet NW, Atlanta, GA, 30308, United States, Marcus Bellamy, Soumen Ghosh

We demonstrate differences in supply networks of focal firms in three different industries. In this study, we highlight the extent to which the industry context plays in terms of the network structural characteristics and firm performance, where the characteristics of an average representative firm in each industry vary considerably.

2 - Global Supply Chains and Cross-border Financing

Jing Wu, City University of Hong Kong, Department of Management Sciences, Rm 7-233, Lau Ming Wai Academic Building, Hong Kong, Hong Kong, Yu Zhang

Financial globalization is still far from complete four decades after the end of the Bretton Woods System largely due to transaction costs and informational frictions. In this study, we ask if global supply-chain relationships help firms access cross-border financing in the international capital markets. Comparing two firms that are otherwise similar, we observe the firm that has formed global supply-chain relationship(s) to have more cross-border financing after the supply chain formation. This result is supported empirically by all major financing vehicles, including stock cross-listing, bond issuance, bank loans, and M&A deals.

3 - Discrimination in Global Sourcing: Field Experiments on Alibaba

Ruomeng Cui, Emory University, 1935 Ridgemont Lane, Decatur, GA, 30033, United States, Jingyun Li, Meng Li, lili Yu

Past research has found discrimination in Business-to-Customer online marketplaces. However, there has been little study on suppliers' discrimination behavior on B2B platforms in the context of global sourcing. We investigate whether price and racial discrimination of suppliers against retailers exists in B2B marketplaces across countries. We conducted two field experiments on Alibaba.com, one of the largest global procurement platforms in the world. Further, we investigate the mechanism behind and explore negotiation tactics to mitigate discrimination.

4 - Demand Volatility in Supply Chain Networks

William Schmidt, Cornell University, 314 Sage Hall, Ithaca, NY, 14850, United States, Nikolay Osadchiy, Jing Wu

Demand volatility can adversely impact the firm's ability to match its supply with its demand, resulting in higher operational costs. As demand propagates upstream in a supply chain, its volatility can be amplified due to the bullwhip effect. We empirically examine this phenomenon in the context of a supply chain network and shed light on how firms may strategically mitigate its consequences.

■ MC20

North Bldg 129A

Joint Session RMP/Practice Curated: Marketplace Analytics

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Wedad Elmaghraby

Co-Chair: Chris Parker, Pennsylvania State University, University Park, PA

1 - Should I Pay for this Purchase or Redeem Points? Effects of Loyalty Program Design on Consumer Decisions to Redeem Points

So Yeon Chun, Georgetown University, Arlington, VA, 22202-7416, United States, Rebecca Hamilton

In many loyalty programs, customers earn points for their purchases, which they can later exchange for additional products and services. In a sense, points function as a currency that consumers can spend instead of money. However, we uncover systematic differences in the way consumers spend points compared with money. We first propose a conceptual model of the consumer's choice to redeem points or use money for a specific purchase, and then we conduct a series of studies to investigate the impact of program design characteristics on consumers' choices. By linking the design characteristics to specific mechanisms, we provide insight into how program managers can influence consumers' decision.

2 - H

ow do Price Promotions Affect Customer Behavior on Retailing Platforms? Evidence from a Large Randomized Experiment on Alibaba

Dennis Zhang, Washington University in St. Louis, University City, MO, 63124, United States, Hengchen Dai, Lingxiu Dong

We study how a promotion strategy—offering customers a discount for products in their shopping cart—affects customer behavior in the short and long term on a retailing platform. We conducted a randomized field experiment involving more than 100 million customers and 11,000 retailers with Alibaba Group, the world's largest retailing platform. We randomly assigned eligible customers to either receive promotions for products in their shopping cart or not. In the short term, our promotion program doubled the sales of promoted products. In the long term, we causally document unintended consequences of this promotion program during the month following our treatment period.

3 - Underrepresented Minorities and LGBT in the Sharing Economy: Bias and Financial Incentives in Ridesharing Platforms

Christopher Dalton Parker, Pennsylvania State University, 411 Business Building, University Park, PA, 16802, United States, Jorge Mejia

Operational transparency can be good for business. However, it may also enable biased behavior if those with information about customers can choose not to provide a service for the customer. We explore this through a field experiment on a major ridesharing platform which recently changed the timing of information provided to drivers in order to reduce bias. We find significant bias still exists against URM and LGBT individuals. However, dynamic pricing moderates the effects. Policy implications will be discussed.

4 - Clearing Matching Markets Efficiently: Informative Signals and Match Recommendations

Yash Kanoria, Columbia Business School, 404 Uris Hall, New York, NY, 10027, United States, Itai Ashlagi, Peng Shi, Mark Braverman

We study how to reduce congestion in two-sided matching markets with private preferences. We measure congestion by the number of bits of information that agents must (i) learn about their own preferences, and (ii) communicate with others, before obtaining their final match. Previous results by Segal (2007) and Gonczarowski et al. (2015) suggest that a high level of congestion is inevitable under arbitrary preferences before the market can clear with a stable matching. We show that when the unobservable component of agent preferences satisfies certain natural assumptions, it is possible to recommend potential matches and encourage informative signals such that the market reaches a stable matching with a low level of congestion. The main idea is to only recommend partners with whom the agent has a non-negligible chance of both liking and being liked by.

■ MC33

North Bldg 222C

Joint Session ORAM/QSR/Practice Curated: Advancements in Spatial Data Analytics Methods for Manufacturing Quality Control

Emerging Topic: OR and Advanced Manufacturing

Emerging Topic Session

Chair: Mohammed Shafae, University of Arizona, Tucson, AZ, 24061, United States

Co-Chair: Wenmeng Tian, Mississippi State University, Mississippi State, MS, 39762, United States

1 - Spatial Statistics and Scan Statistics for SPC: A Comparison

Romina Dastoorian, Western Michigan University, Kalamazoo, MI, 49009, United States, Lee Wells

Modern manufacturing systems contain numerous high-density spatial data-sets that are obtained from advanced measurement technologies. Statistical Process Control (SPC) techniques that have been developed for these data-sets can be separated into two primary categories, namely spatial statistics and scan statistics. Unfortunately, the performances of proposed SPC techniques developed within these two areas are rarely (if ever) been compared. In response, this work presents a fair and balanced simulation-based performance comparison between several spatial statistics and scan statistics SPC approaches across a variety of process shift scenarios for image data.

2 - Layer-wise Anomaly Detection for Spatially-correlated Thermal Images in Laser-based Additive Manufacturing

Ahmed Aziz Ezzat, Texas A&M University, College Station, TX, United States

We propose a layer-wise anomaly detection method for laser-based additive manufacturing as a step towards enabling real-time process control. Using in-process thermal images, process anomalies are signaled through a multi-step data-driven procedure that includes segmentation, spatial modeling, and classification analysis. We validate the proposed method using a case study on a commercial laser powder bed fusion system instrumented with a dual-wavelength imaging pyrometer for capturing the thermal signature during fabrication.

3 - Scene Understanding and Obstacle Detection for Off-road Autonomous Driving Based on Real-time LiDAR Sensing

Wenmeng Tian, Mississippi State University, P.O. Box 9542, Mississippi State, MS, 39762, United States

Scene understanding and autonomous navigation methodologies have been developing rapidly with the help of machine learning and artificial intelligence technologies. Moreover, advanced sensing techniques such as LiDAR systems can generate high volume of point cloud data for scene understanding. In this work, we propose a novel scene understanding and obstacle detection method based on a modified version of the Adaptive Generalized Likelihood Ratio (AGLR) method, originally proposed for surface inspection in manufacturing applications. A case study based on a LiDAR simulator is used to illustrate the effectiveness of the proposed approach.

4 - Generalized Heterogenous Recurrence Analysis of Spatial Data

Cheng-Bang Chen, The Pennsylvania State University, State College, PA, 16801, United States, Hui Yang, Soundar Kumara

Prior research has shown that the heterogeneous recurrence method is effective in the characterization and quantification of heterogeneous recurrence behaviors in the temporal data. With the use of fractal representation, recurrence patterns are investigated in multiple scales. However, very little has been done to investigate heterogeneous recurrence behaviors in spatial data. This research extends the heterogeneous recurrence analysis to the high dimensional spatial data. We develop a novel structure to define the heterogeneous states, then provide a new fractal representation. Our method provides a novel platform for monitoring and control of dynamic recurrences of spatial data.

■ MC54

North Bldg 232B

Joint Session BOM/Practice Curated: Experimental Supply Chain Management

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Andrew M. Davis, Cornell University, Cornell University, Ithaca, NY, 14853, United States

1 - Private Information and Endogenous Matching in Supply Chains: Theory and Experiments

Kyle Hyndman, University of Texas at Dallas, 800 W. Campbell Rd, SM31, Richardson, TX, 75080, United States, Andrew M. Davis

We investigate a supply chain setting where a supplier's cost may be private information (but they may disclose it) and buyers and suppliers may endogenously match into pairs. After forming pairs, the two parties engage in a dynamic bargaining setting. Suppliers always make less than theory predicts, whether their cost is known or private information. This effect is especially pronounced under private information for high cost suppliers, because buyers make more aggressive bargaining offers in such a setting. Thus, contrary to theory, a second result is that higher cost suppliers actually benefit from disclosing their private costs, in an effort to achieve a more favorable outcome while bargaining.

2 - The Commitment Conundrum of Inventory Sharing

Shan Li, City University of New York, Baruch College, 55 Lexington Avenue, New York, NY, 10010, United States, Kay-Yut Chen

In this paper, we take a behavioral lens to study the impact of different transfer price contracting schemes and inventory sharing schemes on local decision making of decentralized retailers, constructing a behavioral model, incorporating bounded rationality, fairness, and psychological pain of excess supply to explain the findings.

3 - Is Simplicity the Ultimate Sophistication? Wholesale Pricing vs. Non-linear Pricing

Behrooz Pourghannad, University of Minnesota, Minneapolis, MN, United States, Guangwen Kong, Tony H. Cui

This paper studies a manufacturer's choice of contract when facing a boundedly rational retailer. In a supply chain with a fully rational retailer a wholesale price contract cannot perform better than buy-back and revenue sharing contracts. When the retailer is boundedly rational, we find that a wholesale price contract can dominate both buy-back and revenue sharing contracts. We characterize the condition under which a wholesale price contract is the optimal choice of the manufacturer. Our findings are supported by laboratory experiments in which human suppliers choose a contract to offer to computerized boundedly rational retailers.

4 - Auctions, Efficient Coordination, and Strategic Complementarities

James Fan, Naval Postgraduate School, Monterey, CA, United States, Anthony Kwasnica

Do auctions always lead to efficient production outcomes? We examine this question in a team coordination game, and we find that the degree of coordination as a result

of an auction is sensitive to the degree of strategic complementarity. Our results are examined in relationship to the behavioral learning model proposed by Crawford and Broseta (1998).

■ MC64

West Bldg 104A

Joint Session DM/Practice Curated: Data Science and Analytics to Manage Power and Water

Sponsored: Data Mining

Sponsored Session

Chair: Durai Sundaramoorthi, Saint Louis, MO, 63130, United States

1 - Time Varying Optimization and Learning in Power Systems
Jiafan Yu, Stanford University, Stanford, CA, United States, Siobhan Powell, Ram Rajagopal

Traditional approaches to reactive power management in distribution networks have focused on designing stable and near-optimal centralized or distributed control schemes under the assumption that network physics constraints are completely known. In this talk, we explore an alternative approach that learns a control procedure by observing streams of measurements from the system. We show that a simple batch learning and optimal control procedure attains comparable performance to existing approaches without requiring any prior knowledge of the network and give some analytical guarantees. We then show how the procedure can be utilized to construct an online learning process for the problem.

2 - Exploration of Machine Learning Techniques in Time Series pH Prediction in Water Distribution System
Xiushuang Li, Arizona State University, Tempe, AZ, 85281, United States, Daniella Saetta, Pitu B. Mirchandani, Treavor Boyer

Accurate prediction of the system state is extremely important in controlling water distribution system. Machine learning appears to be a great way to estimate and predict the state of the dynamic system. We explored the application of Symbolic Regression (SR), Lasso Regression (LR) and Neural Network models (NN) to predict time series pH in a small water distribution system. All three methods can achieve comparable accuracy (R2 > 0.93), but LR and NN models take much less time to train than SR model. LR can also filter insignificant input variables in pH prediction by forcing their coefficients to be zero. Both LR and NN can be a useful tool to build the predictive model in water distribution system control.

3 - A Bayesian Forecasting Model of Electric Outages
Luis J. Novoa, James Madison University, Harrisonburg, VA, United States, Babak Zafari, Goran Vojvodic, Refik Soyer

As an aid for planning and preparation against severe weather events we propose a forecasting model for electric outages under a bayesian framework. We applied the model using real data.

■ MC66

West Bldg 105A

Joint Session AI/Practice Curated: Healthcare Analytics: Machine Learning Approaches for Health Data

Sponsored: Artificial Intelligence

Sponsored Session

Chair: Hongyi Zhu

1 - Automatic Diagnosis of Alzheimer's Disease Using Deep Neural Networks
Maryam Zokaeinikoo, Graduate Research Assistant, Pennsylvania State University, University Park, State College, PA, 16802, United States, Prasenjit Mitra

We propose different neural network models based on Long Short-Term Memory (LSTM) to detect the onset of Alzheimer's early in the course of the disease using textual data from both healthy subjects and patients. These models include LSTM networks, bidirectional LSTM (BLSTM), bidirectional LSTM with attention layer (Attention-BLSTM), and bidirectional LSTM with conditional random fields layer (CRF-BLSTM). Although the LSTM often requires large training datasets, our CRF-BLSTM algorithm demonstrates that even with limited training data it performs well in detecting the Alzheimer's disease. The results are validated using two methods of cross validation.

2 - Computational Algorithms for Tracking Near Falls with Multiple Wearable Sensors
Alla Kammerdiner, New Mexico State University, Las Cruces, NM, United States, Razan Ayasra

A loss of balance that constitute near falls can be tracked with multiple body-worn accelerometers. We consider some new formulations for estimation and optimization problems related to tracking of near falls. We also present and analyze computational algorithms, which are used for space partitioning in statistical estimation and for solving the combinatorial optimization problems.

3 - Seizure Detection Using a Hidden Markov Model Framework
Mahboubeh Madadi, Louisiana Tech University, College of Engineering and Science, P.O. Box 10348, Ruston, LA, 71272, United States, Giovanni Petris, Leonidas Iasemidis

In this study, a hidden Markov models (HMM) is developed to automatically detect different brain states in epilepsy patients. The proposed HMM aims at characterizing the dynamics of intracranial electroencephalographic (iEEG) signals using important features such as generalized partial directed coherence (GPDC). The iEEG signals from epilepsy patients, who underwent long-term monitoring of the brain electrical activity for subsequent surgical removal of their epileptogenic focus, were analyzed to classify a patient's state at a given point in time into one of four states: interictal (seizure-free / between seizures), pre-ictal (pre-seizure), ictal (seizure), postictal (post-seizure).

4 - A Deep Learning Approach of Microarray Data Analysis in Cancer Prognosis
Sharmin Nahar Mithy, Doctoral Candidate, University of South Florida, Tampa, FL, 33612, United States, Grisselle Centeno

Research has shown that a major portion of cancers and related deaths could be prevented by applying existing knowledge about cancer treatment. In this research we present a deep learning approach for cancer gene identification. SDAE based clustering approach is applied here for feature extraction from Gene Expression Profiling and will be compared with some other methods. The performance of the extracted information will be evaluated to verify the usefulness of the new features. The extracted feature will further be utilized to predict the radio sensitivity for 48 cell line used as input in cancer treatment and patient prognosis. We expect to validate the data from 20 patients with rectal cancer.

■ MC75

West Bldg 212B

Joint Session MAS/Practice Curated: Analytic and Data Science Applications

Sponsored: Military and Security

Sponsored Session

Chair: Jon Alt, Naval Postgraduate School, Monterey, CA

Co-Chair: Eric Tollefson

1 - Leveraging the Cloud Computing Environment to Support Decision Makers
Nathan I. Parker, TRADOC Analysis Center - Monterey, 700 Dyer Road, Room 178, Monterey, CA, 93943, United States, Jonathan Shockley

Here we use our ongoing effort to develop a cloud-hosted, browser interfaced decision support tool (DST), leveraging one of TRADOC Analysis Center's simulation models, as a starting point to discuss how cloud computing provides a unique capability to enable distributed data science applications. In addition to presenting the Logistics Battle Command DST itself, we will also discuss the underlying cloud infrastructure we employ and our development, test, and deployment pipeline.

2 - Aerial Exposure Metric
James Jablonski, TRADOC Analysis Center, 1106 Leahy Rd, Monterey, CA, United States

The development of a method to calculate the level of exposure of each point in the sky in a given terrain box to points on the ground. The exposure metric can then be used to characterize the exposure of an area, to determine the optimal routing to minimize exposure in a given area, or to determine the optimal placement of air defense assets to maximize coverage in an area. The research also informs the computational costs of scaling these methods up to a larger terrain box and provides insights into future directions. A proof of principle application, developed using open source tools is provided.

3 - Binary Classification with Asymmetric Error Type Control
Mathew Norton

We introduce a new formulation for binary classification with asymmetric error control inspired by the Neyman-Pearson (NP) paradigm. We propose a computationally efficient large margin classifier with the same generalization benefits as Support Vector Machines in high-dimensional feature spaces, but with fine tuned control over the amount of allowable Type I and Type II error. Our approach is based on a new characterization of uncertainty called Buffered Probability of Exceedance (bPOE) and, as consequence, often reduces to convex or linear programming.

4 - A Methodological Framework for Developing a Defense Data Strategy
Kurt Klingensmith, TRAC, Monterey, CA, United States, Jon Alt

In order to lead the Army's modernization, the emerging Army Futures Command

(AFC) will leverage timely, relevant, and credible analysis to informs and drive critical modernization strategies, priorities, and decisions. Achieving this requires the development and operationalization of a formal AFC Data Strategy. The Data Strategy envisions how the AFC will use data as an enterprise asset in support of modernization activities such as concept development, modernization planning, acquisition, and capability delivery. This presentation will present a systems architecting-based methodology for developing data strategies along with a framework for implementing and executing a data strategy.

■ MC77

West Bldg 213A

Joint Session PSOR/Practice Curated: Transportation Issues in Smart Cities

Sponsored: Public Sector OR

Sponsored Session

Chair: Leila Hajibabai, PhD, State University of New York, Stony Brook, NY, 11794, United States

1 - Integrated Signal Timing and Traffic Metering Optimization in Connected Urban Transportation Networks

Ali Hajbabaie, Washington State University, Raleigh, WA, 99164-2910, United States, Rasool Mohebifard, S.M.A. Bin Al Islam

In this paper, we proposed a distributed mathematical optimization program that dynamically optimizes the traffic signal indications at intersections and at the same time finds the optimal number of vehicles that should enter the transportation network from its boundary gates to maximize the overall network performance. The solution technique has a model distributed predictive control structure that uses the location information of connected vehicles and vehicle counts from loop detectors to estimate the system state to optimize the decision variables. The results show that the proposed algorithm outperforms several benchmark solutions and increases the network throughput by 41.8% to 43.2%.

2 - A Consensus-based Trajectory Control Logic for Connected and Autonomous Vehicles in a Signal-Free Intersection

Leila Hajibabai, State University of New York at Stony Brook, Department of Civil Engineering, 2433 Computer Science, Stony Brook, NY, 11794, United States, Amir Mirheli, Mehrdad Tajalli, Ali Hajibabai

This paper presents a distributed cooperative control logic to plan conflict-free trajectories for connected and autonomous vehicles (CAVs) in signal-free intersections. The problem is formulated into CAV-level mixed-integer non-linear programs (MINLPs) that minimize each vehicle's travel time and avoid near-crash conditions. To push CAV-level solutions towards global optimality, we develop a coordination scheme that shares vehicle states on location and speed over a prediction period and incorporates such information in each CAV's respective MINLP.

3 - Scheduling of Heterogeneous Connected Automated Vehicles at a General Conflict Area

Xiaopeng Li, University of South Florida, 4202 E. Fowler Avenue, ENG 207, Tampa, FL, 33620, United States, Saeid Soleimaniamiri

A mixed integer programming (MIP) model is proposed to solve the joint optimization problem that simultaneously determine scheduling and trajectories of connected autonomous vehicles at a multi-conflict point considering heterogeneous vehicle headways and values of time. A novel dynamic programming based solution approach is proposed to obtain a near optimal solution. A set of numerical examples show that the model solutions can significantly increase the capacity of the conflict point and reduce both travel time and fuel consumption.

4 - Community-engaged Operations Research as a Tool to Support Diversity, Equity and Inclusion in the Profession

Michael P. Johnson, University of Massachusetts Boston, Department of Public Policy & Public Aff, 100 Morrissey Boulevard, Boston, MA, 02125-3393, United States

OR/MS/analytics faces two important questions regarding diversity, equity and inclusion. First, what has the profession done to address important diversity-related social problems? Second, what can the profession do to meet diversity, equity and inclusion goals for INFORMS? In this talk I explain the unique role that community operational research and community-based operations research can play in enabling our profession to become more welcoming to members of diverse backgrounds, and to solving important social problems for which diversity is a critical component.

■ MD06

North Bldg 122C

Joint Session OPT/Practice Curated: Theories and Applications of Noncovex Quadratic Programming

Sponsored: Optimization/Global Optimization

Sponsored Session

Chair: Yiling Zhang, University of Michigan, Ann Arbor, MI, 48105, United States

1 - Strong Formulations for Quadratic Optimization with M-matrices and Indicator Variables

Alper Atamturk, University of California-Berkeley, Industrial Eng. & Operations Research, 4141 Etcheverry Hall, MC 1777, Berkeley, CA, 94720-1777, United States, Andres Gomez

We study quadratic optimization with indicator variables and an M-matrix, i.e., a PSD matrix with non-positive off-diagonal entries. We prove that the minimization problem is solvable in polynomial time by showing its equivalence to a submodular minimization problem. To strengthen the formulation, we decompose the quadratic function into a sum of simple quadratic functions with at most two indicator variables each, and provide the convex-hull descriptions of these sets. We also describe strong conic quadratic valid inequalities. Computational experiments indicate that the proposed inequalities can substantially improve the strength of the continuous relaxations.

2 - Strong Formulations for Conic Quadratic Optimization with Indicator Variables

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

We study the convex hull of a mixed-integer set given by a conic quadratic inequality and indicator variables. We provide the convex hull description of the set under consideration when the continuous variables are unbounded. We propose valid nonlinear inequalities for the bounded case, and show that they describe the convex hull for the two-variable case. All the proposed inequalities are described in the original space of variables and are SOCP-representable. We present computational experiments demonstrating the strength of the proposed formulations.

3 - Exact Semidefinite Formulations for a Class of Random Nonconvex Quadratic Programs

Samuel Burer, University of Iowa, Dept Mgmt Sci/Tippie College of Business, S346 Pappajohn Business Building, Iowa City, IA, 52242-1000, United States, Yinyu Ye

We study a general class of random quadratically constrained quadratic programs (QCQPs), which has exact semidefinite relaxations with high probability as long as the number of variables is significantly larger than the number of constraints.

4 - Ambiguous Chance-constrained Binary Programs under Mean-covariance Information

Yiling Zhang, University of Michigan, Ann Arbor, MI, 48105, United States, Ruiwei Jiang, Siqian Shen

We consider chance-constrained binary programs, where each row of inequalities that involve an uncertain technology matrix needs to be satisfied probabilistically. With the information of the mean and covariance matrix available, we solve distributionally robust chance-constrained binary programs (DCBP). Using two different ambiguity sets, we equivalently reformulate the DCBPs as 0-1 second-order cone (SOC) programs. We further utilize the submodularity of 0-1 SOC constraints and lifting to derive extended polymatroid inequalities. We incorporate the valid inequalities in a branch-and-cut algorithm for efficiently solving DCBPs. Finally, we demonstrate the computational efficacy.

■ MD08

North Bldg 124A

Joint Session OPT/Practice Curated: Integer Programming for Network Optimization and Applications

Sponsored: Optimization/Network Optimization

Sponsored Session

Chair: Ou Sun, University of Arizona, Tucson, AZ, 85719, United States

Co-Chair: Neng Fan, University of Arizona, Tucson, AZ, 85721, United States

1 - Algorithms and Complexity Results for Routing Trains through a Railyard

Kelly Sullivan, University of Arkansas, 4207 Bell Engineering Center, 1 University of Arkansas, Fayetteville, AR, 72701, United States, Negin Enayaty Ahangar

We consider the problem of identifying a shortest route for a locomotive pulling a cut of cars through a railyard network in which nodes correspond to switches and edges correspond to tracks. As compared to a traditional shortest path problem, this problem is challenging because the route must accommodate, subject to the geometry of the yard tracks, the length of the cut of cars plus the length of the locomotive at any time. We model this problem as an integer program, prove its NP-hardness, and propose a solution approach that is polynomial for an important

special case.

2 - Benders Cut-and-solve: A New Versatile Tool for Network Optimization

Carlos Armando Zetina, Concordia University, CORS/INFORMS Montreal Operations Research Stu, 1455 de Maisonneuve Boulevard W, Montreal, QC, H3G 1M8, Canada, Ivan Contreras, Jean-Francois Cordeau

Cut-and-solve has been used to solve the TSP and facility location to optimality. This method can be thought of as a generalized local branching in which at each level of the enumeration tree only two child nodes exist, one corresponding to a smaller "sparse" problem and the other as its complement known as the "dense" problem. We propose the use of Benders-based branch-and-cut as the black box MIP solver for "sparse" problems. Two important advantages of this are the reduced problem size and the re-usability of the Benders cuts generated in previous iterations. We present promising computational results for a naive implementation used to solve the fixed-charge multicommodity network design problem.

3 - Minimum Cost Vertex Blocker Clique Problem

Farzaneh Nasirian, University of Massachusetts-Boston, 100 William T. Morrissey Blvd, Boston, MA, 02125, United States, Foad Mahdavi Pajouh, Josephine Namayanja

This talk addresses the minimum cost vertex blocker clique problem (CVCP) in which we are interested in detecting a subset of vertices in a graph with a minimum blocking cost whose removal bounds the weight of any weighted clique in the remaining graph by a given r>0. We propose new linear 0-1 programming formulations with the exponential number of constraints and a new set of facets for the CVCP polytope. We also develop the first combinatorial branch-and-bound algorithm to solve this problem. The computational performance of these exact algorithms is studied on a test-bed of randomly-generated and real-life graphs.

4 - Manufacturing Processes with Renewable Energy Integration and Demand Response

Jose Luis Ruiz Duarte, University of Arizona, 1127 E. James E. Rogers Way, Tucson, AZ, 85721, United States, Neng Fan

International efforts for CO2 reduction require the engagement of industry sector, as a major energy consumer in the world. The integration of renewable energy sources (RES) into manufacturing processes is an alternative. In this work, a mathematical programming model is developed to obtain the optimal production schedule considering consecutive processes, integration of both onsite and grid RES, onsite energy storage systems, and demand response policies. Robust formulation approach is used to obtain optimal operations under the worst-case scenario for RES generation. A solution algorithm is developed to solve this formulation and is validated by numerical experiments

5 - A Stochastic Mixed Integer Programming for GIS-based Biorefinery Facility Location Problem

Ou Sun, University of Arizona, 827 E. Drachman Street, Tucson, AZ, 85719, United States, Neng Fan

A typical biomass supply chain consists of the following five components: harvesting and collection, storage, pretreatment, transportation, and conversion. Facility location problem is embedded in and vital to both pretreatment, and conversion processes. Geographic information system (GIS) is widely used to decide the facility locations with consideration of different related factors. Due to the special characteristics of biomass, the harvest yield is uncertain, which leads to the uncertainties through the whole supply chain. We take uncertainties into consideration and formulate a stochastic mixed integer programming by utilizing GIS tools for biorefinery facility location problem.

■ MD10

North Bldg 125A

Joint Session MSOM/Practice Curated: Commodity and Energy Operations

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Selvaprabu Nadarajah, University of Illinois at Chicago, 601 South Morgan Street,, UH 2406, Chicago, IL, 60607, United States

Co-Chair: Nicola Secomandi, Carnegie Mellon University, Pittsburgh, PA, 15213, United States

1 - Pathwise Optimization for Merchant Energy Production Modeled as a Switching Option

Bo Yang, Carnegie Mellon University, Pittsburgh, PA, 15213, United States, Selvaprabu Nadarajah, Nicola Secomandi

Merchant energy production modeled as a switching option gives rise to an intractable Markov decision process (MDP). It is common to combine least-squares Monte Carlo (LSM) and information relaxation and duality techniques to compute a feasible operating policy and bounds on the optimal policy value for this MDP. We extend the less explored pathwise optimization (PO) approach for this purpose, developing preconditioning and decomposition methods to make the resulting linear program solvable. On realistic instances, PO leads to substantially better optimality gaps but requires longer run times than LSM, slightly improving on the near-optimal LSM based operating policies.

2 - Analysis of Competitive Energy Markets under Capacitated Transportation

Ian Yihang Zhu, University of Toronto, 144A, 60 Harbord Street, Toronto, ON, M5S3L1, Canada, John R. Birge, Timothy Chan, Michael Pavlin

This paper considers the interplay between the transportation network, market structure and equilibrium prices of energy markets. We derive analytical methods drawing on inverse optimization and clustering methods that allows us to obtain insights into market structure and integration using only easily available regional pricing data. We show through several case studies of the North American gasoline market how our methodology yields results that are consistent with the underlying transportation network and market structure.

3 - Operations and Investment of Energy Storage in a Tree Network

Owen Wu, Indiana University, Kelley School of Business, 1309 E. 10th Street, Bloomington, IN, 47405, United States, Roman Kapuscinski

Matching electricity supply with demand is challenging due to inherent variabilities in demand and renewable power generation. Energy storage, though expensive, is operationally beneficial to electricity systems. In this talk, we discuss the optimization of energy storage investment and operations. In particular, we consider the problem of siting (where to invest) and sizing (how much capacity to invest) storage facilities in a tree network that has one power generation node and many demand nodes. The objective is to minimize the total storage investment and long-run power generation costs. We provide new insights on the key factors that affect storage investment decisions and the total costs.

4 - Managing Shutdown Decisions in Merchant Commodity and Energy Production: A Social Commerce Perspective

Selvaprabu Nadarajah, College of Business, University of Illinois at Chicago, 601 South Morgan Street,, UH 2406, Chicago, IL, 60607, United States, Alessio Trivella, Stein-Erik Fleten, Denis Mazieres, David Pisinger

Merchant commodity/energy production assets operate in markets with volatile prices and exchange rates. Plant closures often adversely affect the parent company and the local community. We study if mitigating these effects is financially viable by designing two types of policies that delay or avoid a plant closure. The first policy is grounded in anticipated regret theory and determined using approximate dynamic programming (ADP), while the second extends production margin-based heuristics used in practice and is computed using ADP and binary classification. Our operating policies significantly delay/avoid shutdowns for small asset value losses on real aluminum production instances.

■ MD11

North Bldg 125B

Joint Session MSOM/Practice Curated: Finance and Risk Management Applications in OM

Sponsored: Manufacturing & Service Oper Mgmt/iFORM

Sponsored Session

Chair: Yuan-Mao Kao, Duke University, Durham, NC, 27708, United States

Co-Chair: N. Bora Keskin, Duke University, Durham, NC, 27708-0120, United States

1 - Government Financing for Clean Technology Development

Seung Hwan Jung, Texas A&M University-Kingsville, 3118 La Rochelle Way, Corpus Christi, TX, 78414, United States, Lingxiu Dong

The goal of this paper is to study government financing for a firm's clean technology development under a financial constraint. In this paper, we investigate the impact of government financing on environment and the firm's bankruptcy risk when market uncertainty exists.

2 - Operational Risk Management: Optimal Incentive Contract

Yuqian Xu, University of Illinois at Urbana-Champaign, Wohlers Hall 487, 1206 S. 6th St, Champaign, IL, 61820, United States, Lingjiong Zhu, Michael L. Pinedo

In this paper, we study how a financial firm can offer incentive bonus contracts to its employees so as to incentivize them to exert efforts in reducing potential operational risk losses. Each employee then needs to balance the trade-off between the effort based bonus and the cost of the efforts to him or her (in a non-monetary form). We characterize the equilibrium strategy between the firm and its n employees, and then discuss the conditions under which incentive bonuses would be issued.

3 - Comparison of Integrated Risk Management Frameworks for Newsvendors

Panos Kouvelis

We study a newsvendor problem with profit risk control using VaR constraints. When a firm's demand correlates with the price of a tradable financial asset, both financial tools (derivatives) and operational tools (inventory) can be used for profit risk management. Such integrated risk management (IRM) approaches have been studied using various optimization frameworks to reflect the risk aversion of decision-makers. To the best of our knowledge, we are the first to study IRM in a newsvendor setting using profit maximization under VaR constraints (mean-VaR). We compare different IRM frameworks and find that only under mean-VaR, inventory and financial hedging decisions are separable.

4 - Impact of Information Asymmetry and Limited Production Capacity on Business Interruption Insurance

Yuan-Mao Kao, Duke University, Durham, NC, 27708, United States, N. Bora Keskin, Kevin Shang

We study adverse selection and moral hazard issues that arise when an insurer offers business interruption insurance to a firm for guarding against disruption risks. The insurer cannot observe the firm's demand forecasts and recovery effort when a disruption occurs. We characterize the optimal insurance contracts to deal with the information asymmetry, and show how the firm's limited production capacity impacts the insurer's contract design. We also analyze the impact of ignoring the information asymmetry in designing insurance contracts.

■ MD12

North Bldg 126A

Joint Session MSOM/Practice Curated: Choice Modeling and Applications in Retail Operations

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Aydin Alptekinoglu, Pennsylvania State University, Pennsylvania State University, University Park, PA, 16802, United States

1 - Product Line Design under Multinomial Logit Choices

Hongmin Li, Arizona State University, WP Carey School of Business, Dept of Supply Chain Management, Tempe, AZ, 85287, United States, Scott Webster, Gwangjae Yu

We study a product-line design problem in which customer choice among multiple products is given by a multinomial logit (MNL) model. A firm determines product attributes and prices in an evolving product line to maximize profit. In particular, given the prices and attributes of products that already exist in a product line, the firm optimizes prices and/or attributes of the new products to be added to the same product line.

2 - Dynamic Pricing for Varying Assortments

Emily Mower, Harvard University, Cambridge, MA, United States, Kris Johnson Ferreira

Most multi-product demand learning and dynamic pricing algorithms learn product-specific demand parameters as opposed to attribute-specific demand parameters. We develop an attribute-specific learning-then-earning dynamic pricing algorithm geared for companies whose assortments change over time. To maximize efficiency in the learning phase, we incorporate methods from conjoint analysis and optimal experimental design. We test our algorithm in a randomized controlled field experiment at an e-commerce platform that sells excess inventory of fitness studio classes offered the following day.

3 - Dynamic Choice and Consumption

John H. Semple, Southern Methodist University, Cox School of Business, 6212 Bishop Boulevard, Dallas, TX, 75205, United States, Aydin Alptekinoglu

We investigate the problem of purchasing a bundle of different (but substitutable) products for future consumption. We term this bundle an "n-pack. The optimal consumption of the pack can be analyzed using dynamic programming, which we use to derive the optimal policy and the structure of the value function for this multi-state problem. In some cases, the value function can be given in closed form, and thus our problem does not suffer from the usual curse of dimensionality.

4 - A Comparative Empirical Study of Discrete Choice Models in Retail Operations

Gustavo J. Vulcano, Universidad Torcuato di Tella, Av Figueroa Alcorta 7350, Suite 405, Buenos Aires, 1428, Argentina, Gerardo Berbeglia, Agustin Garassino

In this paper, we conduct a systematic, empirical study of different demand models and estimation algorithms, spanning both maximum likelihood and least squares criteria. Through an exhaustive set of numerical experiments on synthetic and real data, we provide comparative statistics of the quality of different choice models and estimation methods, and characterize operational environments suitable for different model/estimation implementations.

■ MD14

North Bldg 126C

Joint Session MSOM/Practice Curated: Learning and Information Theory Applications in Queues

Sponsored: Manufacturing & Service Oper Mgmt/Service Operations

Sponsored Session

Chair: Nur Sunar, UNC, UNC, Chapel Hill, NC, 27517, United States

1 - Reinforcement with Fading Memories

Kuang Xu, Stanford Graduate School of Business, 655 Knight Way, Stanford, CA, United States

We study the effect of imperfect memory on decision making in the context of a stochastic sequential action-reward problem. An agent chooses a sequence of actions which generate discrete rewards at different rates. She is allowed to make new choices at rate , while past rewards disappear from her memory at rate . We provide closed-form formulae for the agent's steady-state choice distribution in the regime where the memory span is large (? 0), and show that the agent's success critically depends on how quickly she updates her choices relative to the speed of memory decay.

2 - Signaling in Queues with Risk Averse Customers

Krishnamurthy Iyer, Cornell University, Ithaca, NY, 14850, United States, David Lingenbrink

We study revenue-optimal signaling in an unobservable queue offering service at a fixed-price to a Poisson arrival of customers, who decide to join or balk upon arrival. We focus on the setting where customers are strategic and risk-averse: a customer joins only if the sum of the mean of her waiting time and a multiple of its standard deviation is below a given threshold. Although the revelation principle no longer holds, a restricted form of the principle allows us to formulate an iterative approach to solve the information design problem, where each iteration involves optimizing a linear objective under quadratic constraints.

3 - A Semi-parametric Bayesian Model for Call Center Arrivals

Kaan Kuzu, Univ of Wisconsin-Milwaukee, Sheldon B. Lubar School of Business, P.O. Box 742, Milwaukee, WI, 53201-0742, United States, Refik Soyer

We describe and analyze data for arrivals to a call center by presenting a modulated Poisson process model, which takes into account both covariate and time effects on the call volume intensity. We introduce a semi-parametric model and develop its Bayesian analysis to assess the effectiveness of different advertising strategies as well as to predict call arrival patterns. The proposed model and the methodology are implemented using real call center arrival data. We show that the proposed semi-parametric model has higher prediction accuracy than prior parametric models in literature.

4 - Dynamic Learning and Rational Customers in Services

Nur Sunar, UNC, 1604 Village Crossing Drive, Chapel Hill, NC, 27517, United States, Yichen Tu, Serhan Ziya

We study a queueing system where customers can dynamically learn about a service feature. Our analysis shows that such rational customers can help the service provider boost its expected profit.

■ MD15

North Bldg 127A

Joint Session MSOM/Practice Curated: Business Analytics

Sponsored: Manufacturing & Service Oper Mgmt/Service Operations

Sponsored Session

Chair: Han Ye, U. of Illinois at Urbana-Champaign, Champaign, IL, 61820, United States

Co-Chair: Haipeng Shen, Hong Kong

1 - On the Accuracy of the Last-to-enter-service Announcement: Bridging Theory and Practice

Rouba Ibrahim, University College London, MS&I department, UCL, Gower Street, London, WC1E 6BT, United Kingdom, Achal Bassamboo

We propose a new, practice-driven, correlation-based framework to assess the relative accuracy of static and dynamic delay announcements. For a dynamic announcement, we consider the delay of the last customer to have entered service. Our approach combines queueing-theoretic analysis and an empirical study of real-life data.

2 - Issue Resolution Estimation for Customer Service Centers

Han Ye, U. of Illinois at Urbana-Champaign, 350 Wohlers Hall, 1206 South Sixth Street, Champaign, IL, 61820, United States

Issue resolution estimation is critical for service center management. Traditionally, it is estimated via surveys and monitoring. In this paper, new models are developed to estimate issue resolution from operational data. The proposed models are then compared to existing practices under various scenarios. Performance grids of each studied model are constructed to provide practical guidelines on model selection.

3 - Can Customer Arrival Rates Be Modelled by Sine Waves?
Donald Lee, Yale University, New Haven, CT, 06520, United States, Ningyuan Chen, Haipeng Shen

Customer arrival patterns typically exhibit strong seasonal effects. It is therefore natural to ask: Can a nonhomogeneous Poisson process (NHPP) with a rate that is the sum of sinusoids provide an adequate description of reality? We empirically investigate this question in two settings of interest to operations scholars: Arrivals to an emergency department and to a call centre. We develop novel estimation and testing procedures to show that the model is consistent with arrivals data from both settings. Our findings, combined with the flexibility and tractability of sinusoids, suggest that the NHPP with a sinusoidal rate function is a worthy workhorse model for time-varying arrival processes.

■ MD18

North Bldg 128A

Joint Session BMI/Practice Curated: Empirical Research in Online Marketplaces

Emerging Topic: Business Model Innovation

Emerging Topic Session

Chair: Yao Cui, Cornell University, Ithaca, NY, 14853, United States

1 - Optimizing Services in Retail Networks using High-dimensional Panel Data
Amandeep Singh, The Wharton School, 500 Jon M. Huntsman Hall, 3730 Walnut St., Philadelphia, PA, 19104, United States, Gad Allon, Ken Moon

We study how retail stores' multi-dimensioned service levels affect consumers' buying behavior in a spatial setting. To this end, we propose the Double Block-Lasso BLP estimator, which combines the double selection procedure introduced in Belloni, Chernozhukov, and Hansen (2014), with demand estimation methods set forth in Berry, Levinsohn and Pakes (1995). Under mild assumptions of structural stability and sparsity, we obtain consistent estimates of the influences that retails stores exert across various spatial markets. Using the estimated influence structure, we highlight the service quality interventions promising greatest joint impact on consumers' buying patterns.

2 - Consumer Preferences and System Design for Pooled Transportation
Kashish Arora, INSEAD, Fontaniebleau, France, Fanyin Zheng, Karan Girotra

In this study, we look at the drivers of the choice betweenon-demand cabs and a pre-determined and scheduled shuttle service. We use these to estimate the "inconvenience costs associated with shuttle platforms. Specifically, we estimate the inconveniencecosts associated with walking to the shuttle, waiting for its arrival and traveling the extra distance on the shuttle .Secondly, we use the sensitivity estimates to design policy counterfactuals for determiningthe optimal size and frequency of the shuttle service and to suggest new routes for expansion

3 - Impact of the Mobile Channel on Sales Concentration
Fangyun Tan, Southern Methodist University, 6212 Bishop Blvd, Dallas, TX, 75275, United States, Nitish Jain

This study employs data from a large online apparel retailer, which operates both mobile and PC channels, to compare the causal effects of these two online channels on sales concentration, in terms of the share of popular products. We use a difference-in-differences estimation strategy that leverages a quasi-experiment stemming from the retailer's decision to discontinue its PC sales channel. We find that the mobile channel increases the share of popular products purchased by about 5% as compared with the PC channel. Furthermore, we find evidence which corroborates the role of a search cost led mechanism in driving the difference between the two channels' sales concentration level.

4 - Tax-induced Inequalities in the Sharing Economy: Evidence from Airbnb
Yao Cui, Cornell University, 401N Sage Hall, Ithaca, NY, 14853, United States, Andrew M. Davis

In this paper, we investigate the impact of occupancy tax on Airbnb listings.

■ MD23

North Bldg 131A

Joint Session FSS/Practice Curated:

Stochastic Games with Applications

Sponsored: Finance

Sponsored Session

Chair: Xin Guo, University of California-Berkeley, Piedmont, CA, 94611, United States

1 - A Stochastic Game and Moving Free Boundary Problem
Renyuan Xu, University of California-Berkeley, 4141 Etcheverry Hall, OR Department, Berkeley, CA, 94720, United States, Xin Guo, Wenpin Tang

Stochastic control problems are closely related to free boundary problems, where both the underlying fully nonlinear PDEs and the separating boundaries are integral parts of the problems. In this talk, we propose a class of stochastic games and show how the free boundary problems involve moving boundaries due to the additional game nature. We will provide explicit solutions in terms of Nash equilibria by solving a Skorokhod problem with moving boundaries. We will use some special cases of the games in light of the classical finite fuel problem to compare game strategies in terms of pooling and sharing. We will also discuss the Nash equilibrium strategies in the framework of controlled ranked SDEs.

2 - A Stochastic Numerical Method for Mean Field Games
Mathieu Lauriere, Princeton University, Princeton, NJ, United States

We present a new stochastic algorithm to solve mean field games and optimal control problems of McKean-Vlasov dynamics. This numerical method relies on the system of forward-backward stochastic differential equations characterizing the solutions to these problems. Several examples of applications will be provided. This is joint work with Ren Carmona.

3 - The Coordination of Centralized and Distributed Generation
Matteo Basei, University of California, Berkeley, Berkeley, CA, United States, Ren Aid, Huyen Pham

We analyse the interaction between centralised carbon-emissive technologies and distributed non-emissive technologies. A representative consumer can satisfy her electricity demand by investing in solar panels and by buying power from a centralised firm. We consider the point of view of the consumer, the firm and a social planner, formulating suitable McKean-Vlasov control problems with stochastic coefficients. First, we provide explicit formulas for the production strategies which minimise the costs. Then, we look for an equilibrium price.

4 - Non-zero Sum Stochastic Games with Impulse Control
Haoyang Cao, University of California, Berkeley, Berkeley, CA, United States

This is a joint work with Prof. Xin Guo and Mr. Matteo Basei. We generalize the single-agent impulse control problem, i.e. the cash management problem as in [Constantinides and Richard, 1978], to an N-player impulse game. In this impulse game, each agent controls its own state dynamics and they are coupled together through cost functions. We provide two versions of verication theorems, one requiring value functions to be continuous everywhere, the other relaxing the regularity condition and adding assumptions on cost structures instead. Under a symmetric setting, we are able to give a semi-explicit Nash equilibrium.

■ MD29

North Bldg 221B

Joint Session TSL/Practice Curated: Large-scale Data Analytics in Transportation System Modeling

Sponsored: TSL/Urban Transportation

Sponsored Session

Chair: Shanjiang Zhu, George Mason University, Fairfax, VA, 22030, United States

Co-Chair: Sean Qian, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA, 15213, United States

1 - An Empirical Investigation of the Matching Technology in the Ride-sourcing Market
Daniel Vignon, University of Michigan, Ann Arbor, MI, United States, Zhengtian Xu, Yafeng Yin

With the rise in popularity of ride-sourcing services, ride-sourcing companies face challenges in meeting an ever growing demand. In order to answer these challenges, a deep understanding of the underlying mechanisms at play in the market is needed. For this purpose, we propose an empirical model of the ride-sourcing market, focusing especially on the matching technology. This model allows us to not only understand possible failures modes of the ride-sourcing market, but also how to remedy them.

2 - Inferring Multimodal Day-to-day Travel Dynamics using Smartphone App Data
Shanjiang Zhu, George Mason University, Nguyen Engineering

Building, Suite 1300, 4400 University Drive Ms 6c1, Fairfax, VA, 22030, United States, Zhuo Yang, Guanqi Liu, Lei Zhang

This study investigates the day-to-day travel dynamics on a multi-modal network. Longitudinal travel trajectories data were collected using a smartphone app among commuters during Washington Metro Safetrack project. Algorithms were developed to infer the travel choices before, during, and after the network disruptions, which are crucial for assessing the impact of the unprecedented maintenance work at the Washington Metro. Findings from this study could help to inform agencies who are struggling with the aging infrastructure across the country and help them to develop better strategies.

3 - Early Warning Signal for Congested Large-scale Traffic Networks

Xiaozheng He, Rensselaer Polytechnic Institute, 110 8th St., JEC 4034, Troy, NY, 12180, United States, Chunhen Jiang, Jihui Nie, Jianxi Gao

This study proposes an early warning signal to indicate whether the traffic condition of a congested network is getting close to its critical degradation threshold, beyond which congestion is difficult to mitigate. The early warning signal is developed based on the critical slowing down theory for perturbed dynamical systems. Using the collected field data, we validate the proposed signal and show that the system recovery process becomes increasingly slow when the traffic condition approaches the critical point.

4 - Estimating Probability Density of Origin-destination Matrices on Congested Networks

Yudi Yang, 1420 Lake Boulevard, Apartment 17, Davis, CA, 95616, United States, Yueyue Fan, Johannes Royset

To understand the stochastic nature of travel demand is gaining more attention in transportation studies as reliability and resilience become important performance measures for transportation project evaluation. In this study, we aim to infer the probability density function (pdf) of Origin-Destination (O-D) demand variables by integrating (potentially) multiple data sources. Unlike most traditional statistical approaches that are only applicable to non-congested networks, the proposed method is designed to be capable of incorporating traffic network flow rules/models in a congested network and determining route choice proportion and O-D matrix simultaneously.

5 - Transportation Big Data: Promises, Issues, and Implications

Rong Fan, University of Washington, Seattle, WA, United States, Xuegang (Jeff) Ban

Big data and related data analytics methods have received much attention recently in transportation for various planning and operational applications. This talk summarizes the promises of big data and illustrates the issues of some commonly used big data sources in transportation. We then briefly discuss the implications of such issues and suggest a pathway that may help address those issues.

■ MD33

North Bldg 222C

Joint Session ORAM/QSR/Practice Curated: Data Analytics Methods for Smart Manufacturing Systems Monitoring and Control

Emerging Topic: OR and Advanced Manufacturing

Emerging Topic Session

Chair: Mohammed Shafae, University of Arizona, Tucson, AZ, 85743, United States

Co-Chair: Dazhong Wu, University of Central Florida, FL, United States

1 - A Feature-Based Data-Level Fusion Model for Degradation Modeling and Prognostics

Yupeng Wei, Pennsylvania State University, PA, United States, Dazhong Wu, Janis Terpenny

The rapid development of sensor technologies has enabled multiple in-situ sensors to monitor the degradation status of operation units. To achieve an accurate prediction of remaining useful life (RUL), multiple sensor signals should be fused. This work presents a new data-level fusion methodology for degradation signals based on statistical features, which is designed to provide much more accurate features to better support the prediction of RUL. In addition, 4 machine learning algorithms are facilitated to predict the RUL based on features extracted from the fused signal. Our methodology was evaluated through a degradation dataset of an aircraft gas turbine engine that was generated by C-MAPSS.

2 - Parallel Computing and Network Analytics for the Monitoring of Industrial Internet-of-Things (IIoT) Machines

Chen Kan, TX, United States, Hui Yang, Soundar Kumara

This paper presents a new method for IIoT machine condition monitoring. First, dissimilarities among machine signatures were characterized. Then, we proposed a stochastic learning algorithm to construct a large-scale dynamic network of IIoT machines. When machine condition varies, the network structure is changed accordingly. A parallel computing scheme is further developed to significantly improve the computational efficiency. Results show the developed algorithm effectively and efficiently captures cycle-to-cycle dynamics of a machine and machine-to-machine variations in large-scale IIoT.

3 - Cloud-Based Parallel Machine Learning for Tool Wear Prediction

Dazhong Wu, University of Central Florida, FL, United States

Cloud computing and machine learning have the potential to advance smart manufacturing. One of the limitations of current machine learning methods is that large volumes of training data are required to train predictive models. Consequently, computational efficiency remains a primary challenge. In this presentation, we will introduce a parallel random forests algorithm. This algorithm is implemented on the cloud with varying combinations of processors and memories. This algorithm is demonstrated using condition monitoring data collected from milling experiments.

■ MD44

North Bldg 227C

Joint Session ENRE/Practice Curated: Optimization and Machine Learning for Electric Power Systems

Sponsored: Energy, Natural Res & the Environment/Electricity

Sponsored Session

Chair: Yu Zhang, PhD, UC Santa Cruz, 1156 High St SOE2, Santa Cruz, CA, 95064, United States

1 - Application of Machine Learning to Distribution Synchrophasors

Alireza Shahsavari, University of California, Riverside, Riverside, CA, United States, Hamed Mohsenian-Rad

The recent development of distribution-level phasor measurement units, a.k.a. micro-PMUs, has been an important step towards achieving situational awareness in power distribution networks. A typical micro-PMU is connected to single- or three-phase distribution circuits to measure GPS time-referenced magnitudes and phase angles of voltage and current phasors at 120 readings per second. The challenge in using micro-PMUs is to transform the large amount of data that is it generates to actionable information and match the said information to use cases with practical value to distribution system operators. In this talk, we adopt a big-data approach to address this open problem. We introduce a novel data-driven event detection technique to pick out valuable portion of data from extremely large raw micro-PMU dataset. We then develop a data-driven event classifier to effectively classify power quality events. Importantly, we use field expert knowledge and utility records to conduct an extensive data-driven event labeling. Certain aspects from event detection analysis are adopted as additional features to be fed into the classifier model.

2 - Joint Structure and Parameter Estimation in Power Distribution Under Limited Observability

Deepjyoti Deka, Los Alamos National Lab

Efficient operation of distribution grids in the smart-grid era is hindered by the limited presence of real-time meters. This paper studies the problems of topology and parameter estimation in the limited observability regime where measurements are restricted to only the terminal nodes of the grid and all intermediate nodes are unobserved/hidden. To this end, we propose two algorithms for exact topology (and impedances) estimation. We discuss the computational and sample complexity of our proposed algorithms and demonstrate that topology (and impedance) estimation by our algorithms are optimal with respect to number of nodal observability required.

3 - Stochastic Continuous Time Unit Commitment

Anna Scaglione, Arizona State University, Tempe, AZ, United States, Kari Hreinsson, Bita Analui

Conventional power system unit commitment problems are deterministic and assume piece wise constant behavior of net-load, while in reality net-load is uncertain and inter-period generator ramps are not well defined. We will discuss a stochastic continuous time problem formulation, where we try to give a more realistic generator ramp trajectories, as well as incorporating a multi-stage stochastic decision framework, where dispatch decisions are revised over the modeling horizon.

4 - Wind Power Forecasting via Deep Neural Networks

Yu Zhang, University of California, Santa Cruz, Jiao Hao Miao

Accurate forecasting of renewable generation is a challenging task due to its inherent intermittency and volatility. In this context, this talk deals with a new machine learning approach for predicting wind power generation with various meteorological factors including wind speed, direction, humidity, etc. We first utilize data visualization techniques for the feature selection, and then develop a deep neural network to predict the wind power outputs. Numerical results show that our proposed approach outperforms existing methods including persistence, support vector regression and ARMA.

■ MD46

North Bldg 228B

Joint Session ENRE/Practice Curated: Energy Modeling: Open Source, Applications and New Developments

Sponsored: Energy, Natural Res & the Environment/Energy

Sponsored Session

Chair: Denis Lavigne, PhD, Royal Military College St-Jean, 15, rue Jacques-Cartier Nord, St-Jean-sur-Richelieu, QC, J3B 8R8, Canada

1 - Representing the Demand Side in Energy System Optimization Models

Benjamin D. Leibowicz, Assistant Professor, University of Texas-Austin, ETC 5.128D, 204 E. Dean Keeton St. C2200, Austin, TX, 78712-1591, United States

Energy system optimization models have traditionally focused on supply-side technology investment and operation decisions. They often neglect demand-side dynamics related to end-use technology choices and demand levels because they are determined by myriad actors making individual decisions. This presentation outlines methodologies for representing the demand side in energy system optimization models, with OSeMOSYS formulations of transportation and buildings as examples.

2 - Storage End Effects and the Value of Stored Energy

Taco Niet, British Columbia Institute of Technology, 3700 Willingdon Avenue, Burnaby, BC, V5G 3H2, Canada

High temporal resolution modelling of energy systems often requires modelling a number of sub-periods, with the end condition of one sub-period being used to seed the next. When storage is modeled a challenge is to keep the model from draining the stored energy at the end of each sub-period. A common approach is to model extra-long sub-periods and to discard this end effect, increasing computational complexity. We evaluate the alternative of assigning a monetary value to the stored energy at the end of each sub-period using the OSeMOSYS energy system model. We find that assigning a monetary value to storage is an effective method to reduce the impact of end effects when modelling storage.

3 - Osemosys.org and the Global Climate-land-energy-water Model: An Integrated Resource Assessment Tool Supporting Sustainable Pathways for the Energy System

Mark Howells, KTH Royal institute of Technology, Brinellvagen 68, Stockholm, 10044, Sweden, NA, Agnese Beltramo, Constantinos Taliotis

The Open Source Energy Modelling System (OSeMOSYS) was used recently to perform integrated resource assessment analysis. In these applications, the modelling framework has been enhanced to represent interlinkages in between natural resources and identify possible Climate, Land, Energy and Water strategies (CLEWs) towards more sustainable development pathways for the energy system. In this context, the Global Least-cost User-friendly CLEWs Open Source Explorative (GLUCOSE) model is presented as an example of the developed methodology. It will provide an overview of the resource constraint the environment is facing at the global level and which might affect the energy system in the long run.

4 - An Overview of Past, Present and Future GHG Emissions and Objectives for Canada Leading to Open-source Energy Modeling

Denis Lavigne, Professor, Royal Military College Saint-Jean, 29, rue Louis-Frechette, Saint-Jean-sur-Richelieu, QC, J2W 1E9, Canada

This talk presents an overview of past, present and future GHG emissions and objectives for Canada. The discussion also includes emissions intensities and provincial figures through the years. A parallel history of some particular bottom-up energy modeling tools is presented. It leads to the opportunity to use an open-source modeling framework such as OSeMOSYS to model cities and provinces of Canada. Examples of such existing work is presented.

5 - Open Source Multi-state Continental Investment Models to Support an Analysis Ecosystem

Mark Howells, Royal Institute of Technology (KTH), Stockholm, Sweden, Hauke Henke, Nandi Moksnes, Constantinos Taliotis, Agnese Beltramo

Large multi-state electricity generation investment models have been developed. They can be absorbed into teaching programs; extended for special research applications; reduce the time needed to have a functional model and allow for the extraction of sub-models: either single or multi-state. At present such models exist for three regions of the world. These are TEMBA, SAMBA and OSEMBE for Africa, South America and EU-28 respectively. A model for North America are yet to be developed. This paper discusses pertinent aspects of these model bases and lays out challenges to be addressed.

■ MD47

North Bldg 229A

Joint Session Tutorial/Practice Curated: Coalescing Data and Decision Sciences for Analytics

Emerging Topic: Practice Curated Track

Emerging Topic Session

Chair: Lewis Ntaimo, Texas A&M University, 3131 TAMU, College Station, TX, 77843, United States

1 - Coalescing Data and Decision Sciences for Analytics

Suvrajeet Sen, University of Southern California, Daniel J. Epstein Dept. of, Industrial and Systems Engineering, Los Angeles, CA, 90089-0193, United States, Yunxiao Deng, Junyi Liu

The dream of analytics is to work from common data sources, so that all of its facets (descriptive, predictive, and prescriptive) are supported via a coherent data-driven vision. This vision of analytics is what we refer to as "Integrative Analyticsö. In this tutorial we will cover a variety of OR/MS applications that require specific statistical learning models to be integrated with optimization models. For instance, certain cross-sectional data describing dependence among random variables may lead to regression models with multivariate error terms to be integrated with Stochastic Programming (SP) models. Others may require time series models to be integrated with Stochastic Model Predictive Control (S-MPC). Still other examples lead to particle filtering models providing data for network routing. In essence this tutorial will use these illustrations to motivate a new class of models, which we refer to as Learning Enabled Optimization (LEO) models. As suggested in the title of this tutorial, the applications are derived from integrative analytics. In addition to presenting these examples, the tutorial will cover fundamental concepts for modeling, statistically approximate solution concepts, sampling-based algorithms, and finally, model assessment and selection in the context of LEO models. Given the novelty of this paradigm, we will also outline how instructors may use the material for a graduate course on integrative analytics.

■ MD49

North Bldg 230

Joint Session ENRE/Practice Curated: One and Two-level Equilibrium Modeling with Applications in Energy

Sponsored: Energy, Natural Res & the Environment/Energy

Sponsored Session

Chair: Steven A. Gabriel, University of Maryland, University of Maryland, College Park, MD, 20742-3021, United States

Co-Chair: Ben Hobbs

1 - A Median Function Approach for Discretely Constrained Equilibrium Problems

Steven A. Gabriel, University of Maryland, Dept Civil Environ Eng, 1143 Glenn L. Martin Hall, College Park, MD, 20742-3021, United States

In this talk we present a new approach for solving discretely constrained, complementarity problems. Such problems can related to energy markets with discrete (e.g., go-no go) restrictions and also equity-enforcing restrictions. The result is a mixed integer nonlinear program based on finding the zero of a certain median function and then minimizing the norm of this function subject to integer and other constraints. The approach is presented with both theory and numerical results to proof its usefulness.

2 - Equilibria in Electricity and Gas Systems under Limited Information Interchange

Antonio J. Conejo, The Ohio State University, Department of Integrated Systems Engineering, 210 Baker Systems Building, Columbus, OH, 43210, United States, Sheng Chen, Ramteen Sioshansi

We consider the independent but interrelated operation of a gas system and a power system. The gas operator seeks maximum gas supply profit by solving a second order conic problem, while the electricity operator seeks minimum electricity supply cost by solving a linear programing problem. CCGTs link significantly the operation of both systems. We characterize the equilibria reached under different levels of communication granularity (both temporal and spatial) between the gas and electricity system operators.

3 - Long-term Electricity Market Equilibria with Storage in the Presence Stochastic Renewable Infeed

Christoph Weber, PhD, University of Duisberg-Essen, Essen, Germany

Renewable energy sources (RES) in the electricity system increase the need for

flexible balancing of supply-dependent infeed, storage is thereby one important option. We formulate the long-term partial equilibrium model for competitive electricity markets with conventional generation, storage and stochastic infeed represented by a discrete recombining tree. We explore the KKT conditions to derive operation principles for storage based on a time-varying position in the supply stack resulting from stochastic changes in the co-state variable. Additionally, characteristics of the long-term investment equilibrium are derived based on the zero-excess profit condition.

4 - Strategic Multinational Transmission Expansion Planning using a Three-stage Equilibrium Model
Simon Risanger, MSC, Norwegian University of Science and Technology, Trondheim, Norway, Martin Kristiansen, Paolo Pisciella

Market agents often have different objectives and ignoring this can lead to inefficient markets. An example is multinational transmission expansion planning, where countries maximize their own social welfare, while system and market operators want system optimal results. To confront this challenge, we propose a three-stage equilibrium model. By exploiting relationships between binary variables from disjunctive constraints and dual variables, a mixed integer linear problem providing global optimum is formulated. The method is demonstrated on a case study of the North Sea Offshore Grid.

■ MD52

North Bldg 231C

Joint Session SMA/Practice Curated: Social Media Analytics and Business Value

Emerging Topic: Social Media Analytics

Emerging Topic Session

Chair: Nohel Zaman, Blacksburg, VA, 24060, United States

1 - Effective Text Mining Techniques for Understanding Employee Opinions
David Michael Goldberg, Virginia Tech, 880 West Campus Drive, Suite 1007, Blacksburg, VA, 24060, United States, Nohel Zaman

Employee satisfaction is a vital component of workplace culture, and it has substantial impacts in firm performance. In this work, we propose and compare several text analytics methods for understanding employee perceptions of their work environment using data from online discussions. These techniques will allow firms to understand nuanced employee perceptions and to pursue remediation if necessary.

2 - The Effects of Online Consumer Reviews on Product Sales in Mobile Apps Industry: An Empirical Study
Zhilei Qiao, Virginia Institute of Technology, 880 West Campus Drive, Blacksburg, VA, 24061, United States

Prior studies show that online consumer reviews have significant impacts on consumers' adoption decisions and firms' sales. This study extends the previous research and examines the effect of online user reviews on new product sales in the mobile app industry. Our results show that the review valence has a significant positive effect on new paid products, whereas the review valence has a significant negative effect on free products. Furthermore, we find that in-app purchase option has a moderating effect on the relationship between review characteristics and product sales for free and paid products. These surprising results show that review ratings have strong persuasive effects on product sales.

3 - Comparing Text Analytics Methods for Understanding Hotel Reviews
Nohel Zaman, Virginia Tech, 880 West Campus Drive, Suite 1007, Blacksburg, VA, 24060, United States, David Michael Goldberg

The hotel industry is rife with various service issues, which lead to dissatisfied customers. Online user-generated content presents firms with a valuable opportunity to collect business intelligence and to understand these problems. This study focuses on comparing the performance of text analytics for detecting these instances in online media and determining how best to analyze different types of consumer complaints.

■ MD58

West Bldg 101C

Joint Session HAS/Practice Curated: Analytics and Optimization in Health Systems

Sponsored: Health Applications

Sponsored Session

Chair: Seyma Guven-Kocak, Georgia Institute of Technology, Atlanta, GA, 30340, United States

Co-Chair: Pinar Keskinocak, Georgia Institute of Technology, Atlanta, GA, 30332, United States

Co-Chair: Dave Goldsman, Georgia Institute of Technology,Atlanta, GA, 30332-0205, United States

1 - Pediatric Kidney Post-Transplant Survival Analysis and Risk Factor Identification
Yao Xie, Georgia Institute of Technology, 4049 Wieuca Road NE, Atlanta, GA, 30342, United States, Xi He, Pinar Keskinocak, Joel Sokol

We build statistical models that accurately predict the post-transplant survival functions for pediatric kidney transplant patients and identify the most important risk factors. The pediatric transplant recipients are less commonly studied in the existing literature, while models developed for the general transplant recipients are not applicable. We use a large-scale UNOS (United Network for Organ Sharing) dataset and apply statistical variable selection techniques, specifically the group lasso and the random forest variable importance, to identify the most important risk factors. We also successfully identify multiple subgroups where the survival characteristics are different.

2 - Optimizing Population Screening for Infectious Diseases. The Case of Sleeping Sickness Control in Congo
Harwin de Vries, INSEAD, Boulevard de Constance, Fontainebleau, 77210, France

Population screening by mobile units is crucial to control several infectious diseases. We consider the following planning problem: given a set of populations at risk, the expected evolution of the epidemic in these populations, and a fixed number of mobile units, which villages should be screened when? We present descriptive models for the development of the burden of disease over time which take screening explicitly into account, use these to develop and analyze several classes of planning policies, and numerically analyze them in the context of the control of the HAT disease in D.R. Congo.

3 - Individual Wait Time Estimation in the Organ Allocation System
Ana Maria Estrada Gomez, Georgia Institute of Technology, Atlanta, GA, United States, Kamran Paynabar

When a patient is offered an organ, he/she needs to decide whether to accept or decline it. This complex decision depends in part on the estimated wait time until the next organ offer and that organ's quality. Using a match-run database, we develop methods to predict the wait time for an organ (liver, kidney, lung, heart) offer of a desired quality, given the patient's characteristics and compare our estimates to those provided by UNOS.

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4 - A Scan Statistic for Disease Detection
Dave Goldsman, Georgia Institute of Technology, School of ISyE, Atlanta, GA, 30332-0205, United States, Ignacio Erazo

Consider a square containing a number of uniformly distributed points. We use analytical methods and Monte Carlo simulation to obtain the distributions of certain scan statistics, for instance, the maximum number of points contained in a smaller square as it sweeps through the original square. These distributional results lead to statistical tests to detect the occurrence of a significant event such as a disease outbreak. Several examples illustrate our method's efficacy, statistical power, and ease of use.

■ MD64

West Bldg 104A

Joint Session DM/Practice Curated: Data Science for Food and Agriculture

Sponsored: Data Mining

Sponsored Session

Chair: Durai Sundaramoorthi

1 - Optimal Control in Dynamic Food Supply Chain Under Service Level Constraints

Ashton Kappelman, Kansas State University, 2061 Rathbone Hall, 1701B Platt St., Manhattan, KS, 66506, United States, Ashesh Kumar Sinha

We consider a dynamic food supply chain with multiple suppliers and service level constraints. We propose an integrated approach that involves developing a Bayesian network to analyze the interaction of process parameters of suppliers on the service levels of the end product, and involves stochastic optimization models to provide insights on the structure of the optimal policy comprising of supplier at each level their process parameters.

2 - Predictive Analytics and Vehicle Routing for an Urban Food Delivery Platform

Alexander Hess, PhD Student, WHU - Otto Beisheim School of Management, Burgplatz 2, Vallendar, 56179, Germany

This talk illustrates the application of predictive analytics in conjunction with vehicle routing for an urban food delivery platform. In particular, we show how more accurate forecasts achieved with machine learning algorithms lead to an improved routing. This in turn lowers the need for capacity in vehicles.

■ MD68

West Bldg 105C

Joint Session QSR/Practice Curated: High Dimensional Data Analysis and its Applications in System Informatics and Control

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Mostafa Reisi Gahrooei, Georgia Tech, 755 Ferst Dr, Atlanta, GA, 30318, United States

Co-Chair: Kamran Paynabar, Georgia Tech, Atlanta, GA, 30332, United States

1 - Image Based Online Defect Detection and Closed Loop Quality Control for Additive Manufacturing Processes

Chenang Liu, Virginia Tech, VA, United States, Zhenyu Kong

A major challenge in additive manufacturing (AM) is how to ensure product quality and consistency by eliminating defects. To address this challenge, this work develops an image-based closed-loop quality control system for the fused filament fabrication (FFF) process. This system consists of a real-time image acquisition device, a high accuracy image-based classification algorithm to monitor the status of surface quality, and a PID-based controller for defects mitigation. The case studies based on actual AM experiments demonstrate the effectiveness of the proposed method.

2 - Multiple Tensor-on-tensor Regression

Mostafa Reisi Gahrooei, Georgia Tech, Atlanta, GA, 30318, United States

In recent years, measurement or collection of heterogeneous sets of data such as those containing scalars, waveform signals, images, and even structured point clouds, has become more common. This work addresses the problem of estimating a process output, measured by a scalar, curve, image, or structured point cloud by a set of heterogeneous process variables such as scalar process setting, profile sensor readings, and images.

3 - An Efficient Monitoring of Variance in High-dimensional Process

Sangahn Kim, Rutgers University, 96 Frelinghuysen Road, Room 201, Piscataway, NJ, 08854, United States, Galal M. Abdella, Jinho Kim, Khalifa M. Al-Khalifa, Myong Kee Jeong, Abdelmagid S. Hammuda

In high-dimensional processes, monitoring process variability is considerably difficult due to a large number of variables and the limited number of samples. Monitoring changes in the covariance matrix is often used for monitoring process variability under the assumption that only a few elements in the covariance matrix are changed simultaneously. In this presentation, we propose a control chart based on an adaptive LASSO-thresholding for monitoring process variability and illustrate the advantages of the proposed method through simulated and real data from both semiconductor industry and high-dimensional milling process.

4 - Learning Inter-layer Bonding Effects in 3D Printing through a Convolution Formulation

Yuanxiang Wang, University of Southern California (USC), CA, United States, Qiang Huang

Geometric accuracy control is critical for additive manufacturing (AM) or three-dimensional (3D) printing. The prediction and control of out-of-plane deviation of 3D printed products needs the understanding of inter-layer bonding effects. This work presents a convolution formulation for the inter-layer interactions to predict out-of-plane shape deviations. Experimental investigation using stereolithography process validates the proposed model.

■ MD70

West Bldg 106B

Joint Session DEA/Practice Curated: Applications in DEA

Emerging Topic: Productivity, Efficiency and Data Envelopment Analysis

Emerging Topic Session

Chair: Kankana Mukherjee, Babson College, Wellesley, MA, 02481, United States

1 - Hospitals Efficiency Redux: The Role of Medical and Surgical Research

Antonio Garcia Romero, Assistant Professor, IE Business School, Maria de Molina 31 Bis, MADRID, 28006, Spain, Josep A. Tribo, Alvaro Escribano

DEA methods have been widely applied to the analysis of hospitals' efficiency. However, there is little empirical evidence showing how the research conducted in hospitals can affect their outcomes. The structure of hospitals is a two-stage network process. Therefore, we use two-stage DEA methods for evaluating the performance in a sample of 189 Spanish hospitals over the period 1996-2009. We use the Malmquist productivity index for estimating the changes in efficiency since we use a longitudinal database. We measure the efficiency on several outcomes (i.e., the average length of stay or mortality rate. We measure the hospitals' research activity by using a set of bibliometric indicators.

2 - Labor-cost Efficiency with Indivisible Outputs and Inputs: A Study of Indian Bank Branches

Kankana Mukherjee, Babson College, 231 Forest Street, Babson Park, MA, 02457, United States, Subhash C. Ray, Abhiman Das

This study uses Data Envelopment Analysis to examine the efficiency of branches of a major Indian public sector bank across four large metropolitan cities. We model branch operations following the production approach and introduce several methodological extensions to account for the product mix of branches in creating the efficient cost frontier. Overall, Chennai branches are found to be the most efficient. Across the three types of labor, attaining efficiency in the number of clerks would have the highest impact in terms of cost savings.

3 - Predicting Corporate Failure for Non-Manufacturing Firms - DEA SBM

Joseph C. Paradi, Professor Emeritus, University of Toronto, 200 College Street, College St, Toronto, ON, M5S3E5, Canada

Slacks-Based DEA Model is used to predict corporate failure of non-manufacturing companies. The benchmark was the Altman Z" model. Others used DEA models (BCC) to using Altman's original asset-dominated Z-score model. Here, non-manufacturing firms were examined without their asset size. Data from non-manufacturing companies that filed for bankruptcy between 2000 and 2006 for up to five years before bankruptcy. Non-bankrupt companies were matched these, using SIC codes. Altman's model classified more companies as bankrupt than DEA, whereas DEA classified more as non-bankrupt. This indicated that bankruptcy could be predicted without the use of total assets or liabilities as variables.

■ MD77

West Bldg 213A

Joint Session PSOR/Practice Curated: Emergency Medical Services

Sponsored: Public Sector OR

Sponsored Session

Chair: Pieter van den Berg, RSM, RSM, Rotterdam, 3062 PA, Netherlands

1 - A Scenario-based Ambulance Location Problem with Two Types of Servers

Soovin Yoon, University of Wisconsin-Madison, 1415 Engineering Drive, Room 3261, Madison, WI, 53706, United States, Laura Albert

Emergency medical service planning is challenging when there are heterogeneous patients and ambulances. Some of the challenges stem from uncertain demand and interdependencies between ambulances. We propose a data-driven approach that lifts distributional assumptions by sampling call arrival scenarios directly from the call log. A two-stage stochastic integer program is formulated to deploy and dispatch two types of servers to serve calls promptly and also match server types to varying patient needs. We conduct the numerical study with two real-world datasets to demonstrate the effectiveness of our model.

2 - Determining Ambulance Destinations in the Presence of Offload Delay Using an Markov Decision Process
Mengyu Li, PhD Candidate, Dalhousie University, Halifax, NS, Canada, Peter Vanberkel

Ambulance offload delay (AOD) is a prolongation between an ambulance arrival in the emergency department (ED) and transfer of patient care, typically due to ED crowding. We formulate an infinite horizon, discrete-time Markov decision process (MDP) model to determine when it is advantageous to send appropriate patients to out of region hospitals. Out of region hospitals have longer transport times but shorter offload times. The decision model considers patient acuity, travel distance, and AOD. A computational study is applied and a policy to return ambulances to service more quickly is found. This model can be used as a decision support tool to generate optimal ambulance patient allocation policy.

3 - Shift Schedule Optimization for Basic Life Support Ambulances Using Stochastic Programming
Pieter van den Berg, RSM, Burgemeester Oudlaan 50, Rotterdam, 3062 PA, Netherlands, Theresia van Essen

Many ambulance services have a fixed schedule of shifts for their vehicles. This defines the available capacity for each time of the day, which does not always match the demand for ambulances. We present a Stochastic Programming model to optimize the shift schedules of Basic Life Support (BLS) ambulances that are used for non-urgent patient transportation. By optimizing the schedule based on a large set of simulated scenarios, we find schedules that can improve the service provided to non-urgent patients. As emergency ambulances execute any patient transportation that cannot be served by a BLS ambulance, this also improves the coverage for emergency calls.

■ TA04

North Bldg 122A

Joint Session OPT/Practice Curated: Mixed-Integer Quadratic Programming

Sponsored: Optimization/Integer and Discrete Optimization

Sponsored Session

Chair: Richard Forrester, Dickinson College, Department of Mathematics, College and Louther Street, Carlisle, PA, 17013, United States

1 - Representability in Mixed-Integer Quadratic Programming
Jeffrey Poskin, Boeing, Seattle, WA, United States, Alberto Del Pia

Representability results play a fundamental role in optimization since they provide characterizations of the feasible sets that arise from optimization problems. In this work we study the sets that appear in the feasibility version of Mixed-Integer Quadratic Programming (MIQP) problems. MIQP has a number of practical applications, including in power systems and portfolio optimization, and also serves as a first generalization of Mixed-Integer Linear Programming to Mixed-Integer Nonlinear Programming. This work continues the study of representability in Mixed-Integer Nonlinear Programming performed by the authors as well as Lubin, Zadik, and Vielma. We provide a number of complete characterizations of the sets that appear in different classes of convex MIQPs. These settings include (i) bounded convex MIQPs, (ii) continuous convex QPs, and (iii) mixed binary convex quadratic optimization problems.

2 - Efficient Ways of Computing Strong Upper and Lower Bounds for Generalized Quadratic Assignment Problems
Monique Guignard-Spielberg, Professor, University of Pennsylvania, 500 JMHH-OID Department, Wharton School/Univ Penn, Philadelphia, PA, 19104-6340, United States, Aykut Ahlatcioglu, Jongwoo Park

The Generalized Quadratic Assignment Problem (GQAP) assigns a job to one machine but a machine can handle several jobs, within its capacity. Assignment costs depend on pairwise combinations of assignments. We describe the Convex Hull Heuristic and use it to generate quickly good feasible solutions. We also show how to compute RLT2-quality bounds by computing Lagrangean bounds for a special 0-1 RLT1-like model. We present results for GQAP instances from the literature as well as for the special case of the Crossdock Door Assignment Problem with up to 6000 0-1 variables.

3 - Optimal Solutions to the Quadratic Knapsack Problems: Experiments with Improved Linearization
Yu Du, Professor, University of Colorado Denver, 1475 Lawrence Street, Office 5021, Denver, CO, 80202-2219, United States, Gary A. Kochenberger, Fred W. Glover, Haibo Wang

A common approach for finding optimal solutions to Quadratic Knapsack Problems (QKP) is to adopt an equivalent linearization of the quadratic model and then solve the linear model with an exact solver such as CPLEX. Previous studies have demonstrated the potential of this approach. At the same time, these studies have exposed a limitation in terms of long solution times as problems scale in size.In this study we adopt a successful linearization and experiment with simple ways to enhance its performance by strengthening a key parameter (bound) in the model. Substantial computational experience is provided giving guidance for improved practice.

4 - A Computational Study of Linearization Strategies for 0-1 Quadratic Programs
Richard Forrester, Professor of Mathematics, Dickinson College, Department of Mathematics, College and Louther Street, Carlisle, PA, 17013, United States

A common approach for solving 0-1 quadratic programs is to recast the nonlinear program into an equivalent form through the introduction of auxiliary variables and constraints. Then the resulting model can be solved using a standard mixed 0-1 solver. In this talk we present the results of an extensive computational study examining the strengths and weaknesses of the many different linearization approaches considered in the literature. In addition, we provide recommendations for which approach to use based on the specific class of 0-1 quadratic programs to be optimized.

■ TA10

North Bldg 125A

Joint Session MSOM/Practice Curated: Marketplace Innovation

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Fuqiang Zhang, Washington University in St. Louis, St. Louis, MO, 63130, United States

1 - Managing Ride-sharing Demand Shocks with Surge Pricing
Bin Hu, UNC Chapel Hill, UNC Chapel Hill, Assistant Professor, Chapel Hill, NC, 27599, United States, Ming Hu, Han ZHU

Surge pricing by ride-sharing platforms has long been accused by media of gouging riders. Instead, economic theory advocates surge pricing as a way of efficiently regulating supply and demand. We propose an alternative argument in support of surge pricing. An important, but often neglected feature is that drivers react magnitudes slower than riders to surge pricing. A short-lived surge can inform nearby drivers of unserved riders, attracting them to relocate and leading to a more efficient market outcome than maintaining less varied prices. Moreover, we find a low-then-high penetration surge may be more profitable for the platform than a more commonly-used high-then-low skimming surge.

2 - Crowdfunding or Bank Financing: Effects of Market Uncertainty and Word-of-mouth Communication
Fasheng Xu, Washington University in St. Louis, Saint Louis, MO, 63130, United States, Xiaomeng Guo, Guang Xiao, Fuqiang Zhang

In the fast growing rewards-based crowdfunding marketplace, startups launch projects not only to raise funding directly from the crowd to cover early stage investment, but also to expand product awareness via word-of-mouth communication. Compared to bank financing, we find that crowdfunding is always preferred by startups under weak product awareness base or poor credit rating; otherwise, crowdfunding may underperform when market uncertainty is within certain medium range. Our model provides a framework to rationalize the advantage of crowdfunding by demonstrating three underlying benefits: capital-raising, awareness-expanding, and demand-validating.

3 - Social Learning and the Design of New Experience Goods
Yiangos Papanastasiou, University of California at Berkeley, Pnina Feldman, Ella Segev

This work focuses on the implications of social learning from product reviews for a monopolist firm's choice of product design. Our main finding is that, in the presence of social learning, the firm's design choice results in a product whose expected quality is lower either in the absolute sense, or relative to the product's price.

4 - Information Sharing on Retail Platforms
Zekun Liu, Washington University in St. Louis, One Brookings Drive, St. Louis, MO, 63130, United States, Fuqiang Zhang, Dennis Zhang

We study how the retail platform should share demand information with its sellers under revenue sharing contract. With no fairness concern, the platform always truthfully shares market or private information to a subgroup of the sellers. With fairness concern, the platform has to offer symmetric information for each seller. When the number of sellers is relatively big, the platform has the incentive to share noised private signals to sellers. Furthermore, when the sellers are heterogeneous in their market power, we show that the platform prefers to share information truthfully with sellers who have relatively low market power.

■ TA18

North Bldg 128A

Joint Session BMI/Practice Curated: Empirical Research on Marketplace Innovation

Emerging Topic: Business Model Innovation

Emerging Topic Session

Chair: Ashish Kabra, INSEAD, Fontainebleau, 77305, France

1 - Do P2P Ride-Hailing Platforms Lead to Pooling or Crowding? Quasi-Experimental Evidence from Uber's Entry in California
Suvrat Dhanorkar, Pennsylvania State University, 466 Business Building, University Park, PA, 16802, United States

Taking advantage of Uber's staggered entry into various geographic markets in California, we execute a regression-based difference-in-difference design to estimate the pooling benefits of ride-sharing services.

2 - Designing Incentives to Scale Marketplaces
Ashish Kabra, INSEAD, Boulevard de constance, Fontainebleau, 77305, France

Marketplace operators run aggressive incentive schemes to achieve scale, that is key to the efficacy, survival and eventual domination of a marketplace. This study quantifies and compares the effect of incentives given to the "buyer side and "seller side using data from a leading ride-hailing market. We build a structural model to accurately capture the driver and passenger response to incentives, and the nature of incentives. Driver effort on the platform is unobserved, for which we devise a novel local matching model based imputation method. We find that in short-term (current week) passenger incentives are more effective while the opposite is true in the long-term (next 3 months).

3 - Platform and Merchant Interactions in Online-to-offline Marketplace
Jiaqi Xu, Carnegie Mellon University, Tepper School of Business, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, Hui Li, Sridhar R. Tayur

There are many forms of online platforms that connect local offline merchants to consumers. These business models are referred to as Online-to-Offline (O2O) commerce. We develop a framework to analyze the pricing decision and revenue sharing arrangements between O2O platforms and local merchants. We show that the pricing incentives for the two parties do not align when the revenue sharing arrangement does not fully account for the long-run revenue generated from attracting new consumers. We offer recommendations on how to design the revenue sharing arrangement and discuss the economic viability of various O2O business models observed in practice.

4 - Surge Pricing Under Spatial Spillover: Evidence from Uber's Operations
Brad Lee, Boston University Questrom School of Business, 595 Commonwealth Ave, Boston, MA, 02215, United States, Marcus A. Bellamy, Nitin Joglekar

Ride-sharing platforms employ surge pricing to match anticipated capacity spillover with demand. We develop an optimization model to characterize the relationship between surge price and spillover. We test predicted relationships using a spatial panel model on a dataset from Uber's operation. Results reveal that Uber's pricing accounts for both capacity and price spillover. There is a debate in the management community on the efficacy of labor welfare mechanisms associated with shared capacity. We conduct counterfactual analysis to provide guidance in regards to the debate, for managing congestion, while accounting for consumer and labor welfare through this online platform.

■ TA35

North Bldg 224A

Joint Session AAS/Practice Curated: UAS Applications and Optimization

Sponsored: Aviation Applications

Sponsored Session

Chair: Maga Khachatryan, MagAnalytics, 3883 Park Place Estates Dr., Bridgeton, MO, 63044, United States

1 - Optimization of Grid Coverage Operations in Flight Aerial Imagery Data Collection
Maga Khachatryan, MagAnalytics, St. Louis, MO, United States, Ara Nefian, Naira Hovakimyan

Today, we live in the age of digital revolution which impacts modern agriculture. Every season farmers cultivate millions of acres leveraging technologies such as IoT, drones and satellites. Along with benefits technology also brings challenges. Particularly, cost of aerial imagery throughout growing season can be very high. One of the most common imagery delivery methods are airplanes. Here we describe two-stage airplane routing problem with business constrains. First stage reduces the solution space by generating flight patterns to allow faster second-stage optimization. The second stage optimizes airplane flight schedule by selecting most profitable patterns to fly over farming area.

2 - Opportunities and Challenges of Integrating UAS in the US
Dipasis Bhadra, Economist, Federal Aviation Administration, 800 Independence Avenue 935-937, Washington, DC, 20591, United States, Michael Lukacs

UAS has become one of the most vibrant sector of the economy in the US. With over a million registered owners/operators, the sector holds promises that span over commercial applications of numerous types to personal recreational uses. While the challenges are many, the FAA has launched various initiatives ranging from pilot programs to regulatory reforms integrating UAS into NAS. An active research program undertaken by the Agency facilitates these activities ensuring safe integration of UAS into the National Airspace System (NAS). This presentation will broadly touch on Agency's outlook of the future, activities that are presently undertaken and the challenges/opportunities that lie ahead.

3 - Impact Of Payload Amount On Battery Consumption Rate In a Delivery Application Of Drones
Maryam Torabbeigi, University of Houston, UH, Houston, TX, United States, Gino J. Lim, Seon Jin Kim, Navid Ahmadian

The drone battery charge limitation is an important factor in drone scheduling in order not to run out of battery during the flight. This study investigates the relationship between battery consumption rate (BCR) and the payload amount, and also the impact of payload amount (customer's demand) on the drone scheduling. The collected data verifies a linear relationship between BCR and the payload amount. A routing problem is proposed for the drone scheduling. The model determines the number of drones, their path, the assigned customers, and the battery charge at each flight segment. The results show the impact of including BCR in the scheduling.

4 - Multiobjective Uav Route Planning In Continuous Terrain Using a Preference-based Evolutionary Algorithm
Murat Mustafa Koksalan, Middle East Technical University, Industrial Engineering Department, Ankara, 06531, Turkey, Erdi Dasdemir, Diclehan Tezcaner Ozturk

Multiobjective route planning for unmanned air vehicles (UAV) in continuous terrain involves determining the visiting order of targets and the trajectories used between target pairs under multiple objectives. In this research, a hybrid heuristic approach is developed. Order of targets are first determined with a preference-based evolutionary algorithm converging to the desired regions of the Pareto-optimal frontier using the decision maker's preferences. Then the trajectories between target pairs are found with a heuristic approach using the results of the evolutionary algorithm. The algorithm is implemented on several problems and results are promising.

■ TA36

North Bldg 224B

Joint Session Drones/Practice Curated: Drones in Logistics

Emerging Topic: Robotics, Drones and Autonomous Vehicles in Logistics

Emerging Topic Session

Chair: James F. Campbell, University of Missouri-St Louis, Saint Louis, MO, 63121-4499, United States

1 - Coordinated Logistics with a Truck and a Drone
John Gunnar Carlsson, University of Southern California, 3750 McClintock Avenue, Los Angeles, CA, 90089, United States

We determine the efficiency of a delivery system in which an unmanned aerial vehicle (UAV) provides service to customers while making return trips to a truck that is itself moving. In other words, a UAV picks up a package from the truck (which continues on its route), and after delivering the package, the UAV returns to the truck to pick up the next package. By combining a theoretical analysis in the Euclidean plane with real-time numerical simulations on a road network, we demonstrate that the improvement in efficiency is related to the square root of the ratio of the speeds of the truck and the UAV.

2 - Optimization of a Drone-aided Network
Bahar Kara, Bilkent University, Department of Industrial Eng, Ankara, 06800, Turkey, Aysu Ozel, Oya Ekin Karasan

Integrating drones into delivery networks has advantages such as reduced delivery times, costs and access to hardly reachable points. However, due to the limited abilities of drones, it is not possible to deploy solely drones in delivery networks. Thus, drones should be collaborated with the traditional delivery vehicles and this collaboration requires synchronization between drones and delivery vehicles. In this study we propose a mixed integer mathematical model minimizing the time of the last delivery in a network in which a drone and a truck works in synchronization.

3 - Mothership and Drone Routing Problems
Bruce L. Golden, University of Maryland-College Park, 10375 Eclipse Way, Columbia, MD, 21044, United States,

Stefan Poikonen

The Mothership and Drone Routing Problem considers a tandem between a ship and a drone. The drone is required to visit each of a set of targets. However, the drone has finite battery life and, thus, must coordinate with the ship. The problem combines elements of combinatorial optimization and continuous optimization. Second order cone programming is used in a proposed solution method that is flexible to adapt to alternative objective functions and constraint sets. We then consider several generalizations.

■ TA38

North Bldg 225B

Joint Session APS/Practice Curated: Bandits, Optimal Stopping, and Control

Sponsored: Applied Probability

Sponsored Session

Chair: David Goldberg, Cornell University, Ithaca, NY, 14850, United States

1 - Recent Progress at the Intersection of Optimal Stopping and Bandits

Yilun Chen, Cornell, 292 Rhodes Hall, Ithaca, NY, 14853, United States, David Goldberg

We present progress on the problem of optimal stopping, and its application to bandits. We develop a new pure-dual algorithm for optimal stopping, which leads to an expansion (for the optimal value) in which each term has a natural representation in terms of certain (infima of) conditional expectations, and can enable better approximation with fewer nested conditional expectations. For Bayesian bandits, we present several novel insights into the (optimal) Gittins index policy, shedding light on what, qualitatively, makes the Gittins index policy truly optimal, as compared to other policies optimal only w.r.t. (asymptotic) first-order regret.

2 - Sequential Search For The Best Alternatives

David Brown, Duke University, Fuqua School of Business, 100 Fuqua Drive, Durham, NC, 27708, United States, Santiago Balseiro

We consider a variation of the sequential search problem studied in Weitzman (1979), where a DM sequentially searches a given set of alternatives with unknown rewards, drawn from independent distributions. Search is costly but reveals the rewards of an alternative. The DM can select previously revealed alternatives and collect the associated rewards. We study a variation in which the DM has the capacity to select multiple alternatives, which significantly complicates the problem. We consider a simple reservation price rule, with reservation prices depending only on the remaining capacity and show that the policy is asymptotically optimal as the number of alternatives grows large.

3 - On Learning the C Rule

Subhashini Krishnasamy, Tata Institute of Fundamental Research, Mumbai, 400005, India, Ari Arapostathis, Ramesh Johari, Sanjay Shakkottai

We study the c rule for multi class queueing systems. When the service rates are known, the c rule is known to minimize the expected holding cost over any fixed time horizon in the single server setting. For a parallel server network, we demonstrate that the c rule does not ensure stability. We present sufficient conditions for the stability of the c rule for a general parallel server network and also necessary and sufficient conditions for a specific class of parallel server networks. When the service rates are unknown, we propose, both for single and parallel server networks, algorithms using empirically learned service rates that achieve a holding-cost regret that does not depend on the time horizon.

■ TA51

North Bldg 231B

Joint Session OMS/Practice Curated: Scheduling with Applications

Emerging Topic: Project Management and Scheduling, in Memory of Joe Leung,

Emerging Topic Session

Chair: Marc E. Posner, Ohio State University, 296 Baker Systems Engineering, 1971 Neil Avenue, Columbus, OH, 43210-1271, United States

1 - AGV Control in Large-scale Parallel Transshipment Container Terminal

Qitong Zhao, National University of Singapore, Singapore, Chenhao Zhou, Lee Loo Hay

The AGV system in transshipment container terminal is characterized by a very large number of AGVs and complicated traffic conditions. To ensure deadlock- and conflict-free routing of the AGVs, we propose a modular concept, allowing the AGV control to be divided into two subproblems, the travel module generation problem and the inner module routing and scheduling problem. These two subproblems are integrated and tested in our discrete event simulation platform. Visualization of the solutions validate the deadlock- and conflict-free movements and numerical results show the efficiency of this two-stage event-trigger approach.

2 - AGV Routing in the Parallel Mega Automated Container Terminal Based on a Two-layer Network Structure

Chew Ek Peng, National University of Singapore, Computing Lab, E1-07-26, NUS Department of Eng, Singapore, 117578, Singapore, Zhipeng Qiu

To avoid conflicts and improve system efficiency in the mega-ACT, we propose an efficient routing scheme for large-scale AGVs based on a two-layer network structure. At the upper layer, a column-generation based algorithm is used in a sector-based graph for an integrated problem, which not only solve the path direction design to determine the directions for the links, but also solve the global routing to decide the sector-based routes for the AGVs. At the lower layer, a path planning algorithm is proposed for multi-AGVs within the sector to determine the real-time paths and schedules for AGVs with the guarantee of no conflicts. Finally, this study has used different cases for algorithm testing, and the results show that the scheme is efficient and effective for the routing of large-scale AGV systems.

3 - A New Approximation Algorithm for Unrelated Parallel Machine Scheduling Problem with Release Dates

Ziteng Wang, Assistant Professor, Northern Illinois Universtiy, 590 Garden Road, EB 240, DeKalb, IL, 60115, United States, Zhi Pei, Mingzhong Wan

We consider the unrelated parallel machine scheduling problem with release dates. A 4-approximation algorithm is devised and proved in comparison with the 16/3-approximation. The original scheduling problem is divided into several sub-problems based on the release dates. For each sub-problem, a convex quadratic integer programming model is constructed in accordance with the specific problem structure. Then a semi-definite programming approach is implemented to produce a lower bound via the semi-definite relaxation of each sub-problem. Furthermore, a branch and bound based method and a local search strategy are applied separately to locate the integer solution of each sub-problem.

4 - Approximation Algorithms for Stochastic Scheduling Problems with Few Different Types of Jobs

Lin Chen, University of Houston, 4800 Calhoun Road, Houston, TX, 77004, United States, Lei Xu, Weidong Shi

We consider the classical stochastic identical machine scheduling problem with the objective of minimizing weighted completion time. We show that there exists a quasi-polynomial time approximation scheme if there are a logarithmic number of different kinds of jobs.

■ TA52

North Bldg 231C

Joint Session SMA/Practice Curated: Social Media Analytics Methods, Tools and Platforms

Emerging Topic: Social Media Analytics

Emerging Topic Session

Chair: Tung Cu, Bloomsburg University of Pennsylvania, 400 E. 2nd Street, Bloomsburg, PA, 17815, United States

1 - Does Emotional Arousal Boost or Discount Review Valence Impact? The Role of Purchase Stage

Anh Dang, Northern Kentucky University, Haile/US Bank College of Business, Highland Heights, KY, 41076, United States, Yuping Liu-Thompkins

Conflicting findings exist regarding the impact of review valence on consumers' decisions. The present paper aims to reconcile these findings by examining emotional arousal expressed in review texts as a moderator of review valence impact. Through two experiments and one field study involving clickstream and purchase data of a major UK online retailer, this paper shows that emotional arousal plays two opposing roles depending on which decision stage the consumer is at. During the search stage, it prevents consumers from relying on valence. Meanwhile, when consumers are about to make their purchase decision, negativity bias causes consumers to reject products with negatively high arousal reviews.

2 - Social Media Network Analytics: Methods, Tools and Platforms

Tung Cu, Bloomsburg University of Pennsylvania, 932 Country Club Dr., Bloomsburg, PA, 17815, United States

Social networking media is built on the ideological and technological foundations of web and mobile, and that allow the creation and exchange of user generated content. Research in social media analytics focuses on innovative methods and practices of measuring, analyzing and interpreting user-generated content from a

variety of online social media platforms, websites, and blogs to uncover hidden patterns and correlations to answer questions pertaining to organizational, educational, social as well as political issues. This paper presents a literature review in both theoretical and empirical variety of social network analytics methods, tools and platforms in different contexts.

3 - Social Analytics Governance: A Literate Review of Practices
Tung Cu, Bloomsburg University of Pennsylvania, 932 Country Club Dr., Bloomsburg, PA, 17815, United States, Loreen Powell, Ken Hall, Kuo- Hao Lee, Hayden Wimmer

Over the last ten years, the number of businesses harnessing structured, semi-structured or unstructured data have exploded. Today, many businesses are quick to view social analytic data as evidence or arguments. Oftentimes, the evidence and arguments leads to faulty decisions and lost profit because their data are not properly managed and governed. Thus, a business' ability to deliver accurate analytics is essential to be built on the capabilities of its data and technology governance and practices. Given the increased importance in data governance, this presentation presents a literature review and highlights areas for future research.

■ TA55

North Bldg 232C

Joint Session Sports/Practice Curated: Sports Analytics IV

Sponsored: SpORts

Sponsored Session

Chair: Stephen Hill, University of North Carolina-Wilmington, 601 South College Road, Wilmington, NC, 28403-5611, United States

1 - Optimizing Pitcher Rotations
Cody O'Brien, Slippery Rock University, Slippery Rock, PA, 16057, United States, Bradely Schweitzer, Justin Long

Replacing a starting pitcher with a relief pitcher is rarely backed by analytics. By taking an analytical approach, a manager may be able to detect when a pitcher's performance is starting to decline before it has a negative impact. Historical data is used to calculate multiple indicators of pitcher performance to create a baseline of how each individual pitcher should perform. During a game, current indicators will be calculated and compared to the baseline statistics to understand how the pitcher is performing. When his performance declines passed a set threshold, a relief pitcher will be called in. A fully-functioning GUI is implemented to make the model more accessible.

2 - Simulating Major League Baseball Games
Brad Schweitzer, Slippery Rock University, Slippery Rock, PA, United States, Justin Long

The game of baseball can be explained as a Markov Process, as each state is independent of all states except the one immediately prior. Probabilities are calculated from historical data on every state transition from 2011 to 2016 for Major League Baseball games and are then grouped to account for home-field advantage, offensive player ability, and pitcher performance. Using the probabilities, transition matrices are developed and then used to simulate a game play-by-play. For a specific game, the results give the probability of a win as well as expected runs for each team.

3 - Examination of Gambling Lines in College Football
Mikhail Gordon, Doctoral Candidate, University of Pittsburgh,Pittsburgh, PA, 15224, United States

An investigation of college football team characteristics in the context of gambling, using historical line information. An emphasis is placed on games with large spreads, defined as a spread greater than 15 points.

4 - Social Network Analysis in Field Sports: Irish (Gaelic) Football
Vincent Hargaden, Associate Professor, University College Dublin, School of Mechanical & Materials Engineering, Engineering & Materials Science Centre, Belfield, Dublin 4, Ireland

Irish (Gaelic) football is a 15-a-side field sport played through a combination of hand and foot passing. Each year from May through September, the elite teams complete in conference and play-off games to determine the title winner. Similar to many team sports (basketball, soccer), it is of interest to analyse the players' cooperation from a network perspective. Using passing data between players from games involving the three-in-a-row title winning team (2015-2017), we take a social network analysis approach to identify interactions and team style of play.

■ TA56

West Bldg 101A

Joint Session HAS/Practice Curated: Behavioral Drivers for Decision Making and Productivity: Empirical Evidence

Sponsored: Health Applications

Sponsored Session

Chair: Jónas Oddur Jónasson

1 - Task Selection and Workload
Bradley R. Staats, University of North Carolina at Chapel Hill, Campus Box 3490, McColl 4720, Chapel Hill, NC, 27599-3490, United States, Diwas S. KC

How individuals manage their tasks is central to operations. Recent research focuses on how increasing workload individuals can increase service time. As the number of tasks increases workers may also manage their workload by a different process - task selection. We theorize and test that under conditions of increased workload individuals may choose to complete easier tasks to manage their load. We label this behavior Task Completion Bias (TCB). Using 2 years of data from an emergency department we find support for TCB and show it improves short-term productivity. However, we find that an overreliance on this task selection strategy hurts performance in the long run.

2 - Heuristic Thinking in Patient Care
Diwas S. Kc, Emory University, 1300 Clifton Road, Goizueta Business School, Atlanta, GA, 30322, United States

This paper studies heuristic thinking and cognitive bias using a natural experiment from the field. The setting for the study is a set of acute care hospitals, where we examine the care process and discharge decisions for individual patients. Determining a patient's suitability for discharge is cognitively taxing, calling for the decision maker to draw on up-to-date clinical expertise and detailed information. We postulate that bounded rationality in decision making leads the care provider to substitute clinical readiness for discharge - a more cognitively complex attribute, with a more easily accessible heuristic.

3 - Recovering from Distress: The Impact of Critical Incidents on Operational Performance
Jonas Oddur Jonasson, Assistant Professor, MIT Sloan School of Management, 30 Memorial Drive, E62-588, Cambridge, MA, 02142, United States, Hessam Bavafa

In service operations settings, where the difficulty of jobs can be unpredictable, workers sometimes encounter critical incidents (CIs) — tasks or situations which are sufficiently disturbing to challenge workers' usual coping mechanisms. In the context of ambulance services we find that encountering a CI negatively affects subsequent operational performance. The effect is strong for patient-pickup (a complex, non-standardized task) and weaker for patient handover to the hospital (a more standardized task).

4 - Timeliness and Compliance with Standard Operating Procedures
Reidar Hagtvedt, University of Alberta School of Business, 2-43 Business Bldg, Edmonton, AB, T6G 2R6, Canada, Kenneth L. Schultz, Trish Reay, Sarah Forgie

Compliance with standard operating procedures when looking ahead, or in the very short term, is notoriously difficult to measure. In this paper, we examine two previously ignored aspects of compliance with hand-hygiene regulations in a hospital setting. First, we allow teleological cues to prompt hand-hygiene by re-coding the time of the cue forward. Second, we examine the time immediately after a disruption, to see if a reduction in hand-hygiene is measurable. We use data from a tertiary Canadian teaching hospital.

■ TA57

West Bldg 101B

Joint Session HAS/Practice Curated: Dynamic Models of Patient Health

Sponsored: Health Applications

Sponsored Session

Chair: Maria Esther Mayorga, North Carolina State University, Raleigh, NC, 27695, United States

1 - Dynamic Patient Routing with Nurse Workload Considerations
Siddhartha Nambiar, North Carolina State University, Raleigh, NC, 27606, United States, Maria Esther Mayorga, Muge Capan

We develop a multi-class, multi-server queueing model to route incoming patients to different server pools in an Emergency Department setting, to minimize their sojourn time and to manage the nurses' workload. There is a lack of consensus in analytics and decision science regarding how to quantify workload in healthcare and how to use it in an analytic framework. We first review literature to determine how to define workload, and to identify components, available in electronic health records data, that allow us to measure workload. Following this, we develop both analytic and simulation models to get optimal routing policies and compare them to other workable, realistic policies.

2 - Cost-effectiveness and Decision Analysis of Genetic Testing in Cholesterol Treatment Planning
Wesley J. Marrero, University of Michigan, Ann Arbor, MI, United States, Mariel Sofia Lavieri, Rodney A. Hayward, Suzanne C. Butler, Amit Khera, Sekar Kathiresan, James Burke, Jeremy B. Sussman

We present a simulation-based framework to estimate the risk of heart attacks due to clinical and genetic factors. Additionally, we develop cholesterol treatment plans using risk thresholds (current practice) and a Markov decision process (MDP). By simulating the health status of patients, we determined the cost-effectiveness of genetic testing to guide cholesterol treatment.

3 - Statin Initiation Decision Modeling for Prediabetes Patients
Shengfan Zhang, University of Arkansas, 4207 Bell Engineering Center, Department of Industrial Engineering, Fayetteville, AR, 72701, United States, Muhenned Abdulsahib

While there is much research on statin initiation policies on prevention of heart disease for diabetes, studies on statin initiation policies for prediabetic patients are limited. The goal of this research is to examine the tradeoffs between the risk of heart disease and risk of diabetes on the decision of statin therapy for prediabetes patients. We develop an optimal statin initiation policy to meet both the need to control cholesterol levels and the need to minimize the risk of diabetes, which will provide insights for future treatment guidelines for prediabetes.

4 - Modeling Comprehensive Medication Reviews for Complex Patients in Community Pharmacies
Kathryn N. Smith, North Carolina State University, Raleigh, NC, 27606, United States, Julie Simmons Ivy, Anita Vila-Parrish

Adherence to long-term medication therapies is approximately 50% in developed countries. Patient and provider engagement has been found to be a contributor to improved adherence. One enhanced service aimed at engaging patients is a comprehensive medication review (CMR) provided by pharmacists. CMRs allow a pharmacist to identify drug therapy problems that may be interfering with adherence. In order to incorporate CMRs into the workflow, pharmacies must streamline the CMR process and prioritize complex patients. We developed a simulation model and a dynamic programming model to analyze the integration of the operational and clinical workflows and determine how to prioritize patients.

■ TA58

West Bldg 101C

Joint Session HAS/Practice Curated: Healthcare Analytics II

Sponsored: Health Applications

Sponsored Session

Chair: Pinar Keskinocak, Georgia Institute of Technology, Atlanta, GA, 30332, United States

Co-Chair: Seyma Guven-Kocak, Georgia Institute of Technology, Atlanta, GA, 30340, United States

1 - One-class Adaptive Resonance for Radiotherapy Quality Assurance
Dionne Aleman, University of Toronto, 5 King's College Road, Toronto, ON, M5S 3G8, Canada, Hootan Kamran Habibkhani, Chris McIntosh, Thomas Purdie

Radiotherapy (RT) treatment plans, once designed, must undergo iterative refinements until they pass quality assurance (QA). Machine learning has promised to help automate such QA processes by learning from past data. However, RT plans are usually not recorded until they passed QA and are sent for delivery. Therefore, a clinically-recorded RT dataset is usually imbalanced in favour of the easily-recordable high-quality plans, and binary classifiers struggle to learn from it. Therefore, we develop an adaptive neural network for one-class classification. Our algorithm outperforms one-class SVMs and autoencoders on two RT datasets for breast and prostate patients.

2 - Updating Risk Assessment Tools for Unplanned Extubation in Pediatric Critical Care Patients
Zihao Li, Georgia Institute of Technology, Atlanta, GA, United States, Pinar Keskinocak, Atul Vats

The Risk assessment score (RAS) and revised RAS (rRAS) are scoring tools based on consensus opinion to assess pediatric patients' risk of unplanned extubation (UPE). We reviewed records of 5,749 patients from 2013 to 2017 in 5 ICUs and 2 freestanding children's hospitals and used logistic regression to improve the score. The new model identifies UPE history, weight, age, oral secretion and ventilation length as significant risk factors. The incident rates for low, moderate, high, and extreme risk patients are 0.69, 0.46, 1.14 and 3.01 per 100 vent days, respectively. The new model has a stronger association with UPE occurrence for patients with extreme risk compared to the RAS and rRAS.

3 - Calling for Care? The Risky Proposition of Teletriage for Healthcare Demand Management
Ozden Engin Cakici, American University, Washington, DC, United States, Alex Mills

We investigate the effect of adding teletriage to a healthcare system with traditional or open access primary care and an Emergency Department (ED). Using a partially observable Markov decision process model, we find that while teletriage would benefit patients, it could be costly for the payer and even increase ED usage. We conclude by providing conditions under which teletriage would be beneficial.

4 - Dynamic Personalized Patient Classification via Learning Progression in Chronic Diseases: Application to Glaucoma
Esmaeil Keyvanshokooh, University of Michigan, Ann Arbor, Ann Arbor, MI, 48108-1020, United States, Mark P. Van Oyen, Joshua Stein, Mariel Sofia Lavieri, Chris Andrews

We design a dynamic and personalized classification method for classifying a patient with Glaucoma at each visit as either a "fast" or "controlled" progressor. "Fast refers to relatively rapid deterioration with respect to visual field mean deviation. To this aim, we combine a random forest algorithm with a classification method. We also develop online learning methods to help manage a patient's progression.

■ TA64

West Bldg 104A

Joint Session DM/Practice Curated: Data Science for Novel Applications

Sponsored: Data Mining

Sponsored Session

Chair: Durai Sundaramoorthi, Washington University in Saint Louis, Washington University in Saint Louis, Saint Louis, MO, 63131, United States

Co-Chair: Sundar Victor, Aetna, New York, NY, United States

1 - Study of Mobility in Private Homes
Yan Wang, University of South Florida, Industrial and Management Systems Engineering, 4202 E. Fowler Ave, ENB118, Tampa, FL, 33620, United States, Ali Yalcin, Carla VandeWeerd

Human mobility is shown to be fundamentally regular and potentially predictable based on the study of large-scale geo-location data available through cellular networks and mobile devices. In this work, we study the mobility of residents in private homes, as opposed to outdoor environments. Indoor mobility prediction has far-reaching applications in smart homes and ambient assisted living environments. Using data from ambient sensors, we represent the occupant's movement trajectory as a sequence of symbols and calculate its entropy and an upper bound of its predictability. Our results show that indoor mobility is also predictable and can be quantified.

2 - Deep Neural Networks and Insurance Cross-selling
Xiaoguang Tian, University of North Texas, 1155 Union Circle, Denton, TX, 76203-5017, United States

In this study, we propose applying deep neural networks and ensemble approach to identify the customer who will purchase a new caravan insurance policy and improve the model performance through tuning the parameters. The results show that the approach is effective and outperforms the baseline model on multiple measurements, such as accuracy, sensitivity, and ROC.

3 - Forecasting Demand Distribution for New Products using Subjective Rankings
Marat Salikhov, PhD Student, INSEAD, 1 Ayer Rajah Ave, Singapore, 138676, Singapore, Nils Rudi

We present a framework for demand distribution forecasting for new products that combines historical data for similar products with subjective ranking inputs. The framework is based on the decomposition of a demand vector into aggregate, ordered proportion and ranking components, with historical data being used to forecast the first two components and subjective inputs for the last one. The component forecasts are then combined via a simulation-based method. We propose multiple specifications for each of the components. Finally, we evaluate the out-of-sample performance of the method using actual demand data and subjective inputs from a retail company.

4 - A Data Glove Based American Sign Language Interpreter
Sara Masoud, University of Arizona, 1127 E. James E. Rogers Way Room 111, Tucson, AZ, United States, Bijoy Dripta Barua Chowdhury, Young-Jun Son

Sign language recognition is a central research problem in computerized gesture detection for enabling hearing impaired people. In this work, a real-time hand gesture recognition framework is proposed to detect the 26 sign language alphabets. VMG 30 data gloves are utilized by which each hand gesture is reported as a 132-feature vector. Feature extraction is performed via a linear discriminant analysis to

reduce the size of input vectors to a 25-feature vector and decrease the chance of overfitting. Decision tree models are developed to detect the 26 sign language alphabets based on the 25-feature vector values. The proposed framework has shown a success rate of 98.23% in a real-time environment.

■ TA74

West Bldg 212A

Joint Session MCDM/Practice Curated: Novel Applications of Multiple Criteria Decision Technology

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Jyrki Wallenius, Aalto University School of Business, Helsinki, Finland

1 - A Stepwise Benchmarking Approach to DEA with Interval Scale Data

Jyrki Wallenius, Aalto University School of Business, Runeberginkatu 22-24, Helsinki, Finland, Nasim Nasrabadi, Akram Dehnokhalaji, Pekka J. Korhonen

Conventional DEA models assume that all variables are measured on a ratio-scale. However, in many DEA applications we have to deal with interval-scale data. In an earlier paper, we proposed a model for efficiency analysis using interval-scale data. In this talk, we investigate the concept of benchmarking in the framework of interval-scale data. We propose an algorithm, which results in a path of targets for each inefficient unit.

2 - Helping Atrial Fibrillation Patients with Adherence to Anticoagulation Therapy: Design Framework and Intervention Strategies

Wojtek Michalowski, University of Ottawa, Telfer School of Management, 55 Laurier Avenue E, Ottawa, ON, K1N 6N5, Canada, Mor Peleg, Szymon Wilk, Szymon Wilk, Dympna O'Sullivan, Martin Michalowski, Enea Parimbelli, Marc Carrier

Adherence to therapy is one of the main determinants of treatment success and its poor level leads to a substantial worsening of patient's condition. Research described here addresses issue of medication adherence of older adults with atrial fibrillation who are on anticoagulation therapy for primary stroke prevention. We present a design framework of mHealth solution that implements dominance-based rough set theory to identify behavioral triggers that might impact patients' adherence. We induce rules from patient records capturing and analyze these rules for behavioral triggers. We illustrate proposed approach with simple clinical scenario developed using patient vignettes.

3 - Tradeoff Preservation in Inferring Objective Function Weights in Multiobjective Optimization

Taewoo Lee, University of Houston, E209 Engineering Bldg 2, 4722 Calhoun Rd, Houston, TX, 77204-4008, United States

Given an input solution that may not be Pareto optimal, we present a novel inverse optimization methodology for multi-objective optimization that determines a weight vector producing a weakly Pareto optimal solution that preserves the decision maker's trade-off intention encoded in the input solution. We introduce a notion of trade-off preservation, which we use as a measure of similarity for approximating the input solution, and show its connection with minimizing an optimality gap. We demonstrate the proposed method using clinical data from prostate cancer radiation therapy.

4 - Estimating the Form of a Decision Maker's Preference Function and Converging to Preferred Solutions

Murat Mustafa Koksalan, Middle East Technical University, Indus Engineering Department, Ankara, 06531, Turkey, Gulsah Karakaya

We estimate the form of an underlying preference function that is assumed to represent the preferences of a decision maker in a multi-objective environment. After estimating the form, we use an algorithm that utilizes the properties of the estimated form in order to efficiently converge to a preferred solution of the decision maker. We develop the necessary theory to estimate the form of the preference function. We test our approach on several instances and show that it works well.

■ TA75

West Bldg 212B

Joint Session MAS/Practice Curated: Personnel and Network Applications

Sponsored: Military and Security

Sponsored Session

Chair: Lee Evans, United States Military Academy, West Point, NY, 10996, United States

1 - Utilizing Healthcare Systems Engineering Tools to Reduce Healthcare Associated Infections

Jose M. Jimenez, Assistant Professor, United States Military Academy, West Point, NY, United States

Healthcare acquired infections (HAIs) have decreased over the last decade. Nevertheless, HAIs are still a burden for healthcare systems all over the world. In addition to the increase in morbidity and mortality of patients that are already at risk, HAIs create economic for healthcare facilities. Although many clinical methods are being utilized to combat HAIs, it is also important to apply holistic, non-clinical solutions. Multidisciplinary approaches provide some of the best tools to gather data, analyze, determine solutions, and apply them. This presentation highlights some of the healthcare systems engineering tools that have assisted in the reduction of HAIs.

2 - Operationalizing Open-source Intelligence on the Korean Pennisula

Steven Song, USMA, West Point, NY, United States

In today's information age, the amount of publicly available information has grown significantly faster than the U.S. Army's ability to fully exploit the potential of open-source intelligence (OSINT). While OSINT, or intelligence derived from publicly available information (PAI), has unique advantages, OSINT is still undervalued and underutilized. This presentation highlights the current state of the U.S. Army OSINT enterprise on the Korean peninsula, captures the gaps, and provides recommendations for better operationalizing OSINT. Key findings indicate additional personnel, training, and partnerships with Korean counterparts are necessary to harness the maximum potential of OSINT.

■ TA80

Hyatt, Curtis B

Practice- Supply Chain Management VI

Contributed Session

Chair: Mike Sherwin, Mississippi State University, 1767 Independence Way, Valencia, PA, 16059, United States

1 - Should the Manufacturer Offer an Emergency Order Opportunity with Uncertain Customer Demand

Meimei Zheng, Shanghai Jiao Tong University, Dongchuan Road 800,, Minhang District, Shanghai, 200240, China, Xue-Ming Yuan

We consider a manufacturer-retailer supply chain in the presellingand selling seasons, where the manufacturer can offer theretailer an emergency order opportunity with limited commitment quantity, in addition to the regular order from the retailer before the selling season. Through mathematically modeling and analyzing the supply chain, it is found that when the emergency order opportunity is provided, the manufacturer might be worse off although the retailer is always better off. We derive the conditions where both manufacturer and retailer can benefit from the emergency order, and the supply chain profit can be maximized.

2 - Advertising in a Capital-constrained Supply Chain with Retailers' Different Market Shares

Haijun Wang, Shanghai Jiao Tong University, Huashan Road 1954, Xuhui, Shanghai, 200030, China

We consider a supply chain with a manufacturer (leader) and two retailers (followers), where both retailers advertise to stimulate ad-related demand. One retailer is capital-constrained and has access to bank financing. The retailer goes bankruptcy if he cannot pay off his loan obligation. Each retailer has its own market share and unmet demand in one retailer's market share turn to the other retailer to purchase the product. We formulate the problem as a game theory model with the manufacturer and retailers' objective to maximize their own expected profits. Numerical examples are provided to illustrate the impact of advertising on retailers' capital allocation, and their expected profits.

3 - Sourcing Under Multiple Attributes: Cost Sharing Mechanisms

Shivam Gupta, University of Nebraska Lincoln, P.O. Box 880491, Lincoln, NE, 68588, United States, Milind Dawande, Ganesh Janakiraman, Shouqiang Wang

We propose a simple cost-sharing mechanism for a principal procuring service to complete a project under information asymmetry on the agent's cost and non-cost estimate. We establish its near-optimality, and provide valuable insights into the nature of cost-sharing for its use in practice.

4 - An Optimized Resource Allocation Approach to Identify and Mitigate Supply Chain Risks using Fault Tree Analysis

Mike Sherwin, Mississippi State University, Mississippi State, MS, United States, Hugh Medal, Cameron MacKenzie

Low volume high value (LVHV) supply chains such as airline manufacturing, power plant construction, and shipbuilding are characterized by long lead times and a limited number of suppliers that have both the technical know-how and manufacturing capabilities to deliver the requisite goods and services. In this research, we develop novel approaches that provide a set of tools for industry

practitioners to predict supply chain risks, optimally choose which risks to mitigate, and make better informed decisions with respect to supplier selection and risk mitigation while avoiding costly delays due to disruptions in LVHV supply chains.

■ TA83

Hyatt, Remington

Practice- Health Care I

Contributed Session

Chair: David C. Novak, University of Vermont, 310 Kalkin Hall, 55 Colchester Avenue, Burlington, VT, 05405-0157, United States

1 - Determining Effective and Practical Colonoscopy Screening and Surveillance Policies

Fatih Safa Erenay, University of Waterloo, Waterloo, ON, Canada, Gizem Sultan Nemutlu, Oguzhan Alagoz

Efficient colonoscopy screening and surveillance policies are desired to cost-effectively reduce colorectal cancer incidence and mortality. We developed a partially observable Markov decision process model to dynamically schedule colonoscopy operations based on accumulated risk of having advanced lesions and other risk-factors. However, clinicians may find such optimal policies too complex to adopt. Using a stochastic model, we derive simple yet effective dynamic colonoscopy policies which perform closely to the optimal policies and are easy-to-implement in clinical practice.

2 - A Bayesian Approach to Measuring Healthcare Intervention Impacts

Douglas A. Popken, SVP Analytics, NextHealth Technnologies, Inc, 999 18th Street, Suite 2600, Denver, CO, 80202, United States

Measuring the impact of healthcare interventions is challenging due to the random, infrequent, and highly variable nature of follow-on cost and utilization data. While a randomized controlled trial approach reduces measurement bias, standard statistical techniques based on t-tests may not adequately separate signal and noise. Bayesian methods have the advantage of utilizing prior knowledge as well as providing richer output metrics to inform decision makers, both automated and human-in-the loop. We describe our implementation and provide comparative statistics from rea-world experience.

3 - Economic Assessment of Policies to Prevent Childhood Lead Poisoning

George Miller, Institute Fellow, Altarum, 3520 Green Court, Suite 300, Ann Arbor, MI, 48105, United States, Corwin Rhyan

Lowering current levels of lead exposure for young children has the potential to improve health, increase earnings, save government expenditures, and reduce disparities. We describe an analysis that estimated the annual economic burden of childhood lead exposure in the U.S. at $84 billion dollars, including costs of reduced lifetime productivity, increased health care and social assistance spending, and premature mortality. The analysis also identified the potential for residential lead prevention and remediation policies to cut lead exposure levels for young children, resulting in significant long-term economic benefits and in many cases positive net societal returns.

4 - A Group Decision Making Approach for Risk Assessment in Distribution of Pharmaceutical Products

Shahrzad Faghih Roohi, Postdoctoral fellow, Eindhoven University of Technology, Eindhoven, Netherlands, Alp Akcay, Yingqian Zhang, Eelco De Jong

This paper presents a group decision making approach for risk assessment in distribution of pharmaceutical products. By using a new intuitionistic fuzzy hybrid TOPSIS approach, we prioritize the risks involved in pharmaceutical distribution. The aim is to overcome the current weaknesses of failure modes and effect analysis (FMEA) method by considering unequal weights of risk factors given by experts for different failure modes. A case study on air cargo distribution of pharmaceutical products is presented to demonstrate the potential applications of the proposed approach, and the merits are highlighted by comparing with the traditional FMEA.

5 - Managing Blood Inventory with Random Transfers

David C. Novak, Associate Professor, Grossman School of Business, University of Vermont, 310 Kalkin Hall, 55 Colchester Avenue, Burlington, VT, 05405-0157, United States, Marilyn Lucas, Karti Puranam

We introduce a method to solve the fixed lifetime perishable inventory problem with a lifetime of m > 2 periods, where there are two independent sources of supply. One source is blood deterministically ordered by the blood bank. The other source is blood that is randomly transferred to the blood bank from smaller, lower-usage hospitals in the health care network. We formulate a DP to solve the multi-period cost minimization problem and test our solution approach theoretically and empirically. We then present a novel heuristic approach for determining a near-optimal ordering policy for any perishable product where redistribution represents a second source of supply.

■ TB06

North Bldg 122C

Joint Session OPT/Practice Curated: Convex Optimization and Applications to Machine Learning

Sponsored: Optimization/Global Optimization

Sponsored Session

Chair: Georgina Hall, Princeton University, Princeton, NJ, 08544, United States

1 - Time-varying Semidefinite Programs

Amir Ali Ahmadi, Princeton University, Dept. of Operations Research&Financial Eng., Sherrerd Hall (room 329), Charlton Street, Princeton, NJ, 08544, United States, Bachir El Khadir

Time-varying semide?nite programs (TV-SDPs) are semide?nite programs whose feasible set and objective function vary continuously over a bounded time interval and whose solution is a bounded measurable function of time. We show that the best polynomial solution of a given degree to a TV-SDP can be found by solving an SDP of tractable size. We also prove that under mild assumptions, polynomial solutions are as good as any bounded measurable solution. Joint work with Bachir El Khadir.

2 - Nonnegative Polynomials and Applications to Learning

Georgina Hall, INSEAD Business School, Boulevard de Constance, Sherrerd Hall, Fontainebleau, 77300, France

In this talk, we show how techniques from sum of squares optimization can be applied to two problems at the interface of machine learning and polynomial optimization. In part (i), we study the problem of learning a monotone polynomial from data. This is motivated by regression problems where the underlying function to be learned is monotone (consider, e.g., the price of a car as a function of its fuel efficiency). In part (ii), we study the problem of optimally decomposing a multivariate polynomials as the difference of two convex polynomials. This is motivated by certain majorization-minimization algorithms used in nonconvex optimization that require such a decomposition.

3 - Design of First-order Optimization Algorithms via Sum-of-squares Programming

Mahyar Fazlyab, University of Pennsylvania, Philadelphia, PA, United States, Manfred Morari, Victor M. Preciado

We use tools from sum-of-squares programming to design iterative first-order optimization algorithms for smooth and strongly convex problems. Our starting point is to develop a polynomial matrix inequality as a sufficient condition for exponential convergence of the algorithm. We then formulate a polynomial optimization, in which the objective is to optimize the exponential decay rate over the tunable parameters of the algorithm (e.g. stepsize, momentum coefficient, etc.). Finally, we use sum-of-squares programming as a tractable relaxation of the proposed polynomial optimization problem. We illustrate the utility of the proposed framework by designing an accelerated method.

4 - Near-Optimal Joint Matching via Convex Relaxation

Yuxin Chen, Princeton University, NJ, United States

Joint matching over a collection of objects aims at aggregating information from a large collection of similar instances (e.g. images, graphs, shapes) to improve maps between pairs of them. Given multiple matches computed between a few object pairs in isolation, the goal is to recover an entire collection of maps that are (1) globally consistent, and (2) close to the provided maps – and under certain conditions provably the ground-truth maps. In this work, we develop a convex relaxation algorithm to jointly match multiple objects that exhibit only partial similarities, given a few pairwise matches that are densely corrupted. The algorithm provably exhibits near-optimal error-correction ability.

■ TB33

North Bldg 222C

Joint Session ORAM/QSR/Practice Curated: Panel Discussion on Academic Job Application and Interview Process

Emerging Topic: OR and Advanced Manufacturing

Emerging Topic Session

Chair: Mohammed Shafae, University of Arizona, Tucson, AZ, 85743, United States

1 - Discussion on Academic Job Application and Interview Process

Ahmed Aziz Ezzat, Texas A&M University, College Station, TX, United States

Moderator for INFORMS annual meeting 2018 panel session entitled "Academic Job

Application and Interview Process".

Panelists

Janis Terpenny, Penn State University, Industrial & Manufacturing Engineering, 310 Leonard Building, University Park, PA, 16802, United States

Elsayed A. Elsayed, Rutgers University, Department of Industrial and Systems Eng, 96 Frelinghuysen Road, Piscataway, NJ, 08854, United States

Zhijian Pei, Professor, Texas A&M University, 101 Bizzell St., College Station, TX, 77843, United States

Rachel Cummings, Georgia Tech, 755 Ferst Drive NW, Atlanta, GA, 30332-0205, United States

Murat Yildirim, Wayne State University, 4815 Fourth Street, Detroit, MI, 48202, United States

Mohammed Shafae, University of Arizona, Tucson, AZ, United States

■ TB36

North Bldg 224B

Joint Session Drones/Practice Curated: New Directions in Logistics

Emerging Topic: Robotics, Drones and Autonomous Vehicles in Logistics

Emerging Topic Session

Chair: Dongdong Ge, Shanghai University of Finance and Economics

1 - An Efficient MILP Formulation for Real AGV Systems

Dongdong Ge, Shanghai University of Finance and Economics, School of Information Management and Eng, 777 Guoding Road, Shanghai, 200433, China

Running more than 100 robots in an AGV system is the main difficulty in most AGV warehouses. This project approaches this real time control problem by efficiently formulating its assignment part as an MILP problem, solving it efficiently, and combining it with intelligent partition system and vehicle routing algorithms. The implementation results in Beijing's large warehouse in 2017 showed a great success for 'double eleven' shopping rush.

2 - Last Mile Delivery using Trucks, Drones, and Ground-based Robots

John Gunnar Carlsson, University of Southern California, 3750 McClintock Avenue, Los Angeles, CA, 90089, United States

We determine the efficiency of a delivery system in which a truck acts as a "moving warehouse" for a collection of drones or ground-based robots. Using a theoretical analysis in the Euclidean plane, we derive a closed-form expression describing the time to completion in terms of the number of drones or robots as well as the relative speeds of the vehicles.

■ TB38

North Bldg 225B

Joint Session APS/Practice Curated:Data Driven OR Applications

Sponsored: Applied Probability

Sponsored Session

Chair: Flora Spieksma, Leiden University, Leiden, 2311KL, Netherlands

Co-Chair: Michael N. Katehakis, Rutgers University, Newark, NJ, 07010, United States

1 - Non-parametric Up-and-down Experimentation Revisited

Flora Spieksma, Associate Professor, Leiden University, Niels Bohrweg 1, Leiden, 233CA, Netherlands, Michael N. Katehakis, Sheldon M. Ross

In many applications, it is of interest to estimate a value, the æquantile', of a scalar control variable x that will cause a certain ratio a of successes, or failures, in a binary output variable Y = Y (x). We present a convergent algorithm for estimating the quantile x* and we discuss applications in inventory control under unknown demand distribution, and drug dosage determination.

2 - Asymptotically Optimal Multi-armed Bandit Policies Under Side Constraints

Odysseas Kanavetas, Koc University, Koc University Campus, Istanbul, Turkey, Apostolos Burnetas, Michael N. Katehakis

We develop asymptotically optimal policies for the multi armed bandit (MAB), problem, under side constraints. Such models are applicable in situations where each sample (or activation) from a population (bandit) incurs known bandit dependent costs. We consider the class of feasible uniformly fast (UF) convergent policies, that satisfy sample path wise the constraints. We first establish a necessary asymptotic lower bound for the rate of increase of the regret function of UF policies. Then we provide conditions under which a simple class of UF policies attain this lower bound and are asymptotically optimal within the class of UF policies.

3 - Generative Networks for Data Modeling in Sequential Change Detection

George Moustakides, Professor, Rutgers University, 110 Frelinghuysen Road, Hill 359, Piscataway, NJ, 08854, United States

One of the most important problems in applications is data modeling. When data are time-dependent, we limit ourselves to linear AR or ARMA models therefore silently assuming that the data are Gaussian. Recently, in Machine Learning, nonlinear neural network, known as Generative Networks, were introduced that can be properly trained to capture non-Gaussian behavior. In this work we extend this idea to represent nonlinear time-dependencies instead of simple independent realizations which is the current practice. Our method is then applied to the problem of sequential change detection for the rapid detection of changes in the statistical behavior of observed processes.

4 - Reinforcement Learning: Connections Between MDPS and MAB Problems

Michael N. Katehakis, Distinguished Professor, Rutgers University, 100 Rockafeller Road, Piscataway, NJ, 08854, United States, Wesley Cowan, Daniel Pirutinsky

This talk considers a basic reinforcement learning model dealing with adaptively controlling an unknown Markov Decision Process (MDP), in order to maximize the long-term expected average value. We show how a factored representation of the MDP problem allows it to be decoupled into a set of individual MAB-problems on a state by state basis. Additionally, i) we show the construction of a simple UCB-type MDP policy, dramatically simplifying an earlier proof of its optimality, and ii) we discuss extensions to other MAB policies e.g., Thompson Sampling.

■ TB42

North Bldg 227A

Joint Session Analytics/Practice Curated: Analytics and Machine Learning in Healthcare

Sponsored: Analytics

Sponsored Session

Chair: Aven Samareh

1 - Balanced Random Survival Forests for Mortality Prediction from Extremely Unbalanced, Right Censored Data

Kahkashan Afrin, Texas A&M University, College Station, TX, United States, Gurudev Illangovan, Sanjay S. Srivatsa, Satish Bukkapatnam

Accuracies of survival models are compromised due to the imbalance between the survival and mortality class sizes. Imbalanced datasets results in an underestimation (overestimation) of the hazard of the mortality (survival) classes. A balanced random survival forests (BRSF) model, based on training the RSF model with data generated from a synthetic minority sampling scheme is presented to address this gap. Benchmarking studies were conducted using five datasets from public repositories and a dataset of 267 patients, collected at the Heart, Artery, and Vein Center of Fresno. Investigations suggest that BRSF outperformed both Cox and RSF with an average reduction of 55% in the prediction error.

2 - Effects of Outliers and Robust Logistic Regression Tree

Doowon Choi, Texas A&M, College station, TX, United States, Li Zeng

This study investigates effects of outliers in logistic regression tree (LRT) modeling of binary outcome data in healthcare applications and develops a robust logistic regression tree (RLRT) approach that can alleviate those effects. The effectiveness and advantages of the proposed method is demonstrated in a case study using dataset on cardiac surgeries.

3 - A Semi-supervised AUC Optimization Model for Autism Risk Gene Prediction

Ying Lin, Houston, TX, United States

Autism is a constellation of neurodevelopmental presentations withhigh heritability. Prediction models, e.g. SVM and Random Forest, have been applied to automatically identified causal autism genes based on their expression patterns. But existing models are challenged by the limited training genes, imbalanced gene labels and the spatiotemporal correlations in gene expression. In this study, a semi-supervised AUC optimization model is developed to identified autism risk genes using brain specific gene expression value and their functional relationship network. It's applied to rank more than 25,000 unknown genes and the top ranked genes are potential to enrich the autism risk genes.

4 - Med-chi: Maximum Entropy Discrimination Based Contemporaneous Health Index for Degenerative Disease Monitoring
Aven Samareh, University of Washington, 4324 8th Ave NE, D7, Seattle, WA, 98105, United States, Shuai Huang

We developed a novel contemporaneous health index (MED-CHI) that builds on the theory of maximum entropy discrimination. MED-CHI aims to characterize the monotonic progression characteristic underlying the longitudinal measurements for degenerative disease monitoring. Intuitively, the MED-CHI approach embodies both the data integration power of Bayesian method and the computational power of convex optimization, to handle semi-supervised structure and transfer the learned knowledge to enhance the learning ability to a completely unsupervised source domain.

5 - Dynamic Inspection of Latent Variables in State-space Systems
Tianshu Feng, University of Washington, Seattle, WA, 98195, United States, Xiaoning Qian, Kaibo Liu, Shuai Huang

The state-space models are widely used in a variety of areas where a set of observable variables is used to track latent variables. While most existing works focus on the statistical inferences of the latent variables based entirely on the observable variables, it comes to our awareness that in many applications, the latent variables can be occasionally acquired to enhance the monitoring of the state-space system. In our work, novel dynamic inspection methods under a general framework of state-space models are developed to identify and inspect the latent variables that are most uncertain.

■ TB49

North Bldg 230

Joint Session ENRE/Practice Curated: Open Pit and Underground Mining Applications

Joint Session

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

1 - Managing Production Incidents in Mining using Multistage Stochastic Programming
Bernardo Kulnig Pagnoncelli, Universidad Adolfo Ibanez, Diagonal Las Torres 2640 Penalolen Of. 533-C, Santiago, 7910000, Chile, Lorenzo Reus, Margaret Armstrong

In this work, we consider a long-term mine planning model in the presence of price uncertainty and production incidents. The decision maker must satisfy minimum production levels established by contracts and can hedge against uncertainty by stocking material at a cost. We solve a large scale multistage stochastic programming model using decomposition methods and derive an optimal policy for any realization of the uncertain parameters.

2 - Dispatching Policies in Open Pit Mining
Amanda G. Smith, University of Wisconsin-Madison, 1513 University Avenue, Mechanical Engineering Bldg, Madison, WI, 53706, United States, Jeff T. Linderoth, James Luedtke

The open pit mine truck dispatching problem seeks to determine how trucks should be routed through a mine. Among the challenges of the dispatching problem is the need to balance the distinct objectives of meeting production and quality targets in a dynamic mining environment. We propose an optimization-driven approach to solving the dispatching problem via a MIP model. We also propose two competing policies that match dispatching decisions to rate targets obtained from a nonlinear flow rate model. To evaluate the policies, we use a discrete-event simulation of an open-pit mine. We conclude with computational results demonstrating how each policy performs on mines with different characteristics.

3 - Optimal Selection of Support Pillars in an Underground Mine
Levente Sipeki, Colorado School of Mines,, Golden, CO, 80128, United States, Alexandra M. Newman, Candace Arai Yano

We address the design optimization problem for a mine utilizing the top-down open-stope retreat mining method. Earth below the surface is divided into three-dimensional rectangular blocks. The mine design specifies which blocks are left behind as pillars to provide geotechnical structural stability; the remainder are extracted and processed. We maximize profit subject to geotechnical stability constraints and develop an iterative heuristic in which violated constraints are incorporated into the formulation until all required geotechnical constraints are satisfied. Our approach provides solutions whose estimated profit is 5% better that what industry-standard methods provide.

4 - Adaptive Scheduling under Uncertainty: Application to Open Pit Mining
Patricio Andres Lamas, Universidad Adolfo Ibanez, Santiago, Chile, Marcos Goycoolea, Bernardo Kulnig Pagnoncelli

In the mining industry, schedules are executed under high levels of uncertainty. Traditional scheduling approaches dealing with uncertainty consist of initially fixing an (execution-) policy class and then finding an optimal policy within such a class. These approaches have been successful in making the problem computationally tractable. However, initially fixing a policy class has a negative impact on the optimality of the schedules. We propose a less restrictive approach, which creates schedules that adapt to the uncertainty that is partially realized during execution. The adaptive capability of our approach leads to schedules that dominate those derived from the existing approaches.

■ TB50

North Bldg 231A

Joint Session Practice/Practice Curated: O.R. Applications in Medicine

Sponsored: INFORMS Section on Practice (formerly CPMS)

Sponsored Session

Chair: Umit Deniz Tursun, University of Illinois, Champaign, IL, 61822, United States

1 - Evaluation of Dexketoprofen Trometamol Ef?cacy in Postoperative Pain Management for Open Heart Surgery
Umit Deniz Tursun, University of Illinois, 3308 Sharp Drive, Champaign, IL, 61822, United States

To evaluate comparative statistical analgesic ef?cacy, opioid-sparing, and opioid-related adverse effects of intravenous dexketoprofen trometamol in combination with iv morphine postoperative open-heart surgery. Past data set and outcome predictions of different patient groups based on age and set of patient markers are presented. The opioid requirement is found to be lowered by %55 2.7 with %95 reliability. Routine addition of dexketoprofen trometamol to patient controlled analgesia morphine postoperative open-heart surgery is recommended as an alternative and ef?cacious method. The alternate postoperative pain therapy protocols are presented.

Panelists

Dr. Filiz Dokan, MD, Kosuyolu High Specialized Training and Research Hospital, Istanbul, 34865, Turkey

Umit Tursun Ozer, PhD, University of Illinois Urbana-Champaign, Champaign, IL, 61822, United States

Umit Deniz Tursun, University of Illinois, 3308 Sharp Drive, Champaign, IL, 61822, United States

■ TB51

North Bldg 231B

Practice- Production & Scheduling I

Contributed Session

Chair: Carlos Monardes, Pontificia Universidad Catolica de Chile, Avenida Vi, Santiago, Chile,

1 - Flexible Decisions and Flexible Resources: A Balance for Efficient Operations
Alejandro MacCawley, Catholic University of Chile, Santiago, Chile, Elbio Avanzini, Jorge R. Vera, Sergio Maturana

<Uncertainty in operational environments can be faced with operational flexibility in decisions as well as in resources. However, there are different costs involved, as well as the effects and operational consequences. In this work, we present a multi-stage stochastic optimization decision model, applied to a case in the agricultural industry. The model allows us to analyze the trade-offs between flexibility in the decision process as well as flexibility in the resources, like manpower skills. The analysis and conclusions help management to achieve a better operational planning under uncertainty.>

2 - A Column-generation Approach to Maximizing Angle Board Production
Samir Bhetwal, Northern Illinois University, Dekalb, IL, United States, Christine Vi Nguyen

The project focuses on providing a reliable solution to a paper production company producing angle boards. The company receives raw materials from the sister companies, and therefore has little control over the thickness of the paper that is used to create the angle boards. The column generation algorithm has been developed and a set of patterns are generated for each type of angle board product by which the production run can be maximized with the current available supply of raw materials. The model considers the current set of raw materials and its attributes in the production of good quality angle boards.

3 - Optimal Production and Inventory Planning with Inventory Based Financing
Renato E. de Matta, University of Iowa, 2360 Mulberry Street, Coralville, IA, 52241, United States, Vernon Hsu

We study a multi product, multi period production planning problem with restriction

on the available working capital. We use cycle inventory as collateral to secure loans. We formulate the problem as a mixed integer programming model. The problem with one product is NP hard. We develop an efficient heuristic procedure to solve the multi product problem. We examine a variety of economic scenarios to show how the firm could significantly improve its profitability with the availability of inventory-based financing. We use real world data to validate our model and develop managerial insights.

4 - A Rhythm Wheel Approach for Production Planning and Batch Sizing

Gokhan Memisoglu, LLamasoft, Inc., 201 South Division St., Ann Arbor, MI, 48104, United States, Mike Bucci

In this study, we developed an optimization tool that includes line balancing, production cycle and sequencing. The intent of this tool is to create a high-level tactical solution which can guide a short-term production scheduling application. The tool uses Rhythm Wheel (RW) approach to estimate production cycles and creates a solution that balances setup and cycle stock costs. This tool has been used by a major pharmaceutical company in several project with great success.

5 - A Different Approach to Reduce Dimensionality in Planning Problems

Carlos Monardes, Pontificia Universidad Catolica de Chile, Avenida Vicuna Mackenna 4860, Macul, Santiago, Chile, Alejandro Francisco Mac Cawley, Jorge R. Vera, Susan C. Cholette, Sergio Maturana

Planning faces time dimensionality problems as instances size grows. In this work, we present a methodology to cope dimensionality. First, we defined a data structure to keep off time index in decision variables, which allowed us to construct a MIP model. Second, we solved the former problem using Constraint Generation. We tested this approach in winery industry, where model assists the assignment decision process of harvested grapes to fermentation tanks. This approach has shown interesting properties, increasing computational implementation efficiency.

■ TB52

North Bldg 231C

Joint Session SMA/Practice Curated: Medical Decision Support with Social Media Analytics

Emerging Topic: Social Media Analytics

Emerging Topic Session

Chair: Qingpeng Zhang, City University of Hong Kong, Kowloon, 12180, Hong Kong

1 - Using Search Query Data to Predict HIV New Diagnoses

Qingpeng Zhang, City University of Hong Kong, 83 Tat Chee Avenue, 6/F, Academic 1, Kowloon, 12180, Hong Kong

Objectives: Internet data are important sources of abundant information regarding HIV epidemics and risk factors. A number of case studies found an association between Internet searches and outbreaks of infectious diseases, including HIV. In this research, we examined the feasibility of using search query data to predict the number of new HIV diagnoses in China. Design: We identified a set of search queries that are associated with new HIV diagnoses in China. We developed statistical models (negative binomial generalised linear model and its Bayesian variants) to estimate the number of new HIV diagnoses by using data of search queries (Baidu) and official statistics (for the entire country and for Guangdong province) for 7 years (2010 to 2016). Results: Search query data were positively associated with the number of new HIV diagnoses in China and in Guangdong province. Experiments demonstrated that incorporating search query data could improve the prediction performance in nowcasting and forecasting tasks. Conclusions: Baidu data can be used to predict the number of new HIV diagnoses in China up to the province level. This study demonstrates the feasibility of using search query data to predict new HIV diagnoses. Results could potentially facilitate timely evidence-based decision making and complement conventional programmes for HIV prevention.

2 - Social Support and User Churn Prediction for Online Health Communities – A Trajectory-based Deep Learning Method

Xiangyu Wang, University of Iowa, Iowa City, IA, United States, Apoorva Joshi, Kang Zhao, Xun Wang

Online Health Communities (OHCs) are a great source of social support for patients and their caregivers. Better predictions of user churns from OHCs can help to manage and sustain a successful OHC. We incorporate two methods into churn prediction for OHCs: identifying different types of social support activities from posts users have published via text mining, and using LSTM to learn from users' trajectories in different types of social support activities.

■ TB55

North Bldg 232C

Joint Session Sports/Practice Curated: Sports Analytics V

Sponsored: SpORts

Sponsored Session

Chair: Scott Nestler, University of Notre Dame, Granger, IN, 46530, United States

1 - Analysis of Experimental Rule Changes in the 2018 National Invitation Tournament

Scott Nestler, University of Notre Dame, 51344 Pebble Beach Court, Granger, IN, 46530, United States

In recent years, the National Collegiate Athletic Association (NCAA) has used the National Invitation Tournament (NIT) as a test bed for rule changes under consideration. 2018 modifications included: (1) 3-point line extended by 20 inches; (2) lane expanded from 12 to 16 feet (NBA width); (3) 20-minute halves split into two 10-minute quarters; and (4) resetting the shot clock to 20 (vs 30) seconds after an offensive rebound. In anticipation of the next possible rule change in 2019, this analysis quantifies the effect of these modifications on the college basketball game, through comparison with regular season and other post-season tournament games.

2 - Age Effects in Mixed Martial Arts Competition

Thomas Robbins, East Carolina University, 3212 Bate Building, Greenville, NC, 27858, United States

The impact of age on sports performance has been analyzed in multiple sports including baseball, hockey, soccer, swimming, golf, track and field, and tennis. In this talk, we examine the impact age has on performance in mixed martial arts competition. We find that the age distribution varies significantly with weight class; as smaller more athletic weight classes are younger than the larger weight classes. We also quantify the impact age and age differential have on a fighter's probability of winning. Finally, we investigate whether the age distribution has been impacted by anti-doping policies and USADA testing.

3 - MeetOpt: A Spreadsheet-based Decision Support System for Optimal Athlete-to-Event Assignment in Track and Field

Matthew Bailey, Bucknell University, School of Management, Taylor Hall, Lewisburg, PA, 17837, United States, Maciek A. Nowak

Nationally, track and field is second only to football in participation. Time-constrained track coaches primarily focus on the training and development of athletes. As a result, they overlook and underappreciate the competitive advantage of strategically assigning athletes to events. Working with local coaches, we developed a spreadsheet-based DSS, MeetOpt. MeetOpt is a generalization and extension of an assignment problem which determines an optimal athlete assignment to maximize the expected total team points. We illustrate the value of this model in comparison to commercially available tools and under a variety of scenarios, league rules, and preferences.

4 - Team-specific Ticket Options

Ovunc Yilmaz, University of Notre Dame, South Bend, IN, 46617, United States, Mark Ferguson, Pelin Pekgun, Guangzhi Shang

Team-specific ticket options have recently gained popularity in the sports industry. In this study, we investigate the drivers of prices and transaction volumes in this market using social media data and detailed game/ranking information.

■ TB59

West Bldg 102A

Joint Session HAS/Practice Curated: Applications of Decision-Making Models in Healthcare

Sponsored: Health Applications

Sponsored Session

Chair: Alireza Boloori, Arizona State University, Tempe, AZ, 85283, United States

1 - Bias in Sensitivity Analysis of Comparative Analyses for Medical Decision Making

Michael J. Hintlian, University of Southern California, 1029 South Westmoreland Avenue, #102, Los Angeles, CA, 90006, United States, Julia L. Higle

Comparative analyses for MDM are undertaken examine the cost/benefit impact of various treatment alternatives. These impacts are estimated via model-based analyses after which sensitivity to model parameters is examined. We illustrate the existence of bias in the sensitivity analysis that results from the methods used to select model parameters. We discuss methods for mitigating this bias.

2 - Optimal Genetic Testing Schemes for Cystic Fibrosis

Hussein El Hajj, Virginia Tech, Blacksburg, VA, United States, Ebru Korular Bish, Douglas R. Bish

Cystic fibrosis (CF) is a highly prevalent life-threatening genetic disorder, but early diagnosis can save lives and reduce healthcare expenditures. To date, over 300 CF-

causing mutations are identified, and all 50 states conduct newborn screening for CF, typically starting with a bio-marker test, followed by genetic testing on selected mutations for newborns with elevated bio-marker levels. We develop a stochastic optimization model to determine an optimal genetic testing scheme for CF that minimizes the probability of misclassification under a testing budget. Our case study for California shows that the optimal scheme can substantially reduce misclassification over current practices.

3 - Incentive-Driven Readmission Management with Patients Facing Compliance Barriers

Aditya Mahadev Prakash, University of Florida, Gainesville, FL, 32608, United States, Qiaochu He, Xiang Zhong

We aim to quantify the impact of non-compliance of patients on their post-acute care management, and assist healthcare stakeholders in improving the overall well-being of patients through the most efficient and effective allocation of resources. We establish a game-theoretic model where patients' lack of compliance is modeled by incorporating their heterogeneous and bounded rationality in the context of a congested service system. The optimal structure of subsidies that can monetarily incentivize patients and result in a minimum overall cost for an insurer is developed. The insights obtained from this study would support clinical and operational decision-making by health practitioners.

4 - Impact of Physician's Ambiguity on Management of Medications

Alireza Boloori, Arizona State University, Tempe, AZ, 85283, United States, Soroush Saghafian, Harini A. Chakkera, Curtiss B. Cook

Patients after organ transplantations receive high amounts of immunosuppressive drugs (e.g., tacrolimus) to reduce the risk of organ rejection. However, this practice has been shown to increase the risk of New-Onset Diabetes After Transplantation (NODAT). We propose an ambiguous POMDP framework to generate effective medication management strategies for tacrolimus and insulin. Our approach increases the patient's quality of life while reducing the effect of transition probability estimation errors. We also provide several managerial and medical implications for policy makers and physicians.

■ TB62

West Bldg 103A

Joint Session DM/Practice Curated: Modeling and Analysis of Complex Systems with Applications

Sponsored: Data Mining

Sponsored Session

Chair: Chun-An (Joe) Chou, Northeastern Univeristy

Co-Chair: Miaolin Fan, Boston, MA, 02115, United States

1 - A Novel Framework for Multimodal Physiological Data Fusionnetwork Models of Nonlinear Dynamic Coupling Systems

Miaolin Fan, Northeastern University, 360 Huntington Avenue, Boston, MA, 02115, United States

The human body is considered as a complex dynamic system of multiple physiological subsystems. A novel framework was proposed to present the system as a directed network, and the interrelationship among subsystems was quantified by fusing multimodal physiological time series. Each time series is projected onto a reconstructed state space, where the temporal dependency among system's states is captured. Then, a directed network model is formulated to characterize the coupling relationship between physiological subsystems with a temporally variable structure. We also discuss how the directed coupling can be assessed in the context of specific tasks, e.g. interpersonal communication.

2 - Cost-sensitive Feature Selection using Mixed Integer Programming

Daehan Won, Binghamton University, R4, Eng. Bldg, L2, Vestal, NY, 13902, United States, Shun Cao

Feature selection aims to select a subset of highly informative features that are capable of discriminating observations. Herein we consider the cost components in the selection since the traditional way may result in good selection in theory but not in practical applications. We are developing cost-sensitive classifier that minimizes the error caused by misclassification as well as maintaining the maximum amount of the cost to select the important features. To impose the cost directly, we construct two Mixed Integer Programming (MIP) models. To demonstrate the effectiveness, empirical experiments are conducted while showing that ours are capable of selecting a low-cost subset of features.

3 - A General Embedding Framework for Heterogeneous Information Learning in Large-scale Networks

Na Zou, Texas A&M University, 101 Bizzell Street, 4018 Emerging Technology Building, College Station, TX, 77845, United States

Network analysis has been widely applied in many real-world tasks. To extract features for these tasks, network embedding automatically learns a low-dimensional vector representation. However, it remains challenging to jointly embed the geometrical structure with heterogeneous information as well as problem of scalability. To bridge the gap, we propose a Heterogeneous Information Learning in Large-scale networks (HILL) to accelerate the joint learning. It decomposes the complex modeling into many simple and independent sub-problems. We illustrate the generalizability of HILL by applying it to perform attributed network embedding and second-order proximity learning.

4 - A Low Rank Model for Estimation of Response Function in fMRI Data

Minh Pham, Rochester Institute of Technology, Rochester, NY, 22911, United States

The focus of this paper is on evaluating brain responses to different stimuli and identifying brain regions with different responses using multi-subject, stimulus-evoked functional magnetic resonance imaging (fMRI) data. To jointly model many brain voxels' responses to designed stimuli, we present a new low-rank multivariate general linear model (LRMGLM) for stimulus-evoked fMRI data. The new model not only is flexible to characterize variation in hemodynamic response functions (HRFs) across different regions and stimulus types, but also enables information "borrowing across voxels and uses much fewer parameters than typical nonparametric models for HRFs.

■ TB63

West Bldg 103B

Joint Session DM/Practice Curated: Predictive Analytics and its Applications

Sponsored: Data Mining

Sponsored Session

Chair: Talayeh Razzaghi

1 - Using Predictive Analytics to Forecast Litigation Outcomes

Mohammad Javad Feizollahi, Georgia State University, 755 Ferst Drive NW, Atlanta, GA, 30332, United States, Charlotte Alexander

Text mining and predictive analytics are increasingly being used to analyze and forecast the outcome of lawsuits. In this project, we parse the text of thousands of court documents filed in federal employment law cases to discover features of the plaintiffs, defendants, lawyers, and judges, and the legal claims made in each case. Together, these features help construct a model that can be deployed at different phases of litigation to predict a case's outcome. We describe the methodology and results of this litigation prediction project.

2 - A Sensor-driven Anomaly Detection Model with a Bayesian Hierarchical Framework

Ramin Moghaddass, University of Miami, McArthur Engineering Building, Coral Gables, FL, 33146, United States

In this work, a new Bayesian hierarchical framework is presented that can be used to (a) model systems' response variables in terms of system's inputs (features) without imposing strong distributional assumptions, and (b) detect anomalies regardless of whether or not such anomalies have been observed before based on a trade-off between performance measures, such as true detection rate and false alarms. Using a Bayesian hierarchical setting, the model utilizes only a subset of important features and training samples in the training process.

3 - A Two Objective Linear Programming Approach for Data Classification

Elaheh Jafarigol, University of Oklahoma, Norman, OK, 73071, United States, Theodore B. Trafalis

Multi-objective optimization techniques are a useful tool for designing and analyzing supervised learning systems. This paper presents an optimization model to find support vector hyperplanes to classify large datasets with non-separable classes with modifications to the objective function in traditional support vector machine. To solve this optimization problem, parametric simplex for two-objective LPs is used. The model is implemented in Gurobi through Python to optimize the two-objective model.

4 - Predictive Analytics in Humanitarian Supply Chain using Deep Learning

Donovan Fuqua, New Mexico State University, 4208 Escondido Lane, Las Cruces, NM, 88005, United States, Talayeh Razzaghi

In this work, we propose the use of deep neural networks to predict shipment arrivals and system bottlenecks using multi-channel time series data. We use US Military transportation data from 2004-2015 for humanitarian relief supply chains. Although the research focuses on humanitarian operations, we will discuss multiple applications for supply chains and transportation optimization.

■ TB64

West Bldg 104A

Joint Session DM/Practice Curated: Data Science for

Block Chain, E-Business, and Commerce

Sponsored: Data Mining

Sponsored Session

Chair: Lin Chen, University of Houston, 4800 Calhoun Road, Houston, TX, 77004, United States

1 - Effect of Mimicking News Title on Sponsored Article Engagement
Quan Wang, LinkedIn, 880 W. Maude Ave, Sunnyvale, CA, 94085, United States

Media companies are incorporating sponsored articles in the news feeds which used to be dedicated to editorial news articles. Using a large-scale novel dataset from a leading news website, we investigate whether mimicking news style affects the user engagement with the sponsored article. We employ a combination of human evaluation, natural language processing, binary classification models and econometrics models. We find evidence that mimicking the style of news title could lift the click probabilities by over 100% and increase conversion probability by 40%. Sub-analyses indicate that contextual congruity might be the driving force of the engagement lift.

2 - Using Omnichannel Sales Data Analytics to Decide Between Store and Distribution Center Fulfillment Options
Jingran Zhang, New Jersey Institute of Technology, University Height, Newark, NJ, 07102, United States, Jingran Zhang, Marshall University, Lewis College of Business, One John Marshall Drive, Corbly Hall 423, Huntington, WV, 25755, United States, Sanchoy Das

A brick-and-mortar retailer can fulfill online customer orders in two ways (i) Buy Online Fulfill from Store (BOFS) - Picked from store inventory, and (ii) Fulfill from Distribution Center (FDC) - Picked from DC or warehouse inventory. The fulfillment decision is made in real time for each order, with the primary goal of maximizing the revenue value of the store inventory. Analysis of sales data in both online and store channels is used to forecast the value of the dispersed inventory, and then develop a prescriptive model for making a fulfillment decision.

3 - Google Tells What Happens When Shadow Economy Meets Bitcoin
Zheshi Chen, First and Responding, Harbin Institute of Technology, Management Building 612, West Dazhi Street, Harbin, Heilongjiang China, Harbin, 150001, China, Wenjun Sun, Qiang Ye

In this study, we find striking positive correlations between Bitcoin's key financial indicators and the level of shadow economy, based on the geographic distribution of interests on Google Trend keyword "Bitcoin", along with the corresponding Shadow Economy Index data. Our results indicate that the shadow economy may be one of the key implicit factors driving Bitcoin's prosperity. Our study also shows that Google Trend can be an effective detector of economic and social drivers of Bitcoin.

4 - Identifying Companies with Prospects of Adopting Blockchain
Hamidreza Ahady Dolatsara, Auburn University, 227 Lowder Hall, 405 W. Glenn Ave., Auburn, AL, 36830, United States, Ashish Gupta, Alireza Farnoush, Gelareh Ahadi Dolatsara

This research identifies companies that may adopt blockchain technology based on their similarities to the companies that have already demonstrated an intention to use this technology. Long term financial performance of companies that intended to use blockchain technology is investigated for understanding the characteristics of such companies. Semi-supervised classification method is subsequently employed to identify similar companies.

5 - Smart Contract Execution – The (+-)-Biased Ballot Problem
Lin Chen, University of Houston, 4800 Calhoun Road, Houston, TX, 77004, United States, Lei Xu, Zhimin Gao, Nolan Shah, Yang Lu, Weidong Shi

Transaction system build on top of blockchain, especially smart contract, is becoming an important part of world economy. We consider a blockchain-based smart contract system and study how the behavior of users would affect the consensus. We connect this problem to the classical Ballot problem in combinatorics and establish a more general (+-)-Biased Ballot Problem to model it. We give an asymptotic analysis of this new model.

■ TB66

West Bldg 105A

Joint Session AI/Practice Curated: Social Media and Surveillance: Detection and Prediction

Sponsored: Artificial Intelligence

Sponsored Session

Chair: Yongcheng Zhan, The University of Arizona, Tuscon, AZ

1 - Learning User Age via Locality and its Applications in Regulatory Science: A Deep Learning-Based Approach
Zhipeng Chen, The University of Arizona, Tuscon, AZ, United States, Daniel Dajun Zeng

The development of regulatory science requires researchers to utilize multiple data sources for assessing the safety, efficacy, quality and performance of all regulated products. The large quantity of social media data provides an opportunity to characterize public attitudes in real time. However, the lack of demographic data induces data biases and diminishes the utility of social media data. Our research mitigates this weakness by building a deep learning model to predict user age. The experiment shows the locality is a strong predicator and achieve a satisfiable prediction accuracy. Then we apply the prediction model to an e-cigarette dataset in an e-cigarette brand analysis. The analysis results indicate strong public health implications of demographics prediction.

2 - Illicit and Prescription Drug Street Name Detection using Social Media
Yongcheng Zhan, The University of Arizona, Tucson, AZ, 85719, United States, Zhu Zhang, Scott J. Leischow, Daniel Dajun Zeng

Recent years have observed the spread of America's drug overdose epidemic. Much effort has been made in public health surveillance to realize the potential of early detection and targeted intervention. However, because of the ever-changing drug street names, it is increasingly difficult for researchers and public health practitioners to keep up with the terms. We proposed an innovative method to automatically detect illicit and prescription drug street names by using rich text information from social media. Our method showed its potential by enriching NIH opioid street name list with emerging terms.

3 - Detection of Prejudice from Social Media Streams
Haimonti Dutta, University at Buffalo, 325P Jacobs Management Center, Buffalo, NY, 14260, United States

Multicultural societies are characterized by frequent contact and communication between different social groups. Prejudices, or beliefs about a particular social group, affect the nature and quality of interactions with members of that group. It finds expression in social media platforms when a group of people express anger, resentment and dissent towards another. It is heightened during crises or threat. This paper develops a framework for detection of prejudice from social media streams using deep learning methods. Empirical results presented on a Twitter data stream show that our framework is capable of out-performing state-of-the-art batch systems for prejudice detection.

4 - Forecasting Collective Action using Social Media
Rostyslav Korolov, Rensselaer Polytechnic Institute, 110 Eighth Street, Troy, NY, 12180, United States, David Mendonca, William A. Wallace

We demonstrate the potential of online social media for large-scale behavioral research by developing a multi-disciplinary approach to predicting collective action using social media data. We report three case studies: one concerning charitable donations and two concerning social unrest. Through these case studies we demonstrate the utility of social media data for predictions of different kinds of collective action. We utilize Twitter data (approximately 20 million messages) to predict the volume of disaster response donations, and occurrences of protests.

5 - Predicting Gasoline Shortage in Florida During Irma using Tweets
Abhinav Khare, University at Buffalo, Buffalo, New York, NY, United States, Rajan Batta, Qing He

Shortage of supplies during a disaster is a common issue. Social media usage during disasters also surges .We developed a model to infer demand of supplies during disaster using Twitter and tested it to infer gasoline demand that occurred in Florida during Irma. We built a support vector machine model combined with n-grams and topic models to classify tweets regarding demand and modelled the arrival of tweets as a Space-TIme Poisson Process to infer the spatiotemporal demand. The model was tested on a database of 1.4 million tweets around Hurricane Irma in Florida. Our classification accuracy is high with f-score of 0.879 and the predicted demand correlates highly with the ground truth.

■ TB70

West Bldg 106B

Joint Session DEA/Practice Curated: Theoretical issues in DEA

Emerging Topic: Productivity, Efficiency and Data Envelopment Analysis

Emerging Topic Session

Chair: Peter Bogetoft, Frederiksberg, 2000, Denmark

1 - Rate Design and Grid Efficiency
Jung Sook You, Assistant Professor, California State University-East Bay, 25800 Carlos Bee Blvd, Hayward, CA, 94542, United States

Time-dependent consumer preferences combined with intermittent renewable energy sources may result in excess demand fluctuations on a power grid network. Assuming consumers and generators can be price-anticipating strategic players, this

paper derives the optimal locational marginal prices on the power grid with conventional and renewable generators and provides theoretical prediction of price volatility. Then, the paper simulates the extent to which the optimal locational prices respond to the volatility of renewable sources and consumer demands, using California wholesale market data.

2 - Benchmarking, Contracting, and Incentive Power

Peter Bogetoft, Copenhagen Business School, Porcelaenshaven 16 A, Frederiksberg, 2000, Denmark

Benchmarking is a popular management tool. It is used both to facilitate decision making and incentive provision. In this paper, we show that different benchmarking measures react differently to changes in performance. Therefore, the optimal design of benchmarking based performance contract requires an explicit analysis of the data generation process of the benchmarking approach. As an illustrative application, we investigate the use of Data Envelopment Analysis (DEA), Stochastic Frontier Analysis (SFA) and combinations hereof in revenue cap incentive schemes. Such schemes are applied in the regulation of network companies in many countries.

■ TB74

West Bldg 212A

Joint Session MCDM/Practice Curated: Multi-Objective Simulation Optimization and its Applications

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Susan R. Hunter, Purdue University, West Lafayette, IN, 47907-2023, United States

1 - Digital Twin for the Smart System

Loo Hay Lee, National University of Singapore, 10 Kent Ridge Cresent, Industrial and Systems Engineering, Singapore, 119260, Singapore

In this talk, we will share the digital twin system we have built for the port system and warehouse system, and will discuss how the simulation optimization technique is able to help to design the system.

2 - Indifference Zones in Multi-Objective Ranking & Selection

Juergen Branke, University of Warwick, UK, Warwick Business School, Orms Group, Coventry, CV4 7AL, United Kingdom, Wen Zhang

Multi-objective ranking and selection so far has mostly focused on probability of correct selection as criterion. However, this creates problems if there are two very similar solutions, as many samples would be needed to correctly classify them. Thus, people have proposed to allow for an indifference zone, describing a decision maker's indifference between very similar solutions. We demonstrate that a previously proposed concept of indifference zones in multi-objective problems has some drawbacks, and propose an alternative definition. We also show how this can be used as part of a myopic ranking and selection technique.

3 - Bi-objective Simulation Optimization on Integer Lattices using the Epsilon-constraint Method in a Retrospective Approximation Framework

Susan R. Hunter, Purdue University, School of Industrial Engineering, Grissom Hall, 315 N. Grant Street, West Lafayette, IN, 47907-2023, United States, Kyle Cooper, Kyle Cooper, Kalyani S. Nagaraj

We propose the Retrospective Partitioned Epsilon-constraint with Relaxed Local Enumeration (R-PeRLE) algorithm to solve the bi-objective simulation optimization problem on integer lattices. R-PeRLE uses a retrospective approximation (RA) framework to repeatedly call the PeRLE algorithm at a sequence of increasing sample sizes. Within an RA iteration, the PeRLE algorithm uses the e-constraint method to add new sample-path local efficient points to the estimated local efficient set (LES). Then, it certifies the estimated LES is approximately a sample-path LES. As the number of RA iterations increases, R-PeRLE provably converges to a LES wp1.

4 - Multiple Objective Probabilistic Branch and Bound for Multi-fidelity Simulation Optimization

Hao Huang, Yuan Ze University, IEM Department, Yuan Ze University, 135 Yuan-Tung Road, Chung-Li,, Taoyuan, 32003, Taiwan,

Multi-fidelity framework involves simulation optimization problems involving multiple models with different fidelities, such as an accurate but costly simulation and a quick approximation. A multiple objective simulation algorithm is proposed in this study for the multi-fidelity framework, named Multi-Fidelity and Multi-Objective Probabilistic Branch and Bound (MFOPBnB). MFOPBnB incorporates Multiple Objective Probabilistic Branch and Bound (MOPBnB), a partition-based simulation optimization algorithm approximates the Pareto optimal set. Using information from low fidelity model, MFOPBnB approximates the a Pareto optimal set with statistical quality derived.

5 - Simulation-based Optimization in Outpatient Appointment Scheduling

Payman Jula, Associate Professor, Simon Fraser University, Faculty of Business, Vancouver, BC, V5A 1S6, Canada

This talk addresses the challenges of outpatient scheduling in multi-stage healthcare facilities. We consider stochastic service times, the availability and compatibility of resources, and the presence of a variety of patient types. The proposed methods are based on integrating simulation with mathematical programming, and meta-heuristics algorithms to achieve multi objectives of minimizing the waiting time of patients, the completion time of the facility, and the procedures cancellation. The performance of proposed approaches are analyzed an reported.

■ TB76

West Bldg 212C

Joint Session PSOR/Practice Curated: OR Applications in Humanitarian Logistics

Sponsored: Public Sector OR

Sponsored Session

Chair: Hafizul Islam, North Carolina State University, Raleigh, NC, 27695, United States

1 - Modeling the Logistics Capabilities of Home Health Agencies to Provide In-home Dispensing to Vulnerable Populations During Public Health Emergencies

Ashlea Bennett Milburn, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, Emre Kirac, Charleen McNeill

Public health emergencies may call for medical countermeasures dispensing to affected populations. Many people can visit established dispensing locations en masse, but this is impractical for vulnerable homebound populations. Home health agencies (HHAs) have potential to act as private dispensing entities in this situation, treating homebound persons and their families in their homes. This research establishes the comparative effectiveness of centralized and decentralized operational models of in-home dispensing via HHAs. Results are presented for a mixed urban/rural case study area.

2 - An Integer L-shaped Algorithm for the Integrated Location and Network Restoration Problem in Humanitarian Relief

Ece Sanci, University of Michigan, Ann Arbor, MI, United States, Mark Stephen Daskin

Prepositioning emergency relief items before an anticipated disaster is a common strategy to increase the effectiveness of relief distribution. In this study, we assume that relief distribution is hampered due to damaged roads. We present a two-stage stochastic programming model integrating facility location and network restoration decisions. We propose an integer L-shaped algorithm which deploys lower and upper bounds to solve our model efficiently. Our computational results show significant improvement in unmet demand and cost measures by integrating location and network restoration models.

3 - Dynamic Network Flow Problems Having ARC Setup Costs

Rob Curry, Clemson University, Cole Smith

Some network applications require dynamic flows to be transmitted according to a non-simultaneous schedule. In this talk, we consider a dynamic network flow problem that considers the presence of arc setup costs that may exist whenever an arc begins transmitting flow. This problem can be modeled by the minimum cost flow problem having arc-activation costs (MCF-A), in which an arc (i,j) is said to be activated on a path p when (i,j) is included on p but not on p-1. As an alternative to this mixed-integer programming approach, we employ a relaxation-based algorithm for obtaining upper and lower bounds that increases the number paths in a schedule, as needed.

4 - Robust Optimization Approaches for the Equitable and Effective Distribution of Donated Food

Irem Sengul Orgut, Lenovo, 8209 Pritchett Farm Lane, Raleigh, NC, 27606, United States, Julie Simmons Ivy, Reha Uzsoy, Charlie Hale

Motivated by our partnership with a local food bank, we present a robust optimization model to support the equitable and effective distribution of donated food over the service area. Our model addresses uncertainty in the amount of donated food counties can receive. Letting the capacity of each county vary within a range, the model seeks to maximize total food distribution while enforcing a user-specified level of robustness. We derive structural properties and develop an efficient exact solution algorithm. We illustrate our model using historical data obtained from our food bank partner, summarize the policy implications of our results and examine the impact of uncertainty on outcomes.

5 - A Dynamic Programming Approach for Equitable and Effective Distribution under Uncertain Supply

Md Hafizul Islam, North Carolina State University, 111 Lampe Drive,

Daniel Hall 373, Raleigh, NC, 27695, United States,
Julie Simmons Ivy

Food banks in the United States serve people in hunger need within their respective service regions with donated food. Food banks receive donations from various sources and distribute them in an equitable and effective manner. Uncertainty in food donations is a big challenge for food banks in planning the distributions of food donations for future periods. In this work, we present a Markov decision process model and a dynamic programming solution approach of the model to deal with the uncertain supply for a local food bank over a finite number of periods with an aim to make an equitable and effective distribution of donated food.

■ TB80

Hyatt, Curtis B

Practice- Supply Chain Management V

Contributed Session

Chair: Devaraja Vignesh Radha Krishnan, Oklahoma State University, Stillwater, OK, 74075, United States

1 - Reduce Carbon Emissions Across Supply Chain: The Role of Information Sharing

Sijie Zhou, Doctoral Student, University of Science and Technology of China, No.96 JinZhai Road, Baohe District, Hefei, 230026, China, Yugang Yu

This study is motivated by a few international retailers (like, Walmart and H&M) cooperating with their suppliers to reduce carbon emissions across the supply chains.Our paper investigates the operations associated with information sharing and studies its influence on environment under the real condition. We show that with Bayesian updating of demand, information sharing will benefit supplier but possibly hurt retailer. We reveal the conditions favoring information sharing: information sharing doesn't always benefit the environment, which contradicts to the popular thoughts about the advantage of collaborative contracts between retailers and suppliers.

2 - Does Vertical Integration Allow for More Sustainable Supply Chain? Comparative Analysis within the Apparel Manufacturing Industry

Suri Gurumurthi, Hong Kong University of Science and Technology, Clearwater Bay Road, Kowloon, Hong Kong, HK, Ronald Lau

Through this research, we aim to investigate whether the vertically integrated supply chain can perform better along limited sustainability metrics, as compared to the network or decentralized model of sustainability. We also explore the linkage between vertical integration and targeted technology investment towards sustainability performance. We also comment on how incentives are relatively harder to align in decentralized structures, and the specific role of incentives in sustainability performance.

3 - Impact of Social and Environmental Performance Assessment of Suppliers on Buyer Supplier Relationship and Purchasing Performance

Sivamanikarthikeyan Rajendran, Research Scholar, Indian Institute of Technology Madras, Sardar Patel Road, Opposite to C.L.R.I, Adyar, Chennai, 600036, India, Arshinder Kaur

In this study, we contribute to the existing line of literature by identifying the key social and environmental factors in the Indian context based on an exhaustive review of literature and analyzing the impact of social and environmental performance assessment of suppliers on the purchasing performance of the buying firm. We also study this impact when the focal firm is utilizing supply chain analytics (which acts as a moderating variable). Finally, we develop a conceptual framework based on the underlying relationships between the above mentioned variables which will aid the managers in understanding how social and environmental performance evaluation influences the purchasing performance.

4 - Freight Consolidation Problem with Pickup and Delivery Sequence and Loading Constraints

Devaraja Vignesh Radha Krishnan, Oklahoma State University, Stillwater, OK, 74075, United States, Tieming Liu

In Pickup and Delivery problem (PDP), if multiple shipments are consolidated and placed in a vehicle, then the loading order of shipments is a major cost factor along with the trip distance. We address the PDP with the Last-In-First-Out (LIFO) order for pickup and delivery of shipments. In addition, we relax the LIFO constraints and present an exact formulation and algorithms for PDP with LIFO violation penalties.

■ TB83

Hyatt, Remington

Practice- Health Care II

Contributed Session

Chair: Ajit Appari, Worcester Polytechnic Institute, Worcester, MA, 000, United States

1 - Improving Outpatient Process with Multi Fidelity Models

Bowen Pang, Tsinghua University, Tsinghua Univ. Zijing 14#, Beijing, 100084, China, Xiaolei Xie, Yijie Peng, Bernd Heidergott

Physicians with outpatient departments in large Chinese hospitals face tremendous amount of workload. The limited time spent with each patient contribute to dissatisfaction while it is costly to increase the number of nurses and doctors. We develop a simulation model to analyze the outpatient process in the Department of Ophthalmology in Beijing Tongren Hospital. Using simulation output, we estimate the parameters of the queuing model with tandem MMC queues which balances the system performance and the costs incurred by increased staffing level. The optimal solution obtained by the queuing model is used to find improved settings via simulation model.

2 - Optimizing a High Volume Surgical Center Through Improved Team Dynamics: An Application of Social Network Modeling in Healthcare Operations

Scott T. DeNegre, Vice President, Hospital for Special Surgery, 535 East 70th Street, New York, NY, 10021, United States, Nathaniel Hupert, Mayu Sasaki, Jingyan Yang, Justin Do, Abigail Schmucker, David Grace, Meghan Kirksey, Alexander McLawhorn, Stephen Lyman, Steve Magid

Increasing operating room (OR) capacity provides greater access for patients, improves the financial sustainability of health systems, and is a health policy priority here and abroad. Traditional methods for increasing capacity require multiyear, multimillion dollar capital projects; in this paper, we explore methods for increasing OR capacity through improved team dynamics and develop a novel approach to quantifying team consistency using network models. Results from a high volume surgical center are presented, demonstrating that consistent surgical teams deliver improved efficiency and suggesting that OR capacity can be increased by approximately 20% through improved staffing models.

3 - The Influence of Operational Proximity on Hospitals' Post-acquisition Service-mix Strategies

Yuqiao Cheng, University of Houston, 4800 Calhoun Rd, Houston, TX, 77004, United States, Xiaosong David Peng, Yuan Ye

The study examines whether acquired hospitals reconfigure their service-mix to become more focused after acquisitions. If so, is the enhanced focus associated with improved post-acquisition performance (i.e., cost and quality), and do more common service lines and a shorter geographic distance between acquired and acquirer hospitals enable an acquired hospital to implement a more focused strategy?

4 - How Philanthropic are They? The Impacts of Directors' Professional Background on the Performance of Nonprofit Private Hospitals

Ajit Appari, Worcester Polytechnic Institute, Worcester, MA, United States, Mily Wang

The widening healthcare disparity in the US raises concern on the philanthropic intent of nonprofit private hospitals (NPPHs), and whether they provide charity care to community to satisfy legal threshold or engage in beyond the legal requirements. Building on the Upper Echelon and Corporate Governance literature, we examine whether philanthropic performance of NPPHs vary by professional background of their board of directors; and if this relationship differs by market competition. We report findings from the analysis of 215 NPPHs in California during 2007-2012 using hierarchical linear model.

■ TC02

North Bldg 121B

Joint Session OPT/Practice Curated: Stochastic Integer Program: Theory and Applications

Sponsored: Optimization/Optimization Under Uncertainty

Sponsored Session

Chair: Jie Zhang, Virginia Tech, Blacksburg, VA, 24060, United States,

1 - Stochastic Programming Models for Coordinated and Non-Coordinated Natural Gas and Power Systems

Dan Hu, Iowa State University, Ames, IA, 50010, United States, Sarah M. Ryan

With the growing proportion of electric power generated from natural gas, greater coordination between the two energy systems is gaining importance. We formulate separate but interacting stochastic programs to model the existing non-coordinated daily operations of the natural gas and electric power systems and a single stochastic program for a coordinated alternative. Variable renewable energy generation and demand for gas other than for electric power generation are the uncertain quantities. Through numerical studies we assess the benefits of coordination in terms of the distribution of the daily operational cost.

2 - Polyhedral Analysis of the Single-node Fixed-charge Network Flow

Problem under Uncertainty

David Mildebrath, Rice University, Houston, TX, United States, Victor Gonzalez, Mehdi Hemmati, Andrew J. Schaefer

We consider a two-stage extension of the single-node fixed-charge network flow (SNFCNF) problem with uncertain demands and capacities. The stochastic SNFCNF problem is an important problem arising throughout the fields of network design, vehicle routing, and elsewhere. We present the first polyhedral results for the associated polytope, and establish fundamental connections between facets of the single-scenario (i.e. deterministic) SNFCNF polytope and its stochastic extension. Finally, we provide computational examples to quantify the degree to which knowledge of the structure of each single-scenario sub-problem improves the solution to the extensive form of the stochastic problem.

3 - Robust Multi-product Newsvendor Model with Substitution under Cardinality-constrained Uncertainty

Jie Zhang, Virginia Tech, 820 Newport Terrace, Blacksburg, VA, 24060, United States, Weijun Xie

This paper studies robust multi-product newsvendor model with product substitutions (RMNMPS). The objective of RMNMPS is to determine the optimal order quantities, which maximize the worst-case total profits against budget uncertainty set of the demand. Although RMNMPS is in general nonconvex and NP-hard, we are able to identify several special cases, where the optimal order quantities can be completely characterized, and interesting managerial insights are drawn. For a general RMNMPS, we develop an efficient cutting plane based solution approach by exploring the submodularity of inner minimization problem. The numerical study demonstrates the effectiveness of the proposed algorithm.

4 - A Finite E-convergence Algorithm for Two-stage Convex 0-1 Mixed-integer Nonlinear Stochastic Programs with Mixed-integer First and Second Stage Variables

Can Li, Carnegie Mellon University, Pittsburgh, PA, United States, Ignacio E. Grossmann

We propose a generalized Benders decomposition-based branch and bound algorithm, GBDBAB, to solve two-stage convex 0-1 mixed-integer nonlinear stochastic programs with mixed-integer variables in both first and second stage decisions. We construct the convex hull of each subproblem by applying basic steps to convert each subproblem from conjunctive normal form (CNF) to disjunctive normal form (DNF). We prove the algorithm has finite ?-convergence if we branch on the continuous first stage variables. Since constructing the convex hull can be expensive, we propose a sequential convexification scheme that progressively applies basic steps to the CNF.

5 - Computational Evaluation of New Dual Bounding Techniques for Sparse PCA

Guanyi Wang, Georgia Institute of Technology, Atlanta, GA, United States, Santanu Subhas Dey, Rahul Mazumder

Principal component analysis (PCA) is one of the most widely used dimensionality reduction method in statistics. For additional interpretability, it is desirable to require cardinality constraint, known as the sparse principal component analysis (SPCA). However, the SPCA problem and its ℓ_1 relaxation are hard to compute. We give a framework (convex integer program, IP) that certificates the optimality of solutions of SPCA problem, via dual bounds. We show that, in theoretical, the dual bound obtained from convex IP problem is affinely upper bounded by the optimal value of the SPCA problem, and in practical, plausible dual bounds are obtained via the convex IP method in acceptable time.

■ TC06

North Bldg 122C

Joint Session OPT/Practice Curated: MINLP Theories and Applications

Sponsored: Optimization/Global Optimization

Sponsored Session

Chair: Asteroide Santana, ISyE, Georgia Tech, Atlanta, GA, United States

1 - A Minor Perspective on Rank Constrained Optimization

Shixuan Zhang, Georgia Institute of Technology, Atlanta, GA, United States, Andy Sun

Many combinatorial and mixed-integer nonlinear optimization problems can be formulated with constraints on matrix ranks. We propose a new perspective on dealing with rank constraints by reformulations using matrix minors. We investigate the implications of this minor perspective on generating convexification hierarchy and strong valid inequalities for the cut polytope and some QCQPs in complex variables such as AC optimal power flow.

2 - Preprocessing Algorithms and Tightening Constraints for Multiperiod Blend Scheduling Problem

Yifu Chen, University of Wisconsin-Madison, Madison, WI, United States, Christos T. Maravelias

The multiperiod blend scheduling problem (MBSP) considers the scheduling in a production environment that includes blending processes. MBSP can be considered as a scheduling extension of the pooling problem. In this work, we first introduce novel preprocessing algorithms to calculate bounds on critical variables in MBSP. The bounds obtained from the preprocessing algorithms, along with the new variables we defined to address the product specific features in MSBP, are used to generate tightening constraints. The methods are applicable to previously proposed MINLP models for MBSP, as well as MILP models obtained using different linear relaxation/approximation methods.

3 - A Compact Linear Programming Formulation of the Steiner Tree Problem for a Fixed Number of Terminals

Matias Siebert, Georgia Institute of Technology, Atlanta, GA, United States, Shabbir Ahmed, George L. Nemhauser

Given an undirected graph G=(V,E) with non-negative edge weights, and a subset R of the vertices V, the Steiner tree problem seeks to find the minimum weighted tree T that connects all vertices in R. This problem can be equivalently stated as selecting an arbitrary node r in R, and finding the minimum weighted arborescence rooted in r, whose leaves correspond to nodes in R\{r}, in the directed version of graph G. We observe that in any of those r-arborescences, the paths connecting r to the nodes in R\{r} form a Laminar family. This fact leads to a new linear programming formulation of polynomial size for fixed |R|, whose extreme points are integer and whose optimal solution is an optimal Steiner tree.

4 - New SOCP Relaxation and Branching Rules for Bipartite Bilinear Programs

Asteroide Santana, Georgia Tech, Atlanta, GA, 30318, United States

The bipartite bilinear program (BBP) is a QCQP where the variables can be partitioned into two sets such that fixing the variables in any one of the sets results in a linear program. We propose a new second order cone representable (SOCP) relaxation for BBP, which we show is stronger than the standard SDP relaxation intersected with the boolean quadratic polytope. We then propose a new branching rule inspired by the construction of the SOCP relaxation and show that our approach outperforms the commercial solver BARON in obtaining dual bounds for instances of a new application of BBP.

■ TC07

North Bldg 123

Joint Session OPT/Practice Curated: Network Optimization Models and Applications

Sponsored: Optimization/Network Optimization

Sponsored Session

Chair: Larry J. LeBlanc, Vanderbilt University, Owen Graduate School of Mgmt, Nashville, TN, 37203, United States

1 - Fireline Construction in a Heterogeneous Forest Landscape

Xu Yang, Northeastern University, 360 Huntington Avenue, Snell Engineering, Boston, MA, 02115, United States, Emanuel Melachrinoudis

Most often wildfires are contained with a construction of fireline around the fire perimeter by clearing of combustible material or sufficiently wetting to prevent fire spread. Existing models in the literature assume homogeneous fire environment. This paper presents a novel way of generating an optimal fireline construction through heterogeneous landscape using a network approach. Voronoi Polygons are utilized to represent the homogeneous areas. Dijkstra's algorithm is used to find the fastest paths at a safe distance for two crews who work simultaneously in opposite directions to encircle and contain the fire.

2 - Locomotive Assignment Problem: Integrating the Strategic, Tactical and Operational Level Aspects

Prashant Premkumar, Doctoral Student, Indian Institute of Management Kozhikode, IIM Kozhikode P.O., Kozhikode, 673570, India, Ram Kumar P. N

Over the past couple of centuries, with the increase in the significance of the railways to the economy, the complexity of the railway network and consequently the decision making involved has only increased. Among the host of problems in railways management, we attempt to integrate the strategic, tactical and operational level aspects of one of the most important problems, which is the Locomotive Assignment Problem (LAP). We also demonstrate that by innovatively modelling the problem through the addition of a valid equality, the lower bounds can be improved substantially, thereby reducing the solution time.

3 - Blood Bank Mergers from a Supply Chain Perspective: A Case Study

Amir H. Masoumi, Assistant Professor of Management, Manhattan College, O'Malley School of Business, Riverdale, NY, 10471, United States, Jan Hoffmann, Min Yu

We utilize a supply chain network model to analyze a recent case of merger between two blood banks in California. Our methodological framework evaluates the synergy

associated with the merger from a total cost perspective. The proposed model takes into account the operational cost, discarding cost of waste, as well as the potential capacity overage penalty throughout the blood supply chain. For the case study, clustered blood collection zones are considered in addition to aggregated demand regions representing the hospitals served by the two blood banks. Solution to the proposed models yields the optimal link flows and the link capacity overages corresponding to the pre- and post-merger problems.

4 - Societal Networks in Smart City
Rupei Xu, The University of Texas at Dallas, Richardson, TX, 75081, United States, Andras Farago

In the modern city, societal networks, such as transportation network, communication network, gas pipeline network, delivery network etc., play an important role for the convenience of citizens. Adopting artificial intelligence and Internet of Things (IoT) to societal networks would lead to better technological services. These networks, however, are usually of extremely large scale and vary frequently, thus bringing a lot of new computational challenges. In this research, we apply new computation techniques to handle computational challenges for societal networks in the smart city, providing efficient and practical solutions.

5 - Using Spreadsheet Maps for Heuristic Site-selection Algorithms
Larry J. LeBlanc, Vanderbilt University, Owen Graduate School of Mgmt, Nashville, TN, 37203, United States, Michael Bartolacci, Thomas A. Grossman

Because of the well-known difficulty of finding exact solutions to large scale 0-1 location models, heuristic algorithms are often used. We show how to use 3D maps in Excel and Tableau to guide the selection of sites to open in a global setting from a large set of potential sites. Formulas for a different customer service radius for each site are given. Possible heuristics are discussed.

■ TC21

North Bldg 129B

Joint Session RMP/Practice Curated: Data-driven Applications and Dynamic Learning in Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: N. Bora Keskin, Duke University, Durham, NC, 27708-0120, United States

1 - The Exponomial Choice Model: Assortment Optimization and Data-driven Applications
Jacob Feldman, Olin Business School, 6 Portland Court, Saint Louis, MO, 63108-1291, United States, Mohammed Ali Aouad, Danny Segev

We study the assortment optimization problem under the Exponomial choice model. In this problem, a retailer seeks the revenue maximizing set of products to offer to each arriving customer. Our main contribution comes in the form of the first polynomial time approximation scheme with a provable guarantee for the assortment problem under the Exponomial choice model. We follow up this result with a series of estimation studies using real data, which show that the predictive power of the Exponomial model is on par with the classic MNL model.

2 - Personalized Advertising and Learning Through High-dimensional Data with Limited Samples
Mingcheng Wei, University at Buffalo, 326C Jacobs Management Center, Buffalo, NY, 14260, United States, Xue Wang, Tao Yao

In this paper, we propose a Minimax Concave Penalized Multi-Armed Bandit algorithm for a decision-maker facing high-dimensional data with latent sparse structure in an online learning and decision-making process. This algorithm performs favorably compared to other algorithms, especially when there is a high level of data sparsity or when the sample size is not too large.

3 - Data-driven Pricing for a New Product
Mengzhenyu Zhang, University of Michigan, Ross School of Business, Ann Arbor, MI, 48105, United States, Hyun-Soo Ahn, Joline Uichanco

Decisions regarding new products are difficult to make, and mistakes can have grave consequences to a firm's bottom line. Firms have little foresight on information about new product demand such as the potential market size, the rate of customers' adoption. We study the interplay between pricing and learning to maximize the expected revenue of a new product over a finite time horizon. We consider a setting where a firm can learn by observing sales data. To capture the stochastic adoption process, we develop a continuous-time Markovian Bass model. We derive the optimal pricing policy with learning and propose two simple and computationally tractable pricing policies that are provably near-optimal.

4 - Dynamic Pricing-and-Learning Strategies in Service Operations
Yuan-Mao Kao, Duke University, Durham, NC, 27708, United States, N. Bora Keskin, Kevin Shang

We consider a firm providing a service to its customers under limited information about demand and service requirements. The firm can obtain more information by offering the service over multiple periods. In this setting, we formulate how pricing strategies affect the firm's learning, and we study the performance of near-optimal dynamic pricing strategies.

■ TC26

North Bldg 132A

Joint Session Service/Sractice Curated: Empirical Research for New Service Business

Sponsored: Service Science

Sponsored Session

Chair: Kejia Hu, Vanderbilt University, Nashville, TN, 37215, United States

1 - Shaping Demand Peaks and Valleys in Service Industries Through Online Deals
Simin Li, Kellogg School of Management, Northwestern University, 2211 Campus Drive, Evanston, IL, 60208, United States, Kejia Hu, Martin Lariviere

Using data from three leading online platforms in offering deals, we empirically study how service providers strategically design deals to facilitate demand-supply coordination during holiday demand swings. In particular, using our structural model, we find that service providers strategically design the deal discount and launch date based on their operating margin and foreseeable holiday demand change. Building on the estimation of deal customers' sensitivities to the discount and launch date, we propose an optimal deal strategy to shape demand and therefore increase profit. Moreover, we substantiate the importance of selecting a launch date wisely to manage demand and maximize profit.

2 - The Impact of Waiting on Customer Response Delay
Guangzhi Shang, Florida State University, College of Business, Tallahassee, FL, 32306, United States, Noyan Ilk

We study the impact of waiting times on customer response behavior in the context of online service centers. Using a unique operational data set, we show that waiting before service (i.e., queue wait) accelerates customer engagement, whereas waiting during service (i.e., in-service wait) slows down customer responses. These findings contribute to the service operations literature by showing the significance of the feedback from waiting to (customer-instigated) service time. We discuss the implications of these findings on customer admission decisions and agent workload levels.

3 - Understanding Customers' Retrials in Call Centers: Preferences of Service Speed and Service Quality
Kejia Hu, Vanderbilt University, 300 Ashcroft Pl, Nashville, TN, 37215, United States, Gad Allon, Achal Bassamboo

Using a call-by-call customers contact dataset, we want to understand how customers' preferences of service speed and quality impact their retrial behavior (calling back for the same issue) in the call center.

4 - Need for Speed: The Impact of Website Performance on Online Retailers
Nil Karacaoglu, Kellogg School of Management, Evanston, IL, 60201, United States, Santiago Gallino, Antonio Moreno

In 2016, total online retail sales reached $402.3 billion. Moreover, 49% of offline transactions are influenced by online channels. As the importance of online channels increased, the cost of webpage performance issues increased as well. In this environment, it is paramount for companies to understand how website performance impacts customer behavior and to determine the right balance between perceived website content quality and website performance. In this paper, we focus on how consumer behavior is affected by the performance of retailers' website. In particular, we analyze how website speed impacts conversion rates and online channel revenues.

5 - Does Competition Improve Service Quality? The Case of Nursing Homes Where Public and Private Payers Coexist
Susan F. Lu, Purdue University, Krannert 441, West Lafayette, IN, 47907, United States, Konstantinos Serfes, Gerard Wedig, Bingxiao Wu

Competition plays an ambiguous role in markets for credence goods, where public and private payers coexist. Using nursing home data with a wide range of market structures, we find a U-shaped relationship between competition and service quality when nursing homes serve a mix of private and public segments, and a monotonic relationship when providers only serve the public segment. The outcomes can be explained by the interplay of two opposing effects of competition: the reputation building effect whereby competing firms choose high quality to build a good reputation and the rent extraction effect whereby competition hinders investment for quality improvements by eliminating price premia.

■ TC27

North Bldg 132B

Joint Session PSOR/Practice Curated: Pro Bono Analytics Panel Discussion

Sponsored: Public Sector OR

Sponsored Session

Chair: David T. Hunt, Oliver Wyman, Oliver Wyman, Princeton, NJ, 08540, United States

1 - Pro Bono Analytics Panel Session
David T. Hunt, Oliver Wyman, One University Square, Suite 100, Princeton, NJ, 08540, United States

Pro Bono Analytics (PBA) is an INFORMS program to match analytics professionals who are willing to volunteer their skills with nonprofit organizations that would benefit from analytical techniques. This panel session will begin with a brief description of some actual PBA projects, and will then focus on a discussion by volunteers and Phoenix area nonprofit representatives about the experiences and challenges of introducing analytics solutions into nonprofit organizations. The discussion will include defining the project outcome, overcoming data problems, and implementing the project results.

2 - Using Decision Analysis to Evaluate Fund Raising for a Nonprofit Organization
David Krahl, Kromite LLC, 243 N. Union Street, Lambertville, NJ, 08530, United States

3 - Advancing the Analytics Capabilities at a Workforce Development Organization
Rozhin Doroudi, Northeastern University, Boston, MA, 02116, United States

4 - Amanda Hope Rainbow Angels
Susan Santilena, Amanda Hope Rainbow Angels, Phoenix, AZ, United States

5 - St. Mary's Food Bank
Marcos J. Gaucin, St. MaryÆs Food Bank Alliance, Phoenix, AZ, United States

■ TC31

North Bldg 222A

Joint Session TSL/Practice Curated: Traffic Models and Applications with Emerging Data Sources

Sponsored: TSL/Intelligent Transportation Systems (ITS)

Sponsored Session

Chair: Goktug Islamoglu, Captura ITS, Cengelkoy Mah. Kalantor Sok., 16/3 Uskudar, Istanbul, 34680, Turkey

1 - Efficient Collection of Connected Vehicles Data with Precision Guarantees
Negin Alemazkoor, University of Illinois at Urbana-Champaign, Champaign, IL, United States, Hadi Meidani

Connected vehicles disseminate detailed data with a very high frequency. Therefore, efficient collection of data is critical to prevent overburdening the communication systems. We propose an efficient data collection scheme that selects and transmits only a small subset of data. We have tested the proposed approach to select data points to be transmitted from 10,000 connected vehicles trips. Results show that collection ratio can be as small as 0.05. A simulation study was also performed to evaluate travel time estimation accuracy using the proposed data collection approach. Results show that the proposed approach can significantly improve travel time estimation accuracy.

2 - Inferring High Resolution Individual Activity and Trip Purpose From GPS Trajectories Data Collected from a Navigation App
Shin-Yu Lin, Metropia, 1790 E. River Rd., Suite 140, Tucson, AZ, 85718, United States, Ali Arian, Ali Arian, Alireza Ermagun, Yi-Chang Chiu

Traditionally human mobility patterns and space activities are studied using recall-based travel diaries. Following the ubiquity of location-based technologies, transportation researchers are revisiting the methods of classifying travel activity patterns using geo-location data. The current study contributes to this research line by leveraging granular and detailed activity information collected from a navigation app, Metropia.

3 - Traffic Synchronization Protocol: Ising Model Phase Transitions in Hyperbolic Lattices of Accidents
Goktug Islamoglu, Pamir, Cengelkoy Mah. Kalantor Sok. 16/3 Uskudar, Istanbul, 34680, Turkey

When Turkey's annual accident-vehicle graph is plotted from 1986 to 2016, the points form a spiral expanding around the regression line. Spiral symmetry breaks for all vehicle types except for LCVs (light commercial vehicles), implying a nonlinear dynamic behavior coexisting with the strong linear dependence of accidents to the number of vehicles. Its projection on a 2D cellular automaton through hyperbolic geometry exhibits a Tracy-Widom distribution and provides closed form solutions of the Ising Model. Emergence of accident formations in non-human sources of error suggest the need for a "synchronization protocol of autonomous vehicles, which are developed with the human error assumption.

■ TC36

North Bldg 224B

Joint Session Drones/Practice Curated: Operations Research Applications in Drones

Emerging Topic: Robotics, Drones and Autonomous Vehicles in Logistics

Emerging Topic Session

Chair: Gino Lim, Univeristy of Houston, Houston TX

Co-Chair: Seon Jin Kim, University of Houston, Houston, TX, 77094, United States

1 - A Hybrid Approach for Extending Drone Flight Duration in Real Time
Seon Jin Kim, University of Houston, 422 Cypress Vista, Houston, TX, 77094, United States, Gino J. Lim

This study focuses on continuous flight missions using battery powered drones. There are two types of battery charging techniques: stationary and dynamic wireless charging systems. However, the stationary system requires frequent visits of drones to the ground control center to replace or charge the batteries, while the dynamic system does not have reliable battery charging efficiency. To overcome both of these issues in a battery charging system, a hybrid battery charging system combining stationary and dynamic wireless charging systems has been proposed.

2 - Carrier-drone Vehicle Routing Problem: Multiple Deliveries by a Single Flight
Ho-Young Jeong, Purdue University, 315 N. Grant St, West Lafayette, IN, 47907, United States, Seokcheon Lee

A carrier-drone hybrid delivery vehicle uses a truck as a station for delivery drones. The truck with a larger cargo capacity carries and launches drones to customers in locations where traffic congestions or physical obstructions are present. Because of its significant advantages, various hybrid routing models have recently been proposed and researched. We'd like to introduce a new model that allows drones to make multiple deliveries by a single flight. This property is expected to further enhance logistical efficiency compared to existing models limited to single delivery per flight. In this study, this new hybrid vehicle routing problem is presented along with evidence of its practicality.

3 - Operation Based Vehicle Routing Problem for Drone Assisted Truck Delivery
Jinkun Lee, East Carolina University, Greenville, NC, United States, Sung Hoon Chung

We consider a drone assisted truck delivery problem where the truck serves as a mobile station of single or multiple drones while delivering items to customers at the same time. We formulate the model as a mixed integer programming problem where the objective is to minimize the total delivery time. We describe the pre-process of the exact algorithm where the possible operations, defined as drone-truck delivery combination units, are identified to reduce the overall computational complexity. We present case studies and discuss efficacy and efficiency of the proposed approach.

4 - Deliver or Not?: Revenue and Capacity Management for Drone-based Delivery Services
Zhangchen Hu, University of Massachusetts Amherst, Amherst, MA, 01003, United States, Heng Chen, Senay Solak

Drones are expected to become a key component of commercial delivery services for retailers and courier companies in the near future. Using currently available data, we develop both queueing-based and dynamic programming-based models to determine when drone delivery options should be enabled by retailers. Both analytical and numerical analyses are provided.

5 - An Unmanned Aircraft System Path Planning Model for Inspecting Wind Turbines
Hyeoncheol Baik, PhD Candidate, Auburn University, Shelby 3301, Auburn, AL, 36849, United States, Jorge F. Valenzuela

Rope access is a common technique for maintaining and servicing wind turbines. This technique is risky and inefficient. An alternative approach is to use an unmanned aircraft system (UAS). The challenge is to determine an efficient way to deploy the UAS over a region with multiple wind turbines. In this presentation, we describe a mathematical programming path planning model for a UAS that works cooperatively with a ground vehicle. The objective of the model is to minimize the

total inspection time. We use a real wind farm to test our model.

■ TC42

North Bldg 227A

Joint Session Analytics/Practice Curated: Impactful Applications of Analytics in Industry

Sponsored: Analytics

Sponsored Session

Chair: Subrat Sahu, Caterpillar Inc, Peoria, IL, United States

1 - Operationalizing a Customer Retention Framework in Logistics Industry

Swapnil Srivastava

No Abstract Available.

2 - Operations Research and Mathematical Sciences becomes Pervasive on a Networked, Collaborative Platform

Ben Amaba, IBM

Ben Amaba, University of Miami, Miami, FL, United States

Mathematical modeling has provided a competitive advantage for institutions to aid in understanding, learning, decision making, forecasting and operations. As the number of sensors, smart phones, Internet of Things (IoT), robots, blockchain and other data sources grow, the discipline and methods become foundational on a platform to manage complexity. The power of processors, better networks, less expensive memory and disk space, and better user interfaces are making data sciences accessible to more individuals on an open, secured platform where reuse and collaboration allows users to combine artificial intelligence and other technologies to advance operations research application.

■ TC49

North Bldg 230

Joint Session ENRE/Practice Curated: Underground Applications

Joint Session

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

1 - Production Scheduling in Underground Mine Operations Incorporating Heat Loads

Oluwaseun Babatunde Ogunmodede, Colorado School of Mines, 7216 Winter Ridge Drive, Castle Pines, CO, 80108, United States

Mine production scheduling determines when, if ever, notional three-dimensional blocks of ore should be extracted. The accumulation of heat in the tunnels where operators are extracting ore is a major consideration when designing a ventilation system and, often, the production scheduling and ventilation decisions are not made in concert. Rather, heat limitations are largely ignored.Out model maximizes net present value subject to additional constraints onprecedence, and mill and extraction capacities. The model produces morerealistic schedules that could increase revenue by lowering ventilation costs forthe mine— specifically, refrigeration costsinfluenced by fans in the mine.

2 - Hybrid Design and Scheduling for Underground Mining

Peter Nesbitt, MS, Colorado School of Mines, Golden, CO, 80401, United States, Levente Sipeki, Alexandra M. Newman

Underground mine design is inextricably intertwined with the corresponding production schedules. For deposits that extend deep underground, the mining direction that dictates a most profitable extraction sequence at the highest vertical level may not correspond to that at the deepest level. We formulate a mixed-integer program that determines a design and corresponding production schedule by exploiting the underlying mathematical structure. Solutions yield a more realistic production profile than a traditional one, resulting in an increased quantity of gold ounces pulled forward in the schedule and, hence, higher net present value.

3 - Risk Adverse Optimization for the Ultimate Pit Problem

Gianpiero Canessa, Universidad Adolfo Ibanez, 2540 Diagonal Las Torres, Santiago, Chile, Bernardo Kulnig Pagnoncelli, Eduardo Moreno

In this work we discuss different risk averse approaches for the ultimate pit problem. We consider two sources of uncertainty, ore grade and price, and analyze the solutions using different risk measures. We compare the results of our experiments using the risk neutral case as a benchmark, and discuss the advantages of incorporating risk aversion in the construction of an ultimate pit.

4 - Does Supply Chain Visibility Affect Operating Performance? Evidence from Conflict Minerals Disclosures

Caroline Swift, The Pennsylvania State University, University Park, PA, United States, V. Daniel R. Guide, Suresh Muthulingam

Firms are increasingly held accountable for their suppliers' transgressions. Consequently, firms need to develop supply chain visibility (SCV) to exercise control and mitigate risks in their supply chains. We use data from the U.S. conflict minerals disclosure legislation to assess firms' SCV. Then, we compare the operating performance and market value of firms with high SCV against those with low SCV. We find that firms with high SCV achieve higher profitability, productivity, and market valuation than comparable firms with low SCV. We find no discernible difference in sales between firms with high SCV and firms with low SCV.

■ TC51

North Bldg 231B

Practice- Production & Scheduling

Contributed Session

Chair: Emre Eryigit, UMass, 336 East Hadley Road, Amherst, MA, 01002, United States

1 - Optimal Structure of Joint Inventory and Pricing Management with Dual Suppliers

Xiaoyi Feng, AMSS, Beijing, China, Yangyang Xie, Houmin Yan

We consider a joint inventory-pricing control problem for a single-product, periodic-review, dual-supplier problem. We assume stochastic supply and demand. By extending the definition of stochastically linear in mid-point to a multidimensional setting, we prove the joint concavity of the profit functions and characterize the optimal expedited order as a state-dependent almost-threshold policy. We further clarify the forms of the stochastic supply and demand functions that guarantee the antimultimodularity of profit functions. With the antimultimodular structure, we characterize the optimal regular order and list price policies as monotone with ordered changing rates.

2 - Operations Research Approaches to Mitigate Ergonomic Risks in Manufacturing Systems

Olga Batta a, ISAE-Supaero, 10 av Belin, Toulouse, 31400, France, Alena Otto

To reduce ergonomic risks at workplaces, most companies take the workers' task assignment as given and look for introducing specialized equipment and support tools. However, such policies have limited impact in many cases. The use of operations research approaches allows incorporating ergonomics aspects in the work assignment and scheduling and shows a high potential for improving working conditions in manufacturing systems. In this talk, we review the available modelling approaches that consider ergonomics in operational planning of manufacturing systems and outline future research directions.

3 - A Data-driven Approach to Test Center Scheduling

Nickolas K. Freeman, University of Alabama, 14485 Griffin St, Tuscaloosa, AL, 35405, United States, John Mittenthal

In this paper, we present a data-driven approach for scheduling students at an academic testing center. In addition to describing the approach, we present results from a benchmarking experiment based on real data. The results show that the proposed scheduling method can improve the utilization of the testing center substantially.

4 - Scheduling Meter Readings for Utility Companies in Turkey

Emre Eryigit, PhD Candidate, University of Massachusetts Amherst, 336 East Hadley Road, Amherst, MA, 01002, United States, Ahmed Ghoniem

We examine a meter reading scheduling problem that impacts the quality of the power consumption forecast made by electricity distribution companies in Turkey. The problem is modeled as a 0-1 integer program with constraints related to manpower capacity and other industry restrictions. Exact and heuristic solutions are reported in our computational study for large-scale instances involving several thousand meter groups.

5 - Scheduling Meter Readings for Utility Companies in Turkey

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■ TC62

West Bldg 103A

Joint Session DM/Practice Curated:

Optimization in Data Mining and Analytics

Sponsored: Data Mining

Sponsored Session

Chair: Young Woong Park, Iowa State University, Ames, IA, 50011, United States

1 - A Mathematical Programming Approach for Imputation of Unknown Journal Ratings in a Combined Journal Quality List

Young Woong Park, Iowa State University, 2167 Union Drive, 2139 Gerdin Business Building, Ames, IA, 50011, United States, Jinhak Kim, Alvin Williams

Many journal quality lists rate limited numbers of journals. However, in many academic institutions, fair evaluation procedure is needed to rate journals that are not listed in their trusted journal quality lists. In this research, mathematical programming models are proposed to determine unknown ratings of multiple journal quality lists only using their known rating information. The objective of the models is to minimize the total number of instances where two journals are rated in opposite order by two quality lists. Computational results based on the journal quality list data in https://harzing.com show that our method outperforms existing multiple imputation algorithms.

2 - Recent Advances in Mixed-integer Optimization Approaches to Feature Subset Selection

Yuichi Takano, University of Tsukuba, Tsukuba-shi, Japan, Ryuhei Miyashiro

Mixed-integer optimization (MIO) approach to feature subset selection was proposed in the 1970s, and recently it has received renewed attention due to progress in algorithms and hardware. In this talk, I review some recent advances in MIO approaches to feature subset selection and introduce latest research developments of our group.

3 - Optimal Clustering on a Graph

GOKCE Kahvecioglu, Northwestern University, 2145 Sheridan Road, Room C210, Evanston, IL, 60208, United States, David Morton

We study a hierarchical clustering problem on an undirected graph with a weight function assigning nonnegative weights to the edges. We remove a subset of edges to break the graph into a number of smaller pieces, i.e., clusters. We consider a bicriteria graph clustering problem, in which we maximize the number of clusters while minimizing the weight of deleted edges. Solving this bicriteria problem parametrically identifies solutions that lie on the concave envelope of the efficient frontier, and the breakpoints on this envelope are nested, yielding a hierarchical family of clusters. We illustrate our ideas using NCAA football schedules, attempting to identify conferences, divisions, etc.

4 - Mixture-based Multiple Imputation Models for Clinical Data with a Temporal Dimension

Ye Xue, Northwestern University, Evanston, IL, United States, Yuan Luo, Diego Klabjan

Missing values are commonly occurred in many kinds of datasets, especially in time series. We present mixture-based multiple imputation models for multi-variate time series. We design mixture models with one component capturing the correlation between variables and others catching the fluctuations of time series. The mixture models are optimized by maximazing their mixture likelihood functions using Estimation and Maximization (EM) algorithm. Then the imputation is performed based on the estimates of parameters of the optimized mixture models. We demonstrate the effectiveness of our imputation models on clinical data with a temporal dimension.

■ TC63

West Bldg 103B

Joint Session DM/Practice Curated: Data Science for Electrical Markets

Sponsored: Data Mining

Sponsored Session

Chair: Mehrdad Pirnia, University of Waterloo, 200 University Ave West, Waterloo, ON, N2L3G1, Canada

1 - Internet of Things for Power Consumption

Rachneet Kaur, Student, University of Illinois-Urbana Champaign, Department of Industrial Engineering, TB 21, Champaign, IL, 61820, United States, Richard Sowers, Kevin Thompson

The objective of our research is to use historical pricing data from a U.S. energy supplier to schedule policies which can be implemented in a smart home which allows for a major appliance to be turned on so as to minimize cost. The policy is back tested, showing significant savings. We design a dishwasher that can be activated via voice command through the use of an app, wireless speaker (Amazon Echo Dot), and an AI voice assistant (Amazon Alexa). More importantly, we want to predict the future price of power in order to activate the dishwasher at an optimal time to save the consumer on the operation cost of the dishwasher.

2 - Data-driven Strategies for Trading Renewable Energy Production

Miguel A. Muñoz, PhD. Student, University of Malaga, Edificio I+D Ada Byron, Malaga, Spain, Juan Miguel Morales, Salvador Pineda

In this talk we first introduce the problem of selling renewable energy in day-ahead electricity markets with a dual-price balancing settlement as a newsvendor problem. We then analyze different strategies to include information of auxiliary variables that may have predictive power on the renewable power production. Different data-driven optimization techniques are used to determine the optimal amount of energy to be sold in the market taking into account the information of those variables. The performance of these techniques is evaluated in a realistic case study in which we consider a single renewable power producer trading the whole wind power production of a relatively small country.

3 - A Bilevel Optimization Model for Estimating Utilities of Price-responsive Electricity Consumers

Arnab Roy, PhD Candidate, University of Louisville, 3177 South 3rd Street, Louisville, KY, 40214, United States, Lihui Bai, Chaosheng Dong, Bo Zeng

A bilevel optimization model is presented to estimate parameters of the utility function for price-responsive electricity consumers. The lower level minimizes the sum of electricity cost and inconvenience cost, due to consumers' curtailment of load in a demand response event. Real-world data from a field demonstration project is used in a joint predictive and prescriptive model (Bertsimas and Kallus, 2015). The upper level minimizes the difference between the total consumption determined by the lower level problem and the consumption measurements from the collected data.

4 - Chance Constrained Optimization to Model Micro-grids with Renewables and Storage Capacities

Mehrdad Pirnia, University of Waterloo, 200 University Ave West, Waterloo, ON, N2L3G1, Canada, Hassan Shavandi, Alberto J. Lamadrid, John David Fuller

In this presentation, we develop a social welfare maximization model with storage capacities (batteries), considering wind uncertainties. The uncertainties associated with wind generation is modeled using chance constraints. Furthermore, an equivalent deterministic mixed integer programming model is used to find the solution of the chance-constrained model. We use these models to analytically investigate the impact of storage capacities on the electricity prices, and the optimal number of charge/discharge for batteries. We also present the electricity price differences between the stochastic and deterministic models.

■ TC66

West Bldg 105A

Joint Session QSR/Practice Curated: Prognostics and Health Management

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Tongdan Jin, Texas State University, San Marcos, TX, 78666, United States

Co-Chair: Yan-Fu Li, Tsinghua University, Beijing, 100084, China

1 - Joint Optimization of Maintenance Planning and Workforce Routing for Networked Infrastructures

Chi Zhang, Tsinghua University, Department of Industrial Engineering, Tsinghua University, Beijing, 100084, China, Chuanzhou Jia

The economic development and social well-being of modern societies are highly dependent on networked infrastructures. Thus, it is necessary to timely and effectively maintain them to ensure the reliability of their continuous operation. However, their components are geographically distributed and the time required to transport between the components needs to be considered in order to make achievable maintenance plans. To address this problem, we transfer the time of each component being maintained into their sequence of being visited by each team of workforce, and propose a new approach to jointly optimize the maintenance planning and workforce routing for a networked infrastructure.

2 - A New Algorithm with Real-time Smoothing for Predicting Blood Glucose Concentrations Based on Wavelet Filters

Lei Li, Beihang University, Beijing, China, Jun Yang

Based on the Continuous Glucose Monitoring (CGM) data, we aim at predicting future blood glucose levles so that appropriate actions can be taken in advance to prevent hyper/hypoglycemia. Due to the small fluctuations of CGM data, an ARMA model with a wavelet filter is proposed in the prediction framework. To verify the performance of the proposed method, we conduct the proposed method with different wavelet function, different decomposition levels and threshold methods of wavelet denoise in a case study based on the CGM data of 5 diabetics. Results show

that the proposed methods with db8 wavelet function and minimaxi threshold method has most satisfactory and robust performance.

3 - The Recognition Method of the Equipment State Based on the MTS Modified by FDA

Ning Wang, Chang'an University, Middle-section of Nan'er Huan Road, Xi'an, ShaanXi, 710064, China, Dawei Hu, Yingbin Fu

Mahalanobis-Taguchi System (MTS) is a kind of data classification and reduction method using Mahalanobis distance (MD) as the measurement scale to identify the system state with multidimensional characteristics. In this paper,against the imbalanced classification by the model to identify the sample when the benchmark and abnormal space constructed by the traditional MTS have a serious overlap, a modified MTS amended by Fischer linear discriminant analysis (FDA) is proposed, and to be used to recognize the running state of equipment. The result proves the effectiveness and superiority of the modified model.

4 - Scheduling of Maintenance Teams and Activities for Nuclear Power Plant Subsystems

Meng-Yu Du, Tsinghua University, Beijing, China, Yan-Fu Li

The existing research works on nuclear power plant (NPP) maintenance scheduling normally assume that activities are performed on the exact scheduled times. However, due to budget limit, the shortage of maintenance workers cannot be ignored and thus the plans can be missed. To deal with this problem, we propose an integrated scheduling of maintenance teams and activities. A mixed integer program model is built with the objective of minimizing maintenance cost. The lower bound of system unavailability, limited maintenance workers, etc. are regarded as constraints. The proposed optimization model is applied to an NPP subsystem and solved by a mathematical programming solver.

■ TC67

West Bldg 105B

Joint Session ISS/AI/Practice Curated: Applications of Deep Learning Methods in Information Systems

Sponsored: Information Systems

Sponsored Session

Chair: Xiao Liu, University of Utah

1 - How Are You Feeling Today? Let Online Cancer Communities Help You Feel Better

Anqi Xu, University of Utah, Salt Lake City, UT, United States, Paul Hu

Cancer is devastating and has profound effects on patients' well-beings, both physical and emotional. Cancer patients need strong social support in different aspects and their emotions can greatly benefit from effective support. Toward that, online communities are crucial because they can provide the needed support to cancer patients. This study analyzes patients' different social support needs, then develops and empirically evaluates a deep learning-based, multi-label classification method to scrutinize their respect effects on a patent's emotion change, with a focus on the fit between the patient's particular need and the specific support by an online cancer community.

2 - Using Crowd Reactions to Detect Social BOT Intent

Victor Benjamin, Arizona State University, Tempe, AZ, United States, Kunal Sahay, Raghu Santanam

Social bots hold immense power, as they are excellent broadcasters of good/bad messages in high velocity. Some bots are useful because they can assist other users in several ways, such as providing news article summaries. However, other bots act maliciously by spreading misinformation or exploiting users. As these bots become more prevalent on social media, platform owners must identify strategies to manage them. One key capability that platforms need is the ability to distinguish between beneficial and harmful social bots that exist within their platform. In this research, crowd reactions to known social bots are scrutinized through a deep learning framework to assess the intent of the bot.

3 - Go to YouTube and See Me Tomorrow: The Role of Social Media in Managing Chronic Conditions

Xiao Liu, University of Utah, Salt lake City, UT, United States, Bin Zhang, Anjana Susarla, Rema Padman

To assess the medical knowledge in YouTube videos, we propose an interdisciplinary lens that synthesizes deep learning methods with themes emphasized in Information Systems (IS) research and research on healthcare informatics. We extract medical terminology from videos. We annotate videos using inputs from domain experts and build a logistic regression based classifier to categorize videos based on whether they encode a high degree of medical knowledge or not. We find that medical terminology embedded in textual data is more salient to an assessment of medical knowledge encoded in a video, rather than image analytics.

4 - Predicting Hepatocellular Carcinoma Recurrences: A Data-Driven Multiclass Classification Method by Incorporating Hidden Risk Factors

Qiuhua Sheng, University of Utah, Salt Lake City, UT, 84102, United States, Da Xu, Paul Hu, Tingshuo Huang, Wen-Chen Lee

Hepatocellular carcinoma (HCC), a malignant disease, is normally treated with surgical resections that however often associated with high cancer recurrence rates. We propose a Bayesian network-based method to infer HCC recurrences by incorporating distinctive pathogenesis that differs between early and late recurrences. The proposed method considers the underlying mechanisms control the clinical endpoint in the learning process and offers interpretability and flexibility to support HCC prognosis predictions.

■ TC69

West Bldg 106A

Joint Session QSR/Practice Curated: Reliability and Quality for Industry Applications

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Zhimin Xi, University of Tennessee - Knoxville, 851 Neyland Dr, 517 JDT, Knoxville, TN, 37996, United States

1 - Lithium-ion Battery Pack SOC Estimation Considering Cell-to-Cell Variability

Modjtaba Dahmardeh, Rutgers, The State University of New Jersey, Piscataway, NJ, United States, Zhimin Xi

Accurate estimation of lithium-ion battery pack SOC is technically challenging because of the cell-to-cell variability caused by the manufacturing tolerance. In addition, there is no unanimous definition of the pack SOC since each cell has its own SOC and the pack can be configured in different ways. This study firstly investigates different pack SOC definitions and adopts the one best suitable in our study. Next, uncertainty modeling and propagation analysis are conducted for accurate pack SOC estimations considering the cell-to-cell variability. Both analytical and simulation solutions are reported under different scenarios.

2 - A New Collision Avoidance Algorithm for Autonomous Vehicles Based on the Velocity Obstacle Algorithm

Elnaz Torkamani, Rutgers, The State University of New Jersey, Piscataway, NJ, United States, Zhimin Xi

Vehicle navigation autonomously in a dynamic environment is a challenging task because it should not be pre-programmed under a given handful situations and the vehicle must be able to avoid collisions under numerous unforeseeable but reasonable situations to a human being. From the practical perspective in autonomous cars, the algorithm must be efficient and reliable. This study proposes a new vehicle collision avoidance algorithm for multiple obstacles by eliminating the need of running sampling or optimization approaches, so that the algorithm could be practical useful in real-time collision avoidance under high vehicle speed.

3 - Reliability-Based Optimal Design of a Micro-Grid System under Natural Disasters

Zhetao Chen, Rutgers, The State University of New Jersey, Piscataway, NJ, United States, Zhimin Xi

This study proposes reliability-based optimal design of a micro-grid system under service disruptions due to natural disasters. The objective is to determine the minimum number of generators and their distributions in the micro-grid so that the system's recoverability can be guaranteed under random failure scenarios of the power transmission lines. Power flow analysis combing with the Monte Carlo simulation (MCS) are used for uncertainty propagation analysis to quantify the system's recoverability distribution under random failure scenarios of the transmission lines. The proposed work is demonstrated through a 12-bus power system.

4 - Finite Element Modeling of the Selective Laser Melting Process for Ti-6Al-4V

Alaa Olleak, Rutgers, The State University of New Jersey, Piscataway, NJ, United States, Zhimin Xi

Physics-based modeling of the selective laser melting (SLM) process is critical for better understanding the influence of the parts quality with respect to various process parameters and scanning strategies. The challenge is to balance model validity, domain size, and computational efficiency so that the model can be practically useful for improving reliability and quality of the printed products. In this study, a transient thermal finite element model of a SLM process for Ti-6Al-4V is developed using ANSYS for predicting the melt pool size and its temperature history. The thermal model is then integrated with mechanics-based modeling process for predicting the residual stress of the products.

5 - Deep Autoencoder with Regularization on Sensor Signals for Virtual Metrology in Semiconductor Manufacturing

Jeongsub Choi, Rutgers University, 96 Frelinghuysen Road, Core Building, Room 201, Piscataway, NJ, 08854, United States,

Harshit Bokadia, Myong K. Jeong

In semiconductor manufacturing, feature extraction from raw sensor signals on process equipment is an essential task to build an accurate predictive model for virtual metrology. Autoencoder is a neural network based feature extraction model that compress inputs into features in a latent space. In this talk, we present a new virtual metrology method with a new regularized deep autoencoder considering the characteristics of sensory data. Experimental results with real-life data show that the proposed method improves the performance of prediction models for virtual metrology.

■ TC80

Hyatt, Curtis B

Practice- Supply Chain Management IV

Contributed Session

Chair: Matthew Petering, University of Wisconsin-Milwaukee, Industrial and Manufacturing Engineering Dept, Ems E367, Milwaukee, WI, 53201, United States

1 - Sharing Demand Forecast with Common Retailer under Competition
Aditya Jain, Baruch College, Zicklin School of Business, 55 Lexington Ave, Suite 9-240, New York, NY, 10010, United States

We consider two competing manufacturers' decision to share private demand information with a common retailer. We show that the incentive to share information diminishes with competition intensity, which is contrary to existing results without competition, as well as investigate manufactures' investment in gathering information.

2 - Strategic Management of Humanitarian Supply Chains for Disaster Relief and Readiness
Seong-Hyun Nam, Professor, University of North Dakota, 2517 Sand Hills Ave., Grand Forks, ND, 58201, United States

This research project will also examine the option contract pricing approach to the relief supply chain management and discuss in more detail about how the model presented in this paper can help the humanitarian supply chain managers make strategic decisions on their goal achievement.

3 - Ranking of Key Supply Chain Enablers in Small and Medium Enterprise with Reference to Indian Handloom Sector
Tarunima Mishra, Research Scholar, Indian Institute of Technology, Kharagpur, D 507, Nivedita Hall, Kharagpur, 721302, India, Jitesh J. Thakkar, Kunal Kanti Ghosh

Handloom industry lies in SME which is the second largest sector providing employment to rural people in India but it is battling for its survival. This paper attempts to study and prioritize various enablers responsible for poor performance of small and medium industry while focusing on handloom industry with the help of interpretive structural modelling (ISM) and MICMAC analysis.

4 - The Impact of Supply Chain Disruptions on Organizational Performance: A Literature Review
Mansoor Shekarian, Graduate Student, North Carolina A&T State University, Greensboro, NC, 27408, United States, Mahour Parast

This paper examines the effect of supply chain disruptions on organizational performance. We employ a systematic literature review to identify different conceptualizations and theorizations of supply chain disruptions, and to understand how different types of supply chain disruptions affect organizational performance. We later discuss organizational capabilities (resilience enhancers) that can improve an organizational response to supply chain disruptions. Finally, we outline future research directions in supply chain risk management and supply chain resilience.

5 - Inventory Control with Flexible Demand: Cyclic Case with Multiple Batch Supply and Demand Processes
Matthew Petering, Associate Professor, University of Wisconsin-Milwaukee, Industrial and Manufacturing Engineering Dept, Ems E367, Milwaukee, WI, 53201, United States, Xi Chen, Wen-Huan Hsieh

We introduce, and present methods for solving, the cyclic inventory control problem with multiple flexible batch supply and demand processes. The objective of this new problem is to minimize the average or maximum amount of inventory of a single item that is held during a cycle of given length in a buffer whose stock is replenished by multiple batch supply processes and consumed by multiple batch demand processes. The problem is noteworthy in that the decision maker has control over the timing and lot sizes of all supply and demand processes. Thus, demand is flexible.

■ TC83

Hyatt, Remington

Practice- Health Care III

Contributed Session

Chair: Haolin Feng, Sun Yat-sen University, Lingnan College, Guangzhou, 510275, China

1 - Optimal Resource Allocation Policies in Nonprofit Organizations
Faisal M.M. Alkhannan Alkaabneh, Cornell University, Ithaca, NY, 14850, United States, Siddhartha Banerjee, H. Oliver Gao

We develop a framework for resource allocation, in the context of food banks operations, to help food banks optimize their share allocation policies by considering the nutrition needs of served population. To this end, we propose a convex programming model, a mathematical model whose solution provides a provable utility optimal policies. Through a novel mathematical model and the utilization of decomposition techniques, we arrive at two simpler sub-problems that can be solved efficiently. We prove that both sub-problems can be solved in polynomial time.

2 - New Models and Algorithms for Operating Room Scheduling Problems
Yang Wang, Associate Professor, Northwestern Polytechnical University, 127 West Youyi Road, Xi'an, 710072, China, Xue Yang, Haichao Liu, Haibo Wang

We propose new continuous and discrete mathematical programming models and design dedicated algorithms for solving operating room scheduling problems. The throughput of surgical patients, overtime of operating rooms and satisfaction of patients are optimized. Our algorithms incorporate new coding/decoding rules to represent feasible scheduling and dynamic programming guided scheduling strategy to significantly reduce computational time. We perform extensive experiments on both simulated and real-life hospital data to verify the merit of this study.

3 - Teaching Healthcare Process Management using Discrete Event Simulation
Chester G. Chambers, Asst. Professor, Johns Hopkins University, 100 International Drive, Baltimore, MD, 21202, United States

In this case study we use Discrete Event Simulation to teach about management of patient flow in an outpatient clinic. Students are provided with simulation models built using actual clinic data. Students explore issues involving patient punctuality, parallel activities, pre-processing, and appointment scheduling. This case has been used successfully with a wide array of students to teach about ways to develop process measures, experiment with process improvements, and evaluate potential results from interventions. The case serves as a course capstone to tie together elements of experimentation, process analysis, and process improvement.

4 - Optimal Experimental Design for a Partially Observable Simple Birth Process
Ali Eshragh, Senior Lecturer, The University of Newcastle, Newcastle, 2308, Australia

Our goal is to estimate the rate of growth, lambda, of a population governed by a simple birth process. We may choose n time points at which to count the number of individuals present. But due to detection difficulties, we are able only to observe each individual independently with fixed probability p. We discuss the optimal times at which to make our n observations in order to maximise the Fisher Information for the birth rate lambda. Finding an analytical form of the Fisher Information appears intractable. Nonetheless, we utilise the concept of generating functions to develop a new algorithm to maximise the Fisher Information. Our numerical results reveal the efficiency of this new algorithm.

5 - Clinic Scheduling with Patient Re-entrant
Haolin Feng, Sun Yat-sen University, Lingnan College, Guangzhou, 510275, China, Mark Lawley, Michelle M. Alvarado, Stephen Steidle

We consider a clinic scheduling with same-day patient re-entrants. The motivation is Mohs Micrographic Surgery (MMS), a surgical method for skin cancer excisions. It repetitively removes and examines one skin layer at a time until a cancer free layer is found. Current scheduling practice results in long in-clinic waiting and doctor overtime due to the stochastic nature of excision and pathology. We develop a model for MMS clinic scheduling to improve patient experience and clinic revenues. The model captures the key characteristics of the surgery-pathology and stochastic re-entrants. Theoretical results and numerical study based clinical data are provided to demonstrate the benefit of the method.

■ TC84

Hyatt, Russell

Practice- Innovation/ Entrepreneurship I

Contributed Session

Chair: Wenbo Jiang, Northwestern Polytechnical University, 127 West Youyi Road, Beilin District, Xi'an Shaanx, 710072, China

1 - Advancing Digital Transformation: Integrating the Problem Space, the Solution Space, and the Quality Space for Successful Digital Transformation
Munir Majdalawieh, Associate Professor, Zayed University,

Mirdif, Dubai, 19282, United Arab Emirates

Many c-suite executives are facing various challenges such as rigid processes, risk avoidance, digital disruption, interdepartmental conflict, disinterest in new ideas and complacency to move forward. These challenges require a vastly different approach to transform companies. The objective of this paper is to propose an integrated framework for problem space (design thinking), solution space (lean startup, Agile, SDLC), quality space (total quality management, six sigma) and change management space methods for successful digital transformation.

2 - Design Cost and the Birth of User Entrepreneurs

Ohchan Kwon, Harvard Business School, Wyss House, Soldiers Field, Boston, MA, 02163, United States

This paper examines how a reduction in design cost affects the entrepreneurial entry in the context of the video game industry. I exploit a sudden business model innovation of a major game engine software company, which provides the low-cost licensing option to some user innovators if their existing contents are compatible, but not others. I find that when the licensing cost decreases dramatically, user innovators are more likely to release independent games based on their prior innovation. The effects are stronger if the innovators' idea is of high-quality.

3 - Coexistence of Quality and Innovation an Automotive Perspective

Donna L. Bell, Wayne State University (Detroit, MI), Redwood City, CA, 94063, United States, Ratna Babu Chinnam, Julia Gluesing

In a time when the consumer electronics industry is getting new products to market at a rapid rate, automotive manufacturers must identify ways of getting new products and features to customers faster and with high quality to maintain or increase market share. We provide an analysis of the interviews and surveys completed by professionals of a global automotive company in understanding the impact that quality requirements have on innovation and the advanced product design process.

4 - Too Much is Not a Good Thing: The Inverted U-shaped Relationships of Average Tie Strength, Structural Holes, Intraorganizational Knowledge Search and Transfer

Wei Wang, PhD Student, Xi'an Jiaotong University, No.28, Xianning West Road, Xi'an, Shaanxi, 71, Xi'an, 710049, China, Xiaoming Sun, Antonio Capaldo, Wentian Cui

In this paper, we predict both average tie strength and structural holes exert inverted U-shaped effects on intraorganizational knowledge search and transfer by inventors and further suggest above relationships are flattener in key inventors compared to normal ones. Analysis of American patent data of 33 largest pharmaceutical firms worldwide from 1975 to 2014 offers support for our conjectures, except for the relationship of average tie strength and intraorganizational knowledge search, which is a gradually diminishing positive curve instead. We thus advance network research on knowledge flow by confirming the existence of curvilinear relationships and adding inventor attributes.

5 - Green Entrepreneurial Orientation for Enhancing Firm Performance: A Dynamic Capability Perspective

Wenbo Jiang, PHD, Northwestern Polytechnical University, Chang'an Compus, Xi, 710129, China

Despite much attention has been focused on the importance of green entrepreneurial orientation, its impact on environmental and financial performance remains unclear. Drawing on dynamic capability theory, we hypothesized that green entrepreneurial orientation has positive influences on two dimensions of firm performance, and green technology dynamism and knowledge transfer and integration play moderating roles in the relationship between green entrepreneurial orientation and firm performance. We tested the research hypotheses using data from 264 Chinese firms. This study enhances our understanding of green entrepreneurial orientation, as a dynamic capability applied in the firm.

■ TD06

North Bldg 122C

Joint Session OPT/Practice Curated: Recent Advances in Global Optimization and Applications

Sponsored: Optimization/Global Optimization

Sponsored Session

Chair: Erfan Mehmanchi, University of Pittsburgh, Pittsburgh, PA, 15260, United States

1 - Globally Solving Non-convex Quadratic Programs via Linear Integer Programming Techniques

Luis F. Zuluaga, Lehigh University, Harold S. Mohler Laboratory, 200 West Packer Avenue, Bethlehem, PA, 18015, United States, Wei Xia, Juan C. Vera

Quadratic programming (QP) is a well-studied fundamental NP-hard optimization problem which optimizes a quadratic objective over a set of linear constraints. In this paper, we reformulate QPs as a mixed-integer linear problem (MILP). This is done via the reformulation of QP as a linear complementary problem, and the use of binary variables and big-M constraints, to model the complementary constraints. To obtain such reformulation, we show how to impose bounds on the dual variables without eliminating all the (globally) optimal primal solutions; using some fundamental results on the solution of perturbed linear systems.

2 - Optimizing a Bundle Pricing Problem

Hamid Nazari, Clemson University, Clemson, SC, 29631, United States, Akshay Gupte, Lawrence Joseph McCormick

We are interested in solving a combinatorial matrix assignment problem which appears in literature as a bundle pricing problem in a multi-buyer-single-seller market. The problem has a MIQCQP formulation due to the requirement that a feasible assignment of buyers to bundles have envy-free equilibrium. Literature has many approximation results and polynomial-time algorithms under certain assumptions. We adopt an integer programming approach to solve this problem in general. We test our formulations and polyhedral relaxations on random instances and compare our MIP methodology to the Lagrangian relaxation techniques proposed in literature.

3 - Boundedly Rational User Equilibrium Models in Electricity Consumer Market Studies in Smart Grid

Guanxiang Yun, University of Central Florida, 12800 Pegasus Drive, P.O. Box 162993, Orlando, FL, 32816, United States, Qipeng Zheng

We propose a new boundedly rational user equilibrium (BRUE) model of the residential users' behavior for the consumption of energy schedule with the smart grid. People will accept any option with which utilities just less than a certain level compare to the best option's utility. We also introduce the unit time pricing strategy that can flatten the user's behavior of energy consumption. The problem is solved by using three methods, use BARON directly, penalty method and lagrangian dual method. Even though the BRUE constraints are non-convex constraints, we still find under our conditions, it have the strong duality. From the result, we find by introducing the price, it can decrease the cost of the system.

4 - On Robust Fractional 0-1 Programming

Erfan Mehmanchi, University of Pittsburgh, 4200 Fifth Avenue, Pittsburgh, PA, 15260, United States, Colin P. Gillen, Andres Gomez, Oleg A. Prokopyev

We examine single- and multiple-ratio robust fractional 0-1 programming problems (RFPs) under a broad classes of uncertainty sets. In particular, we demonstrate that under budgeted uncertainty sets single-ratio RFPs are polynomially-solvable if the deterministic counterparts are. We also reformulate the multiple-ratio RFPs as several mixed-integer linear programs (MILPs). Finally, computational experiments are conducted to evaluate the performance of MILP reformulations, as well as to compare the various uncertainty sets.

■ TD07

North Bldg 123

Joint Session OPT/Practice Curated: Network Optimization Models and Algorithms for Evacuation Planning

Sponsored: Optimization/Network Optimization

Sponsored Session

Chair: Maxim A. Dulebenets, Florida A&M University-Florida State University, Tallahassee, FL, 32311, United States

1 - Cost-effective Evacuation Network Design Under Travel Congestion

Nadere Mansouri, Southern Methodist University, Dallas, TX, 75231, United States, Halit Uster

We consider an evacuation network design problem under cost considerations and travel congestion. We propose a mathematical model that prescribes evacuee routes through the road network to shelter locations under evacuation time constraints. To solve our model, we devise an efficient Benders Decomposition framework and present an experimental on its effectiveness using data from Central Texas. We provide computational results illustrating the efficiency of our solution approach and an analysis of evacuation network design strategies.

2 - Cell-based Network Flow Model Under Uncertainty Considering Social Influence for Large-scale Evacuation

Hyeong Suk Na, PhD Candidate, The Pennsylvania State University, 234 Leonhard Building, University Park, PA, 16802, United States, Necdet Serhat Aybat, Sukran Ilgin Guler, Soundar Kumara

The emergency management agencies are faced with numerous challenges during the evacuation due to several unpredictable traffic conditions. This study addresses uncertainties of the road capacity induced by traffic congestion in a real evacuation situation. An evacuation network flow model based on the Cell Transmission Model with joint chance constraints is proposed to deal with the uncertainties and the

model reliability is investigated. In addition, social media is transforming the way of communicating and sharing the evacuation-related information. A numerical case study examines the applicability of the proposed model and the social media influence for the evacuation process.

3 - Modeling a Latency Based Evacuation Process
Hamoud S. Bin Obaid, University of Oklahoma, Norman, OK, 73071, United States, Theodore B. Trafalis

A latency-based evacuation model (LBEM) is developed to optimize the evacuation procedure. The model is composed of two phases. In the first phase, the model builds the feasible space of the time path on every route, then the model uses the feasible space to build the constraints in the second phase as a mixed integer linear programming (MILP) model. The model is capable of capturing the latency of each group of evacuees as the travel time in the model is load-dependent. The evacuees are distributed fairly to balance between system optimum (SO) and user equilibrium (UE). Preliminary computational results are reported.

4 - Emergency Evacuation Planning Optimization in the Areas with Vulnerable Populations
Maxim A. Dulebenets, Florida A&M University-Florida State University, Tallahassee, FL, 32311, United States, Olumide Abioye, Eren Erman Ozguven, Ren Moses, Walter Boot, Thobias Sando

Many U.S. coastal areas, which are characterized with a significant presence of vulnerable populations (e.g., aging adults), often experience natural hazards. In order to facilitate emergency evacuation planning, this study proposes a set of exact and heuristic algorithms for assigning evacuees to the available evacuation routes and emergency shelters, considering socio-demographic characteristics of evacuees, which may further affect their driving ability. Numerical experiments are conducted to evaluate the proposed solution algorithms using real life emergency evacuation scenarios.

■ TD10

North Bldg 125A

Joint Session MSOM/RMP/Practice Curated: Online Retailing and Marketplace Analytics

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Yun Fong Lim, Singapore Management University, Singapore, 178899, Singapore

1 - The Impact of Repeat Business and Word of Mouth for an E-Retailer
Opher Baron, University of Toronto, 105 St George Street, Toronto, ON, M5S 1L7, Canada, Simai He, Hongsong Yuan

We use data from the M&SOM data competition to investigate repeat purchase behavior and the impact of word of mouth (WOM) on reference prices at the giant Chinese e-retailer, Taobao. We develop algorithms to study both questions and demonstrate their usage. Our main findings are that improving repeat business is extremely important to Taobao and that it is important to consider WOM affect in the presence of reference price effects.

2 - Urban Consolidation Center or Peer-to-peer Platform? The Solution to Urban Last-mile Delivery
Qiyuan Deng, Singapore Management University, Singapore, Xin Fang, Yun Fong Lim

The growth of last-mile delivery to urban areas creates negative impacts on the environmental, social, and economic well-being of cities. As a potential solution to address this challenge, an urban consolidation center (UCC) bundles shipments from multiple carriers before delivering them to a city center. Despite the potential benefits, the success rate of UCC projects in practice is low. More recently, a notable number of peer-to-peer platforms have been established to share the carriers' truck capacity. These capacity sharing platforms can potentially be more economically sustainable, while making urban last-mile delivery more operationally efficient.

3 - Distributionally Robust Inventory Management with Network Flows - An Application to Ecommerce and Omnichannel Retailing
Aravind Govindarajan, Ross School of Business, University of Michigan, Ann Arbor, MI, 48104, United States, Amitabh Sinha, Joline Uichanco

A fundamental assumption in network inventory planning is that the underlying joint distribution of demands across locations is known. However, this may not be the case for ecommerce demand due to high volatility in online customer behavior. We propose propose a distributionally robust model for network inventory optimization with reactive recourse, where the worst-case expected cost is minimized over the set of demand distributions satisfying known mean and covariance information. We derive closed-form optimal inventory levels and worst-case distribution for two locations and develop tractable upper bounds and heuristic solutions for the multi-location problem.

4 - Matching Supply with Demand for Online Retailing
Yun Fong Lim, Singapore Management University, Lee Kong Chian School of Business, Singapore, 178899, Singapore, Song Jiu, Marcus Teck Meng Ang

We consider a joint replenishment, allocation, and fulfillment (JRAF) problem over multiple periods for an online retailer. In each period, the retailer determines the replenishment quantity for each product from each supplier and then allocates the inventory to the FCs. After the demand is realized, the retailer chooses the FCs to satisfy it. The retailer's objective is to minimize the expected total cost. We have developed a two-stage approach based on robust optimization to solve the JRAF problem. A case study with a major apparel online retailer in Asia suggests that the two-stage approach can reduce the retailer's current cost by 36.73%, demonstrating a significant value of joint optimization.

■ TD17

North Bldg 127C

Joint Session MSOM/Practice Curated: Topics on Two-Sided Platforms

Sponsored: Manufacturing & Service Oper Mgmt/Supply Chain

Sponsored Session

Chair: Fernando Bernstein, Duke University, Durham, NC

1 - The Impact of the Gig-economy on Financial Hardship
Kaitlin Daniels, Washington University in St. Louis, Saint Louis, MO, United States, Michal Grinstein-Weiss

We empirically measure the impact of Uber's entrance into a market on the welfare of workers. Measures of worker welfare considered include income and financial hardship (e.g. failure to pay bills on time). Analysis elucidates the role of gigs like Uber within the broader economy.

2 - Competition Between Two-sided Platforms Under Demand and Supply Congestion Effects
Fernando Bernstein, Duke University, Fuqua School of Business, 100 Fuqua Drive, Durham, NC, 27708-0120, United States, Gregory A. DeCroix, N. Bora Keskin

This paper explores the impact of competition between two ride-sharing platforms. Customers' and drivers' utilities are sensitive to the prices set by the platforms and to congestion in the system. We consider two scenarios, one in which each driver works exclusively for a single platform ("single-homing") and another scenario in which drivers may work for both platforms ("multi-homing" or "multi-apping").

3 - Price, Wage and Fixed Commission in On-demand Matching
Yun Zhou, McMaster University, 1280 Main Street West, Hamilton, ON, L8S 4M4, Canada, Ming Hu

We study an on-demand platform's price and wage determining problem under uncertain market conditions. Demand and supply functions have different forms in different conditions. While the platform can jointly optimize price and wage in each condition, our research shows that the simpler fixed commission structure achieves a decent portion of profit.

■ TD24

North Bldg 131B

Practice- Blockchain and Innovation

Contributed Session

Chair: Qianyu Hu, Penn State University, State College, PA, 16801, United States

1 - Automation and Ecosystem Level Operations Management via Decentralized Ledger Technology
Michael Zargham, CEO, BlockScience, Oakland, CA, 94609, United States, Matthew Barlin

Incentive functions are engineered to induce independent actors to provide services to decentralized networks. Formal models of the system behavior and careful scoping of models based on design goals is paramount. System models may be derived from game theoretic or behavioral economic models; Operations Research and Swarm Robotics provide existing tools for engineering emergent dynamics. Partitioning the problem improves feasibility and introduces testing requirements and integration challenges for simulation and verification. After deployment, systems require tuning capabilities, monitoring, and maintenance. The safety of public economic infrastructure is a duty of engineers.

2 - Blockchain-based Renewable Energy Certificates Program
Fangyuan Zhao, Tsinghua University, Shenzhen, Chinan, Ying Kong, Xin Guo

In the era of green energy revolution, distributed renewable energy generation is

emerging, while it is out of the scope of conventional renewable energy certificate programs, which involves only large power plants and utility companies. Blockchain shows an advantage of incorporating a galaxy of distributed prosumers in a transparent and low cost manner. This paper proposes a proof of concept model of blockchain-based renewable energy certificates trading system, in which a cryptocurrency is designed for tracing the footprint and stimulating the popularization of renewable energy. The concept model is implemented on Ethereum blockchain for performance and risks analysis.

3 - Blockchain-enabled Pharmaceutical Supply Chain System: A Hyperledger Fabric Design

Qianyu Hu, Penn State University, State College, PA, 16801, United States

The drug supply chain safety has gained immense attention due to prevalent counterfeit products, widespread fake online pharmacies, drug abuse crisis and so on. Serialization, placing unique identifiers on products, can provide some visibility to the pharma supply chain. However, the identifiers suffer from duplicates and are prone to theft. Our blockchain-enabled system keeps the pharma supply chain data in an immutable and distributed manner to enforce zero counterfeits and allows for transparency and accountability. Data stored on the hyperledger fabric system are accessed based on consented permissions to protect users' privacy.?

■ TD58

West Bldg 101C

Joint Session HAS/Practice Curated: Decision Analytics and Models for Medical Diagnostics

Sponsored: Health Applications

Sponsored Session

Chair: Chun-An Chou, Northeastern University,Boston, MA, 02115, United States

1 - SD-CNN: A Shallow-Deep CNN for Improved Breast Cancer Diagnosis

Fei Gao, Arizona State University, 886 N. Cofco Center Court, Unit 1017, Phoenix, AZ, 85008, United States, Teresa Wu, Bhavika Patel, Yanzhe Xu

Deep learning has been widely implemented in practices for imaging based diagnosis. In this research, we first develop a shallow CNN to learn the mapping between low energy digital mammography (LE) and a more advanced breast imaging (recombined image) to tackle the less accessible issue of Contrast Enhanced Digital Mammography for broader clinical uses. A pre-trained deep CNN then takes both LE and "virtual recombined image to generate novel features for improved breast cancer diagnosis. Experimental results indicate significant improvement from this proposed Shallow-Deep CNN approach.

2 - Using Logical Analysis of Data as a Tool in Medical Decision Making

Ruilin Ouyang, Northeastern University, Boston, MA, United States, Chun-An Chou

Transparent results (e.g., if symptom A and symptom B, then outcome C) in addition to achieving high accuracy are desirable as a priority goal in building decision tools for medical diagnosis or health care. In our study, we present a logical analysis approach to build a rule-based decision model for Unplanned ICU transfer. We formulate and solve a mixed-Integer programming model to generate effective logical rules with maximum margins iteratively, and in turn form a compact rule-based decision model. We also compare our computational results with other state-of-the-art supervised learning methods (logistic regression and decision tree).

3 - Autism Risk Genes Prediction Using Spatiotemporal Gene Expression Data

Ying Lin, University of Houston, Houston, TX, 77204, United States

Autism Spectrum Disorder is a constellation of neurodevelopmental presentations characterized by impairments in social and communication behavior. Finding causal autism genes is challenged by small effect of single gene and the lack of common risk loci. Althoughrecent large exome sequencing studies of autism families have identified 65 autism risk genes, they represent only a fraction of the estimated genes involved in autism susceptibility. In this study, a gene ranking model is developed based on the identified genes and their brain specific spatiotemporal gene expression and applied to rank more than 25,000 unknown genes. The top ranked genes are potential to enrich the autism risk genes.

4 - The Effect of Indeterminate Findings on the Cost-effectiveness of Lung Cancer Screening

Iakovos Toumazis, Stanford University, Department of Radiology, James H. Clark Center, Room S255, Stanford, CA, 94305-5446, United States, Tsai B. Emily, Ayca Erdogan, Summer Han, Ann Leung, Sylvia Plevritis

The US Preventive Services Task Force recommends lung cancer (LC) screening for high risk individuals, yet the effect of indeterminate findings on the cost-effectiveness of LC screening is not established. We use a microsimulation model to estimate the cost-effectiveness of alternative LC screening strategies for the US general population under alternative levels of disutility associated with indeterminate findings. We find that as the effect of the disutility of indeterminate findings increases, the eligibility criteria for LC screening become more stringent and if large enough then biennial screening is cost-effective whereas, annual screening is cost-ineffective.

5 - Improving Community Paramedicine via Data Science and Optimization: Selective, Proactive Management of ED Patients

Andrew C. Trapp, Worcester Polytechnic Institute, School of Business, 100 Institute Rd., Worcester, MA, 01609, United States, Shima Azizi, Renata Konrad, Sharon A. Johnson, Brenton Faber

Community paramedicine is a recent healthcare innovation that empowers proactive visitation for chronically ill patients, often as follow-up visitations shortly after ED discharge. However, we are unaware of any studies that have considered it from the viewpoint of analytics. To that end, we purpose to reduce ED costs and increase patient welfare via our data-driven optimization approach. We use real hospital and community data to inform key decisions concerning provision of service, including vehicle and personnel scheduling and routing. We conclude by discussing computational findings.

■ TD59

West Bldg 102A

Joint Session HAS/Practice Curated: OR Applications in Cancer Care

Sponsored: Health Applications

Sponsored Session

Chair: Murat Kurt, Bristol-Myers Squibb, 3401 Princeton Pike, Lawrence Township, NJ, 08648, United States

Co-Chair: Iakovos Toumazis, Stanford University, Stanford, CA, 94305-5446, United States

1 - A Generalized Latent Disease Detection Problem with Application to Active Surveillance of Prostate Cancers

Zheng Zhang, University of Michigan, Ann Arbor, MI, United States, Brian T. Denton

We describe a generalized latent disease detection problem with patient-specific risk factors, a customized number of detection strategies for patients, and a general reward function. We formulate an integer programming model that considers patient-to-strategy assignment decisions and the test planning decision for each strategy. We develop a decomposition-based algorithm as a solution method for the model. We also provide insights based on the application of this model to optimize strategies for active surveillance of low-risk prostate cancers.

2 - A Markov Decision Process Model to Define the Role of Active Surveillance for Small Renal Masses

Jennifer Mason Lobo, University of Virginia, Charlottesville, VA, United States, Tracey L. Krupski

While the majority of small renal masses (SRMs) are indeed kidney cancer, a considerable proportion are either benign or demonstrate indolent behavior. Recent guidelines recommend active surveillance (AS) over definitive treatment for patients with limited life expectancy. In order to determine precisely which patients should be considered for AS, we developed a Markov decision process model to maximize life years or quality-adjusted life years for SRM patients over a ten year horizon, comparing AS, ablation, and surgical treatments. We present personalized treatment recommendations for patients based on demographics, comorbidities, and mass characteristics.

3 - Evaluating the Effectiveness of Supplemental Breast Cancer Screening in Women with High Bi-rads Density

Mahboubeh Madadi, Louisiana Tech University, Ruston, LA, 712720029, United States, Sevda Molani

Since the enactment of the breast density notification law, there have been controversial debates over the necessity of this law. The law requires physicians to inform women with heterogeneously or extremely dense breasts of their breast density results, and the potential effect of high breast density on the sensitivity of mammography. In some states, the physicians are required to notify their patients of the possibility of using more sensitive supplemental screening tests. We develop a partially observable Markov model to evaluate the effectiveness of supplemental screening in term of the expected quality-adjusted life years (QALYs), number of false positives, and biopsies.

4 - Personalized Lung Cancer Screening Strategies Using a Partially Observable Markov Decision Process

Iakovos Toumazis, Stanford University, Department of Radiology, James H. Clark Center, Room S255, Stanford, CA, 94305-5446, United States, Oguzhan Alagoz, Ann Leung, Sylvia Plevritis

The US Preventive Services Task Force recommends lung cancer (LC) screening for

high risk individuals aged 55-80 with at least 30 pack-years, and no more than 15 years since smoking cessation. Many other risk factors are associated with LC incidence, yet screening eligibility is solely based on age and smoking history, leading to sub-optimal screening strategies. We propose a partially observable Markov decision process (POMDP) that provides individualized optimal screening strategies for current and former smokers. Decisions are made based on the risk of the individuals accounting for previous screening results and changes in individuals' smoking behavior.

■ TD62

West Bldg 103A

Joint Session DM/Practice Curated: Data Science and Analytics for Business Decision-Making

Sponsored: Data Mining

Sponsored Session

Chair: Durai Sundaramoorthi, Washington University in Saint Louis, Saint Louis, MO, 63131, United States

1 - Multistakeholder Recommendation with Provider Constraints

Edward Carl Malthouse, PhD, Northwestern, 1845 Sheridan Road, Evanston, IL, 60208, United States, Ozge Surer, Robin Burke

Recommender systems optimize the utility of the user, but often there are other stakeholders. One setting is multisided platforms, which match buyers and sellers and it is necessary to jointly optimize the value for both. We propose an integer programming model, where constraints reflect the goals of the different stakeholders. Our model is a post-processing step, so it can easily be added to an existing recsys to make it multistakeholder aware. For computational tractability, we reformulate the IP using the Lagrangian dual and subgradient optimization. We use two data sets to evaluate the utilities of buyers and sellers and show that our approximation can achieve good upper and lower bounds.

2 - Frequently Bought Together: Market Basket Analysis with Shortened Web Link Click Data

Christopher M. Smith, Air Force Institute of Technology, 2795 Ridge View Ct, Xenia, OH, 45385, United States, James Gallagher

Social Media use has grown tremendously since the advent of "Web 2.0ö. To facilitate the sharing of information, link shortening has become a common method for fitting long web links into space-constrained social media posts. Additionally, most link shortening services provide analytic feedback to users such as how many clicks the link generated or a breakdown by location of those clicks. Market basket analysis using graph mining techniques was applied to this web link data to provide insight into an area's information dissemination patterns. Patterns of access, including by hardware platform and referral sources, within clusters of web domains provide feedback to market research analysts.

3 - Pick-up, Delivery, or Both? An Online Grocer's Optimal Fulfillment Models

Chloe Kim Glaeser, Assistant Professor, UNC Kenan-Flagler Business School, 300 Kenan Center Drive, Chapel Hill, NC 27599, Chapel Hill, NC, United States, Xuanming Su, Ken Moon

We partner with an online grocery retailer to answer the practice-based question of the optimal mix of delivery zones and fulfillment models using data-driven analytics. We investigate (A) how consumers respond to the locally tailored fulfillment options made available to them by the online grocer, and (B) how to leverage data to customize locally available fulfillment options while scaling the retailer's operations. We employ a regression discontinuity design to find the effect of delivery introduction. Based on this empirical evidence, we build and estimate a structural model and perform a counter-factual analysis to estimate the revenue increase from additionally offering delivery.

4 - Machine Learning Approaches to Modeling Category Sales: Implications for Optimal Store-Level Pricing and Promotions

Durai Sundaramoorthi, Washington University in Saint Louis, 10352 Conway Road, Saint Louis, MO, 63131, United States

We propose machine learning approaches - Regression Trees (RT), Bagging (Bag), Random Forests (RF), and Boosted Trees (BT) - with modified loss functions as candidate predictive models of product category profit as functions of marketing variables (price, display, feature, price promotion), both within and across categories at the same retail store. Using store-level weekly scanner data from 24 product categories in each of 9 stores of a supermarket chain over a period of 5 years, we estimate these machine learning models and compare their predictive performance on a validation set. We find that these models with modified loss functions are meaningful in the optimization context.

■ TD63

West Bldg 103B

Joint Session DM/Practice Curated: Data Science for Engineering and Facilities Design

Sponsored: Data Mining

Sponsored Session

Chair: Reza Alizadeh, University of Oklahoma, Norman, OK, United States

1 - Parameter Design Optimization of Products with an Ordinal Categorical Response Using Random Forests

Gulser Koksal, Professor, Middle East Technical University, Industrial Engineering Department, Ankara, 06800, Turkey, Secil Gulbudak Dil

We propose an alternative method for finding optimal settings of product and process design parameters for the case of an ordinal categorical product/process response. The method utilizes Random Forests for modelling mean and variance of the response at a given set of parameter settings. The method uses different weighting strategies of Random Forest, and it is applied on three case problems. Results obtained are compared with those of previous studies that used the same data sets.

2 - Minimization of Cycle Time Variance in Smart Warehousing

Mohamed El Tonbari, Georgia Institute of Technology, 755 Ferst Dr, Atlanta, GA, 30318, United States, Leon McGinnis

We are interested in the operational decision in central fill pharmacies of assigning drugs to dispensers to be collected by vials traveling on conveyors. More specifically, we are concerned with finding the drug assignment which minimizes the cycle time variance. We show that the organ pipe arrangement attains the minimum under the assumption of constant travel times between adjacent dispensers. In the case of varying travel times between dispensers, we propose a heuristic which performs well empirically, achieving an optimality gap in the order of 0.1%. Our results can be generalized to other applications as well.

3 - Queueing Analysis of an MIAPP-AS/RS Order Picking Operation

Jingming Liu, Research Assistant, University of Arkansas, Fayetteville, AR, 72701, United States, John A. White, Haitao Liao

An M/G/1 queue is used to analyze an MIAPP-AS/RS system, in which case-level order picking occurs at multiple in-the-aisle picking positions (MIAPP) located on the floor and mezzanine levels. The S/R machine is treated as a server, and picking positions are treated as customers. Picking positions generate demands for replenishment performed by the S/R machine. Performance measures are obtained analytically for dedicated and random storage policies, as well as for finite and infinite populations. The results yield insights into the impact of the storage policies on the performance measures and the conditions where an infinite population approximation is reasonable.

4 - Using Multiple Surrogates for Metamodeling in Complex Engineering Systems

Reza Alizadeh, Graduate Research Assistant, The University of Oklahoma, 202 W. Boyd Street, Room 219, Norman, OK, 73019-1022, United States, Liagyue Jia, Guoxin Wang, Janet K. Allen, Farrokh Mistree

Surrogate models are commonly used to replace expensive simulations of engineering problems. Frequently, a single surrogate is chosen based on past experience. However, we may use all or a subset of the accurate surrogates. We aim at achieving the least accuracy loss using all or the combination of surrogates using multiple surrogates, cross-validation, covariance matrix approximation, and random forest methods.

■ TD64

West Bldg 104A

Joint Session DM/Practice Curated: Data Science in Finance

Sponsored: Data Mining

Sponsored Session

Chair: Ning Ning, University of Washington, Seattle, WA, United States

1 - The Effect of Emotional Cues on Making Economic Decisions under Uncertainty

Pieter Geelen, Maastricht University, Maastricht, Netherlands, Business Intelligence and Smart Service Institute, Heerlen, Netherlands, Stefano Bromuri, Stefano Bromuri, Mahdi Ebrahim, Mahdi Ebrahim, Deniz Iren, Deniz Iren

We investigate the understudied role of emotions on investors' decision. Specifically, we identify six basic human emotions (i.e. happiness, sadness, surprise, fear, anger, and disgust) expressed by S&P 500 CEOs during their earning conference calls and examine their effects on financial analysts' decisions (i.e. retain, buy or sell shares). To identify CEOs' emotions in more than 500 calls we developed a deep learning algorithm trained by experts annotating vocal data in a subset of calls. Our findings shed light on underlying emotional mechanisms of financial decision-making under uncertainty, thereby contributing to behavioral economic theory.

2 - Modeling Multivariate Time Series of Counts via Common Factors
Fangfang Wang, University of Wisconsin, Madison, WI, United States

We develop a new parameter-driven model for multivariate time series of counts. The mean process is modeled as the product of modulating factors and unobserved stationary processes. The former characterizes the long-run movement in the data, while the latter is responsible for rapid fluctuations and other unknown or unavailable covariates. The latent processes are governed by possibly low-dimensional factors. This model is applied to analyze the intraday trading activity of U.S. stocks from ten sectors in the first quarter of 2012. Dynamic relationship between common factors adjusted by their associated loading and intraday volatility is also investigated.

3 - Insample Tangency Portfolio Based Portfolio Forcasting
Kyungchan Park, PhD Candidate, The University of Iowa, 21 E. Market St, PBB S221, Iowa City, IA, 52242-1994, United States, Hongseon Kim, Seongmoon Kim

Representative portfolio selection model consists of two stages: 1) estimating input values, and 2) constructing portfolio by inputting the estimates. Though estimation errors on inputs are inevitable, optimizations construct portfolios sensitively to the fluctuation of inputs. To date, portfolio models have been designed to minimize the influence of estimation errors while maintaining the two-stage mechanism of optimization based on estimated. Portfolio forecasting method of this study was begun to find a method to utilize the most efficient in-sample portfolio outside of the two-stage mechanism by constructing portfolios using historical in-sample tangency portfolios as input values.

4 - Multivariate Bayesian Structural Time Series Model
Ning Ning, University of Washington, Seattle, Seattle, WA, United States

This paper deals with inference and prediction for multiple correlated time series, where one has also the choice of using a candidate pool of contemporaneous predictors for each target series. Starting with a structural model for the time series, Bayesian tools are used for model fitting, prediction, and feature selection, thus extending some recent work along these lines for the univariate case. We run an empirical study with one-step-ahead prediction on the max log return of a portfolio of stocks that involve four leading financial institutions. The extensive empirical study confirm that this multivariate model outperforms three other benchmark models.

■ TD65

West Bldg 104B

Joint Session DM/Practice Curated: Data Science and Deep Learning III

Sponsored: Data Mining

Sponsored Session

Chair: Muye Wang, Columbia Business School, 3022 Broadway, 4th Floor West, New York, NY, 10027, United States

1 - Network Intrusion Detection Using Partially Labeled Cybersecurity Data
Sandjai Bhulai, Vrije Universiteit Amsterdam, Faculty of Science, De Boelelaan 1081a, Amsterdam, 1081 HV, Netherlands, Jan Klein, Mark Hoogendoorn, Robert van der Mei, Raymond Hinfelaar

Network intrusion detection systems (NIDS) have been used to defend computer networks against malicious cyber activities. The lack of training data hinders discovery of new, previously unknown, intrusions. We use recent cybersecurity partially labeled data based on the 2017 Locked Shields exercise. We show how autoencoder and gradient boosting algorithms deal with missing labels on partially labeled data. The results were analyzed by a cybersecurity expert and confirmed that the models were able to classify the known intrusions as malicious and that they were also able to discover new intrusions. This shows how well an unlabeled dataset can be used to construct and evaluate a NIDS.

2 - A Comparison Between Different Machine Learning Algorithms for Better Accuracy in Trauma Outcomes Prediction
Fatima Almaghrabi, PhD Student, The University of Manchester, Booth street, Manchester, United Kingdom, Dong-Ling Xu, Jian-Bo Yang

Outcome prediction models are useful in identifying the extent of patient injuries and prioritising immediate life threats. This research aims to identify the most accurate tools for building a prediction model and to increase model accuracy to enhance the care services provided to trauma patients. Thus, the research attempts to identify which algorithms have the highest classification accuracy in predicting trauma outcome. The results of some machine learning (ML) algorithms, such as decision tree, logistic regression, random forest and neural network results were compared to the evidential reasoning rule.

3 - Flexible Job Shop Scheduling with Multi Agent Advantage Actor Critic
Jinkyoo Park, Korea Advanced Institute of Science and Technology, 291 Daehak-ro, Yuseong-gu, Daejeon, 34141, Korea, Republic of, Jaehyeong Chun, Jongwoo Ko, Jun Young Park

In this research, we propose a multi-agent reinforcement learning approach to schedule a semiconductor manufacturing process. A semiconductor manufacturing process is composed of a large number of sequential jobs conducted by different types of machines. The optimal scheduling policy seeks to minimize the makespan while satisfying various constraints. We formulate the scheduling problem as a multi-agent team game, and then derive the independent policy for each machine by using the multi-agent advantage actor-critic. Experiment results show that our decentralized multi-agent RL approach is effective compared to centralized scheduling approach or heuristic scheduling approach.

4 - Data Driven Sparse System Identification
Salar Fattahi, PhD, UC Berkeley, Berkeley, CA, 94702, United States, Somayeh Sojoudi

In this work, we study the system identification porblem for sparse linear time-invariant systems. We propose a sparsity promoting estimator to identify the dynamics of the system with only a limited number of input-state data samples. Using contemporary results on high-dimensional statistics, we prove that logarithmic number of data samples is enough to reliably estimate the system dynamics. The developed estimator offers a small estimation error entry-wise and is capable of "exact recovery" of the underlying sparsity structure of the system with small number of data samples. We demonstrate the effectiveness of our approach through different case studies.

5 - Deep Learning in Finance - Estimation of Factor Models
Muye Wang, Columbia Business School, 3022 Broadway, Uris Hall, 4H, New York, NY, 10027, United States

Factor analysis is a statistical method used to describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables called factors. By using a variational autoencoder framework, we are able to incorporate outside relevant information to improve linear factor model's predictive performance. In addition, we also consider extending the traditional linear factor model to a non-linear framework. Finally, we conduct numerical experiments using SP500 daily return data and trading volume data to illustrate the superior performance.

■ TD66

West Bldg 105A

Joint Session DM/Practice Curated: Intriguing Tweaks in Data Science I

Sponsored: Data Mining

Sponsored Session

Chair: Özge Sürer, Northwestern University, 1310 Chicago Avenue 3H, Evanston, IL, 60201, United States

1 - A New Fuzzy Set and Quadratic Surface SVM Approach for Mislabeled Classification with Applications
Jian Luo, Associate Professor, Dongbei University of Finance and Economics, No. 217 Jianshan Street, Shahekou District, Dalian, 116025, China, Ye Tian, Zhibin Deng

To handle mislabeled classification problem, this paper proposes a totally new method which first adopts the intuitionistic fuzzy set method to detect those mislabeled points, then deletes their labels, and utilizes their full position information to build a semi-supervised kernel-free quadratic surface SVM model. Besides, a branch-and-bound algorithm is designed to improve the efficiency and accuracy. Some numerical tests on artificial and real datasets verify the superior performance of proposed method among several benchmark methods. Furthermore, the proposed method is applied to brain-computer interface and credit risk assessment, which strongly demonstrates its effectiveness.

2 - As Good as it Gets? Upper Bounds on Prediction Performance
David Anderson, Villanova University, Philadelphia, PA, United States, Margret V. Bjarnadottir

Taking only an assumption that "very similar" observations should have similar predictions to each other, we formulate a linear program to generate upper bounds on the possible predictive accuracy of a given outcome, using data contained in a dataset. We show results on multiple real-world and simulated datasets.

3 - Building Interpretable and Highly Accurate Supervised Learning Models
Abdelaziz Berrado, Mohammed V. University, BP 765, Avenue Ibn Sina, Agdal, Rabat, 10080, Morocco

Rule based classification algorithms such as CART are very attractive in several applications. They owe their popularity to the simplicity of the tree-building algorithm and the actionability of the resulting models. These algorithms suffer,

however, from instability due to the tree building process: they perform greedy searches for rules, which could lead to missing important rules. Ensemble methods can mitigate this weakness of individual tree learners. They result, however, in blackbox models and are unable to provide insights into the structure of the predictive model. We discuss in this work ongoing research aimed at building accurate and highly actionable classification models.

4 - Data Analytics as a Tool for Problem Structuring
Patrick Hester, UNC Asheville, 28 Gibson Rd., Asheville, NC, 28804, United States

Data analytics is everywhere, from healthcare to business to higher education. Analysts use it to understand, predict, and improve an organization's performance, as a fundamental tool in one's Hard OR toolbox. This perspective misses out on an equally valid, yet overlooked, application of analytics to help us frame our problem; in this arena, data analytics can be very powerful. I will argue for the use of data analytics in the problem structuring (or Soft OR) phase, as a natural complement to its continued use during the solution phase of a problem engagement.

5 - Coefficient Tree Regression for Discovering Hidden Structure
zge S rer, Northwestern University, 1310 Chicago Avenue 3H, Evanston, IL, 60201, United States, Daniel Apley, Edward C. Malthouse

The proliferation of technologies allows us to collect datasets of immense size with a large number of variables. In practice, many groups of predictors often share a common regression coefficient, but the groups are unknown. We propose an algorithm called coefficient tree regression to discover the unknown group structure by utilizing the properties of linear regression in an efficient way. We avoid matrix operations and speed up the computation to obtain an efficient algorithm. Our method achieves high accuracy competitive with existing methods. Finally, we test our algorithm with real datasets and demonstrate that it yields interpretable models by exploring the relations between predictors.

■ TD67

West Bldg 105B

Joint Session ISS/Practice Curated: Mobile App, Commerce, and Analytics

Sponsored: Information Systems

Sponsored Session

Chair: Zhan Shi, Arizona State University, Tempe, AZ, 85251, United States

1 - Are Gaming Apps and Social Media Apps Adversaries or Partners to Education Apps? An Empirical Analysis
Sangpil Han, Arizona State University, Tempe, AZ, United States,, Sungho Park, Sanghak Lee, Wonseok Oh

This paper examines an empirical question of whether spending time on hedonic apps such as Facebook and Angry Birds promote or impede users' usage of educational apps. We investigate this question using an individual-level app usage time data set.

2 - Personalized Targeting to Tackle the Challenge of Low Engagement in Mobile Apps: Combining Structural Hidden Markov Model and Field Experiment
Yingjie Zhang, Carnegie Mellon University, Pittsburgh, PA, United States

Low engagement rates and high attrition rates have been formidable challenges for mobile apps and their long-term success, especially for those whose revenues derive mainly from in-app purchases. This paper proposes a new structural forward-looking Hidden Markov Model (FHMM) and combines it with a randomized field experiment on app notification promotions. Overall, the novel feature of our paper is to propose a new approach of personalized targeting to tackle the challenge of low engagement in mobile apps by combining structural model and field experiment.

3 - Human Behavior in Physical Space and Virtual Space
Lei Dong, MIT, Cambridge, MA, United States

With the widespread of smart phone and location-based services, human 'movements' in the physical space and virtual space are recorded simultaneously. As far as we know, many human mobility patterns in physical space have been studied before, while there are a lot of open questions not be reached combing two spaces together: Does the virtual world have similar patterns of movement with physical space? Are there any interplay patterns between online and offline behavior? How do demographic properties matter in these two spaces? With a mobile phone dataset documenting detailed online and offline behaviors, we are seeking a deep understanding of humans behaviors in online and offline spaces.

■ TD68

West Bldg 105C

Joint Session QSR/Practice Curated: Spatio-Temporal Data Analysis and Applications I

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Jian Liu, University of Arizona, Tucson, AZ, 85721, United States

Co-Chair: Shyam Ranganathan, Virginia Polytechnic Institute and State University, Blacksburg, VA, United States

Co-Chair: Xiao Liu, University of Arkansas, University of Arkansas, Fayetteville, AR, 5, United States

1 - Spatial Variable Selection and an Application to Virginia Lyme Disease Emergence
Yili Hong, Virginia Polytechnic Institute, 213 Hutcheson Hall, Department of Statistics, Blacksburg, VA, 24061, United States

Lyme disease is an infectious disease that is caused by a bacterium called Borrelia burgdorferi sensu stricto. One of the research objectives for the infectious disease community is to identify environmental and economic variables that are associated with the emergence of Lyme disease. In this paper, we use a spatial Poisson regression model to link the spatial disease counts and environmental and economic variables, and develop a spatial variable selection procedure to effectively identify important factors by using an adaptive elastic net penalty. The proposed methods can automatically select important covariates, while adjusting for possible spatial correlations of disease counts.

2 - Penalized Spatio-temporal Regression for Video Monitoring of Additive Manufacturing Process
Hao Yan, 699 S. Mill Ave, Tempe, AZ, 85281, United States

In this work, we focused on detecting the local occurrence of the "hot-spot event" in the metal additive manufacturing (AM) process. Here we propose to model the temporal behavior of the hot-spot event by the autoregressive model and propose a spatial-temporal decomposition approach to isolate the hot-spot event from the background. We also propose a control chart scheme to tell when the event actually happens. The proposed methodology is validated using both simulation and case study in metal AM.

3 - Spatio-temporal Modeling of Topic Flows with an Information Diffusion Monitoring Application on Social Networks
Shyam Ranganathan, Virginia Polytechnic Institute and State University, VT, Blacksburg, VA, United States, Scotland Leman, Peter Hauck, James Hawdon

Spatio-temporal topic flow modeling can be used to understand how information diffusion takes place on networks. We present an extension of the popular Latent Dirichlet Allocation (LDA) model to include spatial and temporal diffusion using ideas from the Gaussian process (GP) and the timeseries literature. We show an application where such a model can be used to monitor how information diffuses on social networks such as Twitter. We build a 'polarization barometer' based on the spatio-temporal model and use it to evaluate the amount of polarization generated by the information diffusion.

4 - A Generic Framework for Multisensor Degradation Modeling Based on Supervised Classification and Failure Surface
Changyue Song, University of Wisconsin, Rm 3221, Mechanical Engineering Building, 1513 University Ave, Madison, WI, 53715, United States

We propose a generic framework for multisensor degradation modeling. Specifically, we model each sensor signal based on random-effect models and characterize failure events by a multi-dimensional failure surface. To overcome the challenges in estimating the failure surface, we transform the degradation modeling problem into a supervised classification problem, where classifiers can be incorporated to estimate the degradation status of the unit based on the underlying signal paths, i.e., the collected sensor signals after removing the noises. The proposed framework is also capable for sensor selection, able to handle asynchronous sensor signals, and easy to implement in practice.

■ TD70

West Bldg 106B

Joint Session DEA/Practice Curated: Applications II

Emerging Topic: Productivity, Efficiency and Data Envelopment Analysis

Emerging Topic Session

Chair: Umit Saglam, East Tennessee State University, Department of Management and Marketing, P.O. Box 70625, Johnson City, TN, 37614, United States

1 - A Dea-based Empirical Analysis for Dynamic Performance of China's Regional Coke Production Chain
Panpan Xia, University of Science and Technology of China, Hefei,

China, Jie Wu, Xiang Ji

Coke plays a critical role in China's national economic activities in the past several decades. However, because of the twofold pressures from the sustainability-concerned public and the international steel market downturn, China's coke industry steps into a dilemma. To help the industry solve its current problems, an empirical analysis for dynamic performance of China's regional coke production chain is demonstrated. Through adopting the slacks-based measure (SBM) in Data Envelopment Analysis (DEA) and a famous dynamic network DEA framework, this paper simplifies the coke production chain into a three-stage process, and captures the interactions between intermediates inside each stage.

2 - Axiomatic Modeling of Fixed Proportion Technologies
Xun Zhou, Doctoral candidate, Aalto University School of Business, Runeberginkatu 22-24, Helsinki, 00100, Finlandi, Timo Kuosmanen

Understanding substitution possibilities of inputs/outputs is critical for efficient resource allocation and firm strategy. There are several important examples of fixed proportion technologies where some inputs and/or outputs are not substitutable. However, there is widespread confusion about appropriate modeling of fixed proportion technologies in DEA. We point out and rectify some misconceptions in the published literature, and show how the fixed proportion technologies can be correctly incorporated into the axiomatic framework.

3 - Technical Efficiency in the Chilean Higher Education System: A Comparison with Traditional Measurements of Efficiency
Gianfranco Cossani, Universidad Catolica del Norte, Avenida Angamos 0610, Antofagasta, 1270709, Chile, Hernan Caceres, Loreto Codoceo, Jorge Tabilo

Data Envelopment Analysis (DEA) has often been used to evaluate the efficiency of higher education institutions in many countries. In Chile, few studies using this technique are available. In this work, we propose a network and dynamic DEA model where each university has a structure with resources shared by teaching and research. For our study case, we examined data from 2013 to 2017 of the Chilean System, and we compared our findings with efficiency scores obtained with four different DEA methods, in addition to rankings commonly used by the government and media outlets.

4 - A Two-stage Performance Assessment of Utility Scale Wind Farms in Texas
Umit Saglam, Assistant Professor, East Tennessee State University, Department of Management and Marketing, P.O. Box 70625, Johnson City, TN, 37614, United States

A two-stage Data Envelopment Analysis (DEA) models are applied to evaluate productive efficiencies of the 95 large utility-scale wind farms' electricity generation in Texas, by using pre-determined three input and two output variables. The slack analysis and projection data are obtained for inefficient wind farms to find out benchmarking input-output variables. The sensitivity analysis is provided for the robustness of the DEA models with different combinations of input and output variables of the original model. Tobit regression models are conducted to investigate the reasons for inefficiency.

5 - An Approach for Autonomous Target Selection for an Agent Swarm
Barin N. Nag, Professor, Towson University, Department of E-Business & Tech Management, College of Business & Economics, Towson, MD, 21252, United States, Sungchul Hong, Xiaoyin Wang

Decision making in target selection for a swarm of drones in military use is a complex process that requires the simultaneous consideration of a number of parameters, some of which may not be known with certainty. An approach is presented here for autonomous targeting decisions. The method uses a combination of Bayesian estimation to overcome problems of uncertainty, and Analogical Reasoning to aggregate a large number of observations to achieve a high level of confidence.

■ TD71

West Bldg 106C

Joint Session ICS/Practice Curated: Networks and Their Applications

Sponsored: Computing

Sponsored Session

Chair: Hamidreza Validi, Oklahoma State University, Stillwater, OK, 74075, United States

1 - The Most Betweenness Central Clique Problem
Foad Mahdavi Pajouh, University of Massachusetts Boston, Boston, MA, 02125, United States, Maciej Rysz, Eduardo Pasiliao

This talk addresses the most betweenness-central clique problem, which is to find a clique of maximum betweenness centrality in a connected network. Central cliques have applications in corporate, social, communication, power grid, and biological network analysis. Complexity results, bounds, and a combinatorial branch-and-bound algorithm for solving this problem are presented. Computational performance of the proposed algorithm is compared with that of a mixed integer programming technique on a test-bed of randomly generated graphs and real-life networks.

2 - Sparse Model Estimation and its Applications to the Insurance Industry
Jessica Wai Yin Leung, University of Sydney, Sydney, Australia, Dmytro Masypura

We study the problem of sparse model estimation in the context of binary classification. We formulate the problem by extending the discrete Dantzig selector to accommodate a hinge loss function. To increase the efficiency in solving the problem, we reformulate the problem as a mixed integer linear optimisation problem (MILP) and propose to add additional bounds and warm-start algorithm to obtain near optimal solutions. Preliminary results show that our method is capable of recovering all the true features with high predictive accuracy within a reasonable time frame when the sample size is less than the number of features.

3 - Interdicting Interdependent Smuggling, Money, and Laundering Networks
Thomas Sharkey, Rensselaer Polytechnic Institute, CII 5015, RPI, 110 8th St, Troy, NY, 12180, United States, Yeming Shen

We consider the problem of disrupting a transnational criminal organization (TCO) operating interdependent smuggling, money, and money laundering networks. The TCO will smuggle contraband across an international border, generate revenue from illegal sales, and then need to send the money back across the border via the laundering network. We examine a bi-level program that seeks to allocate law enforcement resources as to optimally disrupt these interdependent networks. Effective reformulation techniques are discussed as well as examining the impact of disrupting laundering networks across multiple TCOs.

4 - Novel Group Centrality Metrics for Studying Essentiality in Protein Protein Interaction Networks
Saeid Rasti, North Dakota State University, Fargo, ND, United States

We propose a set of novel group centrality metrics and show their performance in estimating protein importance in protein-protein interaction networks. These centrality metrics are extensions of well-known nodal centrality metrics, such as degree, betweenness, and closeness, for a set of nodes which is required to induce a specific pattern. The structures investigated here range from the stricter induced stars and cliques, to a looser definition of an induced representative structure. We then propose mixed integer programming formulations to solve the problem exactly. Finally, the performance of the proposed metrics in identifying essential proteins in a series of organisms is indicated.

■ TD74

West Bldg 212A

Joint Session MCDM/Practice Curated: MCDM Methodology in Emerging Applications

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Serpil Sayin, Koc University, Istanbul, 34450, Turkey

1 - Optimal Planning of a Multimodal Mobility System with Rideshare
Xi Chen, University of Michigan - Dearborn, 2290 Engineering Complex, 4901 Evergreen Rd, Dearborn, MI, 48128, United States, Armagan Bayram, Meigui Yu, Xiao Yu

Public transit aims at providing affordable and energy efficient transportation service to residents on their daily commutes. However, the high setup and operating cost of public transit greatly limits its accessibility and utilization. On the other hand, rideshare services have more route flexibility but bear higher cost and energy consumption per trip served. In this paper, we investigate the value of combining these two transportation modes in satisfying customer travel demand and improving system performance. We formulate an integer program for the multimodal transportation planning problem. We also propose an efficient heuristic to solve this optimization problem.

2 - A Filtering-enabled Interactive Algorithm to Find Preferred Solutions of the Decision Maker
Gulsah Karakaya, Middle East Technical University, Business Administration Dept, METU,Universiteler Mahallesi, Ankara, 06800, Turkey, Ceren Tuncer Sakar

In the presence of multiple conflicting objectives, it is not straightforward to find the best solution. We develop an interactive approach to converge to preferred solutions of the decision maker. Iteratively, we present the decision maker small sets of alternatives and obtain preference information. We apply filtering to the data set to obtain more useful information. We use a weighted La distance function as the preference function. Using rankings data of Times Higher Education, we make tests with universities evaluated with five criteria and demonstrate that our method performs well.

3 - Multiple-criteria Decision Making and Smart Systems: A Literature Review
Tung Cu, Bloomsburg University of Pennsylvania, 932 Country Club Dr., Bloomsburg, PA, 17815, United States

Although MCDM is an old school among OR domains, new breakthrough developments in smart systems have extended research in MCDM to new areas that were not possible before. The aims of the study are twofold. This paper first conducts a rigorous review of literature in both theoretical and empirical issues that address smart systems and MCDM methods, decision support tools and platforms in different contexts such as business, healthcare, education, politics, security and privacy. It then focuses on reviewing typical characteristics of smart system users in making their decisions. Findings on behaviors of traditional and nontraditional decision makers are presented in the paper.

4 - Multi-dimensional Sensitivity Analysis in Operations Research, and its Importance for Preventive Healthcare Services
M Gabriela Sava, Assistant Professor, Clemson University, College of Business, 145 Sirrine Hall, Clemson, SC, 29634, United States, Luis Vargas, Jerrold H. May

We propose a method for analyzing the n-dimensional sensitivity and stability of an n-criterion AHP/ANP model, so as to more fully assess the impact of perturbations, such as those that are caused by additional information, on preferred alternatives. We illustrate our methodology by applying it to a preventative healthcare choice problem.

■ TD80

Hyatt, Curtis B

Practice- Supply Chain Management III

Contributed Session

Chair: Rajiv Saxena, APL Logistics, 11458 N. 128th Place, Scottsdale, AZ, 85259-3528, United States

1 - Exploring the Role of Supplier and Product Characteristics in Vendor-managed Inventory
Roelof Post, University of Groningen, Akkerstraat 77, Groningen, 9717KG, Netherlands, Paul Buijs, Jaap Wieringa, Hans Wortmann

Research shows that transferring stocking decisions and ownership of inventories to suppliers can improve the performance of supply chains, but for which suppliers does this hold? Using both transaction data and empirical observations, we show how supplier and product characteristics affect the gains of a vendor managed inventory (VMI) implementation.

2 - Random Capacity Disruptions in a Make-to-Stock Company with Stochastic Demand and Capacity
Antonio Arreola-Risa, Associate Professor, Texas A&M University, Mays Business School, INFO Department, 4217 TAMU, College Station, TX, 77843-4217, United States, Philip J. Mizzi, Barry Keys

A single-product, make-to-stock firm is considered. Demand and capacity are stochastic, with capacity experiencing random disruptions. Inventory is managed using a base-stock policy and demand stock-outs are back-ordered. The base-stock minimizing the economic cost of inventory holding and demand back-ordering is determined, as is the disruptions' impact on the optimal base-stock and cost.

3 - Supply Chain Optimization in Action – Experiences of a Practitioner
Rajiv Saxena, Vice President, Supply Chain Solutions, APL Logistics, 11458 N. 128th Place, Scottsdale, AZ, 85259-3528, United States

An efficient and effective supply chain could be a competitive differentiator for a company. There is a major potential to cut logistics costs in the supply chain of a company through application of data analytics and optimization techniques. This presentation will include real-life data analytics and optimization case studies covering areas of network design, transportation optimization and facilities design and showcase how a 3PL provider can help a company significantly improve the efficiency and effectiveness of its supply chain.

■ TD83

Hyatt, Remington

Practice- Health Care IV

Contributed Session

Chair: Ting Wu, Nanjing University, Department of Mathematics, No 22 Hankou Road, Nanjing, 210093, China

1 - Analyzing Alternative Doctor to Room Ratio in an Outpatient Clinic as a Means of Improving Overall Patient Access
QIng Wen, University of Pittsburgh Department of Engineering, Pittsburgh, PA, United States, Louis Luangkesorn, Anna Svirsko, Jay Rajgopal

Children's Hospital of Pittsburgh hosts a number of specialty outpatient pediatrics clinics. Currently, the space available is believed to be a constraint in the overall capacity for outpatient appointments. One way to increase capacity is to reduce the ratio of rooms to doctors. However, that creates a risk that the doctor's time will not be as productive due to waiting for patients and rooms to be prepped and cleaned. We develop a simulation to compare the effect of different room to doctor assignment patterns in doctor productivity and throughput. We also use this as part of a larger simulation that models the effect of increased capacity on the patient backlog for the clinic.

2 - A Discrete-event Simulation Model to Optimize Emergency Department Wait Times and Inpatient Unit Flow at an Academic Medical Center
Gokhan Kirlik, University of Maryland Medical System, 920 Elkridge Landing Rd, Linthicum Heights, MD, 21090, United States, Bill Bame, Kenneth Wood, Warren DÆSouza

A discrete-event simulation model is developed to improve the flow of patients from the emergency department (ED) through the inpatient setting at a tertiary/quaternary academic medical center. After comprehensive analysis of electronic medical records (EMR), the main inputs of the model, which include ED arrivals, patient flow in ED, direct admissions, hospital inpatient unit flows, length of stay, discharges and bed/room cleaning are obtained. Validation and verification of the simulation model against EMR confirmed that the model mimic the real-world observations accurately. This model will serve as a reliable test bed for hospital operations improvement initiatives.

3 - Accelerating Kidney Allocation: Simultaneous and Expiring Offers
Michal Mankowski, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia, Sommer Gentry

After the new Kidney Allocation System (KAS) began, the kidney discard rate increases, especially for marginal quality kidneys. Placing non-ideal organs quickly might increase utilization by decreasing discards. We simulated making simultaneously expiring offers to multiple centers, where every center must accept or decline within the same 1 hour. Simultaneously expiring offers would burden centers to evaluate offers that might otherwise never have come to their center. We also estimated additional workload caused by one new allocation scheme.

4 - Prioritization Between Boarding Patients and Patients Currently Waiting or Under Treatment in the Emergency Department
Kim De Boeck, KU Leuven, Leuven, Belgium, Ra sa Carmen, Nico Vandaele

The extra workload introduced by boarding patients is a major concern in emergency departments. Not in the least because this confronts the physicians with a challenging task; making a prioritization decision between boarding patients and patients currently under treatment in the emergency department. The main contribution of this paper is the examination of different control policies for the physicians when needy boarding patients are added to the analysis. Using discrete-event simulation, three static priority policies and one dynamic priority policy are evaluated on various performance measures.

5 - A Discrete-event Simulation Approach for Modeling Human Body Glucose Metabolism
Buket Aydas, University of Wisconsin-Milwaukee, 3200 N. Crammer St., Milwaukee, WI, 53211, United States, Mukul Goyal

This study describes CarbMetSim, a discrete-event simulator that tracks the blood glucose level of a person in response to a timed sequence of diet and exercise activities. CarbMetSim implements broader aspects of carbohydrate metabolism in human beings with the objective of capturing the average impact of various diet/exercise activities on the blood glucose level. Key organs are implemented to the extent necessary to capture their impact on the production and consumption of glucose. Key metabolic pathways are accounted for by using the published values of the average flux along these pathways in the operation of different organs. CarbMetSim has the ability to model different levels of diabetes.

6 - Verify an Anesthesia Approach for the Target Blood Volume Control
Ting Wu, Nanjing University, Department of Mathematics, No 22 Hankou Road, Nanjing, 210093, China, Cheng Zhu

Anesthesia is an inevitable and critical procedure during an operation, resulting in the amount of blood loss directly. This study verifies a typical anesthesia approach for liver surgeries, which can reach the target blood volume control, through simulation models. We provide clinical guidelines for training anesthetists and evaluating their performance.

■ TD84

Hyatt, Russell

Practice- Innovation/ Entrepreneurship II

Contributed Session

Chair: Ping Deng, University of Science and Technology of China, No.96, Hefei, 230026, China

1 - Rights of First Negotiation and Rights of First Refusal in New Product Development Partnerships
Guangyu Wan, Assistant Professor, Hunan University, #724, Admin Building, North Campus, Changsha, 410006, China, Bhattacharya Shantanu, Sameer Hasija, Niyazi Taneri

Strategic control rights such as the right of first negotiation (ROFN) and the right of first refusal (ROFR) are commonly used in the pharmaceutical industry for creating partnerships between biotech and pharmaceutical firms. We build a stylized principal-agent model to study the contract design problem with the ROFN and ROFR. We investigate the efficacy of different control rights being offered from the innovator's (biotech firm) perspective. We also investigate the role of strategic control rights in resolving the adverse selection problem for the innovator. Our results address an important issue, viz., which control right to offer under which circumstances.

2 - Economies Before Scale: Learning, Survival, and Productivity of Young Plants in the Age of Cloud Computing
Wang Jin, Research Associate, MIT, Cambridge, MA, United States, Kristina Steffenson McElheran

Young firms are central to productivity and growth, yet they fail at high rates. Recent advances in how firms access information technology (IT) - in particular, cloud computing - have dramatically lowered the costs of learning about productivity-enhancing IT. Using Census Bureau data from 2006 to 2014, we find that young-plant failure rates fell 5% due to new IT services, while traditional IT proved risky. Conditional on survival, young plants enjoy much higher cloud-related productivity gains compared to older ones. We provide the first large-scale evidence concerning both the magnitude of and mechanisms behind cloud-driven productivity growth in the U.S.

3 - New Knowledge Availability, Intellectual Property Right Regimes and Technology-based Entrepreneurship in China
Ping Deng, PhD Candidate, University of Science and Technology of China, Hefei, China, Jin Hong

This study empirically investigates the contextual influence of intellectual property protection (IPR) on the use of new available knowledge by entrepreneurs in China's high-tech industry. Using a unique database of China's high-tech new formations from 2000 to 2008, we show that higher level investment in new knowledge is critical in encouraging creating high-tech ventures. However, stronger enforcement of IPRs negatively affects new knowledge availability. Industry heterogeneity analyses show that the need of IPR protection varies by industries. These findings contribute to understanding the influence of IPR protection on the technology-based entrepreneurial behavior in China.

■ TE05

North Bldg 122B

Joint Session OPT/Practice Curated: Recent Developments and Applications using Julia for Optimization

Sponsored: Optimization/Computational Optimization and Software

Sponsored Session

Chair: Joey Huchette, MIT, Cambridge, MA, 02139, United States

1 - Infrastructure Optimization in Julia
Carleton Coffrin, Los Alamos National Laboratory, Los Alamos National Laboratory, los Alamos, NM, United States

The significant penetration of distributed renewable energy resources and increasingly dynamic fuel prices present significant challenges for the design and operation of critical infrastructure systems. To help explore how optimization algorithms can address these emerging challenges this work presents a collection of Julia packages for infrastructure optimization. These packages provide a variety of tools for, reproducing state-of-the-art results, developing new problem formulations, and benchmarking novel algorithms using standardized data formats and test cases.

2 - Mixed-integer Programming in Julia: From Formulations to Modeling to Algorithms
Joey Huchette, MIT, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States

In this talk we show how a variety of tools in the Julia programming language can be used throughout the optimization pipeline. First, we present how computational tools can be used to build MIP formulations: by guiding intuition, but also in a completely automated fashion. Next, we present modeling tools for piecewise linear functions that showcase how a high-level interface can help make advanced techniques more accessible to researchers and practitioners. Finally, we show how to use Julia to customize modern MIP solvers to implement advanced and experimental MIP algorithms.

3 - POD.jl: A Global, Mixed-integer Nonlinear Programming Solver in Julia
Kaarthik Sundar, Bryan, TX, 77801, United States

Non-convex, mixed-integer nonlinear programs (MINLPs) are hard optimization problems to solve to global optimality. State-of-the-art global solvers, such as BARON, Couenne, and SCIP, often handle MINLPs using the spatial branch-and-bound approach in combination with various other tools. However, there has recently been a great deal of interest in MILP-based approaches for solving MINLPs that are based on piecewise convex relaxations. In this work, we present a MILP-based global solver for MINLPs, named POD, where the name represents the three key solution techniques to solve MINLPs: Piecewise convex relaxations (P), Outer-approximation (O), and Dynamic partitioning (D).

4 - Modeling and Solving Mixed-integer Nonlinear Optimization Problems in Julia
Christopher D. Coey, Massachusetts Institute of Technology, Cambridge, MA, 02139, United States, Juan Pablo Vielma

We use real-world decision problems to illustrate the convenient modeling power of JuMP (github.com/JuliaOpt/JuMP.jl) for mixed-integer nonlinear optimization. We demonstrate how to access a variety of solvers, including our next-generation mixed-integer conic solver Pajarito (github.com/JuliaOpt/Pajarito.jl). Pajarito is written in Julia and uses a primal-dual continuous conic solver (such as Mosek) and a mixed-integer linear solver (such as CPLEX) to perform conic-certificate-based outer approximation.

5 - Mixed-integer Convex Representability
Juan Pablo Vielma, Massachusetts Institute of Technology, 77 Massachusetts Avenue, E62-561, Cambridge, MA, 02139, United States, Miles Lubin, Ilias Zadik

We consider the question of which nonconvex sets can be represented exactly as the feasible sets of mixed-integer convex optimization problems (MICP). We first show a complete characterization for the case when the number of possible integer assignments is finite. We then further study the characterization for the more general case of unbounded integer variables and introduce a simple necessary condition for representability. We illustrate these characterizations through various examples of sets that can or cannot be modeled as MICP.

■ TE06

North Bldg 122C

Joint Session OPT/Practice Curated: Network Optimization in Applications

Sponsored: Optimization/Global Optimization

Sponsored Session

Chair: Golshan Madraki, PhD, Clarkson University, Potsdam, NY, 13699, United States

1 - Most Closeness Central Clique Problem
Farzaneh Nasirian, University of Massachusetts-Boston, 100 William T. Morrissey Blvd, Boston, MA, 02125, United States, Foad Mahdavi Pajouh

This talk addresses the most closeness-central clique problem in which we are interested in detecting a most accessible clique in a graph. We use two metrics of maximum and total distance to a clique for measuring its accessibility resulting in two variants of the most closeness-central clique problem. For each of these two problems, we address the computational complexity, develop a new mixed 0-1 integer programming formulation, and propose the first combinatorial branch-and-bound algorithm. The computational performance of these exact algorithms is studied on a test-bed of real-life instances.

2 - Information Based Drone Assisted Parcel Delivery in Urban Environments
Cesar N. Yahia, The University of Texas at Austin, Austin, TX, 78705, United States, Can Gokalp, Prashanth Venkatraman, Stephen D. Boyles

We investigate the problem of using unmanned aerial vehicles alongside a truck for last-mile parcel delivery in an urban environment. The objective is to determine the route that the truck should traverse as well as the locations where the drone should be deployed to minimize total truck travel time. We propose real-time algorithms that exploit the travel time estimation capabilities of the drone.

3 - On the Structure of Potential Driven Networks
Gerrit Slevogt, Universit t Duisburg-Essen, Ruediger Schultz, Sabrina Nitsche

Potential driven networks such as water, gas and power are core utilities of today's world. They are governed by specific (non-linear) constraints such as derivatives of the Euler equations in gas and water and Kirchhoff's circuit laws in power networks. Especially in power networks the rise of renewable energies is driving the expansion and meshing of networks. Thus, the problem of finding operational bounds on the supported input-output nominations is getting more complex. Finding optimal

controls or flows on a case by case basis is operationally feasible but unsatisfying. An analysis of the structure of such networks and arising properties can lead to a more comprehensive view of such networks.

4 - Accelerating the Scheduling Improvement Heuristics by Finding the Longest Path in the Perturbed Graph

Golshan Madraki, Clarkson University, Potsdam, NY, USA

Scheduling improvement heuristics iterate over trial schedules to determine a satisfactory schedule. During each iteration, a performance measure (e.g., makespan) is calculated. This research presents an efficient algorithm, Structural Perturbation Algorithm (SPA), that accelerates the calculation of makespan. This means all scheduling improvement heuristics using SPA to calculate makespan for each trial schedule will run faster. We model the manufacturing by a Directed Acyclic Graph (DAG). Schedule trials are represented by perturbed DAGs where multiple edges are added and deleted. SPA can handle multiple edge deletions/additions through a single pass which improves the time complexity in comparison with current approaches.

■ TE07

North Bldg 123

Joint Session OPT/Practice Curated: Network Optimization Models for Transportation

Sponsored: Optimization/Network Optimization

Sponsored Session

Chair: Ayca Altay, Rutgers University, 110 Washington Rd, Princeton, NJ, 08540, United States

1 - Midas Proactive Traffic Control; Autonomous Intersection & Diamond Interchange

Viswanath Potluri, Research Associate, Arizona State University, Tempe, AZ, 85281, United States

MIDAS proactive traffic control uses forward recursion Dynamic Programming (DP) approach with efficient data structures, over a finite-time horizon that rolls forward and, then uses a backward recursion to retrieve the optimal decision sequence. MIDAS architecture uses vehicle GPS data, queue estimation models along with DP framework to optimally manage traffic along diamond interchange corridor. MIDAS proactive control is extended to autonomous vehicular traffic, which optimally schedules vehicle movements and manages platoons(by controlling leader and followers).

3 - Comprehensive and Quantitative Analysis of the Coordination Between Urban Railway and City

Yong Yin, Southwest Jiaotong University, Chengdu, China National United Engineering Laboratory of Integrated and Intelligent Transportation, Chengdu, China, Jie Liu, Qiyuan Peng, Xu Yan, Anjun Li

Evaluating the coordination between urban railway and the city correctly and comprehensively is of great significance for urban railway construction and city development. Based on the fractal theory, the coordination index of urban railway network and urban road network and the coordination index of urban railway station and urban traffic demand were constructed from aspects of multi radius and multi direction. Then, the comprehensive coordination index of urban railway and city was established based on fractal dimension consistency and vector similarity. The research has a certain significance in guiding urban railway planning and improving the coordination between urban railway and city.

4 - Evolvement of Public Charging Infrastructure in a Competitive and Stochastic Market

Zhaomiao Guo, University of Central Florida, 6566 Tealwood Drive, Orlando, FL, United States, Julio Deride, Yueyue Fan, Yueyue Fan

This paper presents a network-based multi-agent optimization model for strategic planning of charging facilities in a competitive and stochastic market. We provide a solution method based on alternating direction method of multipliers (ADMM).

5 - Transit Network Design with Congested Common Lines

David Z.W. Wang, Associate Professor, Nanyang Technological University, 50 Nanyang Avenue, Singapore, 639798, Singapore

This study focuses on a continuous transit network design problem with explicit consideration of congested common-lines. A tri-level programming model is presented to formulate the problem. Basically, the upper-level program optimizes the transit service frequencies to achieve the objective of both operators and transit users; the middle-level problem describes the passengers' routing choices, which is indeed an equilibrium transit assignment problem; the lower-level program formulates the congested common-line problem. The tri-level model is reduced into an equivalent single level program to be solved.The global optimal solution of the problem is to be obtained.

6 - Inspection Based Predictive Maintenance for Railways

Ayca Altay, Rutgers University, 640 Barthalomew Rd, Piscataway, NJ, 08854, United States, Pedro Cesar Lopes Gerum, Melike Baykal-Gursoy

Maintenance activities are essential to preserve safety and cost-effectiveness in railways. The related literature evaluates preventive and corrective maintenance conditions. However, the maintenance activities involve a structured policy of inspections, whose outcomes shape the replacement decisions. This study provides a holistic approach by integrating the prediction of rail and geometric defects, together with the scheduling of inspection-driven maintenance activities. Results indicate a high accuracy rate in prediction and an efficient scheduling structure.

■ TE17

North Bldg 127C

Joint Session MSOM/Practice Curated: New Frontiers in Operations Management

Sponsored: Manufacturing & Service Oper Mgmt/Supply Chain

Sponsored Session

Chair: Nitin Bakshi, University of Utah,Salt Lake City, UT, 84112-8939, United States

1 - Mitigating Disruption Cascades in Decentralized Supply Networks

Nitin Bakshi, University of Utah, 1655 East Campus Center Drive, Salt Lake City, UT, 84112-8939, United States, Shyam Mohan

Using a game-theoretic analysis, we study how firms in a decentralized supply network invest in mitigating the risk from disruption cascades. Specifically, we highlight the informational implications of the equilibrium investments

2 - The Emergence of Superstar Firms: Endogenous Multi-market Competition

Kostas Bimpikis, Stanford University, 655 Knight Way, Stanford, CA, 94305, United States, Sergio Camelo, Michael Koenig

We analyze competitive markets with multi-product firms competing in Cournot. We provide an equilibrium characterization in which both production levels and the market structure are endogenously determined. For homogeneous firms and convex productioncosts we show that the equilibrium market structure is such that each firm participates in only one market. In contrast, in the presence of economies of scale the resulting market structure takes the form of a nested graph. We recapitulate nestedness as a novel empirical fact in a unique panel dataset of firms. The policy implications are discussed with examples of deregulation affecting market entry, firm exi and mergers and acquisitions.

3 - Designing Rewards-based Crowdfunding Campaigns for Strategic Backers

Soudipta Chakraborty, Duke University, Durham, NC, United States, Robert Swinney

We study a model of rewards-based crowdfunding with the all or nothing funding mechanism. The creator of a campaign solicits pledges from backers, and if total pledges exceed a pre-determined threshold, the campaign is successful, the creator receives all pledges and each backer receives a reward. Otherwise, the campaign fails and backers are refunded their pledges. We determine how a creator should design her campaign when the uncertainty of receiving the reward makes backers behave strategically.

■ TE25

North Bldg 131C

Joint Session Service Science/Practice Curated: Analytics in Higher Education and Science Workforce

Sponsored: Service Science

Sponsored Session

Chair: Maryam Alsadat Andalib, Virginia Institute of Technology, Blacksburg, VA, 24060, United States

1 - Happy With a Baby and a Declined Tenure: Effects of Tenure-clock Extension Policies on Career Outcomes of New Parent Faculty Members

Maryam Alsadat Andalib, Data Scientist, Ford Motor Company, Dearborn, MI, United States, Navid Ghaffarzadegan

In this paper, we look at the support mechanisms for new-parent, tenure-track faculty in universities with a specific focus on tenure-clock extension policies. We construct a unique data set to answer questions around the effectiveness of removing the stigma connected with automatic tenure-clock policies. Our results show that such policies are successful in removing the stigma and that, overall, faculty members that have newborns and are employed by universities that adopt auto-TCE policies stay one year longer in their positions than other faculty members. In addition, we investigate the effect of auto-TCE policies on other career outcomes (e.g., getting tenure and job satisfaction).

2 - Using Simulation Modeling to Examine Policy Effects on the Workforce Outcomes of Women in Academic Science

Julie A. Maurer, Lead Research Manager, The Ohio State University, Columbus, OH, 43210, United States

Despite gains made over the past 20 years toward gender pay equity for female scientists working in academic research in the U.S., a persistent gap suggests that existing policies have not gone far enough. Insights into how the workforce structure, institutional policies and employer preferences interact to impact the career development of female scientists using ABM and SD modeling will be shared.

■ TE30

North Bldg 221C

Practice- Smart City and Urban Planning I

Contributed Session

Chair: William Knudson, Clemson University, Clemson, SC, 29634, United States

1 - Spatio-temporal Flexible Parking System

Xin Wang, University of Wisconsin-Madison, Madison, WI, United States, Xiaotian Wang

In a reservation-based parking system, customers departing late cause service failure for subsequent customers. To guarantee the service level, the parking system needs to run at a low utilization, which is a huge waste of parking resources, especially in congested urban area. From the perspective of the public regulator, we propose a flexible reservation system with spatial-temporal flexibility to address above issues and manage social surplus. A game-theoretical model is used to capture the customers' utility over the flexibility.

2 - Site Characterization by Dem And Satellite Images to Estimate Subsurface Site Conditions

Young-Ji Byon, Associate Professor, Khalifa University, Al Saada Street and Airport Road, P.O. Box 127788, Abu Dhabi, 127788, United Arab Emirates, Tadahiro Kishida, Rita Sousa

Site information need to be obtained for civil infrastructure construction before actual field survey is performed. Digital elevation models (DEM) have been successfully applied for this purpose to estimate the subsurface site conditions. Satellite images are also sometimes used to characterize site conditions visually based on the practitioners' experience. However, the combination of the data from DEM and satellite images have not been explored to estimate the subsurface site conditions. This study investigates the methodology to estimate the averaged subsurface site conditions for Japan from DEM and satellite images which are public available for the entire world.

3 - Quality of Service Constrained Microgrid Optimal Scheduling

Yiwei Wu, University of Houston, 4800 Calhoun Road, Houston, TX, 77004, United States, Gino J. Lim, Masoud Barati

The microgrid (MG) optimal scheduling ensures the economic operation subject to secure performance. To maintain the MG stability, MG should have enough reserve capacity. We define a Quality of Service (QoS) index to evaluate the effects of managing the scheduling uncertainties. Under particular QoS, the MG uses estimated reserve quantity to schedule its operation. A two-stage mixed-integer stochastic programming model is proposed to solve microgrid scheduling problem, in which the first stage is to schedule a microgrid under a normal operating condition, and the second stage is to adjust the first stage decision by finding the optimal provided reserve of microgrid under operation uncertainties.

4 - Urban Climate and Air Quality Services for Climate Change Planning – Europe Case Studies

Roberto San Jose, Professor, Tech. University Madrid, UPM Campus Montegancedo, Boadilla del Monte, Madrid, Spain, Juan Luis Perez-Camano, Libia Perez, Rosa Maria Gonzalez-Barras

UPM has developed integrated urban climate and air quality services to cover the special needs of city planners to develop climate change mitigation strategies. The results are based on high resolution numerical simulations run on high performance computers platforms. The methodology includes health impact assessments to know how climate change may affect the health of citizens.

5 - Using Bike Route Data Visualization to Inform Bicycle Share System Design and Redesign

William Knudson, Clemson University, Clemson, SC, United States, Mary Beth Kurz, Paul Glenn, Jack Henderson, Ciara Hill, Anderson Kemp, Isabella Kazmier

Small entities, such as small universities or towns, may want, for reasons such as sustainability or livability, want to invest in a bicycle sharing system with a limited budget, and not be able to follow best-practices in designing their systems. Using crowd-sourced data, such as that collected by Strava users, planners may be able to determine reasonable station location and potential bike routes. In this study, we utilize longitude, latitude and elevation data collected from bicyclists traveling through and on Clemson University's campus, as well as pilot bike share system usage data, to provide updates to the system design.

■ TE32

North Bldg 222B

Practice - Reverse Logistics/ Manufacturing I

Contributed Session

Chair: Debdatta Sinha Roy, Robert H. Smith School of Business, University of Maryland,College Park, MD, 20742, United States

1 - Evaluating Profitability of Remanufacturing Operations

Akshay Mutha, University of Vermont, Grossman School of Business, 55 Colchester Avenue, Burlington, VT, 05405, United States, Saurabh Bansal, V. Daniel R. Guide

We compare different methods for evaluating profitability of remanufacturing operations. We show the application of our model to current industry practices.

2 - Modelling Price Dynamics for New and Remanufactured Smartphones

Supanan Phantratanamongkol, University of Birmingham, Birmingham, United Kingdom, Gu Pang

In this presentation, we model price dynamics of new and remanufactured smartphones listed on eBay by using functional data analysis. More specifically, we explore how price velocity and acceleration evolve over product life cycles. We further investigate how the impact of different factors on the price dynamics may vary. Our results shed light on the price dynamics of buy-it-now live listings and their price determinants guiding both eBay sellers and buyers in making informed decisions.

3 - Optimization Models to Enable Job Rotation Schemes for Worker Safety

Amir Mehdizadeh, Auburn University, Auburn, AL, United States, Alexander Vinel, Mark Schall, Richard Sesek, Sean Gallagher

We consider the problem of employing job rotation schemes to improve worker safety in a manufacturing setting by combining optimization methods with novel modeling techniques developed in the occupational safety community. The work is based on a recently proposed fatigue-failure model for musculoskeletal disorders (MSD) risk evaluation. This leads to nontrivial nonlinear and nonconvex optimization problems which we solve through a combination of analytical and numeric tools. We conduct a realistic case study and conclude that while in some cases job rotation can lead to improvements, its effect is highly dependent on the composition of the job pool.

4 - A Stochastic Multi-echelon Multi-channel Network Problem

Yuan Wang, National University of Singapore, Singapore,119260, Singapore, 119260, Singapore, Loo Hay Lee, Ek Peng Chew

To effectively plan supply chain operations, it is meaningful to integrate strategic decisions on manufacturing capacity with short-term production and distribution decisions considering both demand and supply uncertainties. However, research on integrated supply chain network planning is rather limited in the literature. In this research, a stochastic multi-echelon multi-channel network model is proposed to solve the real supply chain network planning problem with consideration of uncertain demand forecast, production yield and raw material procurement simultaneously. The objective is to minimize overall operating cost through an extended planning horizon.

5 - Voting Mechanism Design in Randomized Strategic Social Choice

Debdatta Sinha Roy, Robert H. Smith School of Business, University of Maryland, College Park, MD, 20742, United States, Debasis Mishra

Consider a voting setup where each agent has an ordering over a set of alternatives. A randomized social choice function (RSCF) assigns probability distributions over the set of alternatives based on the orderings. A voting mechanism should satisfy some socially acceptable properties, for example, unanimity and strategy-proofness. It is well known that an RSCF is unanimous and strategy-proof if and only if it is a random dictatorship. This leads to a roadblock for designing socially acceptable and truthful voting mechanisms. We construct a normalized scoring-based rule that is unanimous and weakly strategy-proof and, therefore, it is not dictatorial. It is fast to compute and easy to implement.

■ TE38

North Bldg 225B

Joint Session APS/Practice Curated: Discrete Convexity and its Application

Sponsored: Applied Probability

Sponsored Session

Chair: Linwei Xin, University of Chicago, Chicago, IL, 60637, United States

Co-Chair: Xin Chen, UIUC, Urbana, IL, 61801, United States

1 - Optimal Inventory Management of a Blood Center

Yixuan Liu, University of Texas, 2110 Speedway, B6000, IROM, Austin, TX, 78705, United States, Youyi Feng, Guoming Lai

We study inventory management for a blood center that periodically collects whole blood and processes it into multiple blood products including red blood cell and platelet. With limited lifetimes, blood products are stored to satisfy random demands or sold in clearance sales before becoming outdated. The blood center also has an option to replenish red blood cells from an alternative source. Applying the concept of multimodularity, we characterize the structural properties of the value function and the optimal strategies. We demonstrate that the replenishment and salvage decisions can be coordinated to optimize the inventory system and discuss the value of implementing the alternative.

2 - Substitutability, M-natural-convexity and Their Applications

Menglong Li, UIUC, Urbana, IL, United States, Xin Chen

Substitutability, an important concept in economics and operations research, poses significant technical challenges. In this paper, we build fundamental properties of M-natural-convexity and its variant SSQM-natural-convexity, and apply them to analyze operations models with substitution: a multi-product multi-period stochastic inventory model and a portfolio contract model where a buyer reserves capacities in blocks from multiple competing suppliers.

3 - Stochastic Optimization with Decisions Truncated by Random Variables and its Applications in Operations

Xiangyu Gao, The Chinese University of Hong Kong, Hong Kong, Xin Chen, Zhan Pang

We study a class of stochastic optimization problems with decisions truncated by random variables. We develop a transformation technique to convert the original non-convex problems to equivalent convex ones. Our transformation allows us to prove the preservation of some desired structural properties, such as convexity, submodularity, and L-natural-convexity, under optimization operations, which are critical for identifying the structures of optimal policies and developing efficient algorithms. We demonstrate the applications of our approach to several important models in operations management.

■ TE39

North Bldg 226A

Joint Session MSOM/Practice Curated: Empirical Studies in Service Operations

Sponsored: Manufacturing & Service Oper Mgmt/Service Operations

Sponsored Session

Chair: Song-Hee Kim, University of Southern California, Los Angeles, CA, 90089, United States

1 - Labor Planning and Shift Scheduling in Retail Stores Using Customer Traffic Data

Marcelo Olivares, Universidad de Chile, Beauchef 851, Santiago, Chile

This work combines empirical analysis of point-of-sales data, customer traffic and employee staffing, with optimization methods to build a decision support tool that can be used by managers to plan labor allocation and working schedules, balancing gross margins, labor costs and employee satisfaction. An econometric model is developed to estimate the effect of labor on sales in an hourly basis, decomposing the effect of labor into conversion and ticket value. The empirical results are used in mathematical program that seeks to find the best feasible schedule to maximize store profitability, accounting for labor regulation restrictions and practical constraints.

2 - Sooner or Later? Learning from Delivery Speed Information

Ruomeng Cui, Emory University, 1935 Ridgemont Lane, Decatur, GA, 30033, United States, Tianshu Sun

Online retailers who sell physical products need to inform customers how fast an order can be delivered. The delivery speed is a crucial service metrics that online retailers can easily adjust on the website. On one hand, an aggressive (faster) delivery estimate could meet more demand and thus may increase current sales. On the other hand, it may also raise the likelihood of customers experiencing a loss in time due to a longer than expected wait, which might hurt future sales. Collaborating with an online store selling custom products, we leverage the exogenous shipping policy change and use a difference-in-difference approach to examine whether and how consumers respond to the delivery information.

3 - Spatially Differentiated Services: Bike-share, Ride-hailing, Etc.

Karan Girotra, Cornell Tech, New York, NY, 10044, United States

We present the the key common patterns from our findings from collaborations with bike-share operators in Paris and London, ride-hailing companies and a shuttle service operator. We find that there are consistent patterns of commuter behavior and preferences in all these systems and use these patterns to provide guidance on the design of such systems.

■ TE49

North Bldg 230

Practice- Game Theory I

Contributed Session

Chair: Ben Hermans, KU Leuven, Naamsestraat 69, Leuven, 3000, Belgium

1 - Spectrum Measurement Markets for Tiered Spectrum Access

Arnob Ghosh, Post-Doctoral Research Associate, Purdue University, 300 N. Grant Street, West Lafayette, IN, 47905, United States,, Randall Berry, Vaneet Aggarwal

The framework for spectrum sharing in the 3.5 GHz band allows for Environment Sensing Capability operators (ESCs) to measure spectrum occupancy to enable commercial users to use this spectrum when it is idle. We consider a scenario in which two spectrum access firms (SAs) seek to access a shared band of spectrum and must purchase spectrum measurements from one of two ESCs. Given the measurements they purchase, the SAs compete on price to serve customers. We consider two cases. When the SAs share the same single band of spectrum, having different qualities of measurements available to different SAs can lead to better economic welfare. When each has a separate licensed band, this difference does not matter.

2 - Coffee Supply Chain Optimization with Respect to Real Value of the Water

Shervin Espahbod, PhD Student, Wilfrid Laurier University, Waterloo, ON, Canada, Michael Haughton

On average, each cup of coffee consumes 500 liters of water. Water footprint clarifies whether the source of water for each product or activity is sustainable or unsustainable. We measured how awareness about water footprint and water taxation of products can shift consumption behavior. First, our behavioral survey explained average global water footprint of verity of coffee. Second, different coffee brands (e.g., Starbucks coffee, Tim Hortons) have different water footprints. With respect to the real value of water that brands consume, they maximize their total profits in an optimal Nash equilibrium.

3 - Two-stage Invest-defend Game: Balancing Strategic and Operational Decisions

Abdolmajid Yolmeh, Rutgers, The State University of New Jersey, 96 Frelinghuysen Road CoRE Building, Room 201, Piscataway, NJ, 08854, United States, Melike Baykal-G rsoy

Protecting infrastructures involves making both strategic and operational decisions. Although usually analyzed separately, these decisions influence each other. To this end, we present a game-theoretic, two-stage model between a defender and an attacker involving multiple target sites. In the first stage, the defender (attacker) allocates investment resources to target sites in order to improve the defense (attack) capabilities. In the second stage, the players decide which target site to defend or to attack. The results reveal that an increase in defense (attack) investments on a target site (increases) decreases the probability of both defending and attacking that target.

4 - Why Low Quality Firms Facilitate P2P Sharing While High Quality Firms do Not

Chenchen Di, UIUC, Champaign, IL, 61820, United States, Yunchuan Liu

We study whether and when should a firm actively facilitate consumers' sharing behavior by reducing transaction costs in a competitive market considering consumer usage uncertainty and consumer heterogeneity in transaction costs. This research provides another rationale for seller-induced sharing strategy. We show that seller-induced sharing behavior depends on consumers' usage uncertainty: when consumers face the great uncertainty of future needs, firms can actually benefit from facilitating consumer sharing by making it more convenient. In competitive sharing markets, the low-quality firm will choose to facilitate consumer sharing, and the high-quality firm will not.

5 - Timely Exposure of a Secret Project: Which Activities to Monitor?

Ben Hermans, PhD Student, KU Leuven, Naamsestraat 69, Leuven, 3000, Belgium, Herbert Hamers, Roel Leus, Roy Lindelauf

A defender wants to detect as quickly as possible whether some attacker is secretly conducting a project that could harm the defender. The attacker, in turn, schedules his tasks so as to remain undiscovered. One pressing question for the defender is: which activities to focus intelligence efforts on? We model the situation as a zero-sum game, establish that the late start schedule is a dominant attacker strategy, and derive a dynamic program that identifies the defender's optimal response. We evaluate the harm-reduction thanks to each task's intelligence effort by means of the Banzhaf value and illustrate our methods on a nuclear weapons development project.

■ TE50

North Bldg 231A

Practice- Retail Management I

Contributed Session

Chair: Rachel Rong Chen, University of California-Davis, 3208 Gallagher Hall, One Shields Avenue, Davis, CA, 95616, United States

1 - Differential Effects of Product Variety on Retailing Performance
Guanyi Lu, Florida State University, Tallahassee, FL, United States, Hyunseok Lee, Junbo Son

Using transaction-level data from a local grocery store, we study how different types of product variety affect retailing sales and profit. Our results have managerial implications on product assortment, which may help retailers achieve better performance.

2 - Dynamic Labour Allocation to Improve Store Performance
Shandong Mou, University of Auckland, 12 Grafton Road, Room 5121, OGGB, Auckland, 1142, New Zealand, David Robb

Despite considerable research on workforce planning, there is limited coverage of real-time labour allocation - a common practice to address real-time mismatches between the demand and supply of labour among departments. We propose a mathematical framework modelling real-time labour allocation and construct heuristics in the context of retail stores. We conduct simulation experiments to compare the performance of heuristics with static and intuitive policies. Simulation results show proposed heuristics outperform other policies.

3 - The Impact of Capacity Changes on Labor Productivity in Retailing
Chien-Ming Chen, Nanyang Technological University-Singapore, 50 Nanyang Avenue, Singapore, 639798, Singapore, Hao-Chun Chuang

Matching in-store staffing level with shopper traffic has been a long-standing principle in retail operations. Using data from a large retail chain, we show that increment of manpower can adversely affect marginal labor productivity in the conversion and sales-generation process. Our findings suggest that managers should be wary of the dark side of capacity increment in the retail environment.

4 - Product Returns, Rebates, and Restocking Fees
Rachel Rong Chen, University of California-Davis, 3208 Gallagher Hall, One Shields Avenue, Davis, CA, 95616, United States, Eitan Gerstner, Daniele Ragaglia, Paolo Roma

We compare the profitability of rebate and restocking fee policies to manage consumer product returns. We show that the use of rebates can be more profitable than the commonly used restocking fee policy under certain conditions.

■ TE62

West Bldg 103A

Joint Session DM/Practice Curated: Data Science in Health Care I

Sponsored: Data Mining

Sponsored Session

Chair: Kaiye Yu, Tsinghua University, Beijing, 100084, China

1 - A Multi-task Warped Gaussian Process Learning for Predicting the Optimal Next Line of Therapy in Multiple Myeloma
Emisa Nategh, PhD Student, University of Washington, Dept of Info Systems & Operations Management, Michael G. Foster School of Business, Seattle, WA, 98195-3226, United States, David Coffey, Hamed Mamani, Yingfei Wang

The objective of this research was to develop a model to predict the sequence of therapy which results in the best progression free survival (PFS). In this paper, we formulate the next line of treatment PFS based on previous line of treatment PFS and its effect on overall survival as a multi-task learning problem in the context of warped Gaussian process. We propose a novel methodology by using composite kernel over tasks in our model to improve our result. We illustrate its practicability by applying it to sequencing of therapy in cancer patients.

2 - Making Predictions of Pediatric Outpatient Clinic Room Requirements to Improve Room Allocation Policies
Tian He, Graduate Student, University of Pittsburgh, 3700 Ohara St, 1025 Benedum Hall, Pittsburgh, PA, 15261, United States, Kiatikun Louis Luangkesorn, Pranay Mohanty

Children's Hospital of Pittsburgh provides space for over 20 specialty outpatient pediatrics clinics on site. These clinics have been having issues with patient access, the ability of patients to schedule an appointment in a timely fashion. While the specialties state that lack of additional space prevents them from increasing capacity, the rooms are currently underutilized on the whole. We develop and apply predictive models based on data found in Electronic Health Records to identify on a session by session basis the presence of excess room which could be reallocated to services that require additional rooms to meet known demand.

3 - A Data Driven Analytical Framework for Hospital Readmission Prediction
Kaiye Yu, Tsinghua University, Room 520, Shunde Building, Beijing, BJ100084, China, Xiaolei Xie

The improvement effort to reduce hospital readmissions necessitates reliable risk prediction tool. We develop and validate an analytics framework for predictive modeling of all-cause readmissions using data-driven approaches. Dimensionality reduction, predictors identification, data sampling and imbalance data handling are performed. A mix-ensemble framework which is integrated by the base machine learning classifiers is proposed after the comparison of the different prediction techniques using hospital administrative data. Finally, the models are assessed and managerial insights are obtained.

4 - A Data Driven Analytical Framework for Hospital Readmission Prediction
Kaiye Yu, Associate Professor, Tsinghua University, Beijing, China, Xiaolei Xie

The improvement effort to reduce hospital readmissions necessitates reliable risk prediction tool. We develop and validate an analytics framework for predictive modeling of all-cause readmissions using data-driven approaches. Dimensionality reduction, predictors identification, data sampling and imbalance data handling are performed. A mix-ensemble framework which is integrated by the base machine learning classifiers is proposed after the comparison of the different prediction techniques using hospital administrative data. Finally, the models are assessed and managerial insights are obtained.

■ TE63

West Bldg 103B

Joint Session DM/Practice Curated: Data Science for Forecasting

Sponsored: Data Mining

Sponsored Session

Chair: Guangrui Xie, Virginia Tech, Blacksburg, VA, 24061, United States

1 - A Data-driven Forecasting Approach for Newly Launched Seasonal Products
Tugba Efendigil, MIT, Cambridge, MA, United States, Vicky Wing Kei Chan, Majd Kharfan

Demand forecasting is becoming a very complicated process in fashion industry due to the short product life-cycle, the obsolescence of the retail calendar, and the lack of information for newly launched seasonal items. Therefore, this study focuses on demand prediction with a data-driven perspective both leveraging machine-learning techniques and identifying significant predictor variables to help fashion retailers achieve better forecast accuracy.

2 - Sparse Reduced-rank Regression with Applications
Haileab Hilafu, Assistant Professor, University of Tennessee, 916 Volunteer Blvd, Knoxville, TN, 37996, United States

We present a sparse estimation of the reduced-rank multivariate regression model. Our estimation proposal minimizes the block-ℓ_1 norm of the rows of the coefficient matrix subject to a sparsity inducing ℓ_∞ norm. Extensive simulation results will be presented to demonstrate effectiveness of the method. We apply the method to build a predictive model for the interest rates time series covering treasuries, corporate, term spreads and public-private spreads, from the FREDQD data. Theoretical properties of the proposed method will also be presented.

3 - An Adaptive Data Communication Scheme for Bandwidth Limited Residential Load Forecasting
Guangrui Xie, Virginia Polytechnic Institute and State University, 112 Durham Hall, 1145 Perry Street, Blacksburg, VA, 24061, United States, Xi Chen, Yang Weng

While adding new capabilities, the proliferation of distributed energy resources makes it challenging to provide reliable power and voltage forecast for operational planning purposes. We propose an integrated Gaussian Process-based method(IGP) for hourly electric load forecasting, which utilizes not only the data streams generated by the target customer but also those of relevant customers in the feeder system. An adaptive data communication scheme is further proposed to maintain the high forecast accuracy of IGP when a data communication bandwidth constraint is imposed in some feeders. The superior efficacy of IGP and the adaptive data comunication scheme is tested on various IEEE test cases.

■ TE65

West Bldg 104B

Joint Session DM/Practice Curated: Data Science and Deep Learning IV

Sponsored: Data Mining

Sponsored Session

Chair: Junzi Zhang, Stanford University, Stanford, CA, 94305, United States

1 - Predicting Information Diffusion Probabilities in Social Networks Based on Neural Networks
Zhecheng Qiang, PhD Student, University of Central Florida, 4000 Central Florida Blvd., Orlando, FL, 32826, United States, Alexander Semenov, Qipeng Zheng

Predicting information diffusion through social networks plays an important role in human activities analysis and influence maximization realization. Our paper focuses on predicting information diffusion probability in social networks based on artificial neural networks. In this paper, we analyze and study the fundamental factors that might affect the diffusion process. Then we implement deep neural network and generalized regression neural network to predict the diffusion probability. We evaluate our models on several real data sets and it shows our models are effective and outperform the state-of-the-art methods.

2 - Multiple Instance Learning via Quadratic Programming
Emel Seyma Kucukasci, Istanbul Commerce University, Kucukyali E5 Kavsagi Inonu Cad No 4, Istanbul, 34840, Turkey Emel Seyma Kucukasci, Bogazici University, Istanbul, Turkey, Mustafa Gokce Baydogan, Z. Caner Taskin

In multiple instance learning (MIL), objects are represented by a bag of instances and the class labels are known for the bags, but not for the individual instances. We present a novel quadratic programming-based approach to classify bags. Our algorithm imposes no additional constraints on relating instance labels to bag labels and applicable to many learning problems such as image classification, molecule activity prediction and text mining. We demonstrate the computational efficacy and classification success of our approach on a wide range of real world datasets.

3 - Features Level Opinion Mining from Informal Text Corpus Using Machine Learning Techniques
Prabin Kumar Panigrahi, Indian Institute of Management Indore, Rau-Pithampur Road, Indore, 453556, India, Nishikant Bele

Due to Internet, torrent amount of informal text is generated. People express their views, emotion, feeling, and opinion on blogs, reviews, and social sites. This paper explores the use of machine learning technique at feature level sentiment categorization of Hindi blogs reviews at unigram, bigram, trigram and n gram level. We used six types of machine learning techniques to study whether unigram, bigram, trigram, and n-gram can be used for sentiment mining at the feature level. Our study shows that bi-gram with SVM outperformed the other methods.

4 - Robust Bayesian Level Set Estimation via Gaussian Processes
Junzi Zhang, Stanford University, Palo Alto, CA, 94304, United States, Andrea Zanette, Mykel John Kochenderfer

This paper focuses on the problem of determining as large a region as possible where a function exceeds a given threshold with high probability. We assume that we only have access to a noise-corrupted version of the function and that function evaluations are costly. To select the next query point, we propose maximizing the expected area of the domain identified as above the threshold as predicted by a Gaussian process, robustified by a variance term. We also give asymptotic guarantees on the exploration effect of the algorithm, regardless of the prior misspecification. We show by various numerical examples that our approach also outperforms existing techniques in the literature in practice.

■ TE66

West Bldg 105A

Joint Session DM/Practice Curated: Intriguing Tweaks in Data Science II

Sponsored: Data Mining

Sponsored Session

Chair: Derya Dinler, Middle East Technical University, ODTU Endystri Myhendisligi, Ankara, Turkey 06800

1 - Sparse Component Analysis of Locally Dominant Source
Syed Mujahid, Asst. Professor, KFUPM, Dhahran, Saudi Arabia

In this talk, the linear case of Blind Signal Separation (BSS) problem is presented. Conventionally, the BSS problem is solved via the Independent Component Analysis (ICA) methods, which requires the statistically independence assumption. A different class of methods that are based on the notion of sparsity, are called as Sparse Component Analysis (SCA) methods. A novel LP model that can solve a specific class of SCA problems will be presented in this talk. Numerical results will be presented to illustrate the usability of the proposed model.

2 - Laplacian Regularized Gaussian Processes for Modeling Expensive Black-Box Functions
Rajitha Meka, University of Texas-San Antonio, One UTSA Circle, San Antonio, TX, 78256, United States, Adel Alaeddini

In an increasing number of cases involving estimation of complex functions in the real world, one is often confronted with situations where there are several factors to be evaluated but experiments are prohibitively complex and/or expensive. Gaussian process (GP) is a well-known non-parametric regression method to fit nonlinear functions. We propose Laplacian regularized Gaussian processes with bilateral kernel to make use of both measured and unmeasured points for efficient modeling of expensive black-box functions.

3 - Probabilistic Distance Clustering on Networks
Cem Iyigun, Associate Professor, Middle East Technical University, Inonu Blvd, Endustri Myhendisligi, Ankara, 06800, Turkey, Derya Ipek Eroglu

In this study, a soft clustering problem on networks is investigated. It is assumed that cluster centers are located not only on vertices, but also on the edges of the network. Two different soft assignment schemes are studied where different membership functions are considered for the assignments. Structural properties for the clustering problem have been derived for different problem settings and the relation to the p-median problem has been shown under specific conditions. As a solution approach, a metaheuristic algorithm using the properties of the problem has been proposed. Computational experiments have been conducted with different problem instances.

■ TE70

West Bldg 106B

Joint Session DEA/Practice Curated: Applications III

Emerging Topic: Productivity, Efficiency and Data Envelopment Analysis

Emerging Topic Session

Chair: Xiang Ji, University of Science and Technology of China, 800 W Renner Road, Richardson, TX, 75080, United States

1 - A Heterogeneous DEA-based Eco-efficiency Measurement of China's Industrial Sectors
Mingjun Li, University of Science and Technology of China, Hefei, China, Jie Wu

Environmental problems brought by industry are attracting extensive attention so a comprehensive analysis of industrial environmental performance is increasingly important. In this paper, we extend the DEA model to consider two-sided non-homogeneous problems, handling DMU sets that have non-homogeneity in both inputs and outputs. This is different from the previous researches which generally focus on regional data to avoid heterogeneity. With this more realistic analysis of environmental efficiency, the Chinese government can make more informed decisions to realize sustainable industrial development.

2 - DEA Cross-efficiency Model with Reciprocal Behavior
Feng Li, Southwestern University of Finance and Economics, Chengdu, 611130, China

A reciprocal behavior is responding much nicer to friendly actions and much nastier to hostile actions. This paper integrates the reciprocal behavior among Decision Making Units (DMUs) into Data Envelopment Analysis (DEA) cross-efficiency approaches. To this end, a series of games are developed by viewing each DMU as a player and adopting different evaluation strategies. Several equilibrium points are obtained for different strategies, and game theoretical implications are provided. Finally, the proposed approach is applied to logistics industries.

3 - Using A Hybrid Heterogeneous DEA Method to Benchmark China's Sustainable Urbanization
Xiang Ji, University of Science and Technology of China, 96 Jinzhai Rd, Hefei, 230026, China, Jie Wu, Qingyuan Zhu, Jiasen Sun

Due to recent official policy changes, China's sustainable urbanization has entered a new type of multi-target heterogeneous situation which has never been scientifically researched before. To deal with this new heterogeneous scenario, we introduce a hybrid heterogeneous data envelopment analysis (DEA) method that contains input segment estimation and efficient frontier construction. We also introduce a bi-level benchmarking method that benchmarks each city's eco-efficiency and uses those benchmarks to guide sustainable urbanization completion in an empirical study of 206 Chinese prefecture-level cities' sustainable urbanization.

■ TE72

West Bldg 211A

Practice- Operations Management I

Contributed Session

Chair: Debdatta Sinha Roy, Robert H. Smith School of Business, University of Maryland, College Park, MD, 20742, United States

1 - An Improved Quasi-experiment to Evaluate the Effectiveness of Performance-based Reward
Lingfeng Li, Vanguard Group, Wayne, PA, United States

Performance-based reward (PBR) has been adopted to facilitate the achievement of

organizational goals. However, evidence on the effectiveness of PBR is limited, and methods to evaluate PBR effectiveness have not been well established. This work is the first effort to introduce an improved quasi-experiment (IQE) to obtain high level of evidence to support decision-making on the application of a PBR. Our pilot results suggest the effectiveness of a PBR could vary across operational settings: PBR could improve the productivity of employees who process not-in-good-order items by at least 5% (p-value = 0.00005). However, evidence is insufficient for employees who process in-good-order items.

2 - Portfolio Choice of Renewable Energy
Chen Wei, University of Electronic Science and Technology of China, Chengdu, China, Ma YongKai, Tang Xiao Wo

Most countries used the Energy Internet,which has a key feature that the electricity is mainly generated by renewable energy, to reduce carbon emissions. Renewable energy (i.e., wind and solar) is volatility, however, renewable energy combination on-grid can reduce the renewable energy volatility. This paper focuses on the portfolio choice of renewable energy. We constructed a model that utility firms, including conventional and renewable energy firms, supply the electricity to the market, in different pricing policies. We find that flat pricing leads to a higher investment level for solar energy, meanwhile, peak pricing leads to invest more wind energy.

3 - Sequencing Mixed Models on an Assembly Line with Variable Rate Launching and Open Stations
Tobias Moench, WHU-Otto Beisheim School of Management, Vallendar, Germany, Arnd H. Huchzermeier

Introduction of new models on an assembly line pools demand risk, but also increases costs of idle time, utility work and space. Opening up station boundaries and introducing variable rate launching instead of a fixed tact time reduces all costs simultaneously. Moreover, the overall line length is reduced significantly.

■ TE80

Hyatt, Curtis B

Practice- Supply Chain Management II

Contributed Session

Chair: Mengke Tian, The Hong Kong University of Science, Room 3208, Dep. of IEDA, Acade, Hong Kong

1 - Impact of Supplier's Lead Time on Assembler's Strategic Decisions
Yuhong He, Assistant Professor, California State University-Fullerton, 2550 Nutwood Avenue, SGMH 4149, Fullerton, CA, 92831, United States, Wenting Pan

This paper examines the impact the supplier's lead time has on the assembler's strategic choice of partnership. Specifically, we study when the assembler would buy components from the suppliers and when the assembler would have a vendor-managed consignment contract with the suppliers. Furthermore, we also explore the conditions under which a supplier would be selected by the assembler as a sub-assembler to manage other suppliers.

2 - Partial Vertical Integration in Supply Chains
Yibin Zhang, Associate Professor, Lixin University of Accounting & Finance, 2800 Wenxiang Road, Songjiang University Town, Shanghai, 201620, China, Xiaoguang Wang, Victor Shi

It is widely assumed in the operations management literature that vertical integration can eliminate double marginalization and boost supply chain efficiency. However, a number of research studies find that full disintegration can be beneficial in certain strategic context. In this paper, motivated by the common business phenomenon that firms hold each other's ownership shares, we study partial vertical integration in supply chains. Our findings show that partial vertical integration can be the equilibrium channel structure in supply chains. Hence, our research provides another important justification for the business practice of partial ownership among firms.

3 - A Supply Chain Framework to Improve Survival and Productivity of Small Firms in Developing Countries: A Case Study in Latin America
Cansu Tayaksi, Postdoctoral Associate, Massachusetts Institute of Technology, 77 Massachusetts Ave, Cambridge, MA, 02139, United States, Josue Velazquez Martinez, Ramon Paulino, Rafaela Pereira Nunes

Small firms represent more than 95% of the companies in developing countries. Due to a lack of productivity, only a fraction survives. In this paper, we study the impact of SC practices in small firms and show that by improving SC expertise, small firms also improve their survival rate. We present a conceptual framework based on a system dynamics model that provides guidance on how small firms can focus on SC and business priorities. We validate our framework via a field study conducted in 50 companies in three countries in Latin America.

4 - Product Line Planning Under Uncertainty
Sakir Karakaya, Industry and Technology Expert, Ministry of Science, Industry and Technology, Mustafa Kemal Mah. Eskisehir Yolu 7.km, Ankara, 06510, Turkey, Gulser Koksal

This study addresses the problem of multi-period mix of product-lines under a product family, which incorporates launching decisions of new products, capacity planning decisions and product interdependencies. The problem is modelled as a two-stage stochastic program in which price, demand, production cost and cannibalisation effect of new products are characterised as uncertain parameters. The solution approach employs the Monte Carlo bounding technique and L-shaped method, which is tested on real-like cases considering VSS and EVPI performance measures. The data collected through two experimental studies is analysed using ANOVA and Random Forest methodology.

5 - A Comparison of Stochastic Service Model and Guaranteed Service Model in Multi-echelon Inventory Systems
Yinan Liu, Lehigh University, Philadelphia, PA, 19144, United States

The Stochastic Service Model (SSM) and Guaranteed Service Model (GSM) are competing models for optimizing multi-echelon inventory systems. SSM accounts for the uncertainty in lead times due to stockouts, while GSM treats lead times as bounded. SSM is more representative of real-world supply chains, but GSM is more tractable and widely used in practice. Our research asks whether GSM is an effective heuristic for SSM. Our results suggest that SSM and GSM agree closely in serial and assembly systems under many conditions. However, the two models often diverge for distribution systems, making GSM more problematic for more complex topologies.

6 - How Does Conspicuous Consumption Affect Product Line Design
Mengke Tian, the Hong Kong University of Science and Technology, Hong Kong, Ying-Ju Chen, Xin Wang

We analyze the effects of conspicuous consumption on the product line design when there is only a monopoly manufacture who tends to directly serve the market with high and low-end products. We find that stronger conspicuous effect undercuts the quality and prices for both products which leads to the increase of demands. The total profit of the manufacture is elevated. The gaps of quality standard and selling price are widened. We extend by adding a retailer in the distribution channel. We find that manufactures adopts the same quality strategies as before. The double marginalization effect leads to higher prices and lower demands. But its influence is mitigated when conspicuous consumption is stronger.

4 - Efficiency and Risk Trade-off in Security Screening Operations
Mehmet Aydemir, Carnegie Mellon University, 5000 Forbes Ave, Pennsylvania, Pittsburgh, PA, 15213, United States, Alexandre Jacquillat, Alan Scheller-Wolf

The management of screening systems involves a trade-off between efficiency and risk. We model a screening system with a range of screening options having different service and risk mitigation characteristics, in which the controller can dynamically select the screening option based on job-level risk profile information. We propose a multi-class Markov decision process model of the control of such a screening system as a function of observed queue length and risk profile information. We show that the optimal policy exhibits a threshold behavior. We extend this model to a setting where customers are strategic. We find conditions where slower screening policies lead to shorter queue lengths.

5 - Data Driven Variability Analysis of Vehicle Routes
Debdatta Sinha Roy, Robert H. Smith School of Business, University of Maryland, 7699 Mowatt Lane, 3330 Van Munching Hall, College Park, MD, 20742, United States, Bruce L. Golden

Delivery and service companies need to send out multiple vehicles to deliver customer products and provide services to customers in a city every single day. These companies generate the vehicle routes using routing software and algorithms provided by third party clients. It is a matter of great importance to maintain the workload balance among the drivers of a company, i.e., the drivers should have similar route times (inclusive of the service times). Based on real route times generated using two different third party software on various street networks, we perform statistical analysis to understand and quantify the variability in the route times and, thereby, make recommendations to the companies.

4 - Tree-structured Data Clustering
Derya Dinler, Middle East Technical University, ODTU Endustri Muhendisligi Bolumu, Cankaya, Ankara, 06800, Mustafa Kemal Tural, Nur Evin Ozdemirel

We consider a clustering problem in which data objects are rooted trees with unweighted or weighted edges and propose a k-means based algorithm which repeats assignment and update steps until convergence. The assignment step utilizes Vertex Edge Overlap to assign each data object to the most similar centroid. In the update step, each centroid is updated by considering the data objects assigned to it. For the unweighted edges case, we propose a Nonlinear Integer Programming (NIP) formulation to find the centroid of a given cluster and solve the formulation to optimality with a heuristic. When edges are weighted, we also provide an NIP formulation for which we have a heuristic not guaranteeing optimality.

■ TE83

Hyatt, Remington

Practice- Health Care V

Contributed Session

Chair: Jens Brunner, University of Augsburg, Universitatsstra e 16, Faculty of Business and Economics, Augsburg, 86159, Germany

1 - Master Surgical Scheduling and Elective Surgeries Scheduling
M'Hallah Rym, Professor, Kuwait University, P.O. Box 5969, Safat, Kuwait, 13060, Kuwait

This paper proposes a stochastic model that determines a two-week master surgical schedule for a leading hospital. It determines the optimal expected number of surgeries per surgery type to plan for every two-week planning horizon. The model accounts for the random duration of both surgery times and post-surgery length of stays and the availability of post-surgery beds. It maximizes the expected operating theater's throughput. The model is solved via a sample average approximation with ranking and selection. Its application illustrates the potential savings it induces, the results' sensitivity to the length of the planning horizon and to the pooling of post-surgery beds.

2 - A Two Stage Stochastic Mixed Integer Programming Approach for Short Term Nurse Schedule Adjustments
Osman Tuncay Aydas, Assistant Professor of Supply Chain Management, Oakland University, 275 Varner Drive, Elliot Hall 308, Rochester, MI, 48309, United States, Anthony Ross, Buket Aydas

We study short-term staffing adjustments of nurse schedules for the upcoming 4-hour shift. Developed two-stage stochastic programming model minimizes total nurse staffing costs, and the cost of adjustments to the original schedules developed in the medium-term planning phase, while ensuring adequate coverage of nursing demand. Our findings indicate, short-term stochastic schedule adjustments can deliver cost savings of up to 20%. As the number of unscheduled admissions increase there is a greater need for scheduling flexibility. We demonstrate the significance of part-time nurses, which alleviate under- and over-staffing risks and provide scheduling flexibility to the nurse managers.

3 - Differentiating the Types of Inter-hospital Transfer Helps Hospital Choice Decisions
Lei (Raymond) Fan, Student, University of Houston, 4800 Calhoun Rd, Houston, TX, 77004, United States, Ming Zhao, Xiaosong David Peng

Inter-hospital patient transfer adds complexity to healthcare operations. We study inter-hospital transfers at the patient level. We develop a methodology to classify the transfers, and for each transfer type, we investigate the effects of transfer decisions on patient care performance. The results may be used by healthcare providers to develop better inter-hospital transfer guidelines.

4 - Does Announcing the Visit Matter? An Empirical Examination in US Nursing Homes
Sehwon Kang, PhD Student, University of Minnesota, Carlson School of Management, Minneapolis, MN, 55455, United States, Rachna Shah, Kevin Linderman

Recently, healthcare accrediting agencies changed their on¡-site accreditation survey visits from announced to unannounced. In this study, using panel data from more than 3,000 US nursing homes over 4 years, we empirically examine the impact of this two regimes in terms of improving and sustaining quality performance.

5 - Leveling of Intensive Care Unit Utilization by Efficient Surgery Scheduling
Jens Brunner, Prof. Dr., University of Augsburg, Universitaetsstrasse 16, Faculty of Business and Economics, Augsburg, 86159, Germany, Steffen Heider

The intensive care unit (ICU) is an expensive hospital resource serving both emergency and elective patients. The vast majority of ICU patients arrive from the operating theatre. In order to increase efficiency, we propose a mixed-integer programming model to optimize surgery scheduling with the goal of balancing the expected occupancy of patients in the ICU. The model is applied to two years of data from our cooperating hospital. We show that a more balanced utilization is possible without changing the master surgery schedule and that days without elective surgery have a negative effect when leveling the utilization at the ICU.

■ TE84

Hyatt, Russell

Practice- Disaster and Disruption Management I

Contributed Session

Chair: Duygu Pamukcu, Middle East Technical University, Ind., Ankara, 06400, Turkey

1 - A Multistage Robust Model for Blood Transshipment Problem in Disasters
Jie Deng, Lecturer, Jiangnan University, School of Business,Jiangnan University, Wuxi, China

This research introduces a robust multi-echelon multi-stage model that can assist in blood transshipment problem with uncertain demand and supply in disasters, the proposed model considers service level-based policy in the blood scheduling process to minimize the unsatisfied demand and the time span between blood production in regional blood centers and consumption in demand zones for reducing blood shortage and wastage.

2 - A Hypercube Queuing Equilibrium Approach to Dynamic Volunteer Firefighter Planning under Probabilistic Service Disruptions
Han Liu, University of Illinois, Urbana-Champaign, 722 Foley Ave, Champaign, IL, 61820, United States, CHAO LEI, Yanfeng Ouyang

We propose a multi-period hypercube queuing equilibrium model for the dynamic volunteer firefighter planning problem with multiple rescue rounds, with the consideration of that rescue services are under the risk of being disrupted. The applicability of the proposed model is tested on an empirical case study in Baoding. Numerical results show that more rescue resources should be dispatched in the first rescue round if the disaster deteriorates fast.

3 - Minimization of the Social Impact of an Earthquake in Lima Metropolitana and Callao Optimizing the Speed of Response with Mathematical Models
Renzo Benavente, Pontificia Universidad Catolica del Peru, Universitaria 1801, Lima, LIMA 32, Peru, Jonatán Edward Rojas Polo

This research shows opportunities for improvement in the response plan after an earthquake for the distribution of humanitarian aid. The proposed methodology begins with a clustering of the geographic area of Lima Metropolitana and Callao in 9 groups with a main warehouse in each. Then, the amount and location of temporary warehouses that will supply the affected population is calculated. Finally, a linear programming model is executed for the distribution of humanitarian aid goods from the central warehouse to the temporary ones. With this, it is possible to reduce the response time and make it more dynamic for the population.

■ WA01

North Bldg 121A

Joint Session OPT/Practice Curated: Healthcare Operations under Uncertainty

Sponsored: Optimization/Optimization under Uncertainty

Sponsored Session

Chair: Yiling Zhang, University of Michigan, Ann Arbor, MI, 48105, United States

1 - Appointment Scheduling under Time Dependent Patient No-Show Behavior
Zhenzhen Yan, Nanyang Technological University, 21 Nanyang Link, Singapore 637371, Qingxia Kong, Shan Li, Nan Liu, Chung-Piaw Teo

This paper studies how to schedule medical appointments with time-dependent patient no-show behavior and random service times. We observe a significant time-of-day effect on patient show-up probabilities from two clinic datasets. We deploy a distributionally robust approach to model the schedule problem. To tackle the case when patient no-shows are endogenous on the schedule, we construct a set of dual prices to guide the search for a good schedule and use the technique iteratively to obtain a near-optimal schedule. Our computational studies reveal a significant reduction in total expected cost by taking into account the time-of-day variation in show-up probabilities.

2 - Hedging the Overtime Riskiness in Online Surgery Assignments
Minglong Zhou, National University of Singapore, Singapore, Melvyn Sim

We study an advanced scheduling problem where patients are assigned to different operating theatre slots. We propose an extended riskiness index as the risk measure. We show such riskiness index shares a representation in terms of a family of measures of risk. We further propose the lexicographical riskiness index, which defines a unifying framework to capture multi-priority or piece-wise preferences. We minimize the risk of failing to meet some targets in a forward looking framework with a non-anticipative policy to incorporate future uncertainty. Simulation results show that our approach controls the risk of overtime while not compromising overall number of surgeries compared to a Benchmark.

3 - Nurse Staffing under Uncertain Demand and Absenteeism
Minseok Ryu, University of Michigan, 1911 McIntyre St, Ann Arbor, MI, 48105, United States, Ruiwei Jiang

This paper describes a data-driven approach for nurse staffing decision under

uncertain demand and absenteeism. We propose a distributionally robust nurse staffing (DRNS) model with both exogenous (stemming from demand uncertainty) and endogenous uncertainty (stemming from nurse absenteeism). We provide a separation approach to solve the DRNS model with general nurse pool structures. Also, we identify several classes of nurse pool structures that often arise in practice and show how the DRNS model in each of these structures can be reformulated as a monolithic mixed-integer linear program that facilitates off-the-shelf commercial software. Also, we propose an optimal nurse pool design model.

4 - Integer Programming Approaches for Appointment Scheduling with Random No-shows and Service Durations
Yiling Zhang, University of Michigan, Ann Arbor, MI, 48105, United States, Ruiwei Jiang, Siqian Shen

We consider a single-server scheduling problem given a fixed sequence of appointment arrivals with random no-shows and service durations, of which only the support and first moments are known. We formulate a class of distributionally robust (DR) optimization models that incorporate the worst-case expectation/conditional Value-at-Risk (CVaR) penalty cost of appointment waiting, server idleness, and overtime as the objective or constraints. We obtain exact mixed-integer nonlinear programming reformulations and derive valid inequalities to strengthen the reformulations. Convex hulls are derived for the least and the most conservative supports of no-shows. Various instances are tested.

■ WA04

North Bldg 122A

Joint Session OPT/Practice Curated: Infinite Dimensional LP with Applications to Sphere Packing

Sponsored: Optimization/Integer and Discrete Optimization

Sponsored Session

Chair: Elahesadat Naghib, Princeton University, Princeton, NJ, United States

1 - The Slater Conundrum: Duality and Pricing in Infinite-dimensional Optimization
Christopher Ryan, University of Chicago, 5807 S. Woodlawn Ave, Chicago, IL, 60637, United States, Kipp Martin, Matthew Stern

In finite dimensions, a dual solution is a vector of "dual prices that index the primal constraints and have a natural economic interpretation. In infinite dimensions, this structure may fail to hold for a broad class of problems with constraint vector spaces that are Riesz spaces that are s-order complete or satisfy the projection property. In these spaces, the existence of interior points required by common constraint qualifications for zero duality gap imply the existence of singular dual solutions that are difficult to find and interpret. We call this the Slater conundrum. We provide sufficient conditions that guarantee that there exists an optimal dual solution that is not singular.

2 - Linear Programming with Fourier Transform Constraints
Elahesadat Naghib, Princeton University, Princeton, NJ, United States, Robert J. Vanderbei

We exploit the special structure of Fourier Transforms that appear in certain linear optimizations to efficiently approximate their optimal solution. In many important instances of this family of problems such as upper-bounds on Sphere Packing, and Turan's extremal problem, computational results can shed light and provide intuition about the form of solutions in these problems. Especially for higher geometrical dimensions that the computational efforts suffer from curse of dimensionality, and a theoretical understanding is very much lacking.

3 - Bounding Infinite Dimensional LPs by Finite Dimensional LPs via Poisson Summation
Jacob Carruth, PhD, University of Texas at Austin, Austin, TX, United States

Optimization problems in which both a function and its Fourier transform are pointwise constrained by inequalities are common in applied and pure math problems. We demonstrate a technique which, if the problem has the right structure, allows one to bound the value of this infinite dimensional problem by the value of a finite dimensional linear programming problem. We'll discuss applications of this technique to sphere packings and to the Beurling-Selberg box minorant problem.

■ WA12

North Bldg 126A

Joint Session MSOM/Practice Curated: Empirical and Theoretical Studies of the Sharing Economy

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Maxime Cohen, NYU Stern, New York, NY, 10012, United States

Co-Chair: Gad Allon, University of Pennsylvania, Philadelphia, PA, 19104, United States

1 - The Impact of Behavioral and Economic Drivers on Gig Economy Workers
Park Sinchaisri, The Wharton School, University of Pennsylvania, Philadelphia, PA, United States, Gad Allon, Maxime Cohen

While gig economy firms benefit from increased labor flexibility, ensuring that their services appeal to independent providers poses a great challenge in planning and committing to a service capacity. We study how on-demand workers make labor decisions: when to work and for how long? Our project is in collaboration with a ride-hailing company with the goal to not only improve the way of predicting the number of active drivers, but also understand how to better recruit them, as a way to match supply and demand. Careful analysis of actual work decisions and responses to incentives, accounted for sample selection and endogeneity, has revealed behavioral insights that can inform better incentive design.

2 - Under the Same Roof: Value of Shared Living in Airbnb
Yao Cui, Cornell University, Ithaca, NY, 14853, United States, Ming Hu

An important difference between Airbnb and traditional hotels is that the guest may be sharing the property with the host. Due to the shared living it enables, Airbnb blurs the line between economic and social exchanges. In this paper, we study how the social exchanges affect transaction prices in Airbnb. We first offer empirical evidence that the guest's desire to stay with the host impacts transaction prices. The empirical evidence thus suggests that the guest may obtain a utility from staying with the host, which we term the social utility. We then theoretically investigate the implications of social utility for the sharing economy stakeholders.

3 - Free-floating Vehicle Sharing Networks
Einar Gunnarsson, University of Minnesota, Minneapolis, MN, United States, Saif Benjaafar

We describe a queueing model of free-floating vehicle sharing networks, such as dockless bikes. We characterize the relationship between service level, fleet size, and the size of the service region. We show that maintaining a high service level can require a disproportionately large fleet.

4 - Dockless Bike-share Systems
Ashish Kabra, INSEAD, Boulevard de Constance, Fontainebleau, 77305, France

Dockless bike-share systems have taken over the VC landscape. We study how their ridership compares and more importantly interacts with station based bike-share systems.

■ WA13

North Bldg 126B

Practice- Supply Chain Management I

Contributed Session

Chair: Konstantinos (Constantine) Moros, EY (Ernst & Young) - Advisory Services, 3 Ipsilandou Street, Alimos, Athens, 17455, Greece

1 - Implementing Blockchain Solution using Smart Contracts for Efficient Container Cargo Tracking
Raja Jayaraman, Khalifa University, P. O. Box 127788, Abu Dhabi, United Arab Emirates, Khaled Salah

Efficient tracking of container cargo is critical in managing global trade and logistics activities. The volume of global container movement combined with information opaqueness and complexity necessitates implementing a robust technology solution with real time tracking capabilities. Blockchain is an emerging technology that offers the necessary framework to track and manage container cargo movements across the supply chain using a peer-to-peer, secured, distributed ledger. In this talk, we present the implementation approach, architectural design, interactions between sender and receiver, and testing of the overall system functionality.

2 - Procurement Design under Asymmetric Information of Uncertain Supply
Feng Liu, Dr., Dongbei Univeristy of Finance and Economics, Dalian, China, Qingkai Ji, Jun Zhuang

Unreliable suppliers may pose a substantial threat to supply chains, especially when they hold private reliability information. We consider a dyadic supply chain where the production yield information of supplier is asymmetric. We propose a new mechanism-design model and derive the buyer's optimal procurement contract menu that can screen the suppliers with private information. We prove that the contract menu is as simple as offering two different inflated order amounts and setting the procuring price sufficiently low to let the suppliers earn reservation profits. This paper provides some new insights into supply chain management under asymmetric information of uncertain supply.

3 - Information Signaling of Superior Supply Chain Management Capability

Suvankar Ghosh, University of Toledo, 2801 W. Bancroft Street, Toledo, OH, 43606, United States, John Thornton, Yewmun Yip

Exceling in managing the supply chain is a challenge. Firms with superior supply chain management (SCM) capability play a key role as other businesses try to emulate them. But businesses have to first know who these capable firms are. Information signaling models assert that having a credential can signal the requisite capability. Gartner publishes annually a list of the top 25 firms that it believes excel in SCM. We treat being in Gartner's list as a credential of superior SCM capability. We study the value of this credential from 2004 to 2014 and find worrying signs that its value may be eroding with time. This has serious implications for both Gartner and the business community.

4 - Multi-criteria Evaluation of Supply Chain Structures

Ravi Suman, University of Wisconsin-Madison, Madison, WI, 53726, United States, Aqueel Nazim Altaf, Ananth Krishnamurthy, Sushanta Sahu

Strategic decisions of which products to make at which facility are often influenced by a combination of quantitative factors (capacity and costs) and qualitative factors (political stability and supply reliability). We develop a decision-making framework that effectively balances these diverse factors and evaluates alternatives. The approach uses a mixed integer programming model to capture the effects of quantitative factors and a generalized TOPSIS model to address the qualitative factors. We show that the combination of the two methods provides a true assessment of alternative scenarios facilitating effective decision making.

5 - Supply Chain Finance Program Offered by Major Retailers: A Strategic Framework of Supplier Assessment Process

Konstantinos Moros, Senior Manager - EY Advisory Services, EY (Ernst & Young) - Advisory Services, 3 Ipsilandou Street, Alimos, Athens, 17455, Greece, Daniel Corsten

The focus of this empirical research is positioned within the intersectional research area of Buyer-Supplier Relationships and Supply Chain Finance. By conducting a survey in a group of suppliers who have been exposed to, informed, and invited to adopt a SCF program, offered by one of the largest multinational retailers, we examine the main non-finance and finance related drivers of supplier-perceived satisfaction and trust and propose a strategic framework of ex-ante and ex-post assessment process followed by suppliers. We also explore the link of these two BSR constructs to the supplier perceived SCF program attractiveness and the risk of buyer opportunism, following a potential adoption.

6 - Supply Chain & Innovation in Consumer Goods Manufacturing. The Operational Impact of New Product Introductions

Rafael D az, Professor of Supply Chain Management, MIT-Zaragoza Logistics Center, Zaragoza, 50197, Spain, Leo Laranjeira Gomes

We analyze and measure the impact of new product introductions into the supply chain of a consumer goods manufacturer. Based on an in-depth analysis of operational panel data from a European company, we identified the factors that impact its supply chain performance and should be considered when analyzing exploration versus exploitation trade-offs.

■ WA16

North Bldg 127B

Joint Session MSOM/Practice Curated: Waste Issues

Sponsored: Manufacturing & Service Oper Mgmt/Sustainable Operations

Sponsored Session

Chair: Arzum E. Akkas, Boston University, Cambridge, MA, 02142, United States

Co-Chair: Dorothee Honhon, University of Texas at Dallas, Richardson, TX, 75080, United States

1 - Package Size and Pricing Decisions with a Bulk Sale Option

Dorothee Honhon, University of Texas at Dallas, 800 West Campbell Road, SM30, Richardson, TX, 75080, United States, Ismail Kirci, Alp Muharremoglu

We investigate the package size and pricing decisions of a retailer selling a perishable product to a population of heterogeneous customers who choose between buying the product in packages of a fixed pre-set size or buying the product in bulk, which allows them to buy the exact quantity which maximizes their expected net utility. We show that, contrary to popular beliefs, the existence of a bulk sale option at the retailer's may not always be environmentally beneficial as it may, in some cases, lead to more waste at the consumer level.

2 - Reducing Carbon Footprint of Grocery Retailing

Elena Belavina, SC Johnson College of Business, Cornell University, Ithaca, NY, 14853, United States, Ekaterina Astashkina, Simone Marinesi

This paper studies how e-retailing of perishables impacts market emissions. With low online adoption, inventory decentralization (due to extra stocking location of an e-retailer) is harmful and increases emissions (the result that is in line with conventional wisdom). However, with high enough adoption, the e-retailer gains enough scale, rendering decentralization, surprisingly, beneficial to the environment. Interestingly, equal demand split among retail locations leads to the worst environmental outcome. That is, we find that traditional models consider the worst kind of inventory decentralization.

3 - Implications of Eliminating Aesthetic Grading in Agricultural Supply Chains

Karthik Murali, University of Alabama, 351 Alston Hall, Tuscaloosa, AL, 35487, United States, Isil Alev

The grading of produce based on aesthetics is among the biggest contributors to food waste. Using a stylized model, we explore how crop yield and consumer preferences shape the economic and environmental consequences of eliminating grading in the agricultural supply chain by introducing aesthetically differentiated produce at the retail level.

■ WA21

North Bldg 129B

Practice- Optimization I

Contributed Session

Chair: Maziar Sanjabi, University of Southern California, Los Angeles, CA, 90007, United States

1 - Job Scheduling with Simultaneous Assignment of Machines and Multi-skilled Workers: A Mathematical Model

Cinna Seifi, Research Assistant, Clausthal University of Technology, Julius-Albert-STrasse, Clausthal-Zellerfeld, 38678, Germany, Jürgen Zimmermann

The primary task of mining companies is the extraction of raw materials. Based on a planning program, a certain quantity of materials is expected to be extracted within a given time horizon. The applied mining method is characterized by nine process steps each of which has to be executed by an appropriate machine and worker. The processing time of a process step depends on the assigned devices and workforces. In this paper, we formulate a mathematical program for a simultaneous assignment of devices and personnel to a selection of jobs. The aim is to minimize the difference between the predetermined quantity and the amount of extracted material, cumulatively over all the process steps, for a work shift.

2 - Effective Rules of Thumb in Analytics Modeling

Yanqi Xu, Director of Applied Technology, Princess Cruises, Valencia, CA, 91355, United States

Various industries build optimization models to provide meaningful solutions to practical problems so as to increase revenue, reduce costs, manage risks, streamline operations, etc. In this talk, we will share our model building experience and lessons learned across different industries. Topics (with real world examples) include: number one concern of model building, how to solve the problem at the right level of details, what to include/exclude, signs that the issues of a model cannot fixed by incremental improvement, performance tradeoffs, and modeling with sparse data.

3 - Generative Adversarial Network Formulations with Convergence Guarantees

Maziar Sanjabi, USC, Los Angeles, CA, United States

Generative Adversarial Networks (GANs) are one of the most practical strategies to learn data distributions. A popular GAN formulation is to use Wasserstein distance as a metric between probability distributions. Unfortunately, minimizing this distance is difficult as its objective is non-convex and non-smooth. In this work, we use smooth approximations of this objective. We show that obtaining gradient information of the smoothed formulations is easy. Based on this observation, we propose a class of first-order algorithms with guaranteed theoretical convergence to stationarity. We apply our method to MNIST and CIFAR-10 datasets and show its effectiveness.

■ WA22

North Bldg 130

Practice- Pricing and Revenue Management I

Contributed Session

Chair: Hao Lu, University of Science and Technology of China, 96 JinZhai Road, Baohe District, Hefei, 230026, China

1 - Which Outlier Detection Approach is Better for Estimating the Elasticity Value

Shuguang Ji, Sr. Data Scientist, Delta Airlines, Atlanta, GA, 30339,

United States

In cases where outliers are present, finding an accurate model to make prediction becomes more difficult. In practice, the mean +/- 3 standard deviations remains common method for outlier detection. Unfortunately, 3 problems can be identified when using this method. Firstly, it assumes that the distribution is normal. Secondly, the mean and standard deviation are strongly impacted by outliers. Thirdly, this method is very unlikely to detect outliers in small samples. In this presentation, the author wants to review the popular outlier detection methods for the elasticity estimation at first. Then the most effective detection methods will be recommended according to the cases in practice.

2 - Pricing and Service Throttling in Cloud Computing

Yingda Zhai, The University of Texas at Austin, Austin, TX, 78703, United States, Maxwell B. Stinchcombe, Andrew B. Whinston

Motivated by unprecedented surging demand for computing resource, we consider a monopoly provider with queue technology prices and allocates computing resource in a complex environment. We establish a service model with no aggregate risk which allows provider accurately to predict and manage queue capacity. A profit-maximizing provider throttles service by (i) limiting overall market supply and (ii) tranching her capacity in terms of service quantity and interruption. We then propose an appealing auction mechanism in the cloud computing spot market to implement the profit-maximizing allocation where users find it a weakly dominant bidding strategy to bid the optimal prices.

3 - Dynamic Pricing Strategy and Simulation Research Considering Strategic Consumers in Perfect Competition Electricity Market

Lingchunzi Li, Huazhong University of Science and Technology, School of Management, No. 1037, Luoyu Road, Hongshan District, Hubei Province, China, Wuhan, 430074, China, Haijun Wang, Nancy Shuojia Guo, Penghong Cheng

China is in the key stage of electricity market reform. This paper is to explore an appropriate pricing strategy to provide reference for reformation and power pricing research in China. Under centralized transactions, a game model considering customers' strategic choice behavior is established. And a time-sharing dynamic pricing scheme is solved to maximize both power enterprises' equilibrium revenue. Simulation results show that the competition between power producers can reduce power price and increase power supply volume effectively. The model we built and the factor of equilibrium validity we introduced are innovations in this paper.

4 - An Optimization Framework for Pricing of Port Services: Case of Major Ports in India

Deepankar Sinha, Associate Professor, Indian Institute of Foreign Trade, 1583 Madurdah, Kolkata, 700107, India

Ports enable inter and intra-modal cargo transshipment to and from ships. The cost incurred in ports impact the total landed cost of any maritime cargo. The ports need to achieve three basic objectives. One, it needs to be efficient in achieving the desired level of productivity with optimal use of resources; second, minimize cost of operation; and third minimize total landed cost of shippers. So far, studies and researches have focused on part of these objectives. In this paper an attempt has been made to encompass all the three objectives. It proposes to use a non-parametric approach to develop a multi-objective optimization model to arrive at a rational pricing framework for port services.

5 - Multinational Merger and Acquisition and Market Value of China's Service Enterprises in the Belt and Road Strip

Hao Lu, PhD Student, University of Science and Technology of China, 96 JinZhai Road, Baohe District, Hefei, 230026, China

The Belt and Road strip (BRS) provides a broad stage for Chinese service enterprises to enter into M&As overseas. However, whether such multinational M&As achieved the expected market value return? This paper uses event study methods to analyse the development of multinational M&As in the service industry in BRS for the period 2013-2017. We found that since 2013, most of China's multinational service M&As have achieved significantly positive abnormal returns (ARs). The ARs of M&As in the technology services and public services were found to be more significant than other sub-industries of service. Among the factors that affect AR, the ratio of M&A contract size is the most significantly positive.

■ WA28

North Bldg 221A

Practice- Logistics 1

Contributed Session

Chair: Josue Velazquez Martinez, Massachusetts Institute of Technology, Cambridge, MA, 02139, United States

1 - A Unified Dynamic Control for Energy-aware Electrical Vehicle Operations

Seokgi Lee, Assistant Professor, University of Miami, 1251 Memorial Drive, McArthur Engineering Building, Room 281, Coral Gables, FL, 33146, United States, Hyun Woo Jeon

This study investigates the time and cost benefits that can be gained by the integrated control of EMV operations combined with an energy consumption prediction. Dynamic models for EMV charging capacity and operations control systems will be developed and serve as a scientific basis for a unified control algorithm, in which charging capacity, routing, and battery charging schedules of EMV are simultaneously controlled in a real-time manner. An electrical load variation at the warehouse facility level will be predicted by developing a novel electrical load forecasting model based on cutting-edge machine learning techniques, which will serve as important guidelines for unified decision-making.

2 - Real-time Package Consolidation for Split Orders in Online Retailing

Yuankai Zhang, Dalian University of Technology, Office Room A1214 Innovation Park Building, Dalian, 116024, China Yuankai Zhang, University of Arizona, Tucson, AZ, 85719, United States, Xiangpei Hu, Wei-Hua Lin

The order splitting has been one of the main challenging problems for multi-item order fulfillment in online retailing. The key issue to fulfill split orders with fast-delivery options in lower costs is: how to make package consolidation (consolidating and packing items of several sub-orders together) decisions in real-time using capacitated warehouses. We formulate an analytic model and propose a rolling horizon based heuristic algorithm to generate efficient real-time package consolidation schemes for online retailers.

3 - A Benders Decomposition Algorithm for the Fulfilment Planning Problem of an Online Retailer with a Self Owned Logistics System

Shuqin Li, Shanghai Jiao Tong University, No.800 Dongchuan Rd., Shanghai, China, Shuai Jia

We consider an order fulfilment planning problem in an e-tailing environment. For each planning period, the e-tailer makes decisions for assigning orders to the fulfilment centers and the delivery stations, as well as the decision for shipping orders under a time window constraint. We develop a mixed integer program to minimize the order processing cost and shipping cost. We show that the problem is strongly NP-hard, and propose a benders decomposition algorithm for solving the problem. We evaluate the computational performance of the algorithm on problem instances that are generated based on the logistics network of JD.com, a leading e-tailer in China who operates a self-owned logistics system.

4 - How Survival of Micro Retail Companies Affects Logistics Costs in Large Consumer Packaged Goods Companies

Josue Velazquez Martinez, Research Scientist, Massachusetts Institute of Technology, Cambridge, MA, 02139, United States, Ximena Castanon Choque, Christopher Mejia Argueta, Jan C. Fransoo

In developing economies, many mom-and-pop stores disappeared per year due to a lack of productivity, while many others appeared because of low barrier of entry. Therefore, the overall micro-retailing market grows per year and represents from 40-70% of demand of large CPG companies. In this paper, we study the impact of these dynamics on logistics costs. We discuss a practical case for a distributor in Mexico City, and by using cost-to-serve estimations and continuous approximation models for routing; we show that by improving survival rate, we may avoid losses in logistics costs up to 30%.

■ WA29

North Bldg 221B

Joint Session TSL/Practice Curated: Patrolling and Service Delivery Problems

Sponsored: TSL/Urban Transportation

Sponsored Session

Chair: Rajan Batta, University at Buffalo (SUNY), Buffalo, NY, 14260, United States

1 - Taking Out the Guesswork: An Analytics Approach to Police Contraband Searches

Anthony Bonifonte, Denison University, 3267 Raccoon Valley Rd, Granville, OH, 30106, United States, Tong Zhou

Police searches of vehicles stopped for traffic violations can seize contraband and improve public safety, but unnecessary searches are time consuming and can lead to community ill will. Using publicly available data, we develop an analytics approach to assisting officer decisions in whether to search a vehicle or not. Using variables such as time and location of stop, we create an objective estimate of whether a vehicle search will discover contraband. We adopt a reject inference approach to account for having outcome data only for vehicles searched. These findings can improve the use of police time and safety, while simultaneously reducing bias in decisions and improving community relations.

2 - Using the Hypercube Queueing Model for Response to Jobs with Degradation

Rajan Batta, University at Buffalo (SUNY), 410 Bell Hall, Buffalo, NY, 14260, United States, Fatemeh Aarabi

The problem of scheduling dynamically arriving jobs over a region is considered, with the features of job degradation, travel time, and multiple servers. A modification of the Hypercube queueing model is studied to address job degradation considerations. A 3 server example is presented along with optimization of response areas, server dispatch preferences and idle server management. Numerical results will be provided.

3 - Post Disaster Assessment Routing

Bahar Yetis, Bilkent University, Ankara, Turkey, Buse Eylul Oruc

We propose a post-disaster assessment strategy as part of response operations. The arcs and nodes to perform assessment activities on are selected based on the value they add to the consecutive response operations. The model considers motorcycles, which can be utilized under off-road conditions, and/or drones. The first objective aims to maximize the total value added by the assessment of the road segments (arcs) and the second maximizes the total profit generated by assessing points of interests (nodes). An epsilon-constraint method and a heuristic is proposed. To test the mathematical model and the heuristic method, a data set belonging to Kartal district of Istanbul is used.

■ WA32

North Bldg 222B

Practice- Vehicle Routing I

Contributed Session

Chair: Amro El-Adle, University of Massachusetts, 121 Presidents Drive, Amherst, MA, 01003, United States

1 - Vehicle Routing Problem with Overlapped Time Windows on Shipping from Online Store

Takashi Irohara, Professor, Sophia University, 7-1 Kioi-cho, Chiyoda-ku, Tokyo, 102-8554, Japan

Due to expansion of online shopping market, online store is increasing. Many companies are focusing on improving delivery as it leads to greater customer satisfaction and reduced delivery costs. In many companies, delivery of online stores is delivered with shifted time window by several hours from the time window, in addition to the conventional time window, in order to improve the usage rate of delivery docks. This is called an overlapped time window. In this paper, we aim to contribute to the delivery planning of online store by proposing a model of delivery planning considering overlapped time window and approximate solution using simulated annealing.

2 - Solving Real World Vehicle Routing Problems at Scale

Bhanu Krishna Potluri, Llamasoft Inc., Ann Arbor, MI, 48104, United States

Vehicle routing problems are known to be notoriously difficult to solve. Modeling real-world constraints such as pickup-delivery time windows, driver hours of service, fleet sizing, etc. further increases complexity. With expanding logistics networks and ever increasing global freight volumes, businesses want to solve problems of realistic scale with real world constraints. This session explores meta-heuristics and cloud computing to achieve scalability of vehicle routing algorithms.

3 - Allowing for Re-optimisation in the Vehicle Routing Problem with Time Windows, Stochastic Customers and Stochastic Demand: Model and Solution Methods

Vincentius Cornelis Gerardus Karels, PhD, Technical University Eindhoven, Duikerstraat 12 Bis, Utrecht, 3582 TB, Netherlands, Lucas Petrus Veelenturf, Tom Van Woensel

We solve a vehicle routing problem with both deterministic and stochastic customers and stochastic demands. For the deterministic customers furthermore self-imposed time-windows are determined. The problem is modeled as a two-stage stochastic programming model. Whereas most similar problems allow for simple recourse in the second stage, we allow for re-optimisation. This introduces additional complexity in the model, for which we will introduce novel solution methods.

4 - Multi-depot Electric Vehicle Routing Problem with Time Windows Considering Non-linear Charging and Discharging

Surendra Reddy Kancharla, Indian Institute of Technology Madras, #238, Building Sciences Block, Alumni Ave, Chennai, 600036, India, Gitakrishnan Ramadurai

A new variant of Electric Vehicle Routing Problem with Time Windows (EVRPTW) to find the routes and charging schedules of vehicles operating from multiple depots with the objective of minimizing energy consumption is proposed. The present variant does not limit the number of visits to a charging station and considers non-linear charging and discharging. A mixed-integer program is formulated and an effective heuristic solution algorithm is presented.

5 - A Vehicle Routing Problem with Drones

Amro El-Adle, University of Massachusetts Amherst, 121 Presidents Drive, Amherst, MA, 01003, United States, Mohammad Reihaneh, Ahmed Ghoniem

We investigate a vehicle routing problem with drones (VRPD) in which customers may be served either by delivery vehicles or by unmanned aerial drones launched from the vehicles. Building on the success of branch-and-price (BP) algorithms for vehicle routing problems, we use a labeling algorithm that generates synchronized drone and vehicle routes. We demonstrate the usefulness of the proposed methodology in our computational study.

■ WA34

North Bldg 223

Practice- Disaster and Disruption Management II

Contributed Session

Chair: John Doerpinghaus, University of Arkansas, Fayetteville, AR, 72701, United States

1 - An Optimization Model for Wildfire Suppression Process and Resident Evacuation

Siqiong Zhou, San Jose State University, San Jose, CA, 95123, United States, Ayca Erdogan

Wildland-urban interface (WUI) wildfires have been big threats in many countries. We present a two-stage stochastic integer programming model for efficient wildfire comprehensive response on firefighting resource allocation and resident evacuation. This model minimizes the number of residents at risk and considers the total cost of resource operation and property loss. Resource preparation and allocation decisions are made based on both fire spread process and population density.

2 - Smart City Emergency Response Simulation Framework

Charles Njelita, Data Scientist, TATA America International Inc, 379 Thornall Street, Edison, NJ, 08837, United States

Cities around the world are becoming smarter and one of the criteria of a smart city is its ability to evacuate its citizens and visitors in the case of natural disaster, bomb blast, highway accident etc. How fast the first responder to the scene of the incidence determines the number of lives saved and injury prevented. The purpose of the paper is to develop a simulation framework which can be used by decision makers in response to an emergency that may have impacts on multiple aspects of the urban environments and socio-economical operations. These researchers will develop a multi-level simulation framework used by decision makers in city to make timely and effective responses to an emergency.

3 - Simulating and Analyzing Cascading Failures in Power Networks in Disaster Aftermath

Alireza Inanlouganji, Arizona State University, 699 S. Mill Ave, Tempe, AZ, 85281, United States, Giulia Pedrielli

Proactive response to disasters is an increasingly interesting area of research with high potential of cost reduction and safety improvement. We propose a novel framework to efficiently simulate and quickly analyze power networks and their interactions with other critical interdependent infrastructures. Both initial, exogenous, failures and failures due to cascading effects are considered and we seek a set of interesting scenarios that lead to worst adverse effects on the power network using an efficient simulation-optimization algorithm.

4 - Management of Interdependent Infrastructure Networks under Disaster-related Uncertainties

Tugce Canbilen, Research Assistant, Middle East Technical University, Universiteler Mahallesi, Dumlupinar Bulvari No: 1, Endustri Myhendisligi Balumu, Ofis: 326, Ankara, 06800, Turkey, Sakine Batun, Melih Celik

After a disaster, multiple infrastructures have disruptions in their services. During the restoration of these services, we need to consider the operational and restoration interdependencies among these infrastructures. In this study, the problem under consideration is Interdependent Infrastructure Restoration with disaster related uncertainties. We propose a two-stage program for this problem. First stage makes reinforcement decisions on the arcs of the network while second stage schedules the restoration activities considering the available resources and inherent interdependencies in the network. We will present our computational tests and preliminary results in the presentation.

5 - Classification of the Interdependencies in the Food and Agriculture Critical Infrastructure in Arkansas

John Doerpinghaus, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, Sarah G. Nurre, Kelly Sullivan, Benjamin R. Runkle

Classifying infrastructure interdependencies is vital for the creation of realistic disaster preparedness and response models. The existing interdependency classifications do not capture many intricacies of the critical food and agriculture infrastructure. We propose new infrastructure interdependency classifications relevant to food and agriculture which can be generalized to many critical infrastructures. With each new classification, we provide real accounts and examples based on over 30 interviews with stakeholders in the food and agriculture critical infrastructure sector.

■ WA36

North Bldg 224B

Joint Session Drones/Practice Curated: Drone Applications in Healthcare

Emerging Topic: Robotics, Drones and Autonomous Vehicles in Logistics

Emerging Topic Session

Chair: Justin James Boutilier, University of Toronto, Toronto, ON, M6G 2P5, Canada

1 - Response Time Optimization with Queuing Constraints for Drone Delivered Defibrillators

Justin James Boutilier, University of Toronto, Toronto, ON, M6G 2P5, Canada, Timothy Chan

Out-of-hospital cardiac arrest (OHCA) is a time-sensitive medical emergency claiming over 400,000 lives each year and an automated external defibrillator (AED) is one of the only effective methods for treating OHCA. In this paper, we propose an integrated location-queuing model to minimize the total number of drones required to meet an average response time goal while guaranteeing a sufficient number of drones are located at each base. We develop a novel reformulation technique that allows us to solve real-world instances and determine the optimal deployment of AED-enabled drone resources using eight years of data covering 26,000 square kilometers around Toronto, Canada.

2 - Drone-aided Healthcare Services for Patients with Chronic Diseases in Rural Areas

Gino Lim, University of Houston, Professor and Chairman, Dept of Industrial Engineering, Houston, TX, 77204, United States, Seon Jin Kim

We present the drone-aided delivery and pickup planning of medication and test kits for patients with chronic diseases in rural areas. A two-stage decision model is proposed to find the optimal number of drone center locations and schedule pickup and delivery in which drones deliver medicine to patients and pick up exam kits on the way back such as blood and urine samples. A preprocessing algorithm, a Partition method, and a Lagrangian Relaxation (LR) method are developed to solve the model. A cost-benefit analysis method is developed as a tool to analyze the benefits of drone-aided healthcare service.

3 - Cure for Healthcare Using Drone Technology in Hospital Processes an Explorative Analysis

Mike Krey, Zurich University of Applied Sciences, Winterthur, Switzerland

The paper at hand aims at outlining the potential and possible fields of application using drone technology inside the Swiss hospital environment. As part of a survey, face-to-face interviews with IT executives of four Swiss hospitals were conducted on the status quo of drone technology providing valuable insights about the current situation and the possible fields of application. The study revealed that different priorities, lack of motivation, and budget constraints were mentioned as the three major obstacles to improving the situation.

4 - A Framework for Using Drones after a Tornado

Sean Grogan, PhD Candidate, École Polytechnique de Montréal, 2500 Edouard Monpetit, 2900 Chemin Polytechnique Office C314.6, Montreal, QC, H3T 1J4, Canada, Robert Pellerin, Michel Gamache

Recent innovations and advancements in unmanned aerial vehicles (UAVs) have increased their utility while reducing the cost of the devices. UAVs in the aftermath of a disaster have an obvious utility where they can fly over a search area rather than be subject to potential road blocks and other impediments. To allocate the UAVs in the aftermath of a tornado has the potential to incorporate weather information and predictions from the National Weather Service, sighting information from spotters and the media, and geographic information system information to allocate UAV resources and, in turn, rescuer resources.

■ WA45

North Bldg 228A

Practice- Energy Policy and Planning I

Contributed Session

Chair: Yanyan Ding, North China Electric Power University, Beinong road, Changping, Beijing, 102206, China

1 - Resilient Based Optimal Interconnection Planning of Community Microgrids in Power Grids

Masoud Barati, Assistant Professor, University of Pittsburgh, Patrick F. Taylor Hall, Room 3325, Benedum Hall, 3700 O'Hara Street, Pittsburgh, PA, 15261, United States

We proposed a resilient planning problem of networked microgrids with DERs. We integrate the investment problem and two sets of operating problems associated with the grid-connected and islanding modes of microgrids into a two-stage stochastic model to capture randomness nature of hazard events and long-term load growth, as well as the islanding risk caused by external disturbances with a joint-chance constraint to prevent the risks. A SOCP formulation is presented to incorporate AC-OPF in short-term operation. Numerical results on distribution systems prove the effectiveness of the model.

2 - An Inter-hourly Methodology for Valuation of Windfarms

Sergio Cabrales, Assitant Professor, Universidad de los Andes, Calle 19 A. no 1-37 Este, ML-325, Bogota, 111711, Colombia, Carlos Valencia, Daniela Moreno, Sebastian Toro

This paper proposes a methodology for the financial valuation of wind power generation based on an hourly estimation approach, including inter-hour velocity and energy spot market. For this purpose, we propose that the energy generation is modelled through an autoregressive copula methodology for univariate series and the spot prices are estimated as the function of two components, a deterministic seasonal pattern and a Gaussian mean-reversion process. We applied the developed methodology to a case study in La Guajira, Colombia, reinforces the idea that an inter-hour approach improves significantly the precision of the financial indicators.

3 - Game Theoretic Demand Side Management with a Shared Storage Device

Jinkyoo Park, Korea Advanced Institute of Science and Technology, 291 Daehak-ro, Yuseong-gu, Daejeon, 34141, Korea, Republic of, Jaeyeon Jo

In this study, we propose a decentralized control strategy for distributed energy storage units in a single shared energy storage system. In the proposed control strategy, each ESS user tries to minimize their energy cost while optimizing the charging and discharging schedule of their storage unit and, at the same time, trading their storage capacity among other users, which results in a Nash equilibrium strategy of all the ESS uses. We show the derived Nash equilibrium strategy with capacity trading significantly reduces the average energy cost of users and reduces the peak load of the grid.

4 - A Contract Design Model for Power Demand Side Management

Lakshmi Palaparambil Dinesh, Visiting Instructor, Purdue University Fort Wayne, 2101 E. Coliseum Boulevard, Neff 340Q, Fort Wayne, IN, 46805-1445, United States

Demand Response (DR) is a mechanism of adjusting electricity usage with respect to peak demand and prices for electricity. DR helps consumers save energy as well as reduce utility bills. This paper covers a novel contract design model that combines customer preferences with utility provider cost minimization model. This novel Contract Design (CD) model has 20% cost savings compared to a benchmark model used in practice. Additionally, we use the CD model to determine the factors leading to cost savings and also identify how customer preferences affect contract design.

5 - Maximum Renewable Utilization with Large Number of Electric Vehicles

Pouya Sharifi, Texas A&M University, Emerging Technologies Building,, 3131 TAMU, 101 Bizzell Street, College Station, TX, 77840, United States

Vehicle to grid uses electric vehicles (EV) as distributed generation/storage devices to maintain the balance of supply and demand. However, the volatile power generation of renewable energy sources (RES) and unpredictable charging schedule of EV owners may cause problems in system scheduling and as a result, may lead to power curtailment. In this work, we propose a new scheduling framework that exploits the charging information and car owners' flexibility to build a reliable system while maximizing the RES utilization. We will simulate the proposed algorithm to check the quality of the solutions and schedules.

6 - Research on the Connection and Construction of Sustainable Development for Smart City and Smart Grid

Yanyan Ding, Research Assistant, North China Electric Power University, No. 2, Beinong road, Changping, Beijing, 102206, China

Smart city is a new form of urban development with the deep integration of ICT technology into the urban life, and the distributed renewable energy has become an indispensable element ofthe sustainable development of smart cities. Smart grids, an application of ICTs, can support to connect the energy production and consumption with plenty of electronic components. This article describes the internal relationship between the construction of smart grids and the sustainable development of smart cities. It points out that building an integrated energy system with millions and thousands of self-equilibrium cells in it can serve as an effective approach for the sustainable development.

■ WA49

North Bldg 230

Practice- Game Theory II

Contributed Session

Chair: Patanjal Kumar, Indian Institute of Management Rohtak, MDU Campus, Everest Hostel, Rohtak, 124001, India

1 - A Decentralized Algorithm for Finding Nash Equilibrium under Imperfect and Incomplete Information
Kyuree Ahn, KAIST, Daejeon, Korea, Republic of, Jinkyoo Park

In this study, we propose a nonparametric decentralized algorithm to find a Nash equilibrium of a repeated game with imperfect and incomplete information. At each iteration of the game, each player executes his own action and observes the reward and other players' executed actions (strategies). Each player then updates his belief both on his own reward function and on other players' joint strategy using Gaussian Process Regression and Log Gaussian Cox Process, respectively. As each player best responds to their beliefs that is being updated, the joint of individually updated strategy converges to a Nash equilibrium in a distributed way.

2 - Socially Differentiated Products: A Game Theoretic Approach
Hannan Sadjady Naeeni, University of Houston, Houston, TX, United States, Powell Robinson

We propose a game-theoretic duopoly model to identify equilibria configurations where one, none, or both of the firms offer socially responsible (SR) products. Our analysis shows how firms' commitment to socially responsible products depends on the marginal cost differences, market growth, and changes in consumer's perception of brand.

3 - Information Aggregation via Rational Learning in Imperfect Information Routing Games
Manxi Wu, Massachusetts Institute of Technology, Cambridge, MA, 02142, United States, Saurabh Amin, Asuman Ozdaglar

We study rational learning dynamics in traffic routing games when travelers have imperfect information about an unknown network state. In each stage, travelers myopically choose routes based on their current belief distribution, and noisy realizations of travel costs on the chosen routes become publicly available. We show that rational learning can lead to a self-confirming equilibrium in which average traveler cost is higher than the cost under full knowledge of the state. We specialize our results in situations in which self-confirming equilibrium does not exhibit such informational inefficiency, i.e., travelers make route choice as if they have complete information about the state.

4 - Using Auditing and Commitment for Engaging a Supplier for Supply Chain Sustainability
Hossein Rikhtehgar Berenji, PhD Candidate, University of Oregon, Lundquist College of Business, 1208 University of Oregon, Eugene, OR, 97403-1208, United States, Nagesh N. Murthy, Zhibin Yang

We model a buyer auditing a supplier for sustainable business practices. We investigate the effect of buyer's upfront commitment to price and quantity on supplier's compliance with the code of conduct and buyer's auditing effort and supply chain sustainability. We analyze implications of raising the standard of code of conduct on sustainability and financial performance.

5 - Impact of Virtual Organization in Sustainable Supply Chain Contracts
Patanjal Kumar, Indian Institute of Management Rohtak, MDU Campus, Everest Hostel, Rohtak, 124001, India, Peeyush Pandey, Gourav Dwivedi

This paper presents a novel approach to coordinate green and socially responsible supply chain using contracts. We compare the traditional and virtually integrated form of an organization using game theoretic approach. Through numerical examples, we demonstrate the effectiveness of our models. Our results reveal that virtual organization performs better than the traditional form of an organization under specific conditions.

■ WA50

North Bldg 231A

Practice- Retail Management II

Contributed Session

Chair: Wenli Peng, Katholieke Universiteit Leuven, Voie du Roman Pays 34 bte L1.03.01, Louvain la Neuve, 1348, Belgium

1 - Win the Buy Box - Reselling or Marketplace
Hao Su, University of Maryland-College Park, 3330 Van Munching Hall, College Park, MD, 20742, United States, Laharish Guntuka, Martin E. Dresner

This paper examines an internet retailer's decision to directly sell a product. The internet retailer offers customers both direct sales and sales through a marketplace. Using empirical analysis, we determine product characteristics that predict the internet retailer's decision to directly sell a product. We hypothesize that the internet retailer is more likely to sell (1) popular (vs. unpopular) products and (2) the products that have large (vs. limited) spillovers onto other products. Findings provide implications to marketplace sellers seeking to avoid direct competition with the internet retailer.

2 - An Investigation of Multi-staged, Dual-pronged Order Fulfillment in E-commerce Marketplace
Hyun Seok (Huck) Lee, Assistant Professor, College of Business, Oregon State University, 3007 NW Morning Glory Drive, Corvallis, OR, 97330, United States, Yusoon Kim, Junbo Son

Increasingly large e-commerce marketplaces bring order fulfillment function in-house. As a result, we observe two internal fulfillment systemsùconventional fulfillment by individual merchants (FBM) and emerging fulfillment by e-commerce platform (FBP)ùand they compete internally over efficiency. In this research, based on real-world e-commerce data on transactions and logistics, we compare the two internal fulfillment systems through uncovering distinctive mechanisms driving different operational and logistical decisions. By doing so, we suggest contingent conditions for moving towards the FBP option.

3 - Coalition Analysis of Basic Hierarchical Graph Model in Solving Climate Change Disputes
Shawei He, Assistant Professor, Nanjing University of Aeronautics and Astronautics, Nanjing, China

Coalition in hierarchical conflicts is studied in basic hierarchical graph model (BHGM). A BHGM consists of two local graph models (LGMs), containing a common decision maker (CDM) in both LGMs and two local decision makers (LDMs), each of which plays in one LGM. Coalition between CDM and an LDM, and between two LDMs, are discussed. Theorems indicate that transition from an equilibrium to another only takes place jointly by CDM and an LDM. An example of disputes over achieving emission goals between the national and provincial governments in China are investigated, suggesting that agreements on achieving stricter emission goals by a province can be reached if being subsidized by the national government.

4 - Cost of Information Sharing Under Group Purchasing
Wenli Peng, Université Catholique de Louvain, Voie du Roman Pays 34 bte L1.03.01, Louvain La Neuve, 1348, Belgium, Gilles Merckx, Philippe Chevalier, Aadhaar Chaturvedi

This paper investigates how information sharing dimension affects OEMs' motivations towards group purchasing, specifically in industries characterized by market demand and technology level uncertainties. Under Cournot competition, we find that group purchasing is preferred by OEMs when product technology strongly affects market demand, and that preference for group purchasing would depend on product substitutability, market demand variability and supplier rebate when influence of the product technology is low. We further find that group purchasing can benefit both the OEMs and the consumers.

■ WA52

North Bldg 231C

Practice – Integer Programming & Applications I

Contributed Session

Chair: Reed Harder, Dartmouth, 14 Engineering Drive, Hanover, NH, 03755, United States

1 - Least Cost Energy Optimization: Pakistan Power Sector Analysis
Raza Ali Rafique, Assistant Professor, Lahore University of Management Sciences, Sector 'U', DHA, Lahore Cantt., Lahore, 54792, Pakistan

In our study, the optimal energy-mix for power generation is sought. We propose a mixed integer linear programming (MILP) model for minimizing the power generation infrastructure cost considering indigenous energy resources of Pakistan. The proposed optimization tool can assist policy makers for strategic planning and development of future energy-mix for power generation in Pakistan.

2 - A Weighting Local Search Algorithm for the Constrained Binary Quadratic Program
Ryutaro Matsumoto, Osaka University, Osaka, Japan, Shunji Umetani, Hiroshi Morita

We develop a 2-flip neighborhood local search algorithm for the constrained binary quadratic program (CBQP) that incorporates an incremental evaluation of solutions and an adaptive control of penalty weights. The proposed method detects the special type of constraints and specifies a suitable neighborhood search. Computational results for a variety of combinatorial optimization problems show that the proposed method achieves comparable results to the specially tailored algorithms for them.

3 - A Software Tool for Interfacing with Linear Programming Solvers
Zachary Steever, University at Buffalo, Buffalo, NY, United States, Chase Murray

Note: We are finalizing a provisional patent for this tool, so we can't disclose details yet. We will update the abstract to be more descriptive well in advance of the conference. We present a new tool to help researchers more efficiently interact with application programming interfaces (APIs) that are often provided by integer programming solvers. This tool streamlines a researcher's typical workflow by automating some steps of the code-writing process. The talk will feature a demonstration of the new software. A roadmap of future enhancements to the tool will be presented, followed by a discussion on how the OR community can influence

the incorporation of new functionality into the software.

4 - A Novel Lattice-based Douglas Rachford Splitting to Solve Convex Optimization Problems over Integers

Shuvomoy Das Gupta, Thales Canada, Research & Technology, 105 Moatfield Drive, Toronto, ON, M3B 0A4, Canada

Convex optimization problems over integer decision variables have a wide range of applications in transportation, management science, computer science and engineering. In this study, we combine results from lattice theory and monotone operator methods to construct a novel lattice-based Douglas-Rachford splitting algorithm to solve convex optimization problems over integers. The algorithm has several desirable properties, namely: its convex steps are parallelizable, and its nonconvex projection step is reducible into projection onto a lattice in a potentially much smaller dimension. We also establish sufficient conditions for the convergence of the algorithm to an optimal solution.

5 - Integer Programming Approaches to Fisheries Observer Assignment

Reed Harder, Dartmouth, 14 Engineering Drive, Hanover, NH, 03755, United States, Vikrant Vaze

Fisheries observers are deployed on commercial fishing vessels to provide independent monitoring of fishing activity. However, effective deployment of observers can present significant challenges in the Western and Central Pacific Ocean: observers board and disembark hundreds of fishing vessels operated by multiple nations at remote ports scattered across the region, and transportation costs between ports can be high. In order to minimize the costs of effective observer deployment, we develop an integer programming approach for assigning observers to scheduled vessel trips, while meeting constraints imposed by the need for impartiality.

■ WA58

West Bldg 101C

Joint Session HAS/PSOR/Practice Curated: Emerging Issues in Treatment Planning and Management

Sponsored: Health Applications

Sponsored Session

Chair: Shengfan Zhang, University of Arkansas, Fayetteville, AR, 72701, United States

1 - Opioid Overdose and the Role of Comorbidity in US Emergency Departments

Nisha Nataraj, Centers for Disease Control and Prevention, 4770 Buford Highway, MS - F62, Atlanta, GA, 30319, United States, Kun Zhang, Gery Guy, Christina Mikosz

The United States is in the midst of an opioid overdose epidemic with 42,249 opioid overdose-related deaths in 2016. Certain medical comorbidities may increase the risk for opioid overdose. We use regression and variable clustering models on national-level hospital discharge data to identify comorbidities most associated with opioid overdose in patients presenting to emergency departments. Results show that the overall number of comorbid chronic conditions is increasing in this population and that comorbid psychiatric, neurologic, and fluid/electrolyte disorders are especially associated with overdose.

2 - A Markov Decision Process Approach to Find the Optimal Time of Operating Lung Volume Reduction Surgery in Patients with Severe Emphysema

Maryam Alimohammadi, University of Arkansas, Fayetteville, AR, 72701, United States, Shengfan Zhang, Art Chaovalitwongse

Emphysema is a chronic lung disease that can be treated with lung volume reduction surgery (LVRS). Despite the advantages of LVRS in specific patients, it has mortality and morbidity risks and costs more than other treatments which makes it crucial to determine the subgroup of patients that can benefit the most from LVRS and assign them to surgery at the best time. To develop an optimization model that maximizes the quality-adjusted life time of the patients, we used Markov Decision Process (MDP) based on the National Emphysema Treatment Trial (NETT), a comprehensive dataset that collected the data of 1218 patients with severe emphysema who were randomized to undergo surgery or have medical treatment.

3 - Characterizing the Uncertainty Associated with Treatment Outcomes for Tuberculosis Patients

Shengfan Zhang, University of Arkansas, 4207 Bell Engineering Center, Department of Industrial Engineering, Fayetteville, AR, 72701, United States

The goal of this research is to use data analytics and stochastic modeling approaches to characterize patient recovery pathway from treatment for tuberculosis (TB). This research will use an existing anonymous data that contain information about follow-up test results for TB patients in Moldova upon initiation of treatment. Specifically, we aim to (1) characterize the pattern of recovery as denoted by the smear and culture test results at follow-ups; and (2) predict patient disposition (i.e., recovered to died) based on the recovery pattern.

4 - Enhancing Community Resilience to Combat Crisis of Opioid Addiction

MD Noor E. Alam, Assistant Professor, Northeastern University, 334 Snell Engineering Center, 360 Huntington Avenue, Boston, MA 02115, United States, MD Mahmudul Hasan, Gary Young, Alicia Modestino

This study focuses on detecting the variation of opioids prescribing pattern by leveraging the Massachusetts All Payer Claim Data (MA APCD) set. Based on the meaningful insights obtained from the data mining, we will devise a set of optimal policies to improve the community resilience to combat the opioid addiction epidemic.

■ WA59

West Bldg 102A

Joint Session HAS/Practice Curated: Equity and Efficiency in Treatment of Chronic Illness

Sponsored: Health Applications

Sponsored Session

Chair: Hadi El-Amine, George Mason University, Fairfax, VA, 22030, United States

1 - Optimization of Human Leukocyte Antigen Based Donor Recipient Matching in Kidney Transplantation

Naoru Koizumi, George Mason University, School of Public Policy, 3351 North Fairfax Drive, Arlington, VA, 22201, United States, Mehdi Nayebpour, Hadi El-Amine

Cold ischemic time and post-operative complications are associated with 30-day mortality of the donor graft. However, long-term patient survival is related primarily to tissue matching, vasculopathy, immunosuppression, and infection. This study examines the preeminent role of tissue matching using an optimization regression algorithm to examine the effect of randomly allocated HLA: A, B, and DR kidney donor on long term patient survival in the largest retrospective study known to date.

2 - Exploring Models for Reducing Geographical Disparity in Organ Allocation

Michal Mankowski, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia, Sommer Gentry

Reducing the geographic disparity in access to organs is emerging issues in the transplant community. The OPTN/UNOS has recently appointed the Ad Hoc Geography Committee to define guiding principle and review models for the use of geographic constraints in organ allocation.We investigate a potential impact of some of the approved models.

3 - Information Theoretic Learning in Markov Decision Processes

Peeyush Kumar, B14, Industrian and Systems Engineering, MEB, University of Washington Seattle, Seattle, WA, 98195-2650, United States

I will present my research on Markov decision processes where the decision maker is uncertain about the model of the system. To maximize expected reward over the planning horizon, we must balance the exploration versus exploitation tradeoff: learn the transition probabilities sufficiently well, and utilize this information to quickly zero-in on actions with high rewards. I propose Information Directed Policy Sampling, which is an information theoretic framework that explicitly manages this tradeoff. We obtain a worst-case regret bound for IDPS. The theoretical guarantees are supplemented with numerical results on a sequential auction-design problem, and a response-guided dosing problem.

4 - The Impact of Imperfect Testing on the Performance of Personalized Medical Interventions

Hadi El-Amine, George Mason University, 4310 Cotswolds Hill Ln, Fairfax, VA, 22030, United States

In this paper, we develop a general framework that analyzes the performance of personalized medical interventions driven by historical patient data. We prove that finding optimal interventions is hard and provide structural properties that provide policy insights.

■ WA60

West Bldg 102B

Joint Session HAS/Practice Curated: New Topics in Healthcare Policy

Sponsored: Health Applications

Sponsored Session

Chair: Soroush Saghafian, Harvard Univeristy, Cambridge, MA, 02138, United States

1 - The Adoption and Diffusion of Medical Technology: Evidence from Cardiac Procedures
Ariel Stern, Harvard Business School, Morgan Hall 433, Boston, MA, 02163, United States, Robert Huckman

The adoption of new health care technologies is a learning process, with evidence showing that new products and procedures often involve physician learning and tradeoffs in quality and productivity. We consider the early years of uptake for a new cardiac procedure - transcatheter aortic valve replacement (TAVR) - and its implications for physician procedure mix and patient outcomes. Using data on all aortic valve replacement procedures performed in New York State over five years, we evaluate patterns in the uptake of TAVR across physicians and hospitals as well as patterns of access and receipt among (potential) patients.

2 - Development of Imminent Mortality Predictor for Advanced Cancer, a Tool to Predict Short-term Mortality in Hospitalized Advanced Cancer Patients
Junchao Ma, Yale School of Management, New Haven, CT, United States, Edieal J. Pinker, Donald Lee

End-of-life care for advanced cancer patients is aggressive and costly. Although cancer patients rely on oncologists for information about prognosis to make decisions about end-of-life care, physicians tend to over-estimate life expectancy and inconsistently initiate goals of care discussions. We developed and evaluated a novel prognostic tool, which generates life expectancy probabilities in real time using EHR time series to support oncologists in counseling patients about end-of-life care. We will also discuss use of similar decision-support tools to improve quality of care in intensive care units.

3 - Do Hospital Closures Improve the Efficiency and Quality of Other Hospitals?
Lina Song, Harvard University, Soroush Saghafian

We study the impact of hospital closures on the surrounding hospitals' efficiency and the mechanisms through which the changes occur. We also investigate the implications of hospital closures on quality. We do these by examining the efficiency, bed utilization, service duration, patient experience, readmissions, and mortality using a nationally representative panel data of Medicare patients. We find that the closure of a hospital in a market results in improvement in efficiency at the remaining hospitals, but this happens at an expense of reducing the service duration. Furthermore, hospital closures are associated with an increase in 30-day mortality of the surrounding hospitals.

4 - Can Public Reporting Cure Healthcare? The Role of Quality Transparency in Improving Patient-provider Alignment
Soroush Saghafian, Harvard Univeristy, Kennedy School of Government, 79 John F. Kennedy Street, Cambridge, MA, 02138, United States, Wallace J. Hopp

Public reporting of medical treatment outcomes is being widely adopted by policymakers in an effort to increase quality transparency and improve alignment between patient choices and provider capabilities. We examine the soundness of this approach by studying the effects of quality transparency on patient choices, hospital investments, societal outcomes (e.g., patients' social welfare and inequality), and the healthcare market structure (e.g., medical or geographical specialization). Our results offer insights into why previous public reporting efforts have been less than fully successful and suggest ways in which future efforts can be more effective.

■ WA63

West Bldg 103B

Joint Session DM/Practice Curated: Data Science for Forecasting and Economic Modeling

Sponsored: Data Mining

Sponsored Session

Chair: Kai Yang, Wayne State University, 4815 Fourth Street, Detroit, MI, 48201, United States

1 - Heteroskedasticity-based Instrumental Variables for Endogeneity Treatment
Bernardo F. Quiroga, Assistant Professor, Pontificia Universidad Católica de Chile, Av. Vicuña Mackenna 4860, Comuna de Macul, Santiago, 29601, Chile

We present a way to achieve econometric identification in instances when outside instruments are not available. By exploiting the structure of the variance-covariance matrix under heteroskedasticity, it is plausible to build orthogonality conditions in presence of endogeneity in otherwise unidentified systems of linear regression equations. Our results build upon the findings presented by different authors in the internal instruments literature (e.g., Arellano and Bond (1991); Lewbel (1996, 2013))

2 - Recent Progresses in Continuous-time Contract Theory
Dylan Possama, Assistant Professor, Columbia University, 500W 120th Street, Mudd 308, New York, NY, 10027, United States

This talk will consists in an overview of recent progresses made in contracting theory, using the so-called dynamic programming approach. The basic situation is that of a principal wanting to hire an Agent to do a task on his behalf, and who has to be properly incenticized. We will show how this general framework allows to treat volatility control problems arising for instance in delegated portfolio management, in electricity pricing, or in central clearing houses. We will also, if time permits, analyze the situation of a Principal hiring a finite number of Agents who can interact with each other, as well as the associated mean-field problem.

3 - How to Project Outpatient Appointments Utilization
Fangzheng Yuan, Doctoral Candidate, UGPTI, 1340 Administration Avenue, Fargo, ND, 58108, United States, Joseph Szmerekovsky, Vera Tilson

In this paper, a probability model known as "shifted-beta-geometric model is implemented as an alternative to commonly used regression models to project the outpatient appointments utilization. This model is easy to use and can be implemented using a simple Excel spreadsheet and the result shows a great accuracy of forecasts and diagnostics for appointment utilization.

4 - A Comparative Study for Patient Workload Prediction
Kai Yang, Wayne State University, 4815 Fourth Street, Detroit, MI, 48201, United States, Mohammad Hessam Olya

This paper suggests a framework for patient workload prediction by using patients' data from VA facilities across the US. To capture the information of patients with similar attributes and make the prediction more accurate, a heuristic cluster-based algorithm for single-task learning is developed in this research. . In this research, we have considered patient-dependent and facility-dependent attributes and the relation between tasks into the model while implementing Multi-Task Learning (MTL) approach and training multiple related tasks simultaneously.

■ WA64

West Bldg 104A

Joint Session DM/Practice Curated: Predictive and Prescriptice Analytics

Sponsored: Data Mining

Sponsored Session

Chair: Lianning Zhu, Texas Tech University, Lubbock, TX

1 - L1 Norm Based Major Component Detection Analysis
Qi An, North Carolina State University, Raleigh, NC, 27606, United States, Shu-Cherng Fang, Shan Jiang

l1 MCDA is a state-of-the-art tool to identify the major components of data with irregularly positioned ``spokes". We develop an algorithmic framework of l1 MCDA for multivariate asymmetric radial data clouds. It consists of locating a central point and calculating the major directions and median radii in those direction via a two-level median fitting process. The central point analysis features a pre-selection procedure to screen out candidate points with sufficient data points in the vicinity. Numerical experiments test the proposed analysis methods on high dimensional data set of various configurations and indicate our proposed method demonstrates superior accuracy and robustness.

2 - A Novel Optimization Based Algorithm for Multi-class Data Classification Problem
Fatih Rahim, Ko University, Rumelifeneri Yolu, Sariyer, Istanbul, 34450, Turkey, Metin T rkay

Multi-class data classification is a supervised machine learning problem that involves assigning data to multiple groups. We present a novel MILP-based algorithm that splits each class's data set into subsets such that the subsets of different classes are linearly separable. At each iteration we form a subset of samples out of the set of unassigned samples by a MILP model that maximizes the cardinality of the new subset. The algorithm terminates when all the samples are assigned. We build classifiers based on the convex hulls of the subsets and the polyhedral regions for the testing phase. We conclude that our optimization based algorithm provides competitive results in terms of prediction accuracy.

3 - Heart Rate Estimation using Wrist-type Photoplethysmography Based on Neural Network
Lianning Zhu, Texas Tech University, Lubbock, TX, 79416, United States, Dongping Du

Photoplethysmography (PPG) signals from wearable devices are easily corrupted by motion artifact (MA), which poses great difficulties on heart rate (HR) estimation. A moving time window was used to segment PPG signals and ACC signals. Here, a new HR tracking algorithm was developed and denoted as NN-Bayesian. HR prediction was performed by a neural network and HR estimation was performed based on predicted HR and Bayesian decision theory. To validate proposed HR tracking framework, HR estimation was performed using raw PPG signals and cleansed PPG signals which were obtained by spectrum subtraction (SS). The proposed framework shows its accuracy and robustness to track HR.

■ WA65

West Bldg 104B

Joint Session DM/Practice Curated: Data Science and Deep Learning V

Sponsored: Data Mining

Sponsored Session

Chair: Di Wang, University of Illinois at Chicago, Chicago, IL, 60607, United States

1 - Active Batch Learning With Cluster-based Stochastic Query-by-forest (CSQBF)

Ghazal Shams, Arizona State University, Tempe, AZ, 85282, United States, Seho Kee, Enrique Del Castillo, Eugene Tuv, George Runger

Modern systems use automated sensing that can generate a large number of unlabeled instances at low cost, but obtaining labels may require human effort that is time-consuming and expensive. In this work, we propose the Cluster-based Stochastic Query-By-Forest (CSQBF) algorithm which introduces an enhanced stochastic querying strategy by combining the supervised knowledge of a trained classifier on the labeled data with unlabeled data cluster information iteratively in a pool-based active learning scenario.

2 - Matched Forest for High-dimensional Matched Case-control Studies

Nooshin Shomal Zadeh, PhD Student, Arizona State University, 699 S. Mill Ave, Tempe, AZ, 85281, United States, Sangdi Lin, George Runger

Matched case-control study designs are commonly used in clinical studies to identify exposure variables associated with a medical condition. Matching is a preprocessing approach which is used in case-control studies to improve the efficiency by enforcing the confounding variables to have same distributions for cases and controls. Existing methods for analyzing matched case-control data sets have limitations in high-dimensional setting (for matching or exposure variables) and with interaction effects. This research proposes a new learning method which is not only flexible for a number of matching and exposure variables, but can also detect interaction effects.

3 - A Multi-model Approach for Sports Betting Recommendation

Ismail T. Yumru, Data Scientist, Algopoly, Istanbul, 34342, Turkey, Mustafa Gokce Baydogan, Berk Orbay

Statistical learning methods are increasingly used in the domain of sports result prediction, where estimating the probabilities of possible outcomes (odds) of a game better than a bookmaker does is key to making profit. In this study, several learning techniques such as multinomial penalized regression, random forest and gradient boosting are carried out first to estimate the odds, then to select the subsets of games that are most likely to be profitable.

4 - Learning Based Mission Planning for Solar Powered Multi Robot System

Di Wang, University of Illinois at Chicago, Chicago, IL, 60607, United States, Mengqi Hu, Yang Gao

To improve the long duration operation for multi-robot system, the solar-powered robot has attracted greater attention. In this research, we propose a Markov decision model for solar-powered multi-robot mission planning to co-optimize the task allocation and energy schedule. A deep reinforcement learning algorithm is developed to solve the Markov model considering variours objectives, such as minimizing traveling distance, traveling time and net energy consumption. Without retraining for new problem instance, the proposed algorithm can generate near optimal mission planning and energy scheduling decisions.

■ WA66

West Bldg 105A

Practice – Data Mining & Control in Manufacturing

Contributed Session

Chair: Arun Chockalingam, Eindhoven University of Technology, Hoog Gagel 62, Eindhoven, 5611BG, Netherlands

1 - Machine Learning-based Quality Prediction for Smart Manufacturing in SMT Process

Dongil Kim, Assistant Professor, Chungnam National University, 99 Daehak-ro, Yuseong-gu, Daejeon, Korea, Republic of, Hyein Kim, Jeongin Koo, Sungsoo Choi, Sang-Hyun Lee, Jeong Tae Kang

Surface Mount Technology (SMT) process is one of the most important processes in electronics industry. Through the SMT process, electronic chips are mounted on a Printed Circuit Board (PCB), and released as final products. Hence, the final quality of product is determined with the SMT process. In this paper, we propose a machine learning-based quality prediction method for SMT process. The input data were collected from the equipment in the process, such as reflow/soldering process. In addition, external variables, such as weather information, were also employed. We evaluate the performance of the proposed method through a real-world SMT process dataset, and the important factors are analyzed.

2 - A Study on Data Preprocessing Method for Relationship and Characterization of Cutting Process Monitoring Signals

Hyein Kim, Korea Institute of Industrial Technology, Cheonan, Korea, Republic of, Dongil Kim, Jeongin Koo

The importance of monitoring, anomalous prediction and autonomous control is increasing to prevent and respond to unusual situation for maintaining the accuracy and operation rate of CNC. To propose optimal machining conditions, we measure the status of real time process through the CNC communication. Based on this, we have attached various sensors to the CNC to collect data on all the situations that occur during machining to understand the relationship and characteristics between the monitoring signals. To clarify relationships of collected data, we set up a machining section based on the position of the axis and applied a variety of analytical methods to perform the data preprocessing process.

3 - Operationalizing the Offshoring Decision

Arun Chockalingam, Assistant Professor, Eindhoven University of Technology, Den Dolech 2, Eindhoven, 5612AZ, Netherlands, Haolin Feng

We consider a manufacturer who has both onshore and offshore production facilities. The manufacturer can dynamically allocate production between both facilities. Adjusting the production allocation incurs both fixed and proportional costs. We formulate this allocation problem as a stochastic-impulse control problem and derive the optimal allocation policy.

4 - Time Allocation Strategy for Evolutionary Process in Biomanufacturing

Mahdi Fatihi, University of Florida, 401 Weil Hall P.O. Box 116595, Gainesville, FL, United States, Marzieh Khakifirooz, Chen-Fu Chien

The most challenging issue in Biomanufacturing is the process constrained on minimal and maximal times for specific process. When molecules limitation versus time limitation assessing the relative incidence of the exhaustion between supply before death versus death before exhaustion of supply and highly depends on the quality of molecules. On the other hand, the stochasticity in market demand precludes a precise evolutionary matching of time allocation and productivity opportunity. This problem is modeled as a multiobjective Pareto optimality problem to minimize the cost per material and cost per time subject to constraints of accelerated evolutionary distribution of molecules.

■ WA67

West Bldg 105B

Joint Session ISS/Practice Curated: Empirical Studies on Platforms

Sponsored: Information Systems

Sponsored Session

Chair: Fujie Jin, Kelley School of Business, Indiana University, Bloomington, IN, 47401, United Statesö

1 - A Deep Learning Approach to Better Understanding of Hospital Quality

Weiguang Wang, University of Maryland, 3330 Van Munching Hall, R.H. Smith Business School, College Park, MD, 20740, United States, Guodong (Gordon) Gao

Hospitals are plagued with quality issues. It is well recognized that factors of providers and patients both contribute to quality issues, but how to separate their effects remains a challenge. We design a deep-learning based method that shows great promise in solving this problem. Firstly, word embedding techniques are adopted to vectorize all elements captured by EHRs. Then a one-to-one model is built using machine learning to link vector representations to hospital quality. Finally, a modification process to remove the effect of certain factors is performed to examine the impact of them on hospital quality. The proposed model is applied to real-world examples using the Florida provider data.

2 - Seeking a Reward or Helping the Entrepreneur-backers Response to a Low-price Probabilistic Choice in Reward-based Crowdfunding

Alvin Zuyin Zheng, Temple University, 1801 N. Broad St, Pennsylvania, Philadelphia, PA, 19122, United States, Jing Gong, Paul Pavlou

Crowdfunding aims to collect small investments from a large number of backers. Since crowdfunding projects typically attract a small number of backers, this study examines the role of the lottery in crowdfunding outcomes. Using a four-year dataset from a reward-based crowdfunding platform in China, we show that although the lottery does indeed help attract a higher number of backers for a project, it reduces the total money raised and the probability of reaching the funding goal. Mechanism analyses show the lottery incentivizes people who would otherwise not fund the project to become opportunistic backers, the lottery also cannibalizes prospective rewardees and donors.

3 - How Does Online Lending Influence Bankruptcy Filings? Evidence from a Natural Experiment

Hongchang Wang, Georgia Institute of Technology, Atlanta, GA, United States, Eric Overby

By providing relatively quick and easy access to credit, online lending platforms may help people overcome financial setbacks and/or refinance high-interest debt, thereby decreasing bankruptcy filings. On the other hand, these platforms may cause people to overextend themselves financially, leading to a "debt trap and increasing bankruptcy filings. To investigate the impact of online lending on bankruptcy filings, we leverage a natural experiment: Lending Club's entry into different states at different times. Using coarsened exact matching and a difference-in-differences approach, we find that Lending Club's entry increases bankruptcy filings by approximately 8%.

4 - Beauty and Counter-signaling in Two-sided Matching Markets: Evidence from a Randomized Field Experiment

Lanfei Shi, University of Maryland, 3330 Van Munching Hall, College Park, MD, 20742, United States

While online platforms place trust at the center, markets with few alternative trust-inducing signals face an even bigger challenge. In such cases, we find that phone verification, when making it optional and visible to others, plays a more significant and strategic role that works as an effective signaling device. We also identify interesting differential ex-ante opt-in decisions and ex-post impact of verification across two sides of the platform. We further discuss the underlying mechanism by applying state-of-the-art deep learning techniques to mine attractiveness using images. Moreover, upon verification users become more proactive, which also contributes to the increase in matching.

■ WA71

West Bldg 106C

Joint Session ICS/Practice Curated: Dynamic Stochastic Optimization in Urban Transportation

Sponsored: Computing

Sponsored Session

Chair: Qie He, University of Minnesota, Minneapolis, MN, 55455, United States

1 - Travel Time Estimation in the Age of Big Data

Sebastien Martin, Massachusetts Institute of Technology, Cambridge, MA, 02139, United States, Patrick Jaillet, Dimitris Bertsimas, Arthur J. Delarue

While travel time estimation has become increasingly mainstream and accurate, it is hard to build application-specific estimations that are reliable and compare with the state of the art without access to clean travel time datasets and detailed routing network information. We develop a method that tractably exploits any amount of origin-destination data and only needs a simplified routing network to build accurate estimations. Using data from the Manhattan taxis, we show that our algorithm can provide insights about urban traffic patterns on different scales and accurate travel time estimations throughout the network. Boston also used it to better route school buses and save millions of dollars.

2 - Absenteeism Prediction and Extra-board Driver Scheduling for Bus Transit Operations

Xiaochen Zhang, University of Minnesota, Minneapolis, MN, 55454, United States, Qie He

We develop a data-driven analytics tool to assist daily scheduling of extra-board drivers in bus transit operations. Extra-board and overtime drivers are used to cover open jobs due to the absences of regular drivers. We build a hierarchical regression model to forecast the daily absences. With the prediction, we develop a two-stage stochastic programming model to determine the daily optimal assignment of extra-board drivers and use of overtime, which also makes recommendations on the daily extra-board size. Our model's recommended assignment based on historical data reduces the expected total operating cost significantly while the probability of losing service remains low.

3 - An Integrated Dynamic Ridesharing Dispatch and Idle Vehicle Repositioning Strategy on a Bimodal Transport Network

Saeid Rasulkhani, Tai-Yu Ma, Joseph Y.J. Chow, Sylvain Klein

In bimodal ridesharing, a private on-demand mobility service operator offers to drop off a passenger at a transit station, where the passenger uses the transit network to get to another transit station, and the service operator guarantees picking up the passenger (not necessarily with the same vehicle) to drop them off at the final destination. We consider dynamic bimodal ridesharing problems where real-time information is available to anticipate future demand. A new non-myopic vehicle dispatching and routing policy based on queueing-theoretical approach is proposed and integrated with a non-myopic idle vehicle repositioning strategy from the literature to solve the problem.

4 - Dynamic Pricing and Resource Allocation in Driverless Ridesharing Systems

Chao Lei, University of Illinois at Urbana-Champaign, 205 N. Mathews Ave., Urbana, IL, 61801, United States, Zhoutong Jiang, Yanfeng Ouyang

We propose a multi-period game-theoretic model for the dynamic ridesharing pricing and idling vehicle reallocation problem in the context of driverless vehicles being applied to providing on-demand ridesharing services. The goal is to achieve the best utilization of ridesharing resources in both spatial and temporal dimensions through the game-theoretic optimization. A mathematical program with equilibrium constraints (MPEC) formulation is developed to capture the independent decision-making process of the mobility service provider and travelers. A non-myopic approximate dynamic programming (ADP) based algorithm is implemented as the solution approach.

■ WA72

West Bldg 211A

Practice- Operations Management II

Contributed Session

Chair: Horst Tempelmeier, Universitaet zu Koeln, Albertus Magnus Platz, Seminar fuer SCM und Produktion, Koeln, D. 50923, Germany

1 - Research on Decision Optimization of Low Carbon Remanufacturing Production under Financing Strategy

Xiaodong Xia, Southeast University, Nanjing, China, Weida Chen

Abstract: This paper devotes to integrating the financial strategies which consists of bank loan, stock financing, debt financing, and financing lease into low carbon remanufacturing production decisions. The remanufacturer can get economical aid by financing to optimize its promotion, which is a convex optimization problem in a nonlinear programming model that can be solved by intelligence algorithms. Finally, there is a hot discussion about optimal production decisions on different financing modes to get better production strategy. Key words: Remanufacturing production decision; financial strategies; Nonlinear programming model; Intelligence algorithms

2 - How the Technology Constraint and Cannibalization Affect Firm's Product Introduction Strategy

Yi Liu, Pennsylvania State University, University Park, PA, 16802, United States, Nicholas C. Petruzzi

We consider the optimal product design question for a firm in a two-segment market characterized by heterogeneous customer valuations of product quality. The firm's product quality is currently limited by a technology constraint that can be removed if product introduction is delayed by one time period. The question is, what, if any product should be introduced now and what, if any, should be introduced later.

3 - Forecast Horizons under Demand Substitution and Backlogging and Production Changeovers with Batch Production

Fuying Jing, Dr., University of Electronic Science and Technology of China, Chengdu, China, Yinping Mu

This paper studies forecast horizons for a two-product dynamic lot size problem under (i) one-way substitution, that is one product can be used to satisfy the demand of the other product but not vice versa; and (ii) the production rate to be any value in the set {0, Q, 2Q,..., nQ}, where n is nonnegative integer; and (iii) backlogging is permitted. It is assumed that the switching cost is occurred when production switches from one product to the other. Based on some properties of the optimal solution, we develop a DP algorithm to solve the problem. By establishing the monotonicity of the production point of two products, we give a sufficient condition to obtain the forecast horizon.

4 - Supply Allocation of Multiple Services on the Ride-hailing Platform

Shuanglong Wang, PhD Student, University of Illinois-Urbana Champaign, Champaign, IL, 61820, United States, Xin Chen

It's a common practice for a ride-hailing platform to manage multiple substitutable services. The platform has to manage the qualities of services by allocating the incoming drivers among them. We use the expected waiting time to capture the qualities of different services and assume that the drivers arrive passively during demand shock. We use the MNL model to describe the choice behavior of waiting-time-sensitive riders and look at the long-term equilibrium between rider's choices and the platform's allocation policy. The optimal strategies of supply allocation are investigated accordingly.

5 - Dynamic Capacitated Lot Sizing with Random Demand and Random Yield

Horst Tempelmeier, Professor, University of Cologne, Albertus Magnus Platz, Department of SCM and Production, Cologne, D. 50923, Germany

We consider a dynamic multi-item capacitated lot sizing problem under stochastic demand and random yield. We develop a planning model which is based on the static uncertainty strategy by Bookbinder and Tan (1988) whereby a cycle fill rate constraint is implemented to control the amount of backorders. We propose several heuristic solution approaches which extend our earlier work on stochastic lotsizing to the considered case of imperfect yield. The performance of the new solution

approaches is analyzed with a numerical experiment.

■ WA74

West Bldg 212A

Joint Session MCDM/Practice Curated: Understanding Multiple Criteria in Healthcare Applications

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Gilberto Montibeller, Loughborough University, School of Business & Economics, Loughborough, LE11 3TU, United Kingdom

1 - Healthcare Resource Allocation in Accountable Care Organizations Based on Data Envelopment Analysis and Multi-objective Integer Programming Approach

Hasan Symum, Graduate Assistant, University of South Florida, Tampa, FL, 33612, United States

Accountable Care Organizations (ACOs) represents a major healthcare reform that aimed to better control cost while improving care quality. However, only (30% - 35%) of the ACOs were able to generate savings from Medicare due to lack of coordination and consistency in care. We propose bi-level multi-objective DEA based decision support system that allocates patients and healthcare resources to the ACOs decision-making unit (DMU) by assigning protocols to minimize spending and variability in care under Medicare-ACO contract framework. It provides a comparison between centralized decision making with the existing system and bi-level model improves overall DMU's efficiency level significantly.

2 - A Strategic Modeling for the Allocation of Ambulance Request to Emergency Departments in the United States System

Jorge Acuna, PhD Student, Univerisity of South Florida, 4202 E. Fowler Avenue, Tampa, FL, 33620, United States

Being able to assign efficiently the services request to emergency departments (ED's) is of paramount importance both from financial and life-threating scenarios. Three strategies based on mixed integer programming for multi-objective optimization, min-max, and game theory approaches, are implemented to improve the ambulance allocation in the U.S. system. A hypothetical scenario of a county is used to compare the efficiency and fairness of each strategy. Policies and disparities implications are analyzed and discussed.

■ WB01

North Bldg 121A

Joint Session OPT/Practice Curated: Hedging Against Uncertainty in Renewable Energy

Sponsored: Optimization/Optimization under Uncertainty

Sponsored Session

Chair: Gokce Kahvecioglu, Northwestern University, Evanston, IL, 60208, United States

1 - Robust Zonal Electricity Markets

Ignacio Aravena, Lawrence Livermore National Laboratory, Livermore, CA, 94550, United States, Anthony Papavasiliou, Yves Smeers

We propose a consistent framework for modeling zonal electricity markets based on projecting the constraints of the nodal network onto the space of the zonal aggregation. We use the framework to model two zonal market designs and we develop cutting-plane algorithms for clearing these zonal markets while accounting for robustness of zonal exchanges to single element outages. We conduct numerical simulations of the zonal market designs for a realistic instance of the Central Western European system under 768000 different operating conditions. We find that robust zonal markets are unable to anticipate congestion and that they are outperformed by a nodal market design without robustness.

2 - Robust Power Dispatch and Renewable Energy Management

Ruiwei Jiang, University of Michigan, Ann Arbor, MI, 48109, United States, Hongyan Ma

In this paper, we propose a robust power dispatch approach through incorporating a corrective re-dispatch and integrating active management of renewable energy, which co-optimizes the power pre-dispatch strategies and the admissible ranges of renewable outputs. Case studies on the modified IEEE systems display the effectiveness and scalability of this approach.

3 - Risk Averse Energy Storage Optimization for High Penetration of Wind Energy

Juliana Nascimento, Princeton University, Sherrerd Hall, Operations Research and Fincl Engineering, Princeton, NJ, United States, Joseph Durante, Warren B. Powell

We propose a modified stochastic dual dynamic programming (SDDP) method aimed at optimizing energy storage for a set of batteries scattered across the energy grid. With the fine-grained time scale of battery storage, we also have to optimize over hundreds of time periods. We consider a hidden semi-Markov model (HSMM) that accurately reproduces the crossing-time behavior of the wind, which captures the amount of time that actual wind sample paths are above or below the forecast. We show that we can significantly decrease the risk of shortages when we consider our HSMM model coupled with the proposed modified SDDP method over the classical iid stochastic model coupled with a standard SDDP algorithm.

4 - Planning Transmission Storage and Generation for Renewable Energy and Carbon Policies Uncertainty

Jing Peng, Johns Hopkins University, 3400 N. Charles Street, Baltimore, MD, 21218, United States, Qingyu Xu, Benjamin Field Hobbs

Renewable energy policies and carbon policies are reshaping the power system by providing incentives to invest more in renewables and displace coal generation. However, the particular timing and implementations of these policies are uncertain to the power system planners. Due to rapidly dropping costs, the energy storage is becoming an increasingly competitive option. We propose an optimization model to plan energy storage, accounting for its substitution and complementary relations with transmission and generation, to hedge against policy uncertainties in the western interconnection of North America.

■ WB02

North Bldg 121B

Joint Session OPT/Practice Curated: Stochastic Assignment Problem Applications to Healthcare and Network Design

Sponsored: Optimization/Optimization under Uncertainty

Sponsored Session

Chair: Onur Tavaslioglu, University of Pittsburgh, Pittsburgh, PA, United States

1 - Stochastic Operating Room Scheduling Under Emergency Arrivals with Integrated Block Assignments

Onur Tavaslioglu, University of Pittsburgh, Houston, TX, 77025, United States, Oleg A. Prokopyev, Andrew J. Schaefer

Operating room scheduling for elective procedures is challenging due to the nonlinear structure and stochasticity. In this paper, we model the operating room scheduling problem as a two-stage stochastic mixed integer program with nonlinear objective and chance constraints. We then present a value function reformulation, which converts the mentioned model into a pure binary program. We propose a dynamic programming based approach to calculate the value functions. We compare our approach to a cut generation approximation from the literature. The performance of our approach is better in computational time and it offers optimal solutions.

2 - Facility Protection and Network Design when the Effect of Protection is Uncertain

Tanveer Hossain Bhuiyan, Mississippi State University, McCain Engineering Building, Room 321, Starkville, MS, 39759, United States, Hugh Medal

We study a facility location and network design problem that involves protecting facilities subject to random disruptions where the protection is imperfect, multi-level, and the effect of disruption is imperfect. The goal of our study is to optimally allocate protection resources to the facilities, and construct links in the network to minimize the expected transportation cost. We model the problem as a two-stage stochastic programming with decision dependent uncertainty where the post-disruption capacity states of the facilities depends probabilistically on the resource allocation decision and the disruption intensity. We implement an L-shaped algorithm to solve the model.

■ WB11

North Bldg 125B

Joint Session MSOM/Practice Curated: Ride-sharing Services Research at Didi Chuxing

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Zhixi Wan, DiDi Chuxing, Beijing, China

1 - Modelling of Driver Supply Behaviour in On-demand Shared Transportation Platforms

Hai Wang, Singapore Management University, Room 5023, School of Information Systems, 178902, Singapore, Hao Sun, Zhixi Wan, Guobin Wu, Qun Li

With the popularization of ride-sharing services, drivers working as freelancers on ride-sharing platforms can design their schedules flexibly. They make daily decisions

regarding whether to participate in work, and if so, how many hours to work. Driver's extra income, participation cost, and maximum allowed working time affect these decisions. We incorporate these features into classical theory of labour economics and propose a theoretical model to describe how drivers make working decisions on the shared platform. We characterize the labour supply pattern of participation, working hours, extensive and intensive margin elasticity on the platform and compare with the traditional taxi.

2 - Carpooling Service: Social Welfare and Pricing Strategies
Shuanglong Wang, University of Illinois at Urbana-Champaign, IL, United States, Zhixi Wan

This paper empirically studies the social welfare created by carpooling service on the ride-hailing platform over the counterfactual situation that only the regular-express service is provided. We use the data from Didichuxing, a leading ride-hailing platform in China, to estimate a nested logit model describing riders' choice behavior over regular express, carpooling and outside options. We also derive a carpooling pricing scheme for optimizing the social welfare and investigate its sensitivity properties. The results show that the carpooling service is advantageous in increasing riders' surplus and provides an alternative solution to supply-demand matching other than surge pricing.

3 - The Efficiency of a Dynamic Decentralized Two-sided Matching Market
Chenyu Yang, University of Rochester, NY, United States, Zhixi Wan, Xiao Liu

This paper empirically studies a decentralized dynamic matching market. We use data from a leading ride-sharing platform in China to estimate a continuous time dynamic model of search and match between drivers and passengers. In counterfactual simulations, we assess the efficiency of the decentralized market and examine how centralized algorithms may improve welfare. Compared with the equilibrium in the decentralized market, centralized algorithms can increase both the match quality and the number of matches by making matches less frequently and matching agents more assortatively.

4 - Balancing Supply and Demand: Queuing versus Surge Pricing Mechanisms
Zhixi Wan, DiDi Chuxing, Beijing, China, Yueyang Zhong, Max Shen

One of the most challenging market-making problem faced all ride-sharing platforms is to deal with the scenarios with high demand and limited supply. Dynamic pricing mechanisms, often called surge pricing, have been used by all major platforms. This talk describes a new mechanism adopted by Didi Chuxing, which uses virtual queuing mechanisms to allocate car supply to waiting riders. It then compares the queuing with the dynamic pricing mechanism in metrics of efficiency, fairness, consumer surplus, etc.

3 - Chance-constrained Bin Packing Problem with an Application to Operating Room Scheduling
Shanshan Wang, Beijing Institute of Technology, 5 South Street Zhongguancun, Haidian District, Beijing, 100081, China Shanshan Wang, Northwestern University, Evanston, IL, United States, Sanjay Mehrotra, Jinlin Li

We develope a branch-and-cut solution scheme for chance constrained optimization of bin-packing problems with random technology matrices. The problem is to allocate items with random weigh to a set of bins with respect to bin size, so as to minimize the total open and allocation cost subjecting to the packing constraints with given probabilistic guarantees. We formulate the integer programs by assuming discrete distributions of random weight. We propose a branch-and-cut framework with several new classes of valid inequalities. Computational study on chance-constrained formulation of surgery assignment problem is conducted to verify the performance of our algorithms.

4 - Multi-mode Resource Constrained Project Scheduling with Optional Activities and Uncertain Network Structure
Chrysanthos Gounaris, Carnegie Mellon University, Doherty Hall 3107, Dept of Chemical Engineering, Pittsburgh, PA, 15213, United States, Nikolaos Lappas, Hua Wang

The classical Multi-mode Resource Constrained Project Scheduling Problem (MMRCPSP) is defined upon a fixed directed graph modeling the precedence of activities that have to be executed exactly once in one of their available modes. In practice, however, there are cases where network structure can be altered both by internal strategic decisions as well as uncertain external factors. To that end, we extend MMRCPSP to accommodate flexible network structures that involve recycles and optional activities via the use of propositional logic, and we present a set of new applicable models that are compared extensively across a comprehensive list of benchmark problems.

■ WB13

North Bldg 126B

Practice- Supply Chain Management

Contributed Session

Chair: Ting Ji, University of Science and Technology of China, 1129 Huizhou Ave, Baohe Qu, Hefei Shi, Anhui Sheng, 230000, China

1 - Optimal (z, Z)-type Contracts for Vendor-managed Inventory
Jun-Yeon Lee, Associate Professor, California State University, Northridge, CA, 91330, United States, Richard Cho

We examine (z, Z)-type contracts for vendor-managed inventory (VMI) between a supplier and a retailer from the retailer's perspective. A (z, Z) VMI contract specifies minimum and maximum inventory levels and their corresponding under- and over-stocking penalties. We provide the optimal (z, Z) VMI contract for the retailer and the corresponding optimal replenishment decisions for the supplier and show that the optimal (z, Z) VMI contract can coordinate the supply chain under mild conditions. We also examine a VMI contract with stockout penalty and holding-cost sharing, which is a special type of (z, Z) contract, and find that it may perform well compared with the optimal (z, Z) VMI contract.

2 - Theory of Constraints Replenishment Solution for Managing Distribution of Perishable Items
Harshal Lowalekar, Associate Professor, Indian Institute of Management-Indore, Prabandh Shikhar, Rau-Pithampur Road, Indore, 453331, India

We develop an analytical model to study the performance of the TOC's replenishment solution in the context of perishable item supply chains. A setting with one producer and one retailer is considered. The retailer follows an order up to level policy with fixed time interval between two consecutive orders. The items are issued at the retailer's end in a random sequence. The analytical model shows that the TOC's replenishment solution will significantly increase the profits of both the producer and the retailer. The product variety and availability at the retailer will increase while the inventory of existing items will decrease due to the TOC approach.

3 - Research on Supplier Selection in Logistics Service Supply Chain of China Railway Express Based on Improved DEA Method
Yinying Tang, Southwest Jiaotong University, Chengdu, China, Qinglin Li, Qiyuan Peng, Yang Ge, Jingru Ren

In this paper, a new framework and a new method are proposed to do the supplier selection in logistics service supply chain of CHINA RAILWAY Express (CRE). Firstly, considering CRE's actual needs, we analyze the basic process of CRE selecting logistics supplier. secondly, considering the demand & supply characteristics of the freight market between China and Europe, a new selection framework containing service quality, service price, service capacity and cooperation risk as second-level indicators is given. Thirdly, considering the uncertainty of CRE's international operation, the improved DEA (data envelopment analysis) Model is proposed and solved to evaluate and select suppliers.

4 - Analysis of a Manufacturer Issuing Free Gift Cards
Yuefeng Li, University of Electronic Science and Technology of China, School of Management of Economics, West Hi-Tech Zone, Chengdu, 611731, China, Jingming Pan, Xiaowo Tang

Manufacturers offer "free gift cards to consumers who buy the particular product. We structure a model of such gift card promotion in a two-product supply chain. It includes the manufacturer who plans to sponsor gift card promotion and takes the gift card cost, another manufacturer who is passively involved in the promotion and a retailer who sells the two products to consumers. The result shows that the two products are complementary with respect to consumers' demand in the promotion. Moreover, the gift cards have a cannibalization effect on the retailer and a spillover effect on the passive manufacturer. Furthermore, we offer a straightforward strategy which could lead to a win-win-win situation.

5 - Supply Chain Coordination with Sales Effort under Cap-and-Trade Regulation
Ting Ji, University of Science and Technology of China, Hefei, China

This paper explores the production decision and the sales effort level in a make-to-order supply chain consisting of a manufacturer and a retailer under cap-and-trade regulation. We explore the supply chain coordination with wholesale price and cost sharing contracts. First, as the marginal sales effort cost increases, the retailer's profit firstly increases and then decreases, while the monotonicity of the manufacturer's profit depends on the cap. Second, both wholesale price and cost sharing contracts can coordinate the supply chain. Third, cap-and-trade regulation has a positive effect on supply chain coordination with the two contracts.

■ WB22

North Bldg 130

Practice – Finance – Risk Management

Contributed Session

Chair: Tiantian Lin, Zhejiang University, Zhejiang Sheng, China

1 - Effect of Venture Capitalist Competition on Seed Funding for Supply Chains
Joyaditya Laik, PhD Candidate, University of Pittsburgh,

241 Mervis Hall, Katz Business School, Pittsburgh, PA, 15260, United States

Startup's raise capital by various means. One of them is by appealing to a Venture Capitalist whose primary stake in the form is the equity he owns. We model a situation when there are two 'types' of VCs and study the effect on the equity shared when both VCs are present. We observe that the equity that's given out is smaller with competition as compared to when there is no competition and that the equity demanded increases in the uncertainty of the potential market demand.

2 - Cooperative Resolution of Crises in Financial Networks

Markku Kallio, Professor, Aalto Univertsity School of Business, Pohjoiskaari 17 D. 17, Helsinki, FIN-00200, Finland, Aein Khabazian

We examine the financial network of systemically important banks as a cooperative game. Governments can act as facilitators enforcing incentives for banks to cooperate and prevent the escalation of a financial crisis. To achieve fair allocation of bailout costs, we use nucleolus which implies a possible subsidizing pattern among the banks. Our approach helps avoid moral hazard and free rider problems. For a demonstration, we use major European banks and a scenario which is linked to the adverse economic scenario used in 2016 EU-wide stress testing. Rescue performance is compared with several alternative non-cooperative approaches.

3 - A Linear Omega Portfolio Model with Optimizing Return Threshold

Jing-Rung Yu, Professor, National Chi Nan University, 470 University Road, Puli, Nantou, 545, Taiwan, Paul Chiou, WenYi Lee

The omega ratio incorporates both the upside profit and downside risk with considering a return threshold. Although the threshold can affect the effectiveness of the Omega portfolio model, its determination has not been thoroughly studied yet. A conventional fixed-value approach simplifies investor's decision without taking economic dynamics into account. This study optimizes the threshold value in the Omega model under certain and uncertain return distributions. The empirical results using the daily returns of the S&P 500 Index composite stocks show that the proposed WOmega model yields lower loss values and better controlling the downside risk than the CVaR related counterparts.

4 - Pass-through of Commodity Price Shocks in Distribution Channels with Risk-averse Agents

Phat Luong, Rutgers University, Piscataway, NJ, United States, Xiaowei Xu

This paper studies how to allocate risk in distribution channels, in which a risk averse supplier faces commodity price shocks and a risk averse buyer faces downstream market uncertainty. The supplier can pass-through commodity price shocks to the buyer under a surcharge pricing system, which is widely used in the steel industry. We model the buyer-supplier relationship as either a Stackelberg leadership game or a Nash bargaining solution. By conducting variance analysis on commodity price shocks and market uncertainty, we derive the closed-form optimal pass-through rate of commodity price shocks, which minimizes the weighted total channel risk and maximizes the channel throughput.

5 - The Allocation of Financial Risk in a Supply Chain with Influence of Supply Chain Characteristics

Tiantian Lin, Zhejiang University, Hangzhou, China, Gangshu Cai, Weihua Zhou

Buyer financing from e-commerce platform and trade credit are two popular financing methods for e-commerce SMEs. The two represent different ways of risk allocation. To detect which kind of risk allocation is more efficient, and how supply chain features influence, we construct a supply chain with a retailer, a manufacturer and a distributor on a consignment basis. We find neither buyer financing nor trade credit always outperforms the other. And the supply chain features like leadership structure influences not only the efficiency of the same risk allocation, but also relative efficiency of different risk allocation.

■ WB27

North Bldg 132B

Practice- Information Systems I

Contributed Session

Chair: Jiaying Deng, University of Washington, 4109 Stevens Way, Seattle, WA, 98195, United States

1 - Understanding Post-adoption of Building Information Modeling in Organizations: A Behavior Perspective

Pei Ma, Tianjin University, Building 25, Weijin Road, Tianjin, 300072, China

Post-adoption is crucial for organizations to realize returns on BIM investment. However, employees rarely use BIM to its fullest potential. We identify exploitation (EI) and exploration (ER), that refer to using BIM in routine way or novel way separately, as two types of usage behaviors. Based on IS continuance model, we examine the impacts of satisfaction (SAT) and perceived usefulness (PU) on ER and EI, and the role of personal innovativeness with IT (PIIT) and organizational support (OS) as moderators. Empirical analysis indicates (1) SAT impacts ER and EI strongly, (2) PU has stronger impact on EI than ER, (3) PIIT positively moderates impacts on ER, (4) OS positively moderates impacts on EI and ER.

2 - Social Responsibility Platforms and Sustainability Reporting

Xue Ning, Business School, University of Colorado, Denver, CO, 80202, United States, Dobin Yim, Jiban Khuntia

This study suggests and investigates the effect of a governance-practice-performance path for social responsibility platforms. Using a dataset of annual sustainability reports of 683 firms over a three-year period, findings of analysis provide insights to implement and steer sustainability governance to better performance.

3 - How Different Incentives Influence Employee Behavior on Enterprise Social Media

Xiaopeng Luo, Beijing University of Posts and Telecommunications, 10 Xitucheng Road, Beijing, 100876, China, Jiayin Qi, Xiangling Fu, Yu Jeffrey Hu

Firms are currently eager to apply ESM (Enterprise Social Media) to facilitate internal information sharing. However, employee engagement on ESM decreases over time. Thus, incentives are widely used to motivate participation. In this paper, two different incentives adopted on ESM have been examined in the context of a large state-owned company. By conducting a quasi-experiment based on the data of 11,432 employees, this study indicates the effect of the two incentives are different: group incentives, which reflect a sense of collectivism, are welcomed to strengthen the social relationships. While individual incentives, which show a spirit of egoism, can be harmful to evoke participation.

4 - Can Employees Benefit from Social Capital? The Evidence from an Enterprise Social Media in China

Jiaying Deng, University of Washington, Seattle, WA, 98195, United States, Yong Tan

In this study, we focus on how employees use the ESM to communicate with each other, and how this communication will affect their collaborative project performance. There's a trade-off.On the one hand, employees may acquire knowledge from others through communication, both from project team members or other experts outside the team. On the other hand, the convenience of chat may result in too many communications, which may distract employees from projects they are working on. In this paper, we try to examine these two effects.Our preliminary result shows that with more and more communication, the project performance significantly decreases over time.

■ WB28

North Bldg 221A

Practice – Logistics II

Contributed Session

Chair: Srimathy Mohan, Arizona State University, Department of Supply Chain Management, W.P. Carey School of Management, Phoenix, AZ, 85069-7100, United States

1 - Locating a Biorefinery under Uncertainty Using a Multistage Scenario Tree

Javier Faulin, Public University of Navarra, Campus Arrosadia, Department of Statistics and OR, Pamplona, Navarra, 31006, Spain, Adrian Serrano-Hernandez, Luis Cadarso, Alejandro Garcia del Valle

This work introduces a case study in which a biorefinery has to be located in Navarre, Spain, considering uncertainty in prices and biomass availabilities. To address this problem, stochastic optimization is employed. A multistage scenario tree featuring strategic and operational scenarios is presented, where operational nodes are rooted in strategic nodes. Then, biorefinery location optimization is reached by solving a mixed integer linear programming model. Promising results are obtained at strategic (location of the facility), tactical (location of collection points), and operational (biomass purchase management) levels.

2 - Sharing Loading Costs for Multi Compartment Vehicles

Bruce C. Hartman, Professor, California State University Maritime, Santa Rosa, CA, 95409, United States

Cold chains are important in world trade. Loading cold items into multiple compartment vehicles (MCVs) with different temperature compartments can keep goods at proper temperatures, allowing better load consolidation. Constructing the optimal load requires heuristics, and the cost must be allocated in a stable manner to the items being shipped. We outline the MCV loading problem, and suggest the optimization and cost allocation problems be solved together using an inductive approach. Constraints generated inductively from minimal balanced collections of subsets reduce the feasible set, helping heuristics find a stable result faster than optimizing first and allocating later.

3 - Long Term Sorting Plan Model for Ecommerce Logistic Distribution Network

Jie Lu, Operations Research Scientist, JD.com, Beijing, China, Hengle Qin

A sorting plan organizes the package flows in the distribution network. It determines package flow combinations and the sequence of distribution centers for each origin-destination pair. In this study, we propose an optimal long-term sorting plan model for a distribution network. In particular, a mixed integer programming model with conditional constraints is developed. We derive a reformulation of the problem to handle the conditional constraints using logical equivalence. The results show that the model can handle hundreds of distribution centers and more than six thousands of routes.

4 - A Beam Search Based Method for Single Container Mix Loading Problem

Tian Tian, Associate Professor, Dongbei University of Finance and Economics, Shahekou District, 217 Jianshan Street, Dalian, China, Jiafu Tang

An audio equipment manufacturer would like to depalletize PSUs and load the individual products, together with other PSUs, into a container, such that the volume utilization of the container is maximized. Once a PSU is depalletized, all of its products must be loaded into the Container. No PSU should be depalletized if the total volume of complete PSUs loaded in the container is not maximized. This problem is named as Single Container Mix-Loading Problem (SCMLP).We prove that SCMLP is a generalized container loading problem. We develop a beam search based two-phase constructive algorithm. We generated 60 test instances and conducted experiments to demonstrate the effectiveness of our approach.

5 - Realizing Business Potentials from Digital Operations in a Smart Port. A Quantitative View on Container Terminal Operations

Leif Meier, University of Applied Sciences Bremerhaven, An der Karlstadt 8, Bremerhaven, 27568, Germany

Business Managers need to evaluate the impact and potentials from new technologies to change the current situation at any time, i.e. to decrease costs, to increase sales and/or increasing the process flexibility. Therefore, new smart procedures do not require a new thinking in management; they are just another technology that may influence the current business situation. Quant Methods allow unfolding potentials that arise from data-driven-technologies - if we understand and solve the right problems. This study shows potentials - and also limits - from smart Container Terminal operations.

6 - Impact of Facility Location and Inventory Allocation in a Blood Supply Chain

Srimathy Mohan, Arizona State University, Department of Supply Chain Management, W.P. Carey School Of Management, Tempe, AZ, 85287-4706, United States, Mohan Gopalakrishnan

The blood supply chain must be well coordinated and high performing. Using American Red Cross (ARC) data, this research focuses on analyzing the strategic decisions that are made when planning for non-blood inventories including, facility location and resource allocation decisions. We first formulate a fixed-charge model to minimize the total cost locating the non-blood supplies and transporting them to the demand points when required. We will also conduct sensitivity analyses for demand input and the fixed facility cost and analyze the impact on location and size decisions. We thus contribute to "management engineering" in the humanitarian

■ WB32

North Bldg 222B

Practice- Vehicle Routing II

Contributed Session

Chair: Darweesh E. Salamah, Mississippi State University, MS, 39763-9542, United States

1 - The Model and Optimization of Container Drayage Problem in Truck Platooning Mode

Jintao You, PhD Candidate, Graduate School at Shenzhen, Tsinghua University, E302F, Datong building, University Town, Shenzhen, 518055, China, Zhaojie Xue

This paper investigates a container drayage problem in which trucks operate in platoon mode. One fleet can be operated by only one driver in the leading truck, while the rest trucks follow the leading one by using semi-autonomous driving technique. A group of leading manned trucks and following unmanned trucks are synchronously scheduled to serve a set of full-container-load customers within a time horizon. A general mathematical model is proposed to describe this problem as a variant of VRP with alterable capacity, temporal constraints and OD pairs. Considering the NP essence of this problem, a local search based heuristic method is proposed to solve the problem.

2 - An Optimized Route for Q100's Bert and Kristin to Visit All Jersey Mike's Subs in Atlanta for Charity

Jessica Rudd, PhD Student, Kennesaw State University, 1000 Chastain Rd, Kennesaw, GA, 30144, United States, Lauren Staples, Sanjoosh Akkineni, Andrew Henshaw

The project built an optimal route for two popular radio show hosts to visit each of the 37 Atlanta area Jersey Mikes Subs in one day. This supported a fundraising effort to send children with chronic and terminal illnesses to Disney World. We developed a combined approach to the Multiple Traveling Salesman Problem that pairs a custom genetic algorithm with Google's combinatorial optimization solver.

3 - Work Crew Routing Problem for Infrastructure Network Restoration

Nazanin Morshedlou, University of Oklahoma, Norman, OK, 73071, United States, Kash Barker, Andres David Gonzalez

This presentation introduces a synchronized routing problem for planning and scheduling restorative efforts for infrastructure networks in the aftermath of a disruptive event. In this problem, a set of restoration crews are dispatched from depots to a road network to restore the disrupted infrastructure network. Two mathematical formulations are presented to scheduling and sequencing disrupted network components to restoration crews and route the crews towards disrupted components to maximize network resilience progress in any given time horizon. We further introduce a feasibility algorithm to derive a strong initial solution for the routing restorative capacity problem.

4 - Management of Charging Stations' Interrelated Electrical Infrastructure Systems under Major Disruption: A Mathematical Model

Darweesh E. Salamah, Mississippi State University, Mississippi State, MS, 39762, United States, Mohannad Kabli, Mohammad Marufuzzaman, Salem Batiyah

Electric vehicles are envisioned to become the main transportation mode for the future. Electrical Infrastructure is a vital component in the operation of electric vehicles' charging stations. Building a resilient electric system that minimizes the power restoration time is essential for a smooth operation of future transportation modes. This paper aims to fortify the connections within and in between all related electrical structures and charging stations to face against any deliberate or sudden power disruptions. A mathematical model is built with the aim of minimizing disruption costs.

logistics domain.

■ WB45

North Bldg 228A

Practice – Environment, Energy, and Natural Resources

Contributed Session

Chair: Chang Liu, Dongbei University of Finance and Economics, No 217 Jianshan St., Shahekou District, Dalian liaoning, 116025, China

1 - The Problem of Information: Moral Hazard and Adverse Selection in Illegal Waste Disposal

Sytske Wijnsma, University of Cambridge, Cambridge, United Kingdom, Dominique Lauga

The illegal dumping and trafficking of waste is one of the fastest growing areas of organised crime, mainly due to imperfect monitoring driven by incomplete information. In the presence of imperfect monitoring, waste can be misclassified to hide its true nature or it can be illegally dumped to avoid expensive treatment cost. This paper examines firms' behaviour and non-compliance when they operate under incomplete information with respect to the other agents in the chain. Further, we underscore how increased monitoring of trade bans whilst ignoring the impact of incomplete information on firms' behaviour can have unintended consequences on the export of waste the ban was not even intended for.

2 - The Effective Mobile Phone Producers Green Supply Chain Management Practices in Reducing Co2 Emissions

Yazan Migdadi, Associate Professor, Qatar University, Doha, 2713, Qatar

The purpose of this study is reporting the effective mobile phone producers green supply chain management practices to reduce CO2 emissions. Quantitative case study methodology was adopted. This study identified a combination of high impact actions in reducing CO2 emissions related to green purchasing, green production, green distribution, green customers' practices, green business travels, green facilities and offices design actions

3 - The Influences of Public Environmentalism on Air Pollutant Emissions: A Multilevel Analysis across Chinese Prefecture-level Cities

Chang Liu, Professor, Dongbei University of Finance and Economics, No 217 Jianshan St., Shahekou District, Dalian Liaoning, 116025, China

Public environmentalism is an effective pollution supervision regulation to moderate pollution emissions, especially when the government has deployed accountability for environmental performance. To what extent will public environmentalism attenuate the effects of economic factors on environmental pollution? We estimate the role of public concern on pollution across 285 Chinese cities over 2004 to 2015 based on the hierarchical structure. The empirical results indicate an inverse U relationship, and

public concern over environment can make the cities reach the turning points at a low GDP level. This result has important policy implicates to moderate pollution emissions.

■ WB52

North Bldg 231C

Practice - Nonlinear and Dynamic Programming for Applications

Contributed Session

Chair: Luca Bertazzi, University of Brescia, Brescia, 25122, Italy

1 - A One-phase Interior Point Method for Nonconvex Optimization
Oliver Hinder, Stanford, Stanford, CA, 94305, United States, Yinyu Ye

The work of Wachter and Biegler suggests that infeasible-start interior point methods (IPMs) developed for linear programming cannot be adapted to nonlinear optimization without significant modification, i.e., using a two-phase or penalty method. We propose an IPM that, by careful initialization and updates of the slack variables, is guaranteed to find a first-order certificate of local infeasibility, local optimality, or unboundedness of the (shifted) feasible region. Our algorithm with closely resembles successful algorithms from linear programming. Experiments also indicate superior robustness and infeasibility detection compared with IPOPT.

2 - Power System Optimization through Joint Placement of Phasor and Flow Measurements
Vahidhossein Khiabani, Assistant Professor, Middle Tennessee State University, Murfreesboro, TN, 37132, United States

We proposed a mathematical method for joint optimal placement of phasor and conventional flow measurements considering the conflicting objectives of Phasor Measurement Units (PMU's) deployment cost, and system reliability. The model places PMUs on a network with a pre-existing conventional measurements, considering zero injection measurements with the goal of complete observability of the system. The proposed approach is tested on IEEE standard bus systems and compared with some models in literature.

3 - Algorithm for Evolutionarily Stable Strategies against Pure Mutations
Sam Ganzfried, Ganzfried Research, Miami Beach, FL, 33139, United States

Evolutionarily stable strategy (ESS) is an important solution concept in game theory which has been applied frequently to biology and even cancer. Finding such a strategy has been shown to be difficult from a theoretical complexity perspective. Informally an ESS is a strategy that if followed by the population cannot be taken over by a mutation strategy. We present an algorithm for the case where mutations are restricted to pure strategies. This is the first positive result for computation of ESS, as all prior results are computational hardness and no prior algorithms have been presented.

4 - Optimization Tools for the Management of Electric Vehicles in Electrical Networks
Rafael Zarate-Minano, Associate Professor, University of Castilla-La Mancha, EIMIA, Plaza Manuel Meca 1, Almaden, 13400, Spain, Alberto Flores, Miguel Carrion, Ruth Dominguez

The generalized use of the electric vehicle in industralized countries could become a reality during the next decade. In this context, it is necessary to carefully anaylize different aspects of the interaction between these vehicles and electrical networks. This work explores the combined application of optimization methods and homotopy tecniques for the modeling of such interaction. The ability of this combination of tecniques to study aspects such as the adecuacy and the operation of the existing transmission and distribution networks in a context of large-scale integration of the electric vehicle is discussed.

5 - Dynamic Task Allocation with Learning and Forgetting
Thomas Vossen, University of Colorado-Boulder, Leeds School of Business, UCB419, Boulder, CO, 80309, United States, Peter Letmathe

We consider a setting where tasks arrive randomly over time for possible processing. Incoming tasks can be allocated to (human) resources, whose productivity depends on the number of tasks processed by the resource before (learning) and is impacted by changes in the workforce over time (forgetting). We formulate the task allocation problem as a weakly coupled stochastic dynamic programming problem, and use a Lagrangian Relaxation approach to derive heuristic allocation policies. We evaluate the flexibility and resilience that emerge from these policies, and analyze how various environmental factors impact performance.

6 - Dynamic Project Expediting in Stochastic Networks
Luca Bertazzi, University of Brescia, Brescia, 25122, Italy, Riccardo Mogre

A project manager is in charge of a project. At each time, she needs to decide the effort level to invest in the project. The progress made on the project is random, constituting disruptions or efficiency problems. We formulate a stochastic discrete dynamic programming model for this problem and design an exact algorithm to find an optimal policy. Computational results show that this algorithm is more efficient than the classical exact algorithms Value iteration, Policy iteration and Linear programming.

■ WB53

North Bldg 232A

Joint Session AMD/Practice Curated: Auctions and Mechanism Design Applications

Sponsored: Auction and Marketing Design

Sponsored Session

Chair: Michael O. Ball, University of Maryland-College Park, College Park, MD, 20742-1815, United States

1 - Quantity-contingent Auctions and Allocation of Airport Slots
Yulin Liu, University of California-Berkeley, 107D McLaughlin Hall, Berkeley, CA, 94720, United States, Michael O. Ball, Alexander Estes, Mark M. Hansen

We define and investigate quantity-contingent auctions, which can be used when there exist multiple units of a single product and the value of a set of units depends on the total quantity sold. A quantity-contingent auction determines both the number of items sold and an allocation of items to bidders. We focus on auctions that allocate airport arrival and departure slots. We propose a continuous model and an integer programming model for the associated winner determination problem. Using these models, we perform computational experiments that lend insights into the properties of the quantity-contingent auction.

2 - Strategic Timing and Pricing in On-demand Platforms
Mustafa Dogan, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, Alexandre Jacquillat, Vibhanshu Abhishek

We design a dynamic pricing and allocation mechanism for service provision in an on-demand platform facing demand stochasticity, heterogeneity across price-sensitive and time-sensitive customers, and information asymmetry. Time is a strategic device to dynamically manage the demand-capacity imbalances; and to provide discriminated service levels. Results suggest that the optimal mechanism depends on the strength of customer heterogeneity and the time preferences of price-sensitive customers. The proposed mechanism increases platform profits as compared to surge pricing policies, and can even provide a Pareto improvement. We also show that higher demand may trigger lower price.

3 - How Efficient is CTOP?
Alexander Estes, University of Maryland, Beltsville, MD, 20705, United States, Farzad Daneshgar, Michael O. Ball

The Federal Aviation Administration sometimes issues traffic management initiatives that restrict the amount of traffic allowed to enter some region of airspace. The Collaborative Trajectory Options Program allows flight operators to specify alternative routes for their flights. The FAA uses the options to more efficiently implement the traffic management initiative. In this work, we compare the efficiency of the current CTOP allocation process and that of a theoretical system-optimal allocation process.

4 - Randomized Mechanism to Coordinate Carriers in Retail Logistics
Paul Karaenke, Technical University of Munich, Department of Informatics (I18), Boltzmannstr 3, Munich, 85748, Germany, Martin Bichler, Stefan Minner

We consider the problem of slot booking by independent carriers at several warehouses and investigate recent developments in the design of electronic market mechanisms promising to address both computational and strategic complexity. Relax-and-round mechanisms describe a class of approximation mechanisms that is truthful in expectation and runs in polynomial time. While the solution quality of these mechanisms is low, we introduce a variant able to solve real-world problem sizes with high solution quality while still being incentive-compatible. We compare these mechanisms to core-selecting auctions, which are not incentive-compatible, but provide stable outcomes with respect to the bids.

■ WB56

West Bldg 101A

Joint Session HAS/Practice Curated: Data Science in Health Care Operations Research

Sponsored: Health Applications

Sponsored Session

Chair: Jay Michael Rosenberger, University of Texas-Arlington, Arlington, TX, 76019, United States

1 - Parameter Adjustment for Pain Management Treatment Optimization
Amith Viswanatha, The University of Texas at Arlington, Arlington, TX, 76013, United States

Mixed Integer Programming (MIP) solvers like CPLEX have several parameters and finding the right parameter settings for a given problem formulation is a challenging task. In this research, we use the design of experiments (DOE) approach to study the influence of CPLEX parameters on the computation time of the pain management optimization model. The orthogonal array design is used to initially screen the significant parameters and a full factorial design is later employed for a detailed investigation on the influence of the selected parameters.

2 - Data-driven Modeling of a Dynamic and Heterogeneous Contact Network for Understanding the Transmission Behavior of Infectious Diseases
Yuan Zhou, University of Texas at Arlington, Arlington, TX, United States

Contacts are fundamentally linked to the propagation behavior of human-to-human transmitted diseases. Although several well-known structures of social network have been widely applied in the literature for establishing contacts, such as small-world and scale-free networks, an argument arises concerning the adequacy of such a network in capturing the public contacts that often take place in between individuals who are not socially affiliated. We develop a two-layer network framework for representing both social and public contacts. We will utilize both simulated demographical data that obtained from public data sources and synthetic data that generated for representing human mobility.

3 - A Multi-column Generation Approach for Radiation Therapy Treatment Planning
Gazi Md Daud Iqbal, University of Maryland School of Medicine, Baltimore, MD, United States, Jay Michael Rosenberger, Hao Howard Zhang

Both intensity modulated radiation therapy (IMRT) and volumetric modulated arc therapy (VMAT) delivery use multileaf collimator to shape the radiation beam in order to achieve modulation. Column Generation approaches have been proposed to generate these shapes (called apertures) to deliver the radiation therapy treatment. Due to large number of candidate columns (feasible apertures), column-generation-based algorithm is computationally expensive, which affects the achievable solution quality within a clinically acceptable time frame. Instead of adding columns one at a time, this research uses a multi-column generation approach to obtain deliverable apertures for both IMRT and VMAT.

4 - Adjusting for Time Varying Confounding with Multiple Treatment Variables
Aera Leboulluec, University of Texas-Arlington, Arlington, TX, 76013, United States, Nilabh Ohol, Victoria C. P. Chen, Jay Michael Rosenberger

Time varying confounding plays a critical role in longitudinal studies. In medical research, estimating an effect of treatment on an outcome of interest is biased due to presence of time varying confounders. This bias results in inconsistent treatment estimates. Most of literature on handling time varying confounding demonstrates the implementation of methods such as inverse probability of treatment weighting to estimate consistent estimates of a single treatment. This presentation extends this approach to multiple treatments and considers both uncorrelated and correlated treatments.

■ WB62

West Bldg 103A

Joint Session DM/Practice Curated: Data Science in Health Care II

Sponsored: Data Mining

Sponsored Session

Chair: Mehrad Bastani, Stanford University, Mountain View, CA, 94040, United States

1 - Predicting Post Operative Survivability of Lung Cancer Patients a Machine Learning Approach
Alireza Fazli Khalaf, Student, Binghamton University, Vestal, NY, 13905, United States, Yong Wang

Thoracic surgery is one of the treatment options for lung cancer. Risk measurement of such surgery is critical to choose the operation or not. In this paper, one-year survivability of lung cancer patients after a thoracic surgery is investigated using machine learning techniques. As the study deals with imbalance dataset, synthetic minority over-sampling technique is used to resolve the problem. Next, the performance of five classification methods, namely na ve Bayes, radial basis function network, support vector machine, logistic regression and random forest, on predicting the survivability are compared. Results show that Random forest outperforms other classifiers.

2 - Automated Surgical Term Clustering Used in Unstructured Surgery Descriptions
Tannaz Khaleghi, Graduate Teaching Assistant, Wayne State University, 4815 4th Street, Suite 1067, Detroit, MI, 48201, United States, Alper E. Murat

Text mining tools provide us a unique opportunity to extract information from textual data. The information therefore can be useful when predicting procedure code and surgery room duration for different surgical cases as text can provide important details about the procedure while other common features might not target them. In this study the goal is to find most informative text feature from unstructured principal procedure and some physician notes by heuristic integrated text mining method which best organize medical text feature set and sets up feature dimensionality reduction efficiently. The output improves surgery code prediction accuracy and produce more reliable surgery duration.

3 - Patient - Demographic and Health Factors Influencing the Length of Stay in Hospital
Surya Ayyalasomayajula, Oklahoma State University, Stillwater, OK, 74074, United States, Ankita Srivastava, Dursun Delen

This study explores the question of what are the demographic and general health factors that predict the length of stay (LOS) of a patient in a hospital. It conceptualizes that general health condition has a major impact on the LOS followed by demographics. The paper than studies the hospital factors that influence the average length of stay (ALOS) or Hospital Length of Stay (HLOS). Data from 22 hospitals and 5553 patients strongly support the proposed idea of LOS is determined by general health and demographics. The results do not support the idea that ALOS is dependent on hospital factors.

4 - A DEA Evaluation of States' Infant Mortality Rate in the U.S.
Negar Darabi, PhD Student, Virginia Tech, Blacksburg, VA, 24060-4913, United States, Alireza Ebrahimvandi, Niyousha Hosseinichimeh, Konstantinos P. Triantis

States vary in terms of their infant mortality rates (IMR). Here, we build a state-level database to compare 50 states' performance with respect to three major variables including IMR, preterm birth, and low birth weight. We use a Data Envelopment Analysis (DEA) approach to test different factors associated with high performance in infant survival by benchmarking states. Prior studies, examined IMR of neighboring states rather than using a mathematical model for choosing their peers. DEA finds the best practices for states that suffer from poor outcomes (i.e., high rate of infant mortality). The results of this analysis would be beneficial for policymakers to implement effective interventions.

5 - Evaluation of Alternative Diagnostic Test Intervals and Thresholds for Lungrads Criteria on the Effectiveness of Lung Cancer Screening
Mehrad Bastani, Postdoctoral Scholar, Stanford University, 305 Campus Drive, Palo Alto, CA, 94305, United States, Sylvia Plevritis, Iakovos Toumazis, Ann Leung

U.S. Preventive Services Task Force recently recommended a low-dose computed tomography (LDCT) lung screening for high-risk current and former smokers based on the National Lung Screening Trial (NLST). In response to the high rates of false-positive observed in NLST (27.3%), the American College of Radiology developed Lung-RADS, a standardized system for reporting and following-up LDCT findings. Several studies have shown reduction in false-positive rate when Lung-RADs is applied to NLST. To complement these studies, we evaluate the effect of alternative diagnostic testing intervals and actionable nodule size thresholds of Lung-RADs on the mortality reduction associated with LC screening.

■ WB64

West Bldg 104A

Joint Session DM/Practice Curated: Data Science for Decision Support

Sponsored: Data Mining

Sponsored Session

Chair: Kazim Topuz, University of Tulsa, 800 Tucker Ave, Tulsa, OK, 74104, United States

1 - Designing Early Detection and Intervention Techniques via Predictive Models for Bottleneck Business Courses
Sinjini Mitra, Associate Professor, California State University-Fullerton, 800 N. State College Boulevard, ISDS Department, Fullerton, CA, 92831, United States, Zvi Goldstein

We present a study of factors affecting student success in two bottleneck Business courses, and use subsets of them to build predictive models of student success. They can be utilized to detect at-risk students early on for implementing suitable intervention techniques to improve their odds of completing the courses successfully. The results that show that students who receive the intervention and take advantage of it, have significantly improved performance at the end of each course compared to those who do not. We conclude by briefly discussing Supplemental Instruction as an

academic support program that benefits such at-risk students greatly.

2 - Should Low Rated Items be Recommended? An Empirical Analysis

Sanjog Ray, Indian Institute of Management-Indore, Rau Pithampur Road, Faculty Block A-202, Indore, 453331, India

Collaborative filtering is the most popular approach used in recommender systems for recommending items likes movies, books etc. Items that a user will most likely rate high are recommended as a result low rated items are never recommended. This paper questions the approach of ignoring low rated items by the recommender systems algorithms. Based on our analysis of two large datasets on movies and books, we show that low rated movies should not be ignored in the final list of recommendations. We also provide suggestions on how low rated movies can be recommended.

3 - Post-traumatic Stress Disorder (PTSD) Diagnosis & Prediction: A Bayesian Network Model

Yi Tan, University of Kansas School of Business, 1654 Naismith Drive, Lawrence, KS, 66045, United States, Prakash P. Shenoy, Catherine Shenoy, Mary Oehlert

In this study, we first propose a Bayesian network model for post-traumatic stress disorder (PTSD) prediction. By using Veteran Administration patient data between 2000 and 2015, the model is constructed based on patients' demographic information, military history, other accompanied mental disorders, and various psychological tests. Psychological tests are usually required to diagnose/confirm PTSD. To aid the diagnosis, we are also working on a decision support technique that psychiatrists can use to decide which psychological tests, and in what sequence, that a new patient should take. The technique will identify the most informative tests based on information theory.

4 - Predicting and Understanding Freshmen Student Retention- Development of a Bayesian Belief Network-based DSS

Kazim Topuz, Assistant Professor, PhD, University of Tulsa, 1826 23rd Avenue SE, Norman, OK, 73071-1065, United States, Dursun Delen

Student attrition is an administratively important, and yet practically challenging problem for decision makers and researchers. This study aims to find the prominent variables and their conditional dependencies/ interrelations that effect student attrition in college settings. Specifically, using a large and feature-rich dataset, proposed methodology successfully captures the probabilistic interactions between attrition and related factors to reveal the underlying, nonlinear relationships.

■ WB65

West Bldg 104B

Joint Session DM/Practice Curated: Data Science and Robust Optimization

Sponsored: Data Mining

Sponsored Session

Chair: Hari Bandi, MIT, Cambridge, MA, 02139, United States

1 - Practical Robust Optimization for Least-squares Problems

Long Zhao, UT Mccombs Bussiness School, 2110 Speedway Stop B6500, CBA 5.334 Q, Austin, TX, 78712-1277, United States, Deepayan Chakrabarti, Kumar Muthuraman

Solution to Robust optimization formulations is sometimes too conservative because of the worst-case performance objective. For the least-squares problem, we describe a way to overcome this by combining its Robust version with the classical formulation. The talk describes the method and how it leverages on a deeper understanding of estimation errors to help improve out of sample performance. For more than 50 different real-world scenarios, the method consistently outperforms other methods that ignore such space-level information and outperforms both ridge and lasso regression most of the time.

2 - Bootstrap Robust Prescriptive Analytics

Bart Paul Gerard Van Parys, MIT, Room E40-154, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States, Dimitris Bertsimas

We discuss prescribing optimal decisions in a framework where the cost depends on uncertain problem parameters that need to be learned from data. Proper prescriptive methods exploit additional observed contextual information on a large number of covariates. Naive use of training data may lead to gullible decisions over-calibrated to one particular data set. We use robust optimization and the bootstrap to propose two novel prescriptive methods. Both resulting robust prescriptive methods reduce to tractable convex optimization problems and enjoy a limited disappointment on bootstrap data.

3 - Learning a Mixture of Gaussians via Mixed Integer Optimization

Hari Bandi, MIT, Cambridge, MA, 02139, United States

We consider the problem of estimating the parameters of a Gaussian mixture model (GMM) given access to n samples x1, x2, ... , xn ? R^d that are believed to have come from a mixture of multiple subpopulations. We present here a novel MIO formulation that optimally recovers the parameters of the GMM by minimizing a discrepancy measure between the empirical distribution function and the distribution function of the GMM. We show that the MIO approaches are practically solvable for datasets with n in the tens of thousands in minutes and achieve an average improvement of 60-70% and 50-60% on MAPE in estimating the means and the covariance matrices, respectively over the EM algorithm independent of the sample size.

■ WB72

West Bldg 211A

Practice- Operations Management III

Contributed Session

Chair: Yiwei Huang, Pennsylvania State University, Mars, PA, 16046, United States

1 - Impact of Shorttermism on Capacity Investment in Competitive Markets

Xiaoyan Liu, PhD Student, Cornell University, Sage Hall, Ithaca, NY, 14853, United States, William Schmidt

We study how a firm's short-term interest in its capital market valuation will affect its capacity decision and long-term profits in the presence of a competitive entrant. We show that the firm with private demand information prefers to signal a high (low) demand when short-termism is high (low). Moreover, pooling equilibria can occur with either low or high levels of short-termism, and both firm types will under-invest in a pooling outcome when short-termism is sufficiently low. We find that the impact of short-termism on long-term profits changes with the firm type and the equilibrium type.

2 - A Wholesale Supply Contract with a Secondary Price Commitment

Ayhan Aydin, George Mason University School of Business, 4400 University Drive, MS 5F4, Fairfax, VA, 22030, United States, John R. Birge, Izak Duenyas

In procurement from low-cost but less flexible supply options, especially of products with highly variable demand and of seasonal nature, advanced auctions and non-linear compensation schedules can be used to correct inefficiencies due to double marginalization, information asymmetry, and demand uncertainty. We introduce an alternative simple-to-administer contracting scheme that requires minimal effort to implement, which can be used especially when the suppliers do not offer revenue sharing, buy-back, or real option contracts. We study how it allows the buyer to benefit further from low-cost distant supply options. We show that a truly low-cost supplier can also benefit from such a scheme.

3 - Quality Control Strategies in Two-sided Market

Lyu Gaoyan, Peking University, No.5 Yiheyuan Street, Beijing, 100871, China, Lihua Chen

Consumers focus on product quality increasingly. We design two quality control strategies to help two-sided platform improve its product quality. Using Stankburg method, we compare the optimal profits with two quality control methods. The result shows that taking any strategy is better than taking no action. Moreover, taking both strategies will bring higher social welfare.

4 - A Framework for Analyzing the U. S. Coin Supply Chain

Yiwei Huang, Assistant Professor, Pennsylvania State University - Shenango, 173 Broadstone Drive, Mars, PA, 16046, United States, Subodha Kumar, Bala Shetty, Chelliah Sriskandarajah, Yunxia Zhu

We analyze the supply side of the U.S. Coin Supply Chain with the objective of providing a near-optimal or an optimal operating policy that minimizes the total cost of producing, supplying, and managing coin inventory in the U.S. Coin Supply Chain. We develop efficient algorithms to solve various versions of the coin-management problem and perform an extensive analysis to answer several managerially relevant questions in the context of improving the efficiency of the U.S. Coin Supply Chain.

■ WB73

West Bldg 211B

Practice- Optimization II

Contributed Session

Chair: Elham Taghizadeh, Wayne State University, Detroit, MI, 48035, United States

1 - Exact Penalization for Generalized Nash Equilibrium Problem

Qin Ba, University of Southern California, Los Angeles, CA, United States, Jong-Shi Pang

The Generalized Nash Equilibrium Problem (GNEP) extends the classical Nash Equilibrium Problem (NEP) by allowing individual players' constraints, in addition to

objectives, to depend on rivals' decisions. It is an important model actively used in many different fields. However, solution algorithms are extremely scarce due to the presence of coupling constraints. This paper studies penalty methods which penalize violation of individual players' coupling constraints and transform a GNEP into a single NEP. Several sufficient conditions are provided which guarantee exact penalization, i.e., the penalized NEP has identical solution sets as the original GNEP for finite penalty parameter.

2 - Underestimate Sequences via Quadratic Averaging

Chenxin Ma, JD.com, Mountain View, CA, United States, Naga Venkata C. Gudapati, Majid Jahani, Rachael Tappenden, Martin Takác

In this work we introduce the concept of an Underestimate Sequence. Our definition of a UES utilizes three sequences, one of which is a lower bound (or under-estimator) of the objective function. We propose several first order methods for minimizing strongly convex functions in both the smooth and composite cases. The algorithm have natural stopping conditions, which provides the user with a certificate of optimality. Convergence of all algorithms is guaranteed through the UES framework, and we show that all presented algorithms converge linearly, with the accelerated variants enjoying the optimal linear rate of convergence.

3 - Optimizing Schedule of Trains in Context of a Large Railway Network

Srinivasa Prasanna, IIIT Bangalore, 26/C, Hosur Road, Electronics City, Opposite Infosys Technologies, Bangalore, 560100, India, Sanat Ramesh, Tarun Dutt, Anushka Chandrababu, Abhilasha Aswal

We present two heuristics based on MILP formulations to optimize utilization for train timetabling problems for portions of one of the largest railway networks. These methods (extending state-of-art solvers) provide flexibility in scheduling additional trains while respecting a large number of constraints. We present methods to validate the deterministic schedule over global correlated variations in travel times without making any probabilistic assumptions.

4 - A Branch and Bound Algorithm for Two-machine No-wait Flow Shop Scheduling with Truncated Learning Function

Vahid Azizi, Iowa State University, Ames, IA, United States, Guiping Hu

There have been increasing interests in production scheduling considering learning effects. However, this problem has not been studied in a no-wait flow shop scheduling setting. This paper addresses a two-machine no-wait flow shop with the effect of the truncated learning function. With the truncated learning function, processing times of the jobs depend on their positions in the sequence and the learning parameter. A branch and bound algorithm is designed to minimize the makespan. A lower bound and two dominance properties are proposed which increase computational efficiency for the branch and bound algorithm.

■ WC03

North Bldg 121C

Practice- Modeling and Optimization for Decision Making II

Contributed Session

Chair: Michele J. Fisher, Northwestern University, Regina, SK, S4S 2H7, Canada

1 - MCDA with Little or No Data

Lawrence D. Phillips, Emeritus Professor, London School of Economics & Political Science, London, NW3 1AH, United Kingdom

Unique decisions involving multiple criteria are often characterised by conflicting or sparse data, or even no data, so we rely on expert judgment. In this talk I explain and illustrate seven best-practice principles, with evidence they lead to reliable and valid results. The principles include impartially facilitating decision conferences of diverse experts, engaging experts' mental models, gaining clarity about the decision context, developing good definitions of criteria, applying proper scoring and weighting techniques, checking consistency, and conducting extensive sensitivity analyses.

2 - Optimization and Scheduling Methodologies to Enable Low Earth Orbit Nano-satellite Communication

Michelle L. Song, University of Washington, Seattle, WA, 98105, United States, Cherry Yu Wakayama, Zelda B. Zabinsky

Communications with low earth orbit nano-satellites (nanosats) are challenging due to short contact time intervals and uncertainty in successful delivery of messages. We present optimization models (with and without energy constraints) to enable timely delivery of messages between gateways and remote users via nanosats. Connections between nanosats and remote users may not be well established; the uncertainty is modeled using a chance constraint. A network flow program is formulated to optimize the scheduling/routing of messages. Decisions are chosen to minimize the delivery time. Although the decisions are binary variables, the models are shown to satisfy the integrality property.

3 - An Application of Doubly Stochastic Nonhomogeneous Poisson Process for Detecting Abnormalities

Joonho Bae, Korea Advanced Institute of Science and Technology, 291, Daehak-ro, Yuseong-gu, Daejeon, Korea, Republic of, Seung-hoon Lee, Woojin Cho, Jinkyoo Park

The anomaly detection problem can be considered with a stochastic counting process. The event of interest is firstly defined as an exceedance of a numerical threshold of the data. Log Gaussian Cox Process, a doubly stochastic nonhomogeneous Poisson process is used to fit the occurrence pattern of the events. The probability value for the data realization within a fixed time interval under the trained intensity function, as a normality score, is calculated and checked if it is below a pre-determined criterion, which is regarded as an anomaly. The robustness of the model is also verified for the abrupt change within the data.

4 - Using Analytics to Improve Patron Engagement at the Los Angeles Philharmonic

Michele J. Fisher, Northwestern University, Chicago, IL, United States, Shelley de Leon, Erin Po, Scott Kennedy

One hundred years ago, the Los Angeles Philharmonic was founded as L.A.'s first permanent symphony orchestra. A century later, the LA Phil is one of the most dynamic music organizations in the world. It combines a commitment to the future with a fresh eye on the past. The Phil has been using analytics of historical giving data to target future fundraising efforts. Our team analyzed demographics, ticketing, and giving history for patrons and built models to predict the likelihood of a donation and the associated amount. This is helping the organization get ready for the next century.

5 - Global Non-probabilistic Validation of Schedules

GN Srinivasa Prasanna, International Institute of Information Technology Bangalore (IIITB), Bengaluru, 560100, India, Anushka Chandrababu, Abhilasha Aswal, Sanat R, Tarun Dutt

Deterministic optimization problems for train timetabling over even small portions of one of the world's largest railway networks become intractable when uncertainty is introduced. We present methods based on linear programming to validate nominal schedules over global correlated variations in travel times (satisfying linear constraints) without making any probabilistic assumptions.

6 - A Hybrid Bat Algorithm for a Risk Averse Two Stage Stochastic Replenishment Problem with Transportation Costs

Elham Taghizadeh, Wayne State University, Detriot, MI, 48202, United States, Saravanan Venkatachalam, Ratna Babu Chinnam

Integrating inventory and transportation decisions can provide significant gains in the supply chain management. In this talk, we present a two-stage risk-averse stochastic programming model with Conditional-Value-at-Risk (CVaR) as risk-measure for a multi-item replenishment problem with transportation cost and demand uncertainty. To circumvent computational complexity, we develop a Hybrid Bat algorithm to solve the large-scale instances. Computational results based on sample average approximation approach will be presented.

■ WC13

North Bldg 126B

Practice- Supply Chain Optimization II

Contributed Session

Chair: Jing Luo, University of Pittsburgh, Pittsburgh, PA, 15260, United States

1 - Supply Chain Design with Multi-modal Shipping and Varying Lead Times

Gang Wang, University of Massachusetts Dartmouth, New Bedford, MA, 02740, United States

This paper considers a multi-echelon supply chain design considering production scheduling, varying lead times, and multiple shipping options. The problem is to determine three types of decisions: a) strategic decision-the location of processing centers; b) tactical decision-the shipping quantities from suppliers to processing centers; and c) operational decisions-order assignment of demand points to processing centers as well as production schedules at both the suppliers and processing centers. We study three scenarios: 1) commit to delivery; 2) nonlinear shipping costs; and 3) complete delivery.

2 - Manufacturing Network Design in the Pharmaceutical Industry under Life-cycle Demand

Gregor Blossey, German Graduate School of Management and Law, Heilbronn, 74076, Germany, Gerd J. Hahn, Achim Koberstein

This research investigates the value of flexibility in manufacturing networks of the pharmaceutical industry. Pharmaceutical companies typically operate under life-cycle demand and are subject to two sources of uncertainty: demand uncertainty and product approval uncertainty. We present a two-stage stochastic programming model to determine the optimal level of capacity flexibility using multiple product

allocations and outsourcing to contract manufacturing organizations. A numerical study is conducted with real-life data provided by a global pharmaceutical company.

3 - Integrated Order Acceptance, Production Planning, and Distribution Problems

Utku Koc, MEF University, Huzur Mah. Ayazaga Cad No: 4, Maslak-Sariyer-Istanbul, Istanbul, 34396, Turkey

We study a manufacturer's multi-period production planning problem to produce and ship a subset of available orders from a given set, meeting due window constraints, with the maximum profit. Each potential order has a revenue, size, and a due window. The profit is calculated as the revenue minus the transportation and inventory holding costs. The manufacturer can use different type of vehicles varying in their price and availability for outbound transportation. We study three different delivery characteristics: 1) whether orders can be split or not, 2) whether they can be consolidated or not, and 3) whether their sizes are restricted to be in integer multiples of vehicle capacities or not.

4 - The Optimal Width Decision for Cardboard Used in On Demand Packaging

Yihuan Yang, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, Xiangtong Qi

For packaging problem, if the box could fit the products perfectly, there would be no packing fillers waste and less corrugated cardboard is used. The box-making machine with one long continuous piece of cardboard is used to cut the right-sized box. So the main problem is how to decide the proper width of the cardboard. The framework introduced in this paper can help to make better decisions so that the material waste is minimized. Compared with other naive methods, the policy obtained by our framework has better performance, especially when the penalty of exceeding capacity is high.

5 - Learning About a New Market from Supplier Perspective

Jing Luo, University of Pittsburgh, Pittsburgh, PA, 15208, United States

How to learn about a new market? What information and method are important for suppliers?

■ WC19

North Bldg 128B

Joint Session RMP/Practice Curated: Modern Applications of Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Maxime Cohen, NYU Stern, New York, NY, 10012, United States

Co-Chair: Renyu Zhang, New York University Shanghai, Shanghai, 200122, China

1 - The Value of Personalized Pricing

Michael Hamilton, Columbia University, New York, NY, United States, Adam Elmachtoub, Vishal Gupta

Increased access to high-quality customer information has fueled interest in personalized pricing strategies, i.e., strategies that predict an individual customer's valuation for a product and then offer them a customized price. While the appeal of personalized pricing is clear, it may also incur costs in the form of market research, investment in information technology, and branding risks. In light of these tradeoffs, in this work, we study the value of personalized pricing over simpler pricing strategies, and provide various closed-form upper bounds on the ratio that depend on simple statistics of the valuation distribution.

2 - Power of Monotonic Reoptimized Pricing in Revenue Management with Strategic Customers

Yiwei Chen, University of Cincinnati, Cincinnati, OH, United States, Stefanus Jasin

We study a canonical revenue management problem that a seller sells a single product with finite inventory over a finite horizon. Customers are forward looking who strategize their purchasing times. We propose a simple heuristic policy that requires the seller to repeatedly solve a simple static optimization problem by using the updated sales information. The price process is restricted to be non-decreasing over time. Thus, it incentivizes customers to behave myopically. We show that when the seller's initial inventory and the length of the horizon proportionally grow large (scaled by k), the regret of our proposed policy is upper bounded by O (log k).

3 - Competition and Coopetition for Two-sided Platforms

Renyu Zhang, New York University Shanghai, 1555 Century Avenue, Shanghai, 200122, China, Maxime Cohen

We study the two-sided competition between online service platforms. We develop a new approach to characterize the existence and uniqueness of equilibrium when platforms compete for both demand and supply. Armed with this result, we then investigate coopetition between different ride-sharing platforms by introducing new joint services. The coopetition between different platforms is through profit sharing contracts. Interestingly, we show that a well-designed profit-sharing contract can will benefit both platforms. In addition, we find that one can design a profit-sharing contract that also benefits riders and drivers.

4 - Electricity Pricing with Limited Consumer Response

Saed Alizamir, Yale University, 206 Elm Street, P.O. Box 209052, New Haven, CT, 06520, United States, Shouqiang Wang, Fariba Farajbakhsh

Retail electricity markets are characterized by nuanced features that distinguish them from mainstream retail settings. Specifically, the consumption quantity is influenced by factors not controlled by the consumer (e.g., weather), and consumption decisions can be readjusted on a continuous basis. In this paper, we study a monopolistic utility firm's pricing decision in a retail electricity market. Using a rational inattention framework, we construct a demand model for consumers, whose consumption decisions demonstrate limited response to their ambient environment for a given price. Implications on social welfare and system reliability are drawn.

■ WC22

North Bldg 130

Practice – Finance Theory & Financial Engineering I

Contributed Session

Chair: Min Dai, National University of Singapore, Dept of Math, Singapore, 119076

1 - Investment and Financing for Cash Flow Discounted With Group Diversity

Zhaojun Yang, Southern University of Science and Technology, 1088 Xueyuan Avenue, Fourth Building of the Faculty Apartment, Shenzhen, 518055, China

We consider a firm's investment and financing decisions made by a group of which each individual may utilize different discount rates to price cash flow generated by the investment project. We show that a higher degree of decreasing impatience or a greater group diversity increases the project value, accelerates investment and postpones default. Both the value of the investment option and the optimal leverage increase with the degree of the decreasing impatience and the group diversity. The inefficiency from asset substitution increases but it from debt overhang decreases with the degree of the decreasing impatience and the group diversity. Our predictions are documented by empirical evidences.

2 - Making the Most Out of Market Forecasts Based on Linear Regression

Hamed Khaledi, PhD Student, Broad Graduate School of Management, 632 Bogue Street, North Business College Complex, Room N203, East Lansing, MI, 48825, United States

This paper presents a mathematical model to make optimal trading decisions using forecasts made by multivariate regression. Given that these results are uncertain, the model maximizes the expected profit from opening and closing trade positions. To this end, a dynamic programming approach is employed. We first find the optimal take profit levels associated with buy and sell positions. Then we decide to buy, sell or wait, based on the maximum expected profit in each case. The approach is applied to find the optimal strategy for trading GBPUSD rate based on a multivariate regression model fitted to the historical daily data in the FOREX Market.

3 - The Design of a Global Supply Chain by Integrating Operational and Financial Strategies

Mengyue Wang, PHD, Tsinghua University, Beijing, China, Hongxuan Huang

In this paper, a scenario-based mixed-integer linear programming model is proposed for designing a flexible capital-constrained global supply chain (CCGSC) in which integrate the applying for loans with operational strategies such as constructing, or leasing facilities and equipments to meet uncertain demands and exchange rates. The research on the CCGSC also indicates that the complementary property holds for both the remaining capital of loans with higher costs and another available loan with a lower cost under certain conditions. A case study is also presented to illustrate effectiveness and efficiency of the scenario-based approach.

4 - Adjusted Portfolio Selection Model Reflecting the End of the Year Effect of Global Economic Growth

Jihye Yang, PhD Student, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul, 03722, Korea, Republic of, Hongseon Kim, Seongmoon Kim

This study suggests improved investment strategy based on adjusted portfolio selection model reflecting The End of the Year Effect, a strong negative relation between end of the year global economic growth and average stock returns(Stig V.2016). We can adjust the proportion of capital invested in risk assets and risk-free assets on the rebalancing date according to end of the year global economic growth. Specifically, if end of the year global economic growth is high, we decrease the proportion of capital invested in risk assets and increase risk-free assets in order to avoid risk. Thus, we can expect superior performance using the proposed investment strategy reflecting The End of the Year Effect.

5 - Optimal Control of an Individual Savings Account in a Defined Contribution Pension System

Luis Chavez-Bedoya, Professor, Universidad Esan, Nestor Bermudez 191, Chorrillos, Lima, LIMA 9, Peru, Ranu Castaneda

In this article, we examine the optimal investment strategy of a particular utility-maximizer participant in a defined contribution pension fund under the system of individual accounts; but, we assume deterministic functions for the fees paid to the pension fund administrator and for the contribution rate of the participant. Finally, we perform a thorough comparison between the two different types of fees (on balance and on flow) and we apply our results to the Peruvian Private Pension System in order to determine equivalent fees on balance and flow.

6 - A Dynamic Mean Variance Analysis with Application to Robo Advising

Min Dai, National University of Singapore, 10 Lower Kent Ridge Road, Dept of Math, Singapore, 119076, Singapore, Hanqing Jin, Steven Kou, Yuhong Xu

In asset allocation for robo-advising, it is desirable to elicit investors' risk profile via several simple online questions and to provide advice consistent with conventional investment wisdom (e.g. rich people should invest more money in risky assets, and for long-term investment people should not short sell major stock indices whose returns are higher than the risk-free rate). We propose a dynamic portfolio choice model with the mean-variance criterion for portfolio log-returns that meets the two challenges. The model yields analytical and time-consistent optimal portfolio policies.

■ WC24

North Bldg 131B

Practice- Programming and Applications I

Contributed Session

Chair: Frank Muldoon, Applied Materials, Piedmont, SC, 29673, United States

1 - Revised Adaptive Linear Programming Algorithm

Lin Guo, University of Oklahoma, Norman, OK, 73071, United States

We revise Adaptive Linear Programming (ALP) to have fewer heuristics in determining the value of critical parameters, using the insight that we get through post-solution analysis. ALP is a second-order derivative linearization algorithm. The algorithm has limitations: 1) the value of critical parameters are determined with heuristics; 2) we use the critical parameters to control the approximation accuracy as well as convergence efficiency, but little knowledge of their tradeoffs has been used to make rules of the parameters setting and updating. To fill in these gaps, we revise the ALP algorithm to self-update the critical parameters using the knowledge from the post-solution analysis.

2 - Managing Navigation Channel Traffic and Anchorage Area Utilization of a Container Port

Shuai Jia, The Hong Kong Polytechnic University, Kowloon, Hong Kong, Chung-Lun Li, Zhou Xu

Navigation channels are fairways for vessels to travel in and out of a container terminal basin. The capacity and availability of a navigation channel is restricted by the traffic lanes and tides. When the navigation channels run out of capacity, the anchorage areas can serve as a buffer. This paper aims to simultaneously optimize the navigation channel traffic and anchorage area utilization of a container port. We provide a mixed integer program of the problem, analyze its complexity, and propose a Lagrangian relaxation heuristic for solving the problem. Computational performance of the heuristic is evaluated on problem instances generated based on the operational data of a port in Shanghai.

3 - On Sensitivity Analysis of Linear Integer Program: The Case of Stochastic Programming and Non-linearity in Parameters

CY (Chor-yiu) Sin, National Tsing Hua University, Kuang-Fu Road, Hsinchu, 30013, Taiwan

A stochastic programming with P states can well be formulated as a deterministic programming with P-1 probabilities. In this and the case with non-linearity in parameters, when one parameter changes the others may also change. Consequently the existing sensitivity analysis in the linear integer program may not be applicable, as it confines the attention to one-parameter change. This paper considers a special type of Lagrangian dual function which renders strong duality. Using this Lagrangian dual function, we first generalizes the result in Shapiro (1977) to multi-parameter cases. Further, we show with synthetic data that our analyses save a lot of computer time in large-scale optimization.

4 - Data-driven Quickest Detection of Customer Churn

Roozbeh Yousefi, Queen's University, Kingston, ON, K7M9H1, Canada, Jue Wang

In many service industries, customers may stop returning for service without informing the service provider. It is important for the service provider to detect such soft churn as quickly as possible, so that appropriate retention can be made. We develop a churn detection model based on partially observable Markov decision processes in which both transition and observation probabilities are unknown. The optimal policy must balance churn detection with parameter learning. We characterize the structure of the optimal policy and show that the infinite-dimensional belief space can be collapsed to two-dimension, making the optimal policy computationally feasible.

5 - Sales & Operations Planning Linear Programming Model Used by Semiconductor Manufactures

Frank Muldoon, Operations Research Application Engineer, Applied Materials, 5225 W. Wiley Post Way, Suite 275, Salt Lake City, UT, 84116, United States

In today's competitive environment, semiconductor manufacturers face the unending challenge of planning for ever-changing customer demands. Factory managers must plan for new orders within existing demands in order to avoid capacity shortfalls of available resources. We propose a linear programming formulation that models this capacity planning challenge in Applied Material's Advanced Productivity Family software. The result of this optimization identifies demands that cannot be satisfied and resource capacity deficits week, months, or even years in advance giving planners time to adjust. We discuss the implementation of our system within a semi-conductor assembly and test facility.

■ WC28

North Bldg 221A

Practice- Transportation-Operations II

Contributed Session

Chair: Young-Ji Byon, Khalifa University of Science Technology, Al Saada Street and Airport Road, P.O. Box 127788, Abu Dhabi, 127788, United Arab Emirates

1 - Layout Optimization of Business Outlets for Railway Scattered Goods Express

Yongxiang Zhang, Southwest Jiaotong University, Chengdu, 610031, China, Qingwei Zhong, Qiyuan Peng, Wenxin Li

Due to the characteristics of scattered goods, how to optimize the layout of business outlets for railway scattered goods express in transportation network has become a worth researching problem. In this paper, firstly, portraying the railway scattered goods express network as a two-level single assignment network composed of three-layer logistics nodes. Then, based on the construction of the assignment network, a mixed integer programming model is established to minimize the total cost of the railway scattered goods express network. Finally, a real-world case of Chengdu is used to verify the effectiveness of the proposed method.

2 - The Access Management Application for Improving Performance of a Signalized Intersection

Maxim A. Dulebenets, Florida A&M University-Florida State University, Tallahassee, FL, 32311, United States, Amir Masoud Rahimi, Arash Mazaheri, Junayed Pasha, Masoud Kavoosi

Different access management techniques have been widely used to improve the traffic flow conditions in large metropolitan areas. This study aims to assess the effects of replacing the direct left turn with the right-turn U-turn maneuver at the signalized intersection performance. The SimTraffic and AIMSUN simulation models are developed to estimate the major intersection and network performance indicators. The computational experiments are conducted for one of the busiest intersections in Tehran metropolitan area (Iran) and demonstrate advantages from the proposed access management treatment.

3 - Optimizing Intermodal Terminal Operations Base Model through Simulation Modeling: A Comparison on Different Settings

Fatemeh Rezaeifar, PhD Candidate, University of Texas at Arlington, Arlington, TX, 76010, United States, Mohammad Najafi, Brian L. Huff

Increasing demand in terminals will raise the risk of terminal congestion due to the increase in system bottlenecks. This research develops a framework for optimizing the capacity of intermodal Underground Freight Transportation (UFT) terminals. To test the variations of performance indicators a discrete event simulation model is used for two scenarios (with and without a stack-yard). The findings confirms that the percentage of bottlenecks in both scenarios significantly decreased and Scenario No. 1 and No. 2 ship respectively 34% and 59% more than the annual expected shipped containers. Also, Scenario No. 2 can handle 25% more containers per year.

4 - A Near Real-time Algorithm for System Optimal Dynamic Traffic Assignment with Multiple Origins and Destinations

Mehrzad Mehrabipour, Washington State University, 1630 NE Valley Road, Apt B204, Pullman, WA, 99164, United States, Ali Hajbabaie

This study introduces an efficient algorithm to find near-optimal solutions to the System Optimal Dynamic Traffic Assignment Problem (SODTA) with multiple origins and destinations in real-time. The proposed Distributed Optimization and Coordination Algorithm decomposes the network-level traffic assignment problem into several intersection-level subproblems that can be solved individually. The complexity of the problem is significantly reduced, and the solutions can be found in

real-time. The results in a case study of 20 intersections are compared with the global optimal solution and the maximum observed optimality gap was 5%.

5 - Air Traffic Noise Monitoring with ADS-B Signal, GIS, and BIM in UAE

Young-Ji Byon, Associate Professor, Khalifa University of Science and Technology, Abu Dhabi, 127788, United Arab Emirates, Tadahiro Kishida

It is essential to monitor and assess air traffic noise levels in the vicinity of airports for impacts on residential and commercial zones in UAE. Recently, commercial airlines have started equipping their planes with ADS-B signal emitters. A GIS layer in a raster format can accumulate the noise in a quantifiable unit of decibels in associated cells for various tempo-spatial analyses of air traffic noises. In order to accurately account for the noise on the ground surface, digital elevation model integrated with building information modeling can provide noise projection on buildings.

■ WC42

North Bldg 227A

Practice- Simulation I

Contributed Session

Chair: Matthew J. Saltzman, Clemson University, Dept of Mathematical Sciences, Martin Hall Box 340975, Clemson, SC, 29634-0975, United States

1 - GPU Supported Large Scale Simulation Models for Influenza Pandemic Outbreaks

Shalome Hanisha Anand Tatapudi, University of South Florida, 4202 E. Fowler Avenue, ENB 118, Tampa, FL, 33620-5350, United States, Zhila Nouri, Tapas K. Das

Influenza pandemics are a serious concern and researchers are trying to understand its patterns. One such tool to effectively understand the disease characteristics is through an agent-based (AB) simulation model, which is versatile, yet has computational limitations when it comes to simulating larger populations. This study integrates the flexibility of AB simulation with computational efficiency of a graphical processing unit (GPU) to create models for pandemic outbreaks in large areas comprising of hundreds of millions of people.

2 - Comparison of MRSA Infection Control Policies in ED Patients

Karthick Srinivasan, Rochester Institute of Technology, Rochester, NY, 14623, United States, Vignesh Krishnan Rajkumar, Levi Toweh, Nasibeh Azadeh Fard

Methicillin-Resistant Staphylococcus Aureus (MRSA) is a major cause of preventable nosocomial infections in ED. The changes made in admission policies of patients with MRSA can affect patient throughput in hospitals. In this research, we study the impact of admission policy change for MRSA patients in an ED of a large hospital in upstate NY using discrete-event simulation modeling.

3 - An Agent-based Model of Subsidized Flooding Insurance

Valerie Washington, University of Michigan, Ann Arbor, MI, 48109, United States

Flood insurance is one strategy for addressing the economic impact of floods to both homeowners and their community. In this paper, I use agent-based modelling to explore how income-based subsidies influence mitigation strategies employed by agents, and whether that includes large-scale abandonment. I investigate the effect of subsidized and unsubsidized flood insurance on community mitigation decisions, damages incurred, and vacancy and move out rates. Damages are evaluated from the perspective of individual homeowners and the community at large.

4 - Review and Analysis of Airplane Boarding Strategies Based on Discrete Events Simulation

Alejandro Garcia del Valle, Professor, University of A. Coruna, Escuela Politecnica Superior, C/ Mendizabal S/N - Esteiro, A. Coruna, 15403, Spain, Roi Sanchez-Tutor, Diego Crespo-Pereira, Javier Faulin

Airport taxes are one of the most critical economic factors for an airline due to the time the plane stays on the airport while turn-around. Boarding is a key part of turn-around for both customer satisfaction and airline profitability. This is the reason why so many strategies have been designed in order to reduce boarding times. By using Discrete Event Simulation, different boarding strategies are analyzed to determine which one is more efficient in Boeing 737-800 according to different scenarios considering plane occupation, delays and 2-door boarding.

5 - What Not to Expect When You're Expecting: Perils of Sampling and Estimating for Lognormal Distributions

Matthew J. Saltzman, Associate Professor, Clemson University, Dept of Mathematical Sciences, Martin Hall Box 340975, Clemson, SC, 29634-0975, United States, William C. Bridges, Neil J. Calkin

Lognormal distributions can be problematic when the variance of the underlying normal distribution is other than very small. We illustrate these problems in terms of sampling issues, interval estimation of the mean, and comparison of lognormal and logbinomial distributions with similar means and variances.

■ WC45

North Bldg 228A

Practice- Electrical Markets

Contributed Session

Chair: Srinivasa Prasanna, Electronics City, Opposite Infosys Technologies, Bangalore, 560100, India

1 - Using Python to Decompose Reduced Costs for a Capacity Expansion Model of the Electric Power Sector

Kelly Eurek, National Renewable Energy Laboratory, 15013 Denver W. Pkwy, Golden, CO, 80401, United States

The Regional Energy Deployment System (ReEDS) is a capacity expansion model that identifies least-cost solutions to build and operate the US electric power grid. ReEDS is formulated as a linear program and written in GAMS. To understand the decision making in ReEDS, we designed a Python tool to harvest data from the MPS and GAMS solution files to reconstruct the reduced costs of the decision variables. Examining reduced costs allows us to calculate the cost and value streams of supply-side technologies and compare which options recover costs versus those that do not. This Python tool helps to identify errors in the model, provides solution transparency, and can be applied to other models written in GAMS.

2 - Implement Real Time Pricing with Multiarmed Bandit Games

Andrew Lu Liu, Associate Professor, Purdue University, 315 North Grant Street, School of Industrial Engineering, West Lafayette, IN, 47907, United States, Zibo Zhao

The situation where price-responsive consumers determine what to do in the near future (such as when to charge their PEVs) forms a dynamic and incomplete-information game, in which the consumers' collective actions will impact electricity prices, which in turn affect their payoffs. We propose a multiarmed bandit (MAB) game framework in which each consumer plays an MAB problem to minimize the cumulative regret, as opposed to naively responding to day-ahead prices. Numerical results show very fast convergence to a steady-state of the MAB game with much reduced price volatility and lower transmission congestion costs than the na ve-response case.

3 - Market Design and Competition in Short Term Electricity Markets - Lessons Learned from a Stochastic Multistage Energy System Model

Frieder Borggrefe, German Aerospace Center (DLR), Pfaffenwald Ring 38-40, Stuttgart, 70563, Germany

This paper provides results from an integrated model for short-term electricity markets, including day-ahead, intraday and balancing markets. Coping with volatile renewable feed-in is a key challenge to the future European electricity system. The paper shows first results from a stochastic linear commitment and dispatch model. Aim of the model is to analyze how trading in the short-term markets will change with increasing shares of renewable energies. The model results are part of the BEAM-ME project: This project developes speed-up methods and applies models to high performance computing (HPC). The paper discusses the next steps to expand the model and challenges when applying the model to HPC.

4 - Community Market Design for Unlocking Congested Distributed Energy Operations

Jesus Nieto-Martin, Senior Research Fellow, London Business School, Sussex Place, Regent's Park, London, NW1 4SA, United Kingdom, Derek W. Bunn

This study is motivated by the Orkney Archipelago in Scotland, which presents a substantial amount of renewables connected to undersized infrastructure and is only linked to the Scottish mainland by two 33kV submarine cables. Currently, there is a curtailment mechanism based on the Last-In-First-Out (LIFO) principle. This study provides a market-based alternative to improve current operations by decreasing the curtailment of wind generators. This is achieved through participation into a Blockchain-based Community Local balancing market among islands, unlocking demand side response actions among them and increasing their trading opportunities.

5 - Handling Optimization in Large Scale Energy Management with Hierarchical Approach

Srinivasa Prasanna GN, Professor, IIITB, Bangalore, India, Sunil K. Vuppala

We present optimization methods of energy management in large scale smart grid systems. We handle violated coupling constraints in a hierarchical approach. We present three cases covering different possibilities of feasibility in the hierarchical approach and techniques to handle the infeasibility. We compare our results with non-hierarchical and a proposed All-or-None heuristic.

■ WC47

North Bldg 229A

Practice- Sustainable Operations

Contributed Session

Chair: Qiangfei Chai, Xi'an Jiaotong University, Xi'an, 2, China

1 - A Performance Measurement System for Green Supply Chain Performance Evaluation

Nima Kazemi, Massachusetts Institute of Technology, Cambridge, MA, 02140, United States, S. Maryam Masoumik

In this paper, a fuzzy-rule based performance measurement system is developed to evaluate the performance measures for both Green supply chain management practices implementation and performance outcomes. To construct the performance measurement system, a comprehensive literature review was conducted to investigate various green supply chain initiatives. Structural equation modeling is used to categorize measures and then a fuzzy membership function is designed for evaluation purpose. The applicability of the developed performance measurement system is evaluated by using a real case study in Malaysian manufacturing industry.

2 - An Analysis of Sustainability in Small Businesses in New York

John Vongas, Ithaca College, Ithaca, NY, United States, Narges Kasiri, Hormoz Movassaghi, Daniel Ruthman

Small and Medium-sized Enterprises (SMEs) are responsible for most of the pollution generated by businesses on earth; they are collectively generate approximately 60% of total carbon dioxide emissions and an alarming 70% of total pollution. Regulations, social and competitor trends, education and businesses' self-motivation are among the major factors behind the small businesses' decision on implementing sustainability in their operations. We examine the data collected from hundreds of SMEs in NY State to identify the motivators and obstacles to the adoption of sustainable solutions by SMEs in NYState.

3 - Optimal Carbon Abatement Strategy Under Cap-and-trade

Qiangfei Chai, Xi'an Jiaotong University, Xi'an, China, Zhongdong Xiao

The importance of carbon abatement has been frequently emphasized around the world. This paper attempts to explore the appropriate carbon abatement strategy for firms who are regulated by cap-and-trade by taking into account the unique advantages of remanufacturing for both the monopolistic environment and the competitive environment. Our results indicate that involving in investment and remanufacturing collectively strategy is the optimal strategy in the monopolistic environment. However, this strategy is no longer optimal for the manufacturer in the competitive environment. We provide some decision guidance for the firms in the competitive environment.

■ WC51

North Bldg 231B

Practice-Scheduling

Contributed Session

Chair: Leonardo Bedoya-Valencia, Colorado State University-Pueblo, 4702 Desert Candle Drive, Pueblo, CO, 81001, United States

1 - A New Extension of the MSRCPSP in a Resource Reallocation Context

Zhentao Hu, Huazhong University of Science & Technology, School of Management, HUST, Hongshan District, Wuhan City, Wuhan, 430074, China, Nanfang Cui

In this research, we proposed a new strategy to optimize MSRCPSP, which expands the problem into a new one named RP- MSRCPSP. For solving the new problem, a heuristic, which is a PSS procedure consisting of activity priority rule, dynamic weight-based resource priority rule, Hungarian method and 0-1programming, is developed. The results of experiment on 1440 instances show that the new strategy is effective and the heuristic is efficient and robust in solving both the new and the previous scheduling problems.

2 - Aircraft Maintenance Planning: Moving A-check Tasks to Line Maintenance

Qichen Deng, PhD Student, Delft University of Technology, Kluyverweg 1, Delft, 2629 HS, Netherlands, Bruno F. Santos, Daniel Coolen

In this study, we present a two-stage optimization model to minimize the total delay of maintenance tasks. It is for the first time to propose to move the A-check tasks from hangar to line maintenance. The model of first-stage is task planning, which groups the A-check tasks into packages and shifts them to line maintenance. The model of second-stage is task scheduling. It minimizes the total amount of delay given a task package. The proposed model is evaluated on a fleet of 30 aircraft. The results show that by task planning and scheduling, it can save up to 18% of aircraft downtime per A-check. Allowing performing tasks 4-14 days earlier than the desired dates can reduce the total delay of tasks up to 66%.

3 - Stochastic Single-machine Scheduling with Learning

Haitao Li, Associate Professor, Univ. of Missouri-St Louis, College of Business Administration, 208 Express Script Hall, St Louis, MO, 63121-4400, United States

Learning is ubiquitous in the modern scheduling environment. While deterministic scheduling with known processing time and learning rate have been extensively studied, limited work exists to address the problems with both learning effect and uncertainty. In this talk, I introduce the single-machine scheduling problem with random nominal processing time and/or random job-based learning rate with both theoretical and computational results.

4 - A Sequential Stochastic Mixed Integer Programming Model for Tactical Master Surgery Scheduling

Ashwani Kumar, PhD Candidate, The University of Melbourne, Peter Hall Building, Parkville Campus, Melbourne, 3010, Australia, Alysson M. Costa, Mark Fackrell, Peter G. Taylor

In this talk, we present a MIP model to optimise master surgery schedule (MSS) under downstream capacity constraints. We optimised the process over several scheduling periods, and we used various scenario realisations to model the uncertainty. Our model had novalty that it used scenarios in chronologically sequential manner, not parallel. We positioned patients randomly in a queue and constrained the model to schedule patients in queuing order. This simple approach enhanced the model's non-anticipative feature. Finally, we developed robust MSSs to maximise throughput while keeping cancellations within limits. The simulation results indicated that the schedules obtained were promising.

5 - Truck Driver Friendly Scheduling Problem a Constraint Programming Approach

Fereydoun Adbesh, J.B. Hunt Transport Inc, 615 J. B. Hunt Corporate Dr, Lowell, AR, 72745, United States, Brain Moore, Douglas Mettenburg

As a transportation company, development of quality work schedules is critical to the retention of drivers. Feasible driver schedules must strictly adhere to delivery appointments and Department of Transportation rules, while also considering soft constraints, such as schedules that start at roughly the same time each day. Several commercial software packages address the former but neglect important human factors. A constraint programming approach is developed to minimize the number of total drivers while increasing the driver-friendliness of the solution. The performance of the model is compared with results from a commercially available routing software over a set of real-world problems.

6 - Developing Dispatching Rules for a Flexible Flow Shop Scheduling Environment at a Wind Mill Tower Assembly Facility

Leonardo Bedoya-Valencia, Colorado State University-Pueblo, 4702 Desert Candle Drive, Pueblo, CO, 81001, United States, Micah Mitchell

This research work proposes the developing of a simulation model used to evaluate different dispatching rules in a multi-stage flexible flow shop scheduling environment (FFSSE). The process analyzed in this research is the rolling, welding and assembling of steel sheets required to manufacture the four sections of a wind mill tower. In this process, the utilization of the welding workstations is the most important measure of performance while keeping the throughput above a lower limit defined by the management of the company. Computational experiments were performed in order to define the group of best dispatching rules that maximizes the resources utilization.

■ WC52

North Bldg 231C

Practice- Transportation Freight 1

Contributed Session

Chair: Juvvala Rambabur, Indian Institute of Technology Kharagpur, Kharagpur, India

1 - Intermodal Freight Network Design Problem: Consideration of the Product Perishability

Maxim A. Dulebenets, Florida A&M University-Florida State University, Tallahassee, FL, 32311, United States, Eren Erman Ozguven, Ren Moses, Thobias Sando, Mehmet Ulak

A significant amount of products, transported via the existing freight transportation networks, are perishable in their nature. This study presents an optimization model for design of freight transportation networks with perishable products, aiming to minimize the total transportation cost, including the cost associated with decay of perishable products. A set of piecewise functions are adopted to linearize the original model. The linearized model is solved using CPLEX. Numerical experiments are performed for the seafood perishable products to draw a number of important managerial insights.

2 - Recovery Optimization for Truckload Freight: Evidence from Practice

Roger D. Lederman, Amazon, Seattle, WA, United States

Our network of truckload freight carriers is critical to the promise of fast and reliable delivery. To achieve high standards of customer service, the network must respond efficiently to both internal and external disruptions. The talk will discuss our work in recovery optimization, which optimally allocates available trucks to maintain service, while minimizing the cost of disruption. Our solution is forward-looking, including proactive mechanisms to keep supply and demand in balance. The tools have improved network performance in the form of lower cancellation rates and decreased reliance on costly spot market capacity.

3 - Investigating the Waiting Time & Carbon Emission Reduction Potential of the Urban Consolidation Centre

Juvvala Rambabu, Research Scholar, Indian Institute of Technology Kharagpur, ND 105 VSRC IIT Kharagpur, 721302, India, S. P. Sarmah

The purpose of this study is to examine the feasibility of the Urban Consolidation Centre (UCC) as a measure to minimize the negative impacts of freight transportation in the city such as congestion and carbon emission. We have employed the established meta-heuristic technique to the NP-hard natureof the mathematical model formulation

■ WC62

West Bldg 103A

Joint Session DM/Practice Curated: Data Science in Health Care III

Sponsored: Data Mining

Sponsored Session

Chair: Maryam Soltanpour Gharibdousti, Binghamton University, 1120 Murray Hill Road, Vestal, NY, 13850, United States

1 - Studying Impact of Physical Activity on Human Learning Propensity and Emotional Response Modulation using EEG Data

Klim Drobnyh, Arizona State University, Tempe, AZ, 85281, United States, Ghazal Shams, Robert Atkinson, George Runger

The goal of our study was to investigate the impact of acute and chronic physical activity on learning propensity and emotional response modulation. Two groups of participants with high and low levels of exercise were instrumented with EEGs and tested for cognitive load, and furthermore different stimuli were presented. This generated high-volume, rich datasets, and several analytical tasks were completed to handle this high-volume data.

2 - Hospital Length of Stay Prediction Model for Neurosurgery Inpatients Applying Various Data Mining Techniques

Sahar Khamsehi, SUNY Binghamton, 4400 Vestal Pkwy E, Binghamton, NY, 13850, United States

Prolonged length of stay (LOS) at hospitals have been controversial topic that leads to extra cost for hospitals. Consequently, it increases patients' turnaround time. The purpose of this study is to determine non-clinical factors that may prolong length of stay and develop predictor models using contributing factors. The results from three prediction techniques of Artificial Neural Network (ANN), Logistic Regression (LR) and Support Vector Machine (SVM) obtained from neurosurgery database for a period of 2 consecutive years inclusive of 14 non-clinical factors, are statistically compared. Conclusively, logistic regression has the highest accuracy among all data mining techniques.

3 - Survival Rate Prediction in Cardiac Patients with Heart Transplant or Assisted Devices

Maryam Soltanpour Gharibdousti, PhD Candidate, Binghamton University, 4400 Vestal Pkwy E, Binghamton, NY 13902, Vestal, NY, 13902, United States, Mohammad Khasawneh

The survival rate prediction for the organ transplant surgery patients can help to classify patients risk levels and potential post-surgical complications. The research used the data for cardiac patients with either medical assist devices such as Impella and Left Ventricular Assist Devices (LAVD) or heart transplant patients. The significant factors such as demographic information, baseline patient characteristics, baseline hemodynamics, laboratory values, and in-hospital complications can predict the survival rate after the transplant surgery. The data from one of the Organ Procurement Organizations (OPO) in New York State is analyzed using several machine learning algorithms.

■ WC63

West Bldg 103B

Joint Session DM/Practice Curated: Data Science for Operations and Quality Management

Sponsored: Data Mining

Sponsored Session

Chair: Yanqing Kuang, University of South Florida, Tampa, FL, United States

1 - Data-driven Consumer Debt Collection via Machine Learning and Approximate Dynamic Programming

Qingchen Wang, Amsterdam Business School, Amsterdam, Netherlands, Ruben van de Geer, Sandjai Bhulai

This paper presents a novel data-driven framework for the optimization of the consumer debt collection process. We consider the problem of scheduling outbound calls made by debt collectors to a portfolio of debtors with heterogeneous and dynamic repayment behavior. We model this problem as a Markov decision process and approximate the value function based on predictions of individual debtors' repayment probabilities by leveraging historical data and using a state-of-the-art machine learning technique. A controlled field experiment with an industry partner showed an increase in collected cases at a significant decrease in calling efforts compared to their current collection policy.

2 - Optimal Return Policy in the Presence of Social Networks

Ehsan Salimi, University of Florida, 376 Weil hall, Gainesville, FL, 32603, United States, Sina Ansari

When a firm allows the return of purchased item, it provides customers with the option of keeping or returning the item. While the option to return item leads to an increase in gross revenue, it may also create additional costs including the social costs associated with returns. In this paper, we study the optimal return policy considering customers' returns behavior in the presence of social networks. Our findings have important implications for the coordination of marketing and operations decisions.

3 - An Anatomy-adjusted Quality Control Tool for Cancer Radiotherapy Plan Evaluation

Arkajyoti Roy, The University of Texas at San Antonio, San Antonio, TX, United States
Arkajyoti Roy, Bowling Green State University, Bowling Green, OH, United States, Dan Cutright, Mahesh Gopalakrishnan, Arthur Yeh, Bharat B. Mittal

A quality control tool is proposed that allows clinicians to evaluate and directly compare cancer radiation treatment quality of a large set of patients, after accounting for variations in patients' anatomies. The effect of the inter-patient variations is accounted for through the use of anatomy-adjusted I-Charts. 69 head-and-neck cancer cases are used for the evaluation of the proposed tool.

4 - Statistical Monitoring of Inhomogeneous Continuous Time Markov Chains

Yanqing Kuang, University of South Florida, Tampa, FL, United States, Devashish Das, Jianguo Wu, Mustafa Y. Sir

In this presentation, we propose a nonparametric scheme for monitoring inhomogenous continuous time Markov chains with a large state space. The proposed framework is used to monitor the timeliness of the healthcare delivery process using time-stamped clinical event sequences.

■ WC64

West Bldg 104A

Joint Session DM/Practice Curated: Data Science for Transportation Related Applications

Sponsored: Data Mining

Sponsored Session

Chair: Sang Min Lee, Korea University, Seoul, Korea, Republic of

1 - Detecting Crash Severity in Passenger Vehicle a Machine Learning Study

Rupesh Agrawal, Research Assistant, Oklahoma State University, 700 N. Greenwood Ave, Tulsa, OK, 74106, United States, Robert Fritts, Dursun Delen

In 2016, National Highway Traffic Safety Administration reported nearly a trillion-dollar impact from the loss of productivity, loss of life, and other consequences related to automobile crashes. This study seeks to enhance the current body of knowledge in discovering variables impacting the level of injury severity in passenger vehicle accidents using variable selection and data balancing techniques (i.e., oversampling and undersampling) using multidimensional, feature-rich, and highly-structured data with Machine Learning algorithms.

2 - Conditional Monitoring of Wheel Wears for High-speed Trains: A Data-driven Approach

Peiwen Xu, PHD Candidate, City University of Hong Kong, 88 Tat Chee Avennue, AC1, Hong Kong, Hong Kong, Weiran Yao, Yang Zhao, CAI YI, Lishuai Li, Jianhui Lin, Kwok-Leung Tsui

The rapid expansion of high-speed railway network is placing increased emphasis on the optimization of the maintenance process to enhance the availability and efficiency of the train system with a high standard of safety and reliability. A data-driven method is proposed to monitor wheel wears in a high-speed railway system.

The result can provide an early warning of a component degradation, enabling the switch from fixed interval maintenance to condition-based maintenance. The proposed method combines signal processing and statistical methods to extract relevant information from vibration data and then predict wheel wears. The accuracy of this method is tested by real operational data in China.

3 - Incremental Learning for Nonstationary Traffic Control in Automated Vehicle Systems

Sang Min Lee, Korea University, 221 New Engineering Building, Korea Univ., 145 Anam-ro, Seongbuk-gu, Seoul, Korea, Republic of, Sung Ho Park, Seoung Bum Kim

We introduce an incremental learning method for adaptive traffic control in a large-scale automated vehicle system. We present a change-aware learning method that combines a change detector with adaptation algorithms. To demonstrate the effectiveness of the proposed method, we conducted an experimental study to evaluate the predictive performance using the high-fidelity simulator.

■ WC68

West Bldg 105C

Joint Session QSR/Practice Curated: Data Analytics for Advanced Manufacturing Systems

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Wenmeng Tian, Mississippi State University, MS, 39762, United States

Co-Chair: Hongyue Sun, University at Buffalo, Buffalo, NY, 14260, United States

1 - Spatial-temporal Modeling for the Additive Manufacturing Process of Ti-6Al-4V

Weihong Guo, Rutgers, The State University of New Jersey, 96 Frelinghuysen Rd, CoRE Rm 220, Piscataway, NJ, 08854, United States, Shenghan Guo, Linkan Bian

This study focuses on modeling the data indicating temperature and heat transfer within the melt pool and heat affected zone atop a thin-walled structure of Ti-6Al-4V during its additive manufacture. A spatial-temporal model is developed to quantify the temperature, heat transfer, and laser-induced, powder-fed melt pool characteristics. The proposed method is integrated with Bayesian inferences for online adaptive modeling and monitoring. A novel control chart is developed to monitor the model parameters to support decision making. The performances of several spatial-temporal models are compared using experimental data.

2 - Customized Modeling for Multi-stage Additive Manufacturing Systems

Hongyue Sun, University at Buffalo, 319 Bell Hall, Industrial and Systems Engineering, Buffalo, NY, 14260, United States, Ramanarayanan Purnanandam, Chi Zhou

Most existing works on additive manufacturing (AM) focus on the single-stage printing at a local 3D printer, and fail to analytically quantify the effect of material preparation and post-processing stages on the printed part quality. To fully investigate AM, multiple stages (both AM and its up-stream and down-stream processes) need to work synergistically. However, the complex functional variable relationships among multiple stages pose challenges for conventional data analytics models. In this work, we propose customized models to address the problem. Both simulation and a constrained-surface stereolithography (SLA) process are used to demonstrate the proposed method.

3 - Online Monitoring for Additive Manufacturing Processes Based on Image Sequence Analysis

Wenmeng Tian, Mississippi State University, P.O. Box 9542, Mississippi State, MS, 39762, United States, Mehrnaz Esfahani, Linkan Bian

The melt pools in thermal images are regarded as the most informative process signature in metal-based additive manufacturing (AM) processes, and thus can be used for real-time process monitoring. However, how to effectively extract features from a series of melt pools for anomaly detection in each fabricated layer is still an open question. In this work, we propose a novel feature extraction approach by formulating the melt pool contours of one entire layer as a 3D space-time object. Low dimensional features can be extracted to characterize the shape variability in the 3D object. A case study based on a thin wall fabrication process is used to validate the proposed approach.

■ WC70

West Bldg 106B

Practice- Quality & Reliability Engineering I

Contributed Session

Chair: Mejdal Alqahtni, Rutgers Univ., Bound Brook, NJ, 08805, United States

1 - Power Systems Reliability Assessment with Variance Reduction and Markov Chain Monte Carlo

Daniela B. Almeida, PSR, Centro Empresarial Rio, Praia de Botafogo 228 / 1701-A Rio de Janeiro, RJ, Rio de Janeiro, 22250-145, Brazil, Carmen L. Borges, Gerson C. Oliveira

The methodology combining Variance Reduction and Markov Chain Monte Carlo significantly reduces the computation time and number of samples required for reliability studies compared to the standard Monte Carlo simulation. Some results from a study with real power systems are presented to highlight the effectiveness of the proposed method.

2 - Condition-based Maintenance (CBM) Optimization for a Two-component System through State Discretization and Proportional Hazard Model (PHM)

Mengkai Xu, Northeastern University, Boston, MA, 02115, United States, Noor E. Alam, Sagar S. Kamarthi, Xiaoning Jin

CBM of mechanical systems with stochastic dependence among their components has drawn much attention recently. Researchers commonly assume the independence of degradation and failure of multiple components to keep the models simple. However, the existence of degradation and failure interactions diminishes the accuracy of the models. To address this issue, the state-rate dependence denoting interaction between degradation states and hazard rates is proposed. A state discretization technique integrated with PHM aimed at capturing the effect of state-rate dependence for maintenance optimization is presented.

3 - Stochastic Modeling of Corrosion Growth

Changxi Wang, Ph.D Student, Rutgers University, Piscataway, NJ, 08854, United States

Corrosion growth modeling is important in industry. Existing methods model corrosion pits depth growth and estimate reliability accordingly. However, volume loss may also lead to failures such as rupture even if corrosion pits depth is small, which usually cannot be captured by such models. We develop a degradation model that captures corrosion volume growth, as well as corrosion depth growth. The influence of stresses on corrosion growth is considered. The distribution of volume loss increments and failure probability in the next time increment is obtained.

4 - Study on Travel Reliability of Urban Rail Transit Network Using Automatic Fare Collection Data

Yong Yin, Southwest Jiaotong University, Chengdu, China Yong Yin, National United Engineering Laboratory of Integrated and Intelligent Transportation, Chengdu, China, Jie Liu, Qiyuan Peng, Xu Yan, Anjun Li

It is important to study the travel reliability of Urban Rail Transit network to ensure people travel through Urban Rail Transit. The OD matrix and travel time between stations are obtained through Automatic Fare Collection data. Three reliability indicators that considering tolerable index are constructed from the aspects of network connectivity, travel time and transport capability. Taking Chengdu Urban Rail Transit as an example, five workday data of Urban Rail Transit are analyzed. The results show that the multi-state model is more effective than single model to fit the travel time distribution and tolerable index has a huge influence of the travel reliability of Urban Rail Transit network.

5 - Process Monitoring Of Three-dimensional Topographic Surfaces

Mejdal A. Alqahtni, Rutgers University, New Brunswick, NJ, 08901-8554, United States, Elsayed A. Elsayed, Myong K. Jeong

This paper develops a real-time monitoring approach for assessing the quality of 3D topographic surfaces. The approach initially improves the representation of 3D surface features by slicing the 3D surface topography into several layers. The functional spatial randomness (FSR) profile is then suggested for surface characterization in which the spatial randomness of topographic values is computed at each layer. By utilizing the functional principal component analysis (FPCA), an anomaly detection approach based on FSR profile is proposed. The developed approach reveals outstanding performance compared to the existing approaches in identifying various forms of surface defects.

■ WC72

West Bldg 211A

Practice- Operations Management IV

Contributed Session

Chair: Fang Fang, California State University, Los Angeles, CA, 91801, United States

1 - Forward-reserve Warehouses: Why a Dynamic Selection of Items is Necessary

Rakesh Venkitasubramony, Assistant Professor, Indian Institute of Management Lucknow, IIM Road, Prabandh Nagar, Lucknow,

226013, India

Forward-Reserve warehouses are popular when small number of Stock Keeping Units (SKU) account for large number of picks. Most studies that approach the design and allocation of SKUs to forward area have static decisions. In this simulation based article, I argue for dynamic selection of SKUs to the Forward area of the warehouse, when individual demands are seasonal.

2 - Competition in Two-sided Market with Quality Control Strategies
Lyu Gaoyan, Peking University, No.5 Yiheyuan, Beijing, 100871, China, Lihua Chen

There are many two-sided markets with similar products. We design mechanism to explore how to cooperate and compete with competitors at the same time. Meanwhile, how to improve their product quality to attract consumers is another important factor in this mechanism. We set cooperate parameter and compete parameter to measure the degree of market competition. The result shows that, with low degree competition, both markets get less profit.

3 - Dynamic Return and Resale Policies for Heterogeneous Strategic Customers with Uncertain Valuations
Lan Lu, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, Hong Kong, Qian Liu

This paper develops a model of return and resale policies with heterogeneous strategic customers who have uncertain valuations prior to purchase. The seller faces a two-period selling season, where the returned products in the first period can be resold in the second period. We characterize the seller's optimal return policies in both periods and compare two resale policies: differentiate the returned products with new products or not. We demonstrate that the seller tends to differentiate the returned products when customers are highly differentiated. Moreover, we find that the seller does not always benefit from the increase of customer valuation.

4 - Robust Optimization Approach to Process Flexibility Designs with Price Differentials
Shixin Wang, New York University, New York, NY, 10012, United States, Xuan Wang, Jiawei Zhang

We study process flexibility designs when products exhibit price differentials. We introduce the Profit Plant Cover Index (PPCI) and prove that a general class of robust measures can be expressed as functions of a design's PPCIs and the given uncertainty set, which leads to a method to compare the worst-case performance of different designs. Applying these results, we prove that under a broad class of uncertainty sets and robust measures, the alternate long chain is optimal among all long chains with an equal number of high-profit products and low-profit products. Finally, we develop a heuristic based on the PPCIs to generate effective flexibility designs when products exhibit price differentials.

5 - In-house vs. Outsourcing: The Effect of Volume-based Learning on Quality Competition
Yanni Ping, Drexel University, 3220 Market Street, Philadelphia, PA, 19104, United States, Seung-Lae Kim

This paper considers an original equipment manufacturer (OEM) who outsources finished products to a contract manufacturer (CM), where the CM, by adopting existing technology, achieves cost reduction and quality improvement through learning-by-doing. Besides the role of upstream partner, the CM also acts like a downstream competitor. We study the OEM's outsourcing strategy dynamically from both cases when competition exists and does not exist by constructing a two-period model and explore the interplay of learning, quality and cost.

6 - Block Ownership in Vertical Relationships in the Presence of Downstream Competition
Fang Fang, Assistant Professor, California State University, Los Angeles, CA, 90032, United States, Baojun Jiang, Jiong Sun

Block ownership (i.e., partial ownership) plays an important role in aligning the incentives of firms involved in vertical relationships. This paper examines the impacts of block ownership on pricing decisions, firm profitability, as well as consumer and social surplus. We show that such impacts may depend on the nature of downstream competition.

■ WC73

West Bldg 211B

Practice- Robust Optimization & Applications I

Contributed Session

Chair: Jonathan David Lonski, Clemson University, Clemson, SC, 29631, United States

1 - Robust Portfolio Optimization Based on Stochastic Dominance and Empirical Likelihood
Peng Xu, Aalto University School of Business, Runeberginkatu 22-24, Helsinki, FIN-00100, Finland

Identifying Second-order Stochastic Dominance (SSD)-efficient portfolios is of great interest to finance research where investors are routinely assumed to be rationally risk-averse in financial decision making. This paper seeks to (i) evaluate some most recent SSD optimization approaches and their out-of-sample performance, and (ii) examine if robust optimization based on SSD and Empirical Likelihood (EL) improves out-of-sample performance of these approaches. We report the results from an empirical application analyzing how robust diversification among industry portfolios using SSD and EL increases the likelihood of obtaining out-of-sample dominance over a given benchmark portfolio

2 - Robust Multi-criteria Decision Making for Hesitant Behavior
Gevorg Stepanyan, PhD Candidate, University of Michigan - Dearborn, Dearborn, MI, United States, Jian Hu

We presents a robust multi-criteria decision making model for hesitant behavior.

3 - Robust Repositioning for Vehicle Sharing
Long He, National University of Singapore, Mochtar Riady Building, BIZ1 8-73, 15 Kent Ridge Drive, Singapore, 119245, Singapore, Zhenyu Hu, Meilin Zhang

Our paper discusses the operational decision of dynamic fleet repositioning for vehicle sharing. We first formulate the problem as a stochastic dynamic program to minimize the expected total repositioning cost and lost sales penalty. To solve for a multi-region system, we deploy the distributionally robust approach that can incorporate demand temporal dependence, motivated by observations from real trip data. In a real-world case study, we quantify the "value of repositioning" and compare with several benchmarks to demonstrate that the proposed solutions are computationally scalable and in general result in lower cost with less frequent repositioning.

4 - Mitigating Disaster-induced Transportation System Losses via Robust Optimization
Jonathan David Lonski, Clemson University, Clemson, SC, 29631, United States, Scott J. Mason

Recent natural disasters like Hurricane Sandy (2012) and Tropical Storm Harvey (2017) have caused $20B+ in economic losses and necessitated $35B+ in restoration efforts. During such disasters, it is often too late for decision makers to spend time and effort analyzing information, and weighing potential outcomes. We present our research into developing robust plans for minimizing the total cost of economic losses and reparations incurred by transportation systems during natural or human-caused disasters. We seek to improve transportation system plan resiliency via robust optimization techniques and establishing an improved, cloud-based method of data collection for use in our models.

■ WC74

West Bldg 212A

Joint Session MCDM/Practice Curated: Theory and Application of the ANP

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Orrin Cooper, University of Memphis, Memphis, TN, 38152, United States

1 - An AHP Consensus Reaching Model with Both Individual and Aggregated Opinions
Qingxing Dong, Central China Normal University, Wuhan, China, Qi Sheng, Gaohui Cao

The Analytic Hierarchy Process (AHP) is an effective tool and has been widely used in group decision making. In this paper a new consensus reaching model based on the AHP is proposed, which considers both individual and aggregated opinions. The compatibility index can be used to determine both the individual consensus level (ICI) and the central consensus level (CCI). Then this model provides feedback suggestions to the most incompatible decision makers so they can adjust their opinions adaptively depending on their ICI and CCI in each round. The integrated adaptive consensus reaching model is constructed. Finally, a numerical example is given to verify the feasibility and effectiveness of the model.

2 - Coherency and Reducing Comparisons in the ANP
Orrin Cooper, University of Memphis, Memphis, TN, 38152, United States

One of the perceived challenges of using the ANP is number of comparisons that need to be made to ensure the model will converge without absorbing states. There are also data quality checks that one can use to increase the confidence she has in the decision. Coherency testing can be balanced to not only test for coherency but also reduce the number of needed comparisons in an ANP model.

3 - The Added Value of a Team-based Model in Preventive Healthcare Services
M Gabriela Sava, Clemson University, College of Business, 145 Sirrine Hall, Clemson, SC, 29634, United States, Luis Vargas, Jerrold H. May, Jennifer Shang, James Dolan

The role and importance of preventive healthcare services has increased significantly due to the health benefits to the patient. The design of such services becomes a challenge due to the increased number of patients that would like to get more

involved in the preventive decision-making process, but they don't possess all the necessary information. We propose a team-based model for designing the process of choosing the most appropriate colorectal cancer screening option. The value-added in the model is the result of the contribution of the healthcare provider to achieve beneficial patient outcomes.

4 - Analogical Evaluation of the Urban Function Combination Mode of the Integrated Transportation Hub Based on AHP Fuzzy Comprehensive Evaluation Method

Siyu Tao, School of Transportation and Logistics, Southwest Jiaotong University, Chengdu, China, Feng Tao, Xinmei Chen, anjun li, Lisha Wang

This paper adopts a AHP fuzzy comprehensive evaluation for the different forms of the integrated transportation hub, the AHP model is used to establish & quantify the assessed level indicators of the urban function combination modes of the integrated transportation hub, & an index evaluation system is established to evaluate the advantages & disadvantages of different combination modes accurately. Suggestions are proposed for optimization & improvement on the evaluation results, & scientific guidance are provided for the development, construction & investment operation of the urban function of the integrated transportation hub.

■ WD05

North Bldg 122B

Joint Session OPT/Practice Curated: SCIP Optimization Suite: Recent Developments and Applications

Sponsored: Optimization/Computational Optimization and Software

Sponsored Session

Chair: Ambros Gleixner, Zuse Institute Berlin, Berlin, 14195, Germany

Co-Chair: Benjamin Mueller, Zuse Institute Berlin, Berlin, 12161, Germany

1 - Reinforcement Learning of Branching Strategies

Maxime Gasse, Polytechnique Montr al, Montr al, QC, Canada, Andrea Lodi

Branching decisions arguably take a central place in traditional branch-and-bound solvers. We formulate the branching problem as a 1-player game, whose ending is triggered once the instance has been solved, and where the goal is to minimize the final tree size. Under this formalism, one can use reinforcement learning to find good branching strategies, e.g. using a mix of Monte-Carlo Tree Search and deep learning (the AlphaGo approach). We will present some preliminary results on MIPLIB instances, based on an implementation that combines the SCIP and PyTorch libraries.

2 - Digging for Variable Holes in MINLPs

Benjamin Mueller, Zuse Institute Berlin, Berlin, 12161, Germany, Andrea Lodi, Gonzalo Munoz

Due to the presence of nonconvex constraints in mixed-integer nonlinear programs (MINLPs), the set of feasible assignments can be disconnected even for continuous variables. The resulting forbidden regions for variables are called "holes", which can be viewed as a generalization of integrality conditions in MILP. This allows us to conceive methods for continuous variables that so far have been mainly developed for integer variables.

We study the concept of holes and their importance in a spatial branch-and-bound framework. Additionally, we show that a branching rule driven by the knowledge of holes in a nonconvex problem can have a significant impact on the performance of the MINLP solver SCIP.

3 - A Branch and Price Approach for an Inventory and Routing Problem to Address the Replenishment of a Network of Automated Teller Machines

Cristian Eduardo Cortes, Universidad de Chile, Blanco Encalada 2002, Santiago, Chile, Daniel Herl, Pablo Andres Rey, Alejandro Cataldo, Leandro C. Coelho

The main goal of this study is to develop a Branch and Price method for the inventory-routing problem arising from the replenishment of an automated teller machines (ATM) network. One interesting feature of the problem is the existence of out of stocks in the inventory of the ATMs. Moreover, one additional difficulty in our pricing subproblem is the existence of column dependent rows, which means that we are forced to dynamically generate columns and rows simultaneously. We implement our B&P algorithm on the SCIP framework, obtaining promising results for selected real instances in Santiago, Chile.

4 - Progress in the Branch-price-and-cut Solver GCG

Marco Luebbecke, RWTH Aachen University, Operations Research, Kackertstr. 7, Aachen, D-52072, Germany, Michael Bastubbe, Christian Puchert, Jonas Witt

GCG is a solver for mixed-integer linear programs. It implements a Dantzig-Wolfe (or similar) reformulation and a full-featured branch-price-and-cut algorithm. Information on how the reformulation should be performed can be given by the user in various ways. However, GCG can and usually does detect a model structure suited for reformulation all by itself. We report on recent developments that lead to the upcoming release 3.0. This includes a completely re-designed structure detection, new cutting planes, and experimental features like deciding whether a reformulation should be applied at all and a Benders decomposition extension. We show experiments and some use cases in which we applied GCG.

■ WD11

North Bldg 125B

Joint Session MSOM/Practice Curated: Smart City Operations Management

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Ho-Yin Mak, University of Oxford, Oxford, OX1 1HP, United Kingdom

1 - The Role of Consumer Waste in Food Retail

Ekaterina Astashkina, INSEAD, Boulevard de Constance, Fontainebleau, 77305, France, Elena Belavina, Simone Marinesi

We investigate how addition of consumer food waste changes the inventory dynamics and emissions of the upstream actors. We find that consumer food waste (unlike transportation emissions) generates spillover effects on upstream tiers: higher consumer food waste prompts higher retail sales and emissions. Hence, practices that cut consumer food waste are particularly efficient in contrast to other instruments that aim to benefit the environment. Further, we find that interventions targeted to reduce travel in the attempt to lower market emissions may in fact achieve the opposite result and increase market emissions, on account of higher consumer food waste.

2 - Revenue Management in Parking Systems under Competition and Information Asymmetries

Xin Wang, University of Wisconsin, WI, United States, Qiao-Chu He, Yuguang Wu

We consider oligopoly pricing game in parking systems under incomplete information. Each agent (garage) has some information (forecast) about the incoming parking demand for some of the garages. They charge a price for their own garage to maximize their profit. We consider the equilibrium wherein each agent's action depends linearly on known forecasts and forms Bayes' estimator for unknown forecasts. Based on the equilibrium strategy, we further investigate the agents' incentive to share their information with others in order to get larger expected payoff.

3 - Peer-to-peer Crowdshipping as an Omnichannel Retail Strategy

Ho-Yin Mak, University of Oxford, Park End Street, Oxford, OX1 1HP, United Kingdom

We study a peer-to-peer crowdshipping strategy for an omnichannel retailer, who enlists in-store shoppers to deliver online orders in their vicinity. Using an analytical model, we investigate the effect of the crowdshipping model on the retailer's profit and consumer surplus. We find that the favorability of crowdshipping heavily depends on the choice of reimbursement scheme and product characteristics.

■ WD12

North Bldg 126A

Practice- Marketing I

Contributed Session

Chair: Frank Hage, Technical University of Munich, Production and Supply Chain Management, Munich, 80333, Germany

1 - Optimal Bundling Strategy for a Retail Platform under Agency Selling

Shengming Zheng, University of Science & Technology of China, 96 Jinzhai Road, School of Management, Hefei, 230026, China, Yugang Yu, Fuqiang Zhang, Xiaolong Guo

Bundling strategy has been widely adopted by online retail platforms under agency selling. We study the optimal bundling strategy for a retail platform through which two independent manufacturers distribute their products. The manufacturers first set their product prices and then the platform decides whether to offer the bundled product or not and the price for the bundled product if it offers a bundle. By analyzing this two-stage Stackelberg game, we find that the platform will adopt the bundling strategy only when the manufacturer's product prices are above a threshold. Additionally, the manufacturers will set high prices to induce the platform to offer bundled products.

2 - Mental Accounting in Consumer Inventory Problem with Uncertain Benefit

Haonan He, University of Science and Technology of China, Hefei,

61820, China

Newsvendor problems describe a situation in which the vendor needs to predict the demand by a buyer when a fixed unit profit is predetermined. But sometimes, the vendor can effectively affect the demand, that is, when he is also the buyer. This paper first considers how a consumer's mental accounting behavior affects whether consumer reaches a theoretically prespecified optimal inventory level when the unit profit is not fixed and how to exacerbate and mitigate potential judgment inaccuracies. The result shows that changes to the benefits affect inventory more strongly and lead to more deviation than to the cost. Besides, inventory could increase even when the volatility of demand increases.

3 - Double Auctions for Truthful Information Sharing in Sales and Operations Planning

Frank Hage, Technical University of Munich, Production and Supply Chain Management, Munich, 80333, Germany, Martin Grunow

We study a sales and operations planning problem. Operations persons are responsible for production sites and have private information on production costs. Sales persons are responsible for customer markets and have private information on customer demand. Due to function-oriented bonus schemes, both parties have conflicting interests: While operations persons aim to minimize production and inventory costs, sales persons aim to maximize turnover. Both parties have an incentive to misrepresent their private information, which leads to inefficient capacity allocation and lower profitability. To address this problem, we develop an iterative double auction for capacity allocation.

■ WD14

North Bldg 126C

Joint Session MSOM/Practice Curated: Healthcare Operations

Sponsored: Manufacturing & Service Oper Mgmt/Service Operations

Sponsored Session

Chair: Sukriye Nilay Argon, University of North Carolina, Chapel Hill, NC, 27599, United States

Co-Chair: Serhan Ziya, University of North Carolina, Chapel Hill, NC, 27599, United States

1 - Who is Next: An Empirical Study of Patient Prioritization in an Emergency Department

Zhankun Sun, City University of Hong Kong, Kowloon, Hong Kong, Jeff Hong, Li Wenhao

In the emergency department (ED), priority scores are assigned to patients at triage based on their acuity levels. However, using operational data from more than 150,000 patient visits, we find that doctors may deviate from this priority sequence, and within each priority class, patients may not be served in a first-come-first-serve manner. Our analysis shows that when selecting the next patient to treat, doctors prioritize patients who are more likely to be discharged after treatment at ED when many ED beds are occupied by boarding patients, in an effort to avoid further access block to the ED.

2 - How to Manage Doctor Appointments with a Shared Medical Appointment Option

Nazli Sonmez, London Business School, Regent's Park, London, NW1SN, United Kingdom, Kamalini Ramdas, Sarang Deo

Shared medical appointments are an alternative to traditional one-on-one appointments for routine care of chronic diseases that offer an innovative, interactive approach to healthcare delivery. They are not widely used even though there is a high potential. To adopt this new healthcare delivery method, the service providers must make an upfront decision on how to allocate service capacity. We develop a model that will incorporate what we learn about how patients make trade-offs while choosing an appointment, when offered two different appointment types using the data from a healthcare provider. This model will provide insight into how many appointments from each type need to be scheduled.

3 - Equilibrium Behavior of Patients Served by a Dual Practice Physician

Lerzan E. Ormeci, Koc University, Dept of Industrial Engineering, Rumeli Feneri Yolu, Istanbul, 34450, Turkey, Dimitrios Andritsos, Yiannis Dimitrakopoulos

We consider a physician who has a dual practice in public and private sectors. We model this system as two M/M/1 queues with a coupled server. The server alternates between the queues with exponential rates. The system has three levels of decisions: First, government provides the main rules for having a dual practice, which may limit the time she spends in her public and private offices and regulate the private service fee. Second, the physician decides on how much time she will spend in each practice and the private fee to maximize her revenue. Finally, patients decide on the office to visit to maximize their utility which is a function of their waiting time, value of service and private fee.

4 - Modelling the Use of Patient Activation Measure (PAM) in Chronic Care Management

Evrim D. Gunes, Koc University, Rumeli Feneri Yolu, Sariyer, Istanbul, 34450, Turkey, Lerzan E. Ormeci, Odysseas Kanavetas, Christos Vasilakis

We develop a Markov Decision Process framework to manage care for individual patients with multiple chronic conditions through a complex care hub. Complex care provision influences the evolution of Patient Activation Measure (PAM), an indicator for healthy behavior, which affects the evolution of health state of patients. We define a general model where the transition probabilities and the rewards are time dependent parameters. Then, we explore optimal and heuristic policies which maximise the welfare for static parameters. Through numerical experiments we explore the performance of alternative policies that focus on managing more complex patients or improving activation of all patients.

■ WD19

North Bldg 128B

Joint Session RMP/Practice Curated: New Applications of Revenue Management and Pricing

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Joline Uichanco, University of Michigan, Ross School of Business, Ann Arbor, MI, 48109-1234, United States

1 - Price Markdowns to Induce Customers to Opt Out of Free Returns

Sajjad Najafi, Ross School of Business, University of Michigan, 701 Tappan Ave, Ann arbor, MI, 48109, United States, Izak Duenyas

In this paper, we consider a firm offering a product to a set of consumers who can return it over a grace period of time. The firm aims at finding the optimal return policy to improve its total expected revenue.

2 - Life Cycle Pricing of Multiple Differentiated Products

Hongmin Li, Arizona State University, WP Carey School of Business, Dept of Supply Chain Management, Tempe, AZ, 85287, United States

This paper considers the centralized pricing problem of a firm managing multiple substitute or differentiated products. Demands of these products undergo a diffusion process and customers choose among the products, with the choice probability of each product given by the logit model. We examine the firm's optimal pricing problem in this context.

3 - Dynamic Pricing and Replenishment for Seasonal and Regular Products

Oben Ceryan, LeBow College of Business, Drexel University, Philadelphia, PA, 19103, United States

We consider a firm that offers two substitutable products that differ in how their inventories are managed, a seasonal product with a fixed initial quantity that allows dynamic price adjustments but no replenishments, and a regular product with a static price that can be periodically replenished. We study the impact of these asymmetries on optimal dynamic pricing and replenishment decisions and utilize the insights gained to develop a simple-to-implement and effective heuristic policy.

4 - Competitive Revenue Management with Sequential Bargaining

Yuanchen Li, Purdue University, 2192 Tortuga Lane, West Lafayette, IN, 47906, United States, Qi Feng, J. George Shanthikumar

We study the role of bargaining in competitive revenue management. The seller firms each have some fixed initial stocks and compete to sell to a random arrive stream of potential buyers who are heterogeneous in product valuation. We fully characterize the equilibrium outcome, which depends on the length of the selling season and the initial stock levels. When the selling season is up to three periods, the seller with a lower stock level is weakly preferred by an incoming buyer. When the selling season is longer than three periods, the seller with a higher stock level may win the competition.

■ WD22

North Bldg 130

Practice- E-Business/Commerce I

Contributed Session

Chair: Roger William Baugher, TrAnalytics, LLC, Johns Creek, GA, 30097, United States

1 - The Moderating Effect of Reputation and Presentation on Trust Transfer of Trusted Third Party

Cong Cao, University of Wollongong, Wollongong, NSW 2522,

Australia, Jun Yan, Mengxiang Li

Based on experimental data, this paper not only shows the significant influence of trusted third party (TTP) on consumers' behavior, but further explains its trust transfer function in the online shopping environment. Moreover, it also reveals moderator variables of the trust transfer, namely the reputation and presentation of TTP. The research results show that the certification service provided by TTP with high reputation can significantly improve the degree of consumer trust in enterprises. The concrete and detailed description and presentation of TTP services can effectively enhance consumers' cognition of TTP services and therefore influence their behavioral intention.

2 - End-to-end Inventory Replenishment Model

Yuanyuan Shi, University of Washington, 6319 65th Avenue NE, Seattle, WA, 98115, United States, Di Wu, Meng Qi, Rong Yuan, Yuhui Shi, Max Shen

Traditional inventory models often assume a predict-then-optimize paradigm. A prediction model which depicts the demand uncertainty is built then an optimization model is applied to solve for optimal inventory decisions based on the forecasting. However, the criteria by which we train the prediction model often differs from the ultimate criteria on which we evaluate them. In this research, we focus on building an end-to-end inventory replenishment model which simultaneously learns the probabilistic info of multiple uncertainty sources such as demand, lead time, while making replenishment decisions that directly capture the cost-based objective.

3 - Competitive Intelligence Analysis from Customer Online Concerns of Series Products for Engineering Design

Jian Jin, Beijing Normal University, No. 19, Xinjiekouwai street, Beijing, 100875, China, Qian Geng, Ping Ji

Online concerns inform valuable messages to customers, dealers and product designers. Conventional studies mainly focus on the sentiment analysis of online opinions and few explore their capacities on comparison of series products. In this study, a framework is presented to highlight shared pros and cons of series products by mining online concerns. Customer opinions of specific features across series products are initially extracted and clustered to identify similar concerns. Then, an optimization problem is formulated to sample a few representative sentences for designers. This study aims to integrate big consumer data for competitive intelligence analysis in market driven product design.

4 - Current State of Railroad Yard Technology

Roger William Baugher, President, TrAnalytics, LLC, Johns Creek, GA, 30097, United States

Given the high cost of improvements to a rail yard's infrastructure, railroads are investigating and implementing new control technology and enhanced information systems to improve performance and reduce costs. These efforts will be discussed and a summary presented.

■ WD24

North Bldg 131B

Practice- Productivity Improvement in Manufacturing

Contributed Session

Chair: Douglas Thomas, NIST, 100 Bureau Drive, Gaithersburg, MD, 20899-8603, United States

1 - The Direction of Causality between Personnel Management Practices and Productivity

Juha Eskelinen, Researcher, Aalto University, Runeberginkatu 22-24, Helsinki, 00100, Finland, Ossi Aura, Guy Ahonen, Timo Kuosmanen

Causal relationship between personnel management practices and productivity remains ambiguous. This longitudinal study combines survey data from Finnish small and medium size enterprises in manufacturing with productivity indicators for years 2008-2016 (17100 observations). Controlling for firm specific factors such as capital intensity, we find that measures regarding management development, work environment and content are associated with increase in future productivity. In contrast, measures like increasing non-financial employee benefits follow high productivity and do not precede it.

2 - The Impact of Patents on Manufacturing Productivity

Anand Kandaswamy, Economist, NIST, Washington, DC, 20008, United States

The traditional economics models in manufacturing usually look at factors like plant and equipment spending, worker education, and research and development funding to measure changes in productivity levels. What they tend to ignore is the role of innovation in driving productivity. Patents have traditionally been recognized as an excellent proxy for levels of innovation. Using data from 2004 to 2014, the author focused on six key manufacturing industries and created a model in R Studio that tries to determine the relative importance of innovation (as represented by patent activity) with respect to the more traditionally accepted components of economic productivity.

3 - The Effect of Flow Time on Productivity and Production

Douglas Thomas, Economist, NIST, Gaithersburg, MD, 20899-8603, United States

Operations management strategies incorporate flow time and inventory turns as a metric for tracking and improving performance; however, there is limited understanding regarding the impact of reducing flow time. This paper examines the impact that flow time has on productivity and production, measured using the multifactor productivity index and manufacturing value added. A total of 6 models are presented and two simulations. The results suggest that flow time reflects and impacts productivity and production both within an industry and between industries. Moreover, the results are consistent with using flow time as a metric to identify industry level bottlenecks and improve productivity.

4 - Experimental Investigation of Stratasys J750 Polyjet Printer: Effects of Printing Parameters on Bending Strength

Xingjian Wei, Graduate Student, Texas A&M University, College Station, TX, 77843, United States, Abhinav Bhardwaj, Zhijian Pei, Bruce Tai

Additive Manufacturing (AM) has found significant applications in the engineering of prototypes as well as functional parts. These advances have resulted in the origination of high-resolution, multi-material printers such as the Stratasys J750: world's first full-color, multi-material 3D printer. In this research, we analyze the effects of printing parameters on the bending strength of samples printed by the Stratasys J750 printer. The results from this study would be valuable to research institutions and businesses leading high-resolution, multi-material 3D printing of polymers.

5 - The Motivation of Capital-giving in Crowdfunding Market: A Self-determination Theory Perspective

Xiang Yuan, TongJi University, Shanghai, China, Hongwei Wang, Yuan Meng

How to promote crowd-funding results successfully are crucial to crowdfunding projects. The results of crowd-funding projects are determined by investors'subjective behavior, which is triggered by some certain motivations. Through identifying different motivation modes mainly influenced by the project description, it will be beneficial to identify the investment intention of each investor. In this paper, based on the self-determination theory, we first create the corpus targeting different motives by means of the text mining method. Then, we classify the project description and project investment options. Last, we conduct an econometric model to examine the effect of investor's motives.

■ WD28

North Bldg 221A

Practice- Transportation-Operations IV

Contributed Session

Chair: Zhen Tan, Cornell University, Ithaca, NY, 14850, United States

1 - Multi-methodological Approach for Risk Mitigation Strategy Selection in the Trucking Industry: A Truck Drivers Perspective

Krishna Kumar Dadsena, Indian Institute of Technology Kharagpur, Kharagpur, Vs Hall, B. 243, IIT Kharagpur, Kharagpur, 721302, India, Sarada Prasad Sarmah, V. N. A. Naikan

This study aims to identify the operational risks induced by the truck drivers' job satisfaction criteria, and to select the most suitable risk mitigation strategy on managing the operational efficiency of the trucking industry. The approach based on the systematic application of survey-based analysis and fuzzy theory is used to develop a novel algorithm to support the strategy selection process.

2 - Dynamic Subsidy-pricing Models for Multi-modal Transportation Integration: The One Belt-one Road Strategic Context

Tanmoy Kundu, National Taiwan University, Taipei, Taiwan, Jiuh-Biing Sheu

One Belt-One Road (OBOR) is a regional/international developmental initiative recently initiated by the Chinese government. One of the challenges being faced in the OBOR operations is the ineffective utilization of the multiple modes of transportation. Huge subsidy to one mode of transportation is leading to the cannibalization of the other. Hence, this work offers various dynamic subsidy-pricing models associated with the dynamic multimodal transportation networks along the OBOR corridors.

3 - An Efficient Iterative Algorithm for the Integrated Optimization of Train Timetabling and Maintenance Task Scheduling

Yongxiang Zhang, Southwest Jiaotong University, Chengdu, 610031, China, Qiyuan Peng, Andrea D'Ariano, Bisheng He

Track maintenance tasks need to be scheduled to retain the railway tracks in an appropriate state. However, the planning of track maintenance activities is interrelated with the train timetabling process. In this work, train timetabling is optimized together with maintenance task scheduling to solve potential planning conflicts and to allocate the available railway capacity more efficiently to the scheduled services. A new mixed integer linear programming model is formulated and an efficient iterative algorithm is proposed to find near-optimal solutions within

a short computation time. The experimental results show that the proposed algorithm outperforms previously proposed approaches.

4 - The Pareto-improving Hybrid Fare Scheme with Heterogeneity in Commuter's Scheduling Flexibility

Yili Tang, Hong Kong University of Science and Technology, Academic Building, Room 3595, Hong Kong, China, Hai Yang

This paper proposes a hybrid fare scheme (HFS) combining a fare-reward scheme (H-FRS) and a uniform fare scheme (H-UFS) by considering the heterogeneous commuter's scheduling flexibility in transit bottleneck model. It aims at reducing peak-hour congestions with alternative options catered for various commuters. In H-FRS, a commuter is rewarded with a free ride during shoulder periods after taking a number of paid rides during the central period in peak hours. The H-UFS determines a uniform fare. The preliminary results demonstrate that the HFS is not only revenue-preserving but also Pareto-improving. An optimally designed hybrid scheme can achieve a reduction in total time costs by at least 25%.

5 - Effect of Information Delay on Real-time Routing and a Potential Remedy

Zhen Tan, Nottingham University Business School (China), Ningbo, 14850, China, Jamol Pender, H. Oliver Gao, Xiaoning Zhang

In dynamic routing, travel time information is often delayed and hence inaccurate because of challenges in data collection and sensor working principal. This inaccuracy can misguide motorists and result in unstable traffic patterns that exacerbate congestion. To alleviate this negative effect, we analyzed the potential of providing drivers with real-time en-route air pollution information (in addition to travel time) using a new queueing model. Results of our theoretical and numerical analysis indicate that provision of real-time air pollution information can help stabilize traffic. We verified this benefit by traffic simulation of the George Washington Bridge based on real-world data.

■ WD30

North Bldg 221C

Practice – Shipping & Transportation Operations & Management I

Contributed Session

Chair: Qingcheng Zeng, Dalian Maritime University, School of Transportation Management, Dalian, 116026, China

1 - Revenue Management in Ocean Shipping

Andres Iroume, Revenue Analytics, Atlanta, GA, United States, Michael Seelhorst

Container shipping companies face many of the same issues addressed by traditional revenue management (RM): perishable inventory, demand uncertainty and customers with different price sensitivities, among others.Historically, operations research based decision support systems have been implemented in this industry, including empty container repositioning, terminal operations, disruption management and others.Today, some of the first revenue management systems are being implemented. We discuss nuances and similarities with previous applications of RM.

2 - Bi-level Optimization Method to Minimize Externalities by Means of Eco-transfer Staging Areas in Urban Cores

Mario E. Arrieta-Prieto, Graduate Research Assistant, Rensselaer Polytechnic Institute, Troy, NY, 12180, United States, Abdelrahman Ismael, Carlos Rivera-González, John E. Mitchell

Changes in urban population combined with the rise of e-commerce have had tremendous impacts on sustainable supply chains at urban cores. This paper proposes a methodology to decide optimal location of on-street staging areas in urban cores. By using a bi-level optimization problem the authors were able to capture how the agents involved in the decision pursue different objectives. In freight systems the public sector aims to maximize social welfare while the private sector looks for maximizing profit. The result of the research exhibits a formulation and a case study scenario in Manhattan that allows the evaluation of on-street staging areas from both the private and the public sector perspective.

3 - Modelling the AGV and ALV System in Automated Container Terminals

Qingcheng Zeng, Dean, Dalian Maritime University, Linghai Road 1, Dalian, Dalian, 116026, China

This paper addresses the impact of the number of operations on the terminal efficiency based on AGV and ALV transport systems. Performance indicators of AGV and ALV transport system is obtained by queuing models, where AGV transport system is modelled by a closed queuing network and ALV transport system is modelled by a mixed queuing network. We also developed a cost model to investigate the present values of total cost of AGVs and ALVs, including operation cost, capital cost and labour cost. Numerical experiments indicate that the efficiency of ALVs and AGVs. Sensitive analysis shows the impact of the number of buffers and vehicle travelling speed on terminal efficiency.

■ WD31

North Bldg 222A

Practice- Rail Transportation I

Contributed Session

Chair: Manuel Fuentes, Universidad Rey Juan Carlos, Camino del Molino, 5, Fuenlabrada, 28943, Spain

1 - A Capacity Estimation System for High-speed Railway: An Integrated Approach Considering Railway Traffic and Rolling Stock Utilization

Haiying Li, Prof., Beijing Jiaotong University, Shangyuan Cun No 3, Beijing, 100044, China, Zhengwen Liao, Ying Wang, Xinyi Li

A capacity estimation approach considering both the passing capacity of railway open track segments and stations, as well as the holding and the circulation of rolling stocks is introduced in the presentation. A MIP model which jointly optimizes the timetabling, track assignment and rolling stock circulation problems is proposed to generate a saturated integrated plan. For solving the MIP model, a pressure testing method is embedded in a time-rolling algorithm framework for generating a whole-day train timetable. Based on the algorithm, a decision support system with the user interface is developed and applied in a case study on Beijing-Tianjin intercity railway.

2 - Research on the Risk Fuzzy Evaluation and Control Measures of China's Rail Transportation Projects Based on Economic Sensitivity

Xu Yan, Southwest Jiaotong University, Chengdu, China National United Engineering Laboratory of Integrated and Intelligent Transportation, Chengdu, China, Qiyuan Peng, Jie Liu, Yong Yin, Yongxiang Zhang

This paper construct a multi-level risk evaluation system based on the sources of risk analyses in China's rail transportation projects. Then an improved fuzzy comprehensive risk evaluation model is established in order to evaluates the risks of projects from the perspective of economy and efficiency, which combining economical sensitivity analysis method with expert scoring method to determine the weight of each level's index. Then the model verification is carried out with two examples of China's rail transportation projects. The results from multiple angles is consistent with the actual situation and the risk control measures are put forward according to it.

3 - Railway Crew Scheduling with Semi-flexible Timetables

Ulrich Thonemann, Universitat zu Koln, Wirtschafts und Sozialwissenschaftliche, Fakultat Albertus Magnus Platz, Koeln, D-50923, Germany, Christian Raehlmann

We investigate the impact of coordinating the timetable and the crew schedule in an operational freight railway system. Usually both problems are solved sequentially - resulting in suboptimal schedules with long idle times for the train drivers. We coordinate the timetable and the crew schedule by adding flexibility to the timetable. We introduce small time windows, that allow to shift entire trains forwards and backwards by discrete time periods. We solve our model with a column generation heuristic and test it on three real datasets. Our results show large reductions in idle time and cost.

4 - Integrated Crew Scheduling & Crew Rostering Model for Rapid Transit Networks

Manuel Fuentes, Universidad Rey Juan Carlos, Camino del Molino, 5, Fuenlabrada, 28943, Spain, Luis Cadarso

Solving Crew Planning Problem sequentially, by tackling first the Crew Scheduling and then the Crew Rostering problems independently, usually leads to suboptimal solutions. Instead, facing the problem without splitting it into two may improve the global solution. However, this is often impractical when using exact methods, due to the complexity of the problem.We propose a heuristic approach for solving the integrated crew planning problem for rapid transit networks, where the schedules are usually daily repeated and the crews are sequenced in rotating rosters.

■ WD36

North Bldg 224B

Practice- Inventory Management

Contributed Session

Chair: Yixuan Xiao, City University of Hong Kong, 83 Tat Chee Avenue, Kowloon, 1, Hong Kong

1 - Capacity Expansion with a Bundled Supply of Capacity Attributes

Mohammad Ebrahim Arbabian, University of Washington, Seattle, WA, 98105, United States, Shi Chen, Kamran Moinzadeh

We study the well-known problem of expanding capacity of server attributes in a cloud company where supply of attributes is bundles. We consider a cost minimization problem in a continuous review, finite horizon setting. Furthermore, the best server configurations to be deployed each cycle are studied

2 - Managing Perishable Inventory Systems with Multiple Age-differentiated Demand Classes
Shouchang Chen, Zhejiang University, Hangzhou, China, Yanzhi Li, Yi Yang, Weihua Zhou

In this paper, we consider a periodic-review inventory system with perishable products. In the market, there are different demand classes; each can be characterized by its different lost-sale cost and freshnessrequirement. By establishing some new properties of multimodularity, we partially characterize the structure of the optimal policy. Based on optimality analysis, we design several efficient approximation approaches.Numerical studies show that our heuristic policy outperforms the traditional heuristics proposed by prior literature.

3 - Determining Optimal Parameters for an Expediting Policy under a Service Level Constraint
Simon Hoeller, University of Cologne, Albertus-Magnus-Platz, Cologne, 50923, Germany, Raik Oezsen, Ulrich Thonemann

We consider a periodic review inventory system with stochastic demand, deterministic lead times, back-ordering, and the option to move outstanding units forward in the replenishment pipeline. The objective is to minimize inventory holding and expediting costs per period subject to a minimum service level constraint. We consider a generalized base-stock policy where outstanding units are expedited when the inventory level drops below a certain threshold. We develop structural properties and present an efficient procedure to determine optimal policy parameters. In a numerical study, we show that the expediting policy offers substantial savings compared to the classical base-stock policy.

4 - An Aggregation-based ADP Approach for the Periodic Review Model with Random Yield
Ulrich Thonemann, Universitat zu Koln, Wirtschafts und Sozialwissenschaftliche, Fakultat Albertus Magnus Platz, Koeln, D-50923, Germany, Michael Voelkel, Anna-Lena Sachs

A manufacturer places orders periodically for products that are shipped from a supplier. Orders may get damaged with some probability, i.e. the order is subject to random yield. The manufacturer may track its orders to receive information on damages and to place additional orders. We solve this model with stochastic demand, tracking cost and random yield in all periods to optimality. We propose a novel aggregation-based approximate dynamic programming algorithm and provide solutions for larger instances for which it is not feasible to obtain optimal solutions. We analyze the effect of dynamic tracking and develop a heuristic that takes tracking costs into account to solve even larger instances.

5 - A Newsvendor Analysis with Carbon Emission Regulations
Sungyong Choi, Assistant Professor, Yonsei University, College of Government and Business, 1 Yoneseidae-gil, Wonju, 26493, Korea, Republic of

This paper aims to provide an optimization model for operational efficiency in individual firms considering various types of carbon emission regulations. More specifically, this study assumes that customer demand is given as a probability distribution. Under this circumstance, I formulate newsvendor models including carbon emission regulations and then derive practical implications for the policymakers in carbon emission regulations. Then, I analyze the models to provide closed-form solutions and conduct a sensitivity analysis for the impacts of model parameters on the optimal solutions through a comparative static analysis. All analytical results are reconfirmed by numerical analysis.

6 - Inventory Management under Corporate Income Tax
Yixuan Xiao, City University of Hong Kong, 83 Tat Chee Avenue, Kowloon, Hong Kong, Zhan Pang

Corporate income tax is a significant cost for companies and an important input into many corporate decisions. Corporations use after-tax earnings to reinvest in their core business and pay out dividends. We propose a framework to study a firm's inventory decisions under taxation in multi-accounting periods where each accounting period consists of multiple ordering periods. We show that in the backlog model under a convex tax or in the lost-sales model under a flat-rate tax and mild conditions, a state-dependent base-stock policy is optimal. We also examine the static effect and intertemporal effect of tax on a firm's inventory decisions.

■ WD41

North Bldg 226C

Practice - Decision Support Systems & Applications I

Contributed Session

Chair: Juri Yanase, Complete Decisions, LLC, 10517 Springbrook Ave., Baton Rouge, LA, 70810, United States

1 - A Minimum Cost Consensus Model for Social-network Group Decision-making Problems with Incomplete Linguistic Preference Relations
Dong Cheng, Xi'an Jiaotong University, Xi'an, 710049, China, Zhili Zhou

In this study, we propose a minimum cost consensus framework in social-network group decision-making with incomplete linguistic preference relations. First, a uninorm-based iterative procedure is presented to estimate the missing preference values. Next, we obtain the user weights by analyzing the tie strength and topology structure of their social network. Then, inconsistent users are identified through both the consistency and consensus measures. To help them reach a consensus with the minimum adjustment costs, an optimization-based consensus model is built to provide customized recommendations to them. Finally, the validity of the proposed method is verified by an example.

2 - Optimal Pricing and Ordering Strategy in a Single Supplier Group Purchasing Problem with a Newsvendor Framework
Abdollah Mohammadi, UNC Charlotte, 532 Lex Dr., Charlotte, NC, 28262, United States, Ertunga Ozelkan

Procurement cost account for a significant percentage of the total cost in a business entity. Group purchasing is a procurement strategy that helps companies save in their purchasing cost. In this research we are considering a group purchasing problem where a single supplier offers a quantity discount pricing schedule and retailers should decide about their price and ordering policy to maximize their profit in a single period problem. Through theoretical analysis we find out the optimal result condition and develop a heuristic algorithm to find out the near optimal results for a test problem.

3 - Blockchain Adoption under Uncertainty of Regulation
Reza Alizadeh, The University of Oklahoma, 815 Russell Circle, E. Brooks St, Norman, OK, 73071, United States, Leili Soltanisehat

Demand for decentralization of the organizational processes is getting strong throughout the world. The entity of the decentralization technology and the governmental regulations may differ among enterprises. We consider a decentralized IT system (Blockchain) inside an enterprise under uncertain governmental regulation and standards when there is a competitive tendency to adopt blockchain in the market.

4 - Shared Decision Making (SDM) as a Fast Emerging Field in the Interface of OR / MS and Medicine: Its Past, Present, and Likely Future
Juri Yanase, Complete Decisions, LLC, 10517 Springbrook Ave., Baton Rouge, LA, 70810, United States, Evangelos Triantaphyllou, Zaina Qureshi

The rapid evolution of medicine has resulted in multiple treatment options for many chronic conditions. These treatments are associated with different risk-benefit profiles, and preferences by individual patients. SDM provides a unique platform for patients and clinicians to collaboratively determine the best treatment option for individual patients. We review SDM's history, the state-of-the-art and some challenges for the future.

■ WD42

North Bldg 227A

Practice- Simulation and Optimization

Contributed Session

Chair: Julien Vaes, University of Oxford, Kings Cross, London, NW1 2DB, United Kingdom

1 - Data Driven Optimization and Statistical Modeling to Improve Meter Reading for Utility Companies
Debdatta Sinha Roy, Robert H. Smith School of Business, University of Maryland, 7699 Mowatt Lane, 3330 Van Munching Hall, College Park, MD, 20742, United States, Christof Defryn, Bruce L. Golden, Edward Wasil

Utility companies collect usage data from meters on a regular basis. Each meter has a signal transmitter that is automatically read by a receiver within a specified distance using radio-frequency identification (RFID) technology. In practice, there is uncertainty while reading meters from the planned routes of the vehicles. The RFID signals are discontinuous, and each meter differs with respect to the specified distance. These factors can lead to missed reads. We use data analytics, optimization, and Bayesian statistics to address the uncertainty. Simulation experiments using real data show that a hierarchical Bayesian model performs the best by designing improved routes for the vehicles.

2 - UNIPOPT: Univariate Projection-based Optimization without Derivatives
Ishan Bajaj, Texas A&M University, College Station, TX, 77840, United States, Faruque Hasan

We present a novel derivative-free framework UNIPOPT (UNIvariate Projection-based OPTimization) based on projecting all the samples onto a univariate space defined by summation of the decision variables. We illustrate that a univariate function (defined as lower envelope) exists on this space such that its minima is the same as that of the original function. The UNIPOPT framework identifies the points on the lower envelope and uses these samples to optimize it. UNIPOPT finds solutions within 1% of the global minima for 10-30% more problems compared to other solvers when applied on 485 constrained black-box problems. We also show

the convergence of UNIPOPT to first order critical point.

3 - Design a Power Network for Charging Electronic Vehicles
Ting Wu, Nanjing University, Department of Mathematics, No 22 Hankou Road, Nanjing, 210093, China, Cheng Zhu, Yasmina Maizi

Electronic Vehicles contribute to a green environment in a smart city, they, however, raise a challenging problem for an existing power network to accommodate their charging facilities. This study aims to verify an upgraded power network via simulation models, providing managerial insights for adjusting existing power networks given a transportation network.

4 - Optimal Trade Execution Strategy under Volume and Price Uncertainty
Julien Vaes, University of Oxford, Andrew Wiles Building, Radcliffe Observatory Quarter, Woodstock Road, Oxford, OX2 6GG, United Kingdom, Julien Vaes, The Alan Turing Institute, 96 Euston Road, Kings Cross, London, NW1 2DB, United Kingdom

In the seminal paper on optimal execution of portfolio transactions, Almgren and Chriss define the optimal trading strategy to liquidate a fixed volume of a single security under price uncertainty. Yet sometimes, like in the power market, the volume to be traded can only be estimated and becomes more accurate when approaching a specified delivery time. We develop a model that accounts for volume uncertainty and show that a risk-averse trader has benefit in delaying trades. We demonstrate that the optimal strategy is a trade-off between early and late trades to balance risk associated to price and volume respectively.

■ WD44

North Bldg 227C

Joint Session ENRE/Practice Curated: Data Science in Energy Systems

Sponsored: Energy, Natural Res & the Environment/Electricity

Sponsored Session

Chair: Hoon Hwangbo, Texas A&M University, College Station, TX, United States

Co-Chair: Eunshin Byon, University of Michigan, Ann Arbor, MI, 48109, United States

1 - Variance Reduction Method for Wind Turbine Extreme Load Estimation
Qiyun Pan, University of Michigan, Department of IOE, Ann Arbor, MI, 48109-2117, United States, Eunshin Byon, Henry Lam

This study develops a computationally efficient variance reduction method for wind turbine extreme load estimation with the stochastic simulation model. We propose an adaptive method that iteratively refines the input sampling density so that sampling efforts can be steered to focus on important input regions. We devise a parameter updating rule to make the sampling density parameter converge to the unknown target extreme load and prove the extreme load estimation uncertainty becomes smaller than that from crude Monte Carlo simulation.

2 - Quantifying the Effect of Vortex Generator Installation on Wind Power Production
Hoon Hwangbo, Texas A&M University, College Station, TX, 77840, United States, Yu Ding

Vortex generator installation is known to improve wind power production, and how much to improve is a fundamental managerial question to be addressed. Quantifying the effect of the installation is, though, quite challenging due to the presence of multiple sources of variation causing difference in power output between pre- and post-installation periods. For more accurate quantification, we use a machine learning model to control for some environmental effects in power output and consider the temporal change of wind power production between the two periods of installation, which shows quite consistent results.

3 - Update on NREL Work in UQ for Loads Analysis
Katherine Dykes, NREL, Golden, CO, United States

This presentation will provide an update on NREL work using statistical methods applied to wind turbine extreme and fatigue loads analysis. Loads analysis is a cumbersome part of wind turbine design and analysis with significant uncertainty; advanced statistical methods can help improve the accuracy and computational efficiency of this process.

■ WD47

North Bldg 229A

Practice- Sustainable Operations & Development

Contributed Session

Chair: Anita Lee-Post, University of Kentucky, Department of Marketing and Supply Chain, 455f Business & Economics Bldg, Lexington, KY, 40506, United States

1 - The Value of Quality Grading in Remanufacturing under Quality Level Uncertainty
Meltem Denizel, Iowa State University, 2340 Gerdin Business Building, 2167 Union Dr., Ames, IA, 50011-2027, United States, Ihsan Yanikoglu

In remanufacturing, variability in quality levels of cores has an impact on both the process cost and time. While previous research suggest that quality grading adds value, there are also concerns about how reliably the grades can be identified. We develop a robust optimization model for remanufacturing planning. Both the unit cost and time of remanufacturing are uncertain parameters that are assumed to reside in two uncertainty sets; box or ellipsoidal. We analyze uncapacitated and capacitated cases and based on extensive numerical analysis, conclude that while there is still value in grading on average, it becomes significantly smaller than the case when uncertainty is not accounted for.

2 - Firm Performance through Corporate Social Responsibility Leveraging the Supply Chain
Feng Cheng, PhD Candidate, Arizona State University, Tempe, AZ, United States

This study examines the effect of supply-chain CSR adoption - i.e. adoption of Corporate Social Responsibility in the value chain (from supply base to customer base) - on the focal firm's financial performance. Our results show that supply-chain CSR does not necessarily lead to superior firm performance. We uncover pathways that can benefit a firm from the adoption of supply-chain CSR; namely, (1) innovation driven from both focal firm CSR and supply-chain CSR and (2) employee performance. The results suggest that a firm benefits from supply-chain CSR only if the adoption inspires innovation and high employee productivity. Such positive effect becomes larger in less eco-friendly industries.

3 - Optimal Fleet Size and the Efficiency-effectiveness-equity Trade-offs in Humanitarian Procurement Policies
Laura Turrini, European Business School, Oestrich Winkel, Germany

We focus on fleet management and empirically estimate the real needs of a decentralized humanitarian organization that operates both relief and development operations. We study the optimal allocation of vehicle procurement, based on a set of constraints, in order to satisfy organizational needs as efficiently, effectively and equitably as possible.

4 - Sustainable Consumption Behavior
Anita Lee-Post, University of Kentucky, Department of Marketing and Supply Chain, 435Q Business & Economics Bldg, Lexington, KY, 40506, United States, Chon-Huat Goh

The purpose of this research is to further our understanding on sustainable consumption behavior. An empirical study is sought to investigate the pathway linking attitude, social influence, and sustainable consumption behavior using a survey methodology. Operational and marketing implications of findings from this study will be presented.

■ WD52

North Bldg 231C

Practice- Transportation Freight II

Contributed Session

Chair: Allan Larsen, Technical University of Denmark, DTU Management Engineering, Building 424, DTU, Lyngby, DK-2800, Denmark

1 - Truck Appointment Systems Considering Impact to Drayage Truck Tours
Mohammad Torkjazi, University of South Carolina, Columbia, SC, 29205, United States, Nathan Huynh, Samaneh Shiri

This study proposes a novel approach for designing a Truck Appointment System (TAS) intended to serve both the marine container terminal operator and drayage operators. The aim of the proposed TAS is to minimize the impact to both terminal and drayage operations.

2 - Design and Operation of China Railway Express under Market Competition
Yingzi Peng, Tsinghua University, Beijing, 100084, China, Lefei Li

As an important symbol of "The Belt and Road transportation interconnection, China Railway Express has obtained a great increasement in the number of commodity freight. Most mathematical models of intermodal network design have been developed as stakeholder of an intermodal operator. In this research, we develop a network design and operation model in order to help China Railway Express, as a carrier, to solve for better freight routes and schedules considering competition with other carriers. The model is formulated as a bilevel nonlinear integer program, which is difficulty to solve.

3 - Design of a Relay Network in Long-haul Transportation

Amin Ziaeifar, Southern Methodist University, Dallas, TX, 75205, United States, Halit Uster

We present a new model to strategically design a relay network for long-haul transportation by considering alternative routings. We devise a Benders decomposition based solution algorithm that is enhanced by strengthened benders cuts, heuristics, and surrogate constraints to solve it efficiently. We present the computational results to demonstrate the efficiency of our algorithm on large-scale instances.

4 - Freight Demand Modeling in Bangladesh: A World Bank Project

Abdelrahman Ismael, Rensselaer Polytechnic Institute, Troy, NY, 12180, United States, Jose Holguin-Veras, Lokesh Kumar Kalahasthi, Wilfredo Yushimito

This presentation explains the freight modeling performed as a part of a project funded by the World Bank group. Freight generation, freight trip generation were modelled at district level in Bangladesh, using the survey conducted by the team. Freight Origin-Destination Synthesis, a process of obtaining the loaded and empty flows between the districts was performed, using the confidential Census datasets, road network, link travel time estimated using the GPS data, and the traffic count data for year 2013. Imports and export traffic flows were modeled using the Customs data. A doubly constrained gravity model is used for trip distribution, and Noortman and van E's model is used for empty trips.

5 - Using Electric Vehicles for Commercial Urban Transports

Allan Larsen, Professor, Technical University of Denmark, DTU Management Engineering, Building 424, DTU, Lyngby, DK-2800, Denmark, Dario Pacino, Michael Bruhn Barfod, Jonas Mark Christensen, Satya Sarvani Malladi

Electric vehicles (EVs) are facing a rapid development enabling such vehicles to be used in commercial transport. The EU project, EUFAL (Electric Urban Freight and Logistics), sets out to examine the potentials of using EVs in city logistics. This presentation will provide an overview of the planning and management problems met when implementing EVs in urban freight transport. Two real-life optimization problems dealing with routing EVs for collection of blood samples from private physicians and the fleet management of electric service vehicles visiting construction sites will be introduced.

■ WD55

North Bldg 232C

Practice- Technology and Project Management

Contributed Session

Chair: Christian Ruf, Technical University Munich, Arcisstr. 21, München, D-80333, Germany

1 - Motivating Employees' Information Security Compliance: Leadership Style or Protection Motivation?

Jiawen Zhu, Xi'an Jiaotong University, Xi'an, China Jiawen Zhu, City University of Hong Kong, Hong Kong, China, Gengzhong Feng, Kwok Leung Tsui

This study investigates the moderation effect of Paternalistic Leadership on the relationship between Protection Motivation Theory and employeesæ Information Security Compliance behavior. Using questionnaire data from 760 employees, we found that, Paternalistic Leadership dimensions, Authoritarianism, Benevolence, Morality, dampen the weight of most protection motivation elements to employees' compliance. This suggests that when certain leadership style is salient, employees' protection motivation perceptions, such as threat severity, self-efficacy and maladaptive reward perception, may have no significant influence on employees' information security compliance.

2 - Asymmetric Information Sharing in Information System Security

Yueran Zhuo, University of Massachusetts Amherst, 121 Presidents Drive, Amherst, MA, 01003, United States, Senay Solak

In information security practice, the asymmetry in information sharing levels might hurt the information sharing firms' incentives. A possible solution to the problem is to impose charges on the shared information and treat it as a commodity. In this study we try to answer the questions: What fair price should a firm pay when also sharing a certain level of information? How would the price of information vary as more firms join an information sharing alliance? We develop analytical expressions to identify the pricing of information in an information sharing community with multiple firms and explore the overall benefits to the information sharing community due the implementation of pricing strategies.

3 - Introducing a Predator-prey System with Michaelis-menten Type of Prey and Predator Harvesting Considering Diffusion Terms and Inconstant Carrying Capacity for the Prey

Aram Bahrini, University of Virginia, Thornton Hall, P.O. Box 400259, Charlottesville, VA, 22904-4259, United States University of British Columbia, 1984 Mathematics Road, UBC, Vancouver, BC, V6T1Z2, Canada, Behnam Malmir, Mohammad Najjartabar Bisheh

In this paper, we made a modification on the Hu and Cao (2017) model in which in our model the effect of harvesting for the prey is non-zero and considered as a Holling II functional response predator-prey system. In addition, since by changing the reproduction rate, the carrying capacity may change as well, the scenario in which the carrying capacity is considered as unfixed and a function of reproduction rate for the pray is taken into consideration. Additionally, a diffusion term is added to make the model more realistic especially in fishery application. Results show that the model analyzed in this paper can cause more realistic behaviors compared with other presented systems.

4 - Long-term Capacity Planning of a Workforce with Hierarchical Skills and Random Resignations

Christian Ruf, TU München, Arcisstr. 33, Munich, 80333, Germany, Jonathan F. Bard, Rainer Kolisch

We address a multistage capacity planning problem for a hierarchically skilled workforce. Recruits are hired and trained over multiple periods to perform jobs that require ever greater skills. The training comprises a combination of off-the-job and on-the-job elements. Random resignations result in labor shortfalls that jeopardize continuous operations. The problem is modeled as a Markov decision process for which a parameterized decision rule is proposed. To determine good parameter values, we present a very large-scale neighborhood search. Experimental results on real-world industry data is presented.

■ WD61

West Bldg 102C

Practice – Supply Chain Competition, Practice and Risk Analysis

Contributed Session

Chair: Jian Li, Northeastern Illinois University, 5500 N. St Louis Avenue, Chicago, IL, 60625, United States

1 - Supplier Development and Learning Spillover in a Triadic Supply Chain under Competition

Abhishek Srivastava, Doctoral Student, Indian Institute of Management Kozhikode, IIMK PO Kunnamangalam, Kozhikode, 673570, India, Arqum Mateen

We model a triadic supply chain in which two competing asymmetric buyers source from common supplier, invest in supplier development to improve profits. Buyers may benefit from each other's investment equally (uniform spillover; US) or unequally (differential spillover; DS). The supplier offers a uniform wholesale price (UWP) and buyer-specific wholesale price (BWSP). Our results indicate that optimal wholesale price increases with market share, intensity of competition, spillover effect. UWP under US works against the larger buyer, who consequently prefers a DS structure. We establish that both the buyers prefer investment under DS structure for higher values of competition and spillover.

2 - A Study on Logistics Companies' Financial and Supply Chain Performance

Hossein Najmi, University of North Texas, 1307 W. Highland Street, Denton, TX, 76201, United States, Seock Hong

Financial performance indicators (FPIs) are long used to find supply chain excellence. But examining FPIs specific to a sector is understudied. To address this gap, we applied discriminant analysis, logistic regression, and MANOVA to analyze 103 logistics companies. We found the FPIs that measure the performance of logistics companies supply chain and differences among industries.

3 - Rush Purchasing for Hoarding during Natural Hazards – An Empirical Study in Agricultural Products Supply Chain

Hsintsz Kuo, National Taiwan University, New Taipei, 24943, Taiwan, Jiuh-Biing Sheu

Disruption management is the important part in the recovery process. This paper proposes a research model to investigate the causal relationships among internal influence and external influence, rush purchasing behavior and its antecedents after huge natural hazards. We argue that the emotional contagions can moderate the relationship among rush purchasing behavior and psychological response after a huge natural hazard.

4 - A Baseline Approach to Supply Chain Risk Assessment

Joπo Dias da Silva, PhD Researcher, University of Porto, Porto, 4149-002, Portugal, Alcib ades Guedes

Over the past decades, global manufacturing and logistics networks have attained unprecedented levels of complexity, with supply chains becoming ever more prone to operational disruptions of unforeseen causes and consequences. This research project takes a fresh look at fundamental supply chain risk definitions and determinants, and proposes a new generic, coherent, repeatable and primarily intrinsic methodology to measure and rate the propensity for operational disruptions in supply chain systems. The rationale of the construct, some implementation examples, the relevance for theory and practice, as well as some anticipated limitations and potential improvements are discussed.

6 - Commodity Farming in Developing Countries with an Application to

the Cotton Supply Chain in Mozambique

Jian Li, Northeastern Illinois University, 5500 N. St Louis Avenue, Chicago, IL, 60625, United States, Maqbool Dada, Panos Kouvelis

We develop a model of cotton supply chains in which two farmers, who are supported by two ginners, make two types of fundamental decisions under yield uncertainty: how much land to allocate to cotton production before the start of the growing season, and, the pricing rules followed by ginners that purchase the cotton harvest. The focus of the study is on characterizing the optimal decisions and the impact of a government-specified minimum price.

■ WD62

West Bldg 103A

Joint Session DM/Practice Curated: Data Science in Transportation

Sponsored: Data Mining

Sponsored Session

1 - Studying the Efficiency Limit of Ride Sharing

Mustafa Lokhandwala, PhD Candidate, Purdue University, West Lafayette, IN, 47906, United States, Hua Cai

Dynamic ride sharing offers passengers a facility to share a ride with others with the flexibility of choosing their own pick up and drop off locations while increasing the occupancy of vehicles up to a certain limit. We study this efficiency limit of ride sharing in autonomous electric vehicles using an agent-based model. Preliminary results have indicated that during peek hours, about 30% of the vehicles are available to accept new shares, but an approximately equal number of vehicles do not accept new shares. The most common reason (about 80%) that a taxi does not search for new shares has been found to be the tolerance limit of the rider to deviate from his route.

2 - Dynamic Origin Destination Estimation Based on Time Delay Correlation Among Zonal Location-based Social Network Check-in Data

Jing Jin, Assistant Professor, Rutgers, The State University of New Jersey, CORE 613, 96 Frelinghuysen Rd., Piscataway, NJ, 08854, United States, Wangsu Hu

Location-based Social Network (LBSN) services allow users to confirm their current locations by “check-in with places of interests. Through analyzing the check-in arrival sequences, LBSN data can identify and quantify the spatial-temporal correlation of travel demand between pairwise zones to generate the dynamic Origin-Destination (OD) flow matrix. Empirical insights can be obtained by analyzing the predicted dynamic OD flow patterns for different land use types, day-of-week, and time-of-day periods.

■ WD64

West Bldg 104A

Joint Session DM/Practice Curated: Data Science for Text Analysis

Sponsored: Data Mining

Sponsored Session

Chair: Babak Zafari, Babson College, Babson Hall 218C, Babson Park, MA, 02457, United States

1 - Text Mining Analysis of Business Data Analytics and Data Science Jobs Requirements

Zinovy Radovilsky, Professor, California State University-East Bay, 25800 Carlos Bee Boulevard, Hayward, CA, 94506, United States, Vishwanath Hegde, Anuja Acharya, Uma Uma

We identify and compare knowledge and skills for business data analytics (BDA) and data science (DS) professions. We collected primary BDA and DS job posting data from online job-related websites, developed document data matrix, and applied text mining analysis including singular vector decomposition, VARIMAX rotation, and latent class analysis. Based on this text mining analysis, we identified main similarities of and important differences between the BDA and DS job requirements. These results provide vital insights for designing curriculum and training in the evolving BDA and DS areas, and also enable professional to sharpen their skills aligned with job market requirements.

2 - Deception or Truth? The Impact of Linguistic Cues to Fraud on Capital-giving Willingness: Evidence from Crowdfunding Market

Xicheng Yin, Tongji University, Shanghai, China, Wei Wang, Kevin Zhu, Hongwei Wang, Pei Yin, Wei Chen

We adopt the following indicators to measure the linguistic cues to fraud: Cognitive Load, Internal Imagination, Dissociation, Negative Emotion, Lexical Diversity, Lexical Ease of Read, Lexical Complexity and New Word Ratio as well. Locational prepositions and temporal prepositions in reward statement, non-first-person prepositions in blurb and reward statement, and cohesion in project description normally result in successful campaigns. The concreteness of blurb and detailed description makes the project look like a deception. We provide a method to detect linguistic cues to fraud on crowdfunding campaigns and provide suggestions to project founders to better describe their projects.

3 - Knowledge Mining in Scientific Literature for Complex Social Problems: An Example using Multi-stakeholder Performance Management

Victor Zitian Chen, University of North Carolina, Charlotte, NC, United States, Reza Mousavi, Wlodek Zadrozny

The volume of scientific publications and the degree of knowledge fragmentation creates information overload problems and makes knowledge synthesis for solving complex social problems exceedingly difficult. Built on text mining techniques and keyword dictionaries, we develop a literature review algorithm to automate the search, comparing, and grouping of predictors of corporate performance measures from multiple stakeholders’ perspectives (customers, employees, societies, and investors).

4 - Expanding a Theoretical Model with Survey Simulations

Seyede Yasaman Amirkiaee, PhD Candidate and Teaching Fellow, University of North Texas, 1307 West Highland Street, BLB 357D, Denton, TX, 76201, United States, Nicholas Evangelopoulos

Traditional survey design involves iterations of instrument development steps that include assessments of item reliability, and construct convergent and discriminant validity. These iterations are time consuming and tend to overuse human subjects. In an effort to economize on these resources, this research uses traditional survey methods to fit a theoretical model for the intention to ride a self-driving vehicle, and then expands the model to include additional constructs by performing survey simulations that do not involve human participants.

5 - Topic Modelling for Medical Prescription Fraud and Abuse Detection

Babak Zafari, Babson College, Babson Hall 218C, Babson Park, MA, 02457, United States, Tahir Ekin

Medical prescription fraud and abuse has been a pressing issue in the U.S. resulting in large financial losses and adverse effects on human health. In this work, we use the real world Medicare Part D prescription data to analyze prescriber-drug associations. In particular, we propose the use of topic models to group drugs with respect to the billing patterns and exhibit the potential aberrant behaviors. The prescription patterns of the providers are retrieved with an emphasis on opioids, and aggregated into distance based measures which are visualized by concentration functions. This output can enable medical auditors to identify leads for audits of medical providers.

■ WD66

West Bldg 105A

Practice - Quality Management & Applications

Contributed Session

Chair: Bhupesh Shetty, University of Iowa, Iowa City, IA, 07030, United States

1 - Real-time Data-driven Monitoring for High Dimensional Multistage Manufacturing Process

Mohammadhossein Amini, PhD Candidate, Kansas State University, 2061 Rathbone Hall 1701B Platt St, Manhattan, KS, 66506, United States

Today’s manufacturing processes are much more complex including multiple stages, and sensors are embedded throughout the processes that generate a huge amount of data in high dimensions. However, current quality engineering practices still do not efficiently use the generated data. This study aims to develop predictive models using machines production data to monitor the high dimensional multistage process in real-time.

2 - Dual Response Surface Optimization of One Side Single Quality Characteristic Using the CPK Process Indicator Index

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

Dual Response Surface methodology is a powerful tool for simultaneously optimizing the mean and the variance of a quality characteristic in the field of quality engineering. The optimization of dual response systems in order to achieve better quality has played a major role in the design of industrial products and processes. In this work we derive a new method to optimize the mean and variance of a product or process defined by a single quality characteristic and has a one sided specification limit. For this aim, we suggest the usage of the process capability index as the objective function to find the optimal values of the control variables thus allowing to maximize the yield of the process.

3 - An Image Based Multivariate EWMA Control Chart with PCA for Faults Detection under Multiple Capturing Settings

Shengfeng Chen, Western Michigan University, Kalamazoo, MI, 49008, United States, Lee Wells

Machine vision systems are increasingly being used in manufacturing shop floor in product quality control. Our approach extends the current research that use only one image capturing setting for fault detection. As image quality can be affected by light intensity, color and glare, we propose multiple capturing settings for better fault detection. In addition, the use of a multivariate EWMA for monitoring industrial products in conjunction with PCA analysis are used to deal with the increased data dimensions. Extensive computer simulations show that the proposed multiple capturing settings outperform the single capturing setting with greater in-control and out-of-control ratios.

4 - Identifying Sources of Assignable Error via Process Pattern Mining

Bhupesh Shetty, PhD Student, University of Iowa, Iowa City, IA, 52245, United States, Nick Street, Jeffrey W. Ohlmann

We explore the problem of identifying the root cause of product defects using event logs in a manufacturing process. We use a pattern mining algorithm based on Apriori to identify frequent patterns, and use binary correlation measures to identify patterns associated with elevated error rate. We design a simulation model to generate synthetic datasets to test our algorithm. We compare the effectiveness of different correlation measures, target pattern complexities, and sample sizes with and without knowledge of the underlying process. We show that knowledge of the underlying process helps in identifying the pattern that is associated with defects.

■ WD68

West Bldg 105C

Joint Session QSR/Practice Curated: Data Analytics in Complex Systems: Methodology and Applications

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Changyue Song, University of Wisconsin-Madison, Madison, WI, 53715, United States

1 - A Cross-study Analysis for Reproducible Sub-classification of Mild Traumatic Brain Injury

Bing Si, Arizona State University, Mesa, AZ, 85201, United States

The current stratification of traumatic brain injury (TBI) into “mildö, “moderateö, or “severe does not adequately account for the patient heterogeneity. The objective of this study was to identify reproducible clusters of mild TBI patients based on rich data available at the time of the initial post-TBI patient evaluation. A sparse hierarchical clustering is applied to simultaneously select informative variables and identify underlying clusters with selected variables. Two independent datasets were utilized. Clusters found in one dataset are tried to be reproduced in another dataset. Reproducible clusters with different patient outcomes could be used to guide mTBI patient prognosis.

2 - Recent Advances in Calibration of Computer Models

Rui Tuo, Atlanta, GA, 30318, United States

In this talk I will show some recent advances in calibration for computer models and an application example. The goal of calibration is to identify the model parameters in deterministic computer experiments, which cannot be measured or are not available in physical experiments. In a study of the prevailing Bayesian method we find that this method may render unreasonable estimation for the calibration parameters. Inspired by a new advance in Gaussian process modeling, called orthogonal Gaussian process models, I have proposed a novel methodology for calibration. This new method is proven to enjoy nice properties.

3 - Modeling and Change Detection for Count-weighted Multi-layer Networks

Hang Dong, Tsinghua University, Beijing, 100084, China, Nan Chen, Kaibo Wang

In a typical network with a set of individuals, it is common to have multiple types of interactions between two individuals. In practice, these interactions are usually sparse and correlated, which is not sufficiently accounted for in the literature. This work proposes a multi-layer weighted stochastic block model (MZIP-SBM) to characterize the sparse and correlated interactions of individuals among different layers. A variational-EM algorithm is developed in order to estimate the parameters in this model. We further propose a monitoring statistic based on the score test of model parameters for change detection in multi-layer networks and evaluate the performance of this method.

4 - An Effective and Efficient Algorithm for Moving Targets Detection and Tracking with a Moving Camera

Yinwei Zhang, University of Arizona, Tucson, AZ, United States, Young-Jun Son, Jian Liu

Detecting and tracking moving targets with video surveillance systems is challenging, especially when using a moving camera. Conventional algorithms using projective transformation and frame differencing are inaccurate and slow. A new algorithm that combines a type of optical flow and color features is proposed to improve both detection accuracy in and tracking speed. Case studies of a variety of complex scenarios were conducted to demonstrate its effectiveness and efficiency.

■ WD69

West Bldg 106A

Joint Session QSR/Practice Curated: Blockchain Study and Application

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Hong Wan, Purdue University, West Lafayette, IN, 47907, United States

1 - A Mechanism Design Approach to Blockchain Protocols

Hong Wan, Purdue University, West Lafayette, IN, 47907, United States, Abhishek Ray, Mario Ventresca, Xinqi Gao

Blockchain-based systems such as cryptocurrencies are achieving widespread usage, with a market capitalization of $150B as of September 2017. However, the most prominent platforms that account for over 70% of this market - Bitcoin & Ethereum - are exhibiting increasingly lower levels of decentralization. This poses the problem of concentrating levers of consensus to a select group of agents in the system. Essentially, centralization in a system designed to be decentralized can lead to security threats such as 51% attack. In this paper, we demonstrate the use of game theory and mechanism design to find ways of solving the problem of centralization in blockchain systems. Since decentralization vs centralization is related to non-cooperative vs. cooperative behavior, using simple models based on non-cooperative and cooperative game theory we propose a way of designing payoffs in order to disincentivize certain exhibited behaviors and incentivize desired behaviors of miners or validators in such systems.

3 - BitExTract: Interactive Visualization for Extracting Bitcoin Exchange Intelligence

Siyuan Liu, Pennsylvania State University, University Park, PA, United States

The emerging prosperity of cryptocurrencies, for example, Bitcoin, has come into the spotlight during the past few years. In this paper, we present BitExTract, an interactive visual analytics system, which, to the best of our knowledge, is the first attempt to explore the evolutionary transaction patterns of Bitcoin exchanges from two perspectives, namely, exchange versus exchange and exchange versus client. The effectiveness and usability of BitExTract are demonstrated through three case studies with novel insights and further interviews with domain experts and senior Bitcoin practitioners.

■ WD70

West Bldg 106B

Practice - Computer Science – Applications to OR

Contributed Session

Chair: Hiroko Okajima, Towson University, 8000 York Road, Towson, MD, 21252-0001, United States

1 - On the Consistency and Computation of Maximum Likelihood Estimators for Multivariate Hawkes Processes

Anran Hu, PhD Student, UC Berkeley, Albany, CA, 94706, United States, Xin Guo, Renyuan Xu, Junzi Zhang

We establish the first consistency result for the maximum likelihood estimators (MLEs) of multivariate Hawkes processes (MHPs) with general linear intensity processes, under mild and verifiable conditions. We also develop an alternating minimization type algorithm with guaranteed global convergence to the set of critical/stationary points. The performance of the proposed algorithm on both synthetic and real-world data is reported, showing the advantage of our approach.

2 - Balance Optimization Subset Selection with Multiple Treatment Levels

Hee Youn Kwon, Northwestern University, 2211 Campus Drive, Evanston, IL, 60208, United States, Jason J. Sauppe, Sheldon H. Jacobson

Matching and Balance Optimization Subset Selection (BOSS) are two frameworks for causal inference with observational data. These methods find an estimate for the treatment effect either by matching each treatment unit to a control unit or by finding a control group that is balanced with respect to the treatment group. However, when there are multiple - more than two - treatment levels, methods of comparing two levels are not directly applicable. The goal of this talk is to generalize the BOSS framework which was developed under a binary treatment setting to a multi-treatment setting. The BOSS estimator is computationally compared to the matching estimators.

3 - A Balancing Block Based Formulation for the Police Districting

Problem: The Case of Antofagasta Police Department
Evelyn Arrey, Universidad Catolica del Norte, Avenida Angamos 0610, Building Y1, Antofagasta, Chile, Hernan Caceres

Preventive security is one of the most critical social priorities of a community, for which a typical strategy is to design patrol areas. Such designs consist on dividing a city according to one or several features of its neighborhoods, that are area-based indicators in most cases. In this work, we propose a mixed integer program that splits an urban area by balancing a cumulative block-based indicator among a given number of sub-divisions. For our numerical example, we present a case study of the Police Department of Antofagasta, Chile. We compare our results with the division that the city currently uses, that is based on the nation-wide program Quadrant Plan.

4 - Can Group Giving Boost Contribution?
Hiroko Okajima, Assistant Professor, Towson University, 8000 York Road, Towson, MD, 21252-0001, United States

Group giving (collective giving) has been gaining popularity in practice, but little has been studied in literature. This study supplements the existing literature by providing empirical results on group giving. Our laboratory experiment reveals that group giving is especially effective in increasing giving rates when it is used in combination with stepwise rebates.

■ WD72

West Bldg 211A

Practice- Operations/ Marketing Interface

Contributed Session

Chair: Jinpeng Xu, Xidian University, School of Economics and Management, Xi'an, 710126, China

1 - Supply Network Effects on the Scalability of Online Grocery Retail Platforms
Lina Wang, Student, Arizona State University, Tempe, AZ, 85257, United States, Timothy Richards, Elliot Rabinovich

A grocery retail platform acts as a two-sided market connecting consumers and suppliers. Its scalability depends on the type and the number of vendors participating in the platform. We study empirically indirect network effects on scalability in one of these platforms. Whether these effects are positive will depend on the impact that the number and types of vendors participating in the platform have on consumers' demand. Results obtained from a consumer demand model and a supply provision equilibrium model confirm the existence of a positive indirect network effect on the scalability of these platforms.

2 - Keep the Buzz and Binge on Optimal Content Release Strategies
Clint Ho, Imperial College Business School, London, SW2 7AZ, United Kingdom, Esma Koca, Wolfram Wiesemann

Video-on-demand platforms unveiled a game-changing media consumption phenomenon, binge-watching, with the release of all episodes of series at once (entire season at once policy) and hence generate a binge-watching driven buzz among viewers. As opposed to this, traditional strategy (episodic release strategy) creates a viewer-generated chatter around the story, commonly called as the water-cooler effect. We argue that a hybrid and a personalized strategy may activate both levers and investigate three aspects of the optimal content release: (1) optimal release of a series, (2) optimal order of multiple series, and (3) discrimination on the content across heterogeneous viewers.

3 - Entry of Pseudo Sharing
Siyi Wang, University of Science & Technology of China, Hefei, China

Pseudo sharing—-the phenomenon of professional agents participating in the sharing market—-has caused a huge uproar among the affected traditional markets and governments. It exists in different sharing platforms that involved in different mechanisms. We develop a game-theoretic model to exam the sharing platforms' interaction with pseudo sharers, as well as the genuine one. Our equilibrium results suggest that, to some extent at least, it enhances the matching rate when the clutter of genuine sharing supply and demand caused most occasional transaction failed.

4 - When Should Retailers Integrate Online and Offline Channels Under Competition?
Jinpeng Xu, Xidian University, School of Economics and Management, Xi'an, 710126, China, Yufei Huang

This paper considers two multichannel retailers selling a product to consumers with different channel preferences. Retailers can choose to operate their online and offline channels separately, with different prices and unit costs in different channels. They can also choose to integrate the two channels, thereby achieving the same price and unit cost in different channels. We use a game-theoretical model to study when one or two retailers should integrate their channels in competition.

5 - Product Quality Decision and Return Channel Choice with Uncertain Demand
Buqing Ma, Doctor Student, University of Science and Technology of China, Baohe District, hefei, Anhui province, China, Hefei, 230035, China, Yunchuan Liu

The practice of accepting product returns from consumers directly is understudied in previous literature where consumers return products to manufacturers through retailers. In this paper, we study a manufacturer's return channel choice and product quality decision with demand uncertainty, and find some interesting relationship between product qualities, return channel choice, and demand uncertainty.

■ WD77

West Bldg 213A

Practice- Modeling for Complex Systems I

Contributed Session

Chair: George C. Mytalas, CUNY, New York, NY, 11209, United States

1 - Building Total Cost of Ownership Model for Power Battery Consumer
Chunyan Duan, Tongji University, Room 1114, Tongji Building A, Siping Road 1500, Shanghai, 200092, China
Chunyan Duan, University of Arkansas, Fayetteville, AR, 72701, United States, Jianxin You, Hu-Chen Liu, Luning Shao, Mengmeng Shan

Power battery's economic performance is the main influence on the economic performance of the electric vehicle. We are modeling power battery consumer's total cost ownership by applying the mathematical modeling method, and exploring the factors of the power battery consumer's total cost ownership and its relationship between these factors under the fast charging mode and the slow charging mode.

2 - Continuous-time Principal-agent Model in Regulating Disruptive Technology
Qi Luo, University of Michigan-Ann Arbor, Ann Arbor, MI, 48109, United States, Romesh Saigal, Zhibin Chen

Innovative technologies can achieve a faster penetration and therefore disrupt an existing market. For example, self-driving technology may have massive impact on the transportation network, and consequently the government needs to regulate the market by financial subsidies. We study the decentralized decision-making problem as a principal-agent model in continuous time. The market dynamics is described by the diffusion of innovation and the problem can be converted to solving a Hamilton-Jacobi-Bellman (HJB) equation. Similar applications include the regulations of new drugs, electric vehicles and wireless networks.

3 - Dynamic Tracking of Software Errors: A Big Data Approach
John G. Wilson, Professor, Ivey Business School, 1255 Western Road, London, ON, N6G ON1, Canada, Dov Te'eni

In the internet age, a proliferation of services appear on the web. Errors in using the internet service or app are dynamically introduced as new devices/interfaces/software are produced. The number of users who can detect various errors changes dynamically. Allowing new users and errors to enter dynamically poses considerable modeling and estimation difficulties. In the era of Big Data, methods for dynamically updating as new observations arise are important. We provide a general model that allows for a procedure for finding maximum likelihood estimators of key parameters where the number of errors and the number of users can change.

4 - Aggregate Production Planning in Stochastic Manufacturing Systems: A Simulation Study
Gerd J. Hahn, Professor, German Graduate School of Management and Law, Bildungscampus 2, Heilbronn, 74076, Germany

This paper studies the issue of integrated capacity and batch planning in stochastic manufacturing systems. Classical mathematical programming-based approaches to production planning typcially omit the impact of variability on the performance of manufacturing systems. Therefore, a hierarchical planning approach is presented that integrates a queuing network model to anticipate the stochastic behavior of the manufacturing system. A simulation study is conducted to show the benefit of this approach using a real-life case example.

5 - A Queueing System with Disaster Events under Different Policies
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We consider an M/G/1 queueing system with batch arrivals subject to disasters and server breakdowns under N-policy. The server is turned off as soon as the system empties. When the queue length reaches or exceeds a value N (threshold), the server is turned on and begins to serve the customers. When a disaster occurs the system is cleared of all customers and the server initiates a repair period. During the repair period arriving batches of customers accumulate in the queue without receiving service. Besides, the server has an exponential lifetime in addition to the catastrophe process.