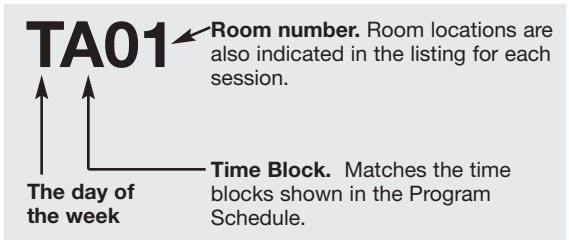
How to Navigate the Technical Sessions

There are four primary resources to help you understand and navigate the Technical Sessions:

- This Technical Session listing, which provides the most detailed information. The listing is presented chronologically by day/time, showing each session and the papers/abstracts/authors within each session.
- The Author and Session indices provide cross-reference assistance (pages 78-84).
- The floor plan on page 7 shows you where technical session tracks are located).
- The Master Track Schedule is on pages 88 and back cover

Quickest Way to Find Your Own Session

Use the Author Index (page 80) — the session code for your presentation will be shown along with the room location. You can also refer to the full session listing for the room location of your session.



Time Blocks

Sunday

C — 1:30pm - 3:00pm
D — 3:30pm - 5:00pm

Monday

A — 9:00am - 10-30am
B — 11:00am - 12:00pm
C — 1:30pm - 3:00pm
D — 3:30pm - 5:00pm

Tuesday

A — 9:00am - 10-:30am
B — 11:00am - 12:00pm
C — 1:30pm - 3:00pm
D — 3:30pm - 5:00pm

Wednesday

A — 9:00am - 10-:30am
B — 11:00am - 12:30pm
C — 1:30pm - 3:00pm

Sunday, 1:30pm - 3:00pm

■ SC01

01-Level 4, Salon 8

NSERC Discovery Grant Program Workshop

Cluster: Sunday Workshop- NSERC Discovery Grant Program
Invited Session

Chair: Mme Benoit,

1 - NSERC Discovery Grant Program Workshop
Mme Benoit

NSERC Staff and Bernard Gendron, Section Chair of the Civil, Systems and Industrial Engineering Evaluation Group, will make a presentation to familiarize researchers with the peer review process and the way the Evaluation Groups function. Advice will be given on how to prepare a Discovery Grant application. While the workshop will be most helpful to new faculty members and those preparing applications this fall, all researchers are welcome to attend. The workshop will cover topics such as Discovery Grants Evaluation Groups, criteria for evaluation and ratings, tips on how to prepare an application. A question period will follow the presentation.

■ SC02

02-Level 3, Drummond West

Dynamic Problems in Healthcare I

Cluster: Healthcare
Invited Session

Chair: Antoine Legrain, Polytechnique Montreal, 2500, Chemin de Polytechnique, Montreal, Canada, antoine.legrain@polymtl.ca

1 - Determining the Optimal Vaccine Administration Policies with Multi-Dose Vials
Gizem Sultan Nemutlu, PhD Student, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, gsnemutl@uwaterloo.ca, Osman Yalin Ozaltin, Fatih Safa Erenay

As the multi-dose vials are used in vaccination practices, health facilities have to consider the open shelf life of the vials for efficient administration of available vaccine inventory with minimal waste. Availability of different vial sizes can reduce the open vial waste. We provide a finite-horizon Markov decision process (MDP) model to determine which of the available vial sizes should be opened when to maximize the demand coverage. We also present structural properties of the MDP model.

2 - Integrative Robust Bed Capacity Planning and Nurse Staffing
Dominic Breuer, PhD Student, Healthcare Systems Engineering Institute, Northeastern University, 360 Huntington Ave., Boston, MA, 02115, United States of America, dbreuer@coe.neu.edu
Shashank Kapadia, Nadia Lahrichi, James Benneyan

Determining bed capacity and nurse staffing levels is a difficult task under uncertainty because of the trade-off between accepting new patients, reducing transfers, referrals, and operating costs. Our approach takes into account variability of arrivals and length of stay data as uncertainty sets, and considers desired patient-nurse ratio, service level, and occupancy through a robust optimization model. The price of robustness is found to adjust capacity efficiently and incrementally.

3 - Optimal Distribution of Influenza Vaccine
Ozden Dalgic, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, oodalgic@uwaterloo.ca
Fatih Safa Erenay, Osman Yalin Ozaltin

Vaccination is the most effective intervention method against influenza. In an influenza pandemic, individuals are vaccinated by considering risk profiles. We use a network-based stochastic simulation model and a Mesh Adaptive Direct Search algorithm to find the most effective age-specific vaccine distribution policy under various performance measures. Our computational experiments show that our proposed policies outperform alternative policies and methods recommended in literature.

■ SC03

03-Level 3, Drummond Centre

Forest Value Chain Management

Cluster: Applications of OR in Forestry

Invited Session

Chair: Catalin Ristea, Research Leader, FPInnovations, 2665 East Mall, Vancouver, Canada, catalin.ristea@fpinnovations.ca

1 - An Interactive (Man/Machine) Optimization System for Tactical Supply Chain Planning

Francois Chéné, Université Laval - Forac, 1045 avenue de la Médecine, Québec, Canada, francois.chene.1@ulaval.ca
Claude-Guy Quimper, Jonathan Gaudreault

In this presentation, we discuss the interest of involving human decision makers in the optimization process of tactical supply chain planning. We talk about mixed-initiative systems and propose their application to tactical planning. We discuss mathematical properties that allow such system to perform in real-time. We also propose avenues to increase the value of the human agent participation in the planning process.

2 - Strategic Decision Tool for Innovative Forest Products Manufacturer Based on Life Cycle Assessment

Achille-B. Laurent, Student, Université Laval, 3514, Pavillon Adrien-Pouliot, 1065, av. de la Médecine, Quebec, QC, G1V 0A6, Canada, achille-benjamin.laurent.1@ulaval.ca

In some sectors, the ability to make a competitive offer at lower environmental impacts can allow the company to significantly increase its market share. The objective of this project is to develop a model to assist the strategic decision of the logistics network of a logging company. The multi-criteria optimization model proposed to merge environmental life cycle assessment and activity based costing analysis of all the family of products of an innovative forest products manufacturing unit.

3 - Decision Making Framework for Tactical Planning Taking into Account Lumber Market Opportunities

Jean Wéry, FORAC / Université Laval, 1065, av. de la Médecine, Québec, G1V 0A6, Canada, jean-francois.wery.1@ulaval.ca
André Thomas, Jonathan Gaudreault, Philippe Marier

Using specialized simulation tool for the lumber manufacturing process, it is possible to determine the impact of sawmill suppliers and parameter modifications on the mix of products. This gives new information which can be used within a tactical planning model to evaluate the profitability of integrating new products and new suppliers to the existing product mix. We present a decision making framework which makes use of these two elements to identify the best production strategy.

4 - A Discrete Event Simulation Model for Log Sort Yard Operation Management

Nazanin Shabani, Research scientist, FPInnovations, 2665 East Mall, Vancouver, BC, V6T 1Z4, Canada, Nazanin.Shabani@fpinnovations.ca, Brian Jung, Catalin Ristea

Log sort yards are a critical component being used for grading, sorting and consolidating logs into bundles and then placing them onto bunks. The complexity of their process increases as the number of different log sorts increase. FPInnovations developed a simulation model of a BC Coastal log sort yard to evaluate different yard layout options, number and types of bunks, number of sorts, etc. The results of machine travel, work-in-progress, and bottlenecks are provided in this presentation.

■ SC04

04-Level 3, Drummond East

Applications in Data Mining

Cluster: Contributed Sessions

Invited Session

Chair: Wheyming Song, Professor, Tsing Hua University, Department of Industrial Engineering, 101, Kung Fu Road, Hsinchu, Taiwan - ROC, wheyming_song@yahoo.com

1 - Data Analysis on Vascular Sounds

Wheyming Song, Professor, Tsing Hua University, Department of Industrial Engineering, 101, Kung Fu Road, Hsinchu, Taiwan - ROC, wheyming_song@yahoo.com, Moon Chiang

This research focuses on analyzing vascular sounds to increasing the sensitivity and specificity of the dialysis treatment for a specified device. The proposed approach is based on a series of scientific procedures, including using design of analysis to collect data systematically and applying independent component analysis to remove the noise of vascular sounds.

■ SC05

05-Level 2, Salon 1

Transportation - Freight

Cluster: Contributed Sessions

Invited Session

Chair: Ted Gifford, DMTS, Schneider National Inc, 3101 S Packerland Dr, Green Bay, Wi, 54313, United States of America, giffordt@schneider.com

1 - A Set-Covering Model for a Bidirectional Multi-Shift Full Truckload Vehicle Routing Problem

Ruibin Bai, PhD, University of Nottingham Ningbo, 199 Taikang East Road, Ningbo, China, ruibin.bai@nottingham.edu.cn
Ning Xue

This presentation introduces a multi-shift bidirectional full truckload transportation problem. The problem is different from the previous container transport problems and the existing approaches are either not suitable or inefficient. A set covering model is developed for the problem based on a novel route representation. It was shown that the model can be used to solve real-life, medium sized instances of the container transport problem at a large sea port.

2 - An Exact Algorithm for the Modular Hub Location Problem

Moayad Tanash, Concordia University, 1455 De Maisonneuve Blvd. W., Montréal, Qc, H3G 1M8, Canada, tanash25@yahoo.com
Ivan Contreras, Navneet Vidhyarthi

In this talk we present the modular hub location problem that explicitly models the flow dependency of the transportation cost on all arcs of the hub network. We present a branch-and-bound algorithm, which uses a Lagrangean relaxation algorithm to obtain lower bounds at every node of the enumeration tree. Computational results are reported.

3 - Using Analytics to Improve Optimization Modeling and Business Performance

Ted Gifford, DMTS, Schneider National Inc, 3101 S. Packerland Dr, Green Bay, Wi, 54313, United States of America, giffordt@schneider.com

Efficient, effective solutions for large-scale transportation routing problems require intuition and judgment in the modeling as well as applying solutions in operational business settings. We describe the use of data mining to analyze solution characteristics and sequential solution deltas as inputs change data with real-time updates to an dray network operations. We then show how this analysis provides insight for model adjustments and business policy modifications.

■ SC06

06-Level 2, Salon 2

Manufacturing Applications of Simulation

Sponsor: Simulation

Sponsored Session

Chair: Scott Bury, Principal Research Scientist, The Dow Chemical Company, 1173 W Maynard Rd, Sanford, MI, 48657, United States of America, SJBury@dow.com

1 - Minimizing Blocking Failures for Inventory Constrained Batch Operations

LATE CANCELLATION

Scott Bury, Principal Research Scientist, The Dow Chemical Company, 1173 W Maynard Rd, Sanford, MI, 48657, United States of America, SJBury@dow.com

Batch processes rarely have catch-up capacity. Blocking or starving a batch process means production lost forever to the sands of time. In an integrated system, failures from blocking propagate back upstream and disrupt the overall system throughput. This paper will present a data-driven simulation to minimize the risk of blocking failures.

2 - Quantitative Production Start-up Schedule Development
Bryan Syndor, Chief Production Engineer, The Boeing Company, 1130 E. Appleton St., Long Beach, CA, 90802, United States of America, tallbryan@me.com

In development of a new product-line, methods for developing quantitative estimates for the early deliveries is often a function of using correlation to similar activities using subject matter experts and tribal knowledge. The presentation outlines a method for developing quantitative estimates for delivery of the early production units using a combination of Material Machine Man Method standards development, resource based Discrete Event Simulation and traditional Schedule Management tools.

3 - Inventory Management in Production Networks under Uncertainty
Pablo Garcia-Herreros, Carnegie Mellon University, 5000 Forbes Ave., Pittsburgh, PA, 15213, United States of America, pgarciah@andrew.cmu.edu, Anshul Agarwal, John M. Wassick, Ignacio E. Grossmann

We address the inventory management in production networks under uncertainty by solving a stochastic programming problem in a receding horizon. The formulation includes policies for network operation and inventory management that are modeled using disjunctions. The solution of the problem yields the optimal parameters of the policies (e.g. utilization priorities, base-stock levels). The proposed inventory management strategy is implemented in a set of simulations to estimate its performance.

4 - Simulating the Market Introduction of a Smart Product: An Agent-Based Approach
Christian Stummer, Prof., Bielefeld University, Universitaetsstr. 25, Bielefeld, 33615, Germany, christian.stummer@uni-bielefeld.de Lars Lüpke, Sabrina Backs, Markus Günther

When introducing radical innovations into market, managers typically can only resort to limited experiences with comparable products or services. Still, they have to make decisions with far-reaching economic consequences. An agent-based market simulation may provide valuable decision support in this regard. In our talk, we will outline such an approach and discuss some initial results from an application example taken from the German Leading-Edge Cluster "it's OWL".

■ SC07

07-Level 2, Salon 3

Marketing Interface

Cluster: Contributed Sessions

Invited Session

Chair: Yeming Gong, Dr., EMLYON, 23 Avenue Guy de Collongue, Ecully, France, gong@em-lyon.com

1 - The Advantage of Price Bundling when Demand is Unknown
Amit Eynan, Professor, University of Richmond, 1 Gateway Dr, Richmond, VA, 23173, United States of America, aeynan@richmond.edu, Eitan Gerstner

Price bundling is a known marketing technique to boost profit through second degree discrimination. By offering two (or more) products at a price lower than their sum sellers can extract more surplus from customers. We show that when demand is uncertain price bundling can also increase profit by drastically reducing inventory risks. Thus, sellers of rapidly value declining products can profit from offering bundles early in the season instead of waiting for end-of-season to clear unpopular items.

2 - Market Deployment Planinning
Salman Kimiagari, PhD Student, Laval University, Business School(FSA), G1V0A6, Quebec, Canada, s_kimiagari@yahoo.com Benoit Montreuil

In fast-paced global economy, entrepreneurs progressively tend to design their business ventures during the early stages of business formation. This tendency highlights the need for an efficient and systematic approach for market deployment planning due to the dynamic and complexity nature of market planning and global strategic positioning. We present a novel line in order to develop a market deployment roadmap. The proposed approach uses SOM and an optimization model for market deployment.

3 - Dynamic Lot Sizing and Pricing Models for New Products
Yeming Gong, Dr., EMLYON, 23 Avenue Guy de Collongue, Ecully, France, gong@em-lyon.com, Xiang Wu

After introducing new products, demand dynamics caused by new product diffusion will challenge inventory replenishment decisions. We integrate the dynamic lot sizing models with the discrete Bass models to provide optimal decisions for inventory replenishment problems. We study the joint influence of product diffusion parameters and pricing parameters on dynamic lot sizing decisions, and provide new insights in pricing strategic choice when coordinating with inventory replenishment.

■ SC08

08-Level A, Hémon

Applications of DFO at Hydro-Québec

Cluster: Derivative-Free Optimization

Invited Session

Chair: Sébastien Le Digabel, Associate Professor, École Polytechnique de Montréal, C.P. 6079, Succ. Centre-ville, Montréal, QC, H3C 3A7, Canada, sebastien.le-digabel@polymtl.ca

1 - Simulation-Based Optimization of the Control Strategy for Isolated Power Grids via Blackbox Software
Nicolas Barris, École Polytechnique de Montréal, C.P. 6079, succ. Centre-ville, Montréal, Qc, H3C 3A7, Canada, nicolas.barris@polymtl.ca, Stéphane Alarie, Miguel F. Anjos

Hydro-Québec must provide electric power to every region of Québec. For remote areas, the electricity is produced locally. The generation depends on rules based on fixed levels of the use rates of diesel generators. The objective of the presented work is to determine optimal levels that minimize diesel consumption, operational costs and GHG emissions using simulation-based blackbox optimization methods.

2 - Massive Distribution of Black Box Calculation for Model Calibration
Louis-Alexandre Leclaire, IREQ, 1800, Boul. Lionel-Boulet, Varennes, Qc, J3X 1S1, Canada, Leclaire.LouisAlexandre@ireq.ca

We present a flexible framework to determine the best parameters set when calibrating models. Distributed version of black box optimization tools were tuned for IREQ's supercomputer. Migration efforts toward an on-demand virtual cluster running in a public cloud will be described. We share our attempts to define new optimization strategies to exploit hundreds of cores. Real cases in Building Energy Modeling and Hydrology will introduce benchmarks of parallel variants of the MADS algorithm.

3 - Global Optimization with NOMAD for the Simultaneous Tuning of Several Power System Stabilizers
Stéphane Alarie, Institut de Recherche d'Hydro-Québec, 1800 boul. Lionel Boulet, Varennes, Canada, alarie.stephane@ireq.ca Nadir Amaioua, Charles Cyr

Power system stability can be compromised by disturbances (short-circuits, generation loss, etc.). Power system stabilizers are used to enhance the damping of the power oscillations occurring after disturbances but must not be detrimental to other machines on the same power system. In practice, they are generally tuned one at a time. Since it limits the overall performance, we propose to do a simultaneous optimization of tuning considering several stabilizers.

■ SC09

09-Level A, Jarry

Stochastic Models in Aviation

Sponsor: Aviation Applications

Sponsored Session

Chair: Heng Chen, Isenberg School of Management, University of Massachusetts Amherst, 121 Presidents Drive, Amherst, MA, 01003, United States of America, heng@som.umass.edu

1 - Two-Stage DEA for Runway Performance Evaluation
Yu Zhang, Assistant Professor, University of South Florida, Tampa, 4202 E. Fowler Ave, Tampa, FL, 33620, United States of America, yuzhang@usf.edu, Dipasis Bhadra, Yuan Wang

Upon reviewing the airport capacity analytics spanning over the last three decades, this paper lays out a simple methodology, called Data Envelopment Analysis (or DEA), that may be adopted by airport planners and aviation analysts alike. Using this methodology, the paper demonstrates the calculation of efficiency index for arrivals and departures at two of the busiest runways at JFK and compares them against a relevant metric reported by the FAA.

2 - Optimal Gate and Metering Area Allocation Policies under Departure Metering Concept
Heng Chen, Isenberg School of Management, University of Massachusetts Amherst, 121 Presidents Drive, Amherst, MA, 01003, United States of America, heng@som.umass.edu, Senay Solak

Departure metering is an airport surface management procedure which shortens the departure queue by holding excess aircraft at current gates or at a predesigned metering area. In this paper, we propose a stochastic dynamic programming framework to identify the optimal gate, metering area and departure queue allocation policies to minimize expected overall costs. We also provide specific policies given different airport configurations.

3 - Combining Control by CTA and Dynamic Enroute Speed Control to Improve GDP Performance

James Jones, University of Maryland, 3117 A.V Williams, College Park, MD, 20742, United States of America, jonesjc1@umd.edu
David Lovell, Michael Ball

In recent years there has been much discussion regarding a move from the use of a controlled times of departure (CTDs) to a controlled times of arrival (CTAs) for ground delay programs (GDPs). In this talk we show that, by combining control by CTA with en route speed control, significant improvements to GDP performance can be achieved. Our analysis introduces both new GDP control procedures and stochastic integer programming models to support flight operator GDP planning.

■ SC10

10-Level A, Joyce

Data-Driven Robust Optimization

Cluster: Stochastic Optimization

Invited Session

Chair: Jonathan Yumeng Li, Telfer School of Management, University of Ottawa, Ottawa, Canada, Jonathan.Li@telfer.uottawa.ca

1 - Two Perspectives on Robust Empirical Optimization

Michael Kim, University of Toronto, 5 King's College Road, Toronto, Canada, kimmi@mie.utoronto.ca, Andrew Lim, Jun-ya Gotoh

We consider a robust formulation for empirical optimization. Our main finding is that robust empirical optimization is essentially equivalent to two different problems - an empirical mean-variance problem and the problem of maximizing a (probabilistic) lower bound on out-of-sample performance.

2 - Robust Regression with Application to Index Tracking

Jonathan Yumeng Li, Telfer School of Management, University of Ottawa, Ottawa, Canada, Jonathan.Li@telfer.uottawa.ca

In this work, we present new robust forms of regression models that have intuitive appeal to users who intend to better utilize the data in hand. We demonstrate the value of the new models in the context of financial index tracking, and show how they can outperform existing models based on classical robust optimization.

3 - Ambulance Emergency Response Optimization in Dhaka, Bangladesh

Justin Boutilier, University of Toronto, 5 King's College Road, Toronto, Canada, j.boutilier@mail.utoronto.ca, Timothy Chan, Moinul Hossain

Dhaka, the capital city of Bangladesh and the tenth largest city in the world, does not currently have a centralized emergency medical service (EMS) system or 9-1-1 type number. As a result, patients experience restricted access to healthcare. To address this problem, we have developed a novel data-driven robust location-routing model that can be applied to Dhaka and other developing urban centers. The model uses traffic data collected via GPS to construct an uncertainty set for travel times.

4 - Data-Driven Risk-Averse Two-Stage Stochastic Program with zeta Structure Probability Metrics

Chaoyue Zhao, Oklahoma State University, 322G Engineering North, Stillwater, OK, United States of America, chaoyue.zhao@okstate.edu

In this talk, we develop a data-driven stochastic optimization approach to provide a risk-averse decision making under uncertainty. In our approach, starting from a given set of historical data, we solve the developed two-stage risk-averse stochastic program, for discrete and continuous distribution cases. We prove the risk-averse problem converges to the risk-neutral one exponentially fast as more data samples are observed.

■ SC11

11-Level A, Kafka

COMEX: Combinatorial Optimization: Metaheuristics and EXact Methods I

Cluster: Network Design

Invited Session

Chair: Bernard Fortz, Prof., Université Libre de Bruxelles, GOM CP212, Bld du Triomphe, Brussels, 1050, Belgium, bernard.fortz@ulb.ac.be

1 - Distributed Monitoring Problem

Dimitri Papadimitriou, Alcatel-Lucent, Copernicuslaan 50, Antwerp, 2018, Belgium,
dimitri.papadimitriou@alcatel-lucent.com, Bernard Fortz

The objective consists in minimizing the total monitoring cost for the placement and configuration of a set of passive monitoring devices to realize a joint monitoring task of time-varying traffic flows. The formulation can also be dualized to determine the utility gain obtained when varying the budget constraint on the total monitoring cost. Simulation results show that as the size of the instances increases, the time efficiency and solution quality as produced by existing solvers decreases.

2 - Optimal Design of Switched Ethernet Networks Implementing the Multiple Spanning Tree Protocol

Martim Moniz, Université Libre de Bruxelles, GOM CP212, Bld du Triomphe, Brussels, 1050, Belgium, martim.moniz@ulb.ac.be
Bernard Fortz, Luis Gouveia

We propose different MIP formulations to the problem of finding optimal designs for switched Ethernet networks implementing the Multiple Spanning Tree Protocol. This problem consists in designing networks with multiple VLANs, such that each one is defined by a spanning tree that meets the required traffic demand. Additionally, all the VLANs must jointly, verify the bandwidth capacity of the network. Meanwhile, the worst-case link utilization (ratio between link's load and capacity) is minimized.

3 - Decomposition-Based Branch-and-Bound with Lower Bound Propagation for the Traveling Umpire Problem

Túlio A.M. Toffolo, KU Leuven, Gebroeders de Smetstraat, 1, Gent, 9000, Belgium, tulio.toffolo@kuleuven.be
Sam Van Malderen, Greet Vanden Berghe, Tony Wauters

The Traveling Umpire Problem (TUP) is an optimization problem in which umpires have to be assigned to games in a tournament, while respecting hard constraints. The objective is to minimize the total travel distance over all umpires. We present a branch-and-bound approach in which an iterative round-based decomposition scheme is applied for generating strong lower bounds. The algorithm is able to generate optimal solutions for all instances with 14 teams in very short runtime.

4 - Theoretical And Computational Comparisons of Formulations for Stackelberg Bimatrix Games

Martine Labbé, Département d'Informatique, Université Libre de Bruxelles, Boulevard du Triomphe, B-1050, Brussels, Belgium, mlabbe@ulb.ac.be, Fernando Ordonez,
Carlos Casorran - Amilburu, Bernard Fortz

Stackelberg Games confront contenders, a leader and a follower, with opposed objectives, each wanting to optimize their rewards. The objective of the game is for the leader to commit to a reward-maximizing strategy anticipating that the follower will best respond. A Stackelberg game can be modeled as a bilevel bilinear optimization problem. We present different single level reformulations and compare their LP relaxations from both theoretical and computational points of view.

■ SC12

12-Level A, Lamartine

Combinatorial Optimization in Constraint Programming

Cluster: Constraint Programming

Invited Session

Chair: David Bergman, Assistant Professor, University of Connecticut, 1 University Place, Stamford, CT, 06901, United States of America, david.bergman@business.uconn.edu

1 - Lagrangian Relaxation Based on Decision Diagrams
Andre Cire, University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C-1A4, Canada, acire@utsc.utoronto.ca
David Bergman, Willem-Jan van Hoeve

A new research stream in optimization considers the use of multivalued decision diagrams (MDDs) to encode discrete relaxations of combinatorial problems. In this talk we discuss how to strengthen an MDD relaxation by incorporating dual information in the form of Lagrangian multipliers into its cost structure. Computational experiments show that the strengthening techniques can improve solving times substantially.

2 - Learning to Backtrack to Solve Combinatorial Optimization Problems
Ilyess Bachiri, Université Laval, 2255, rue de l'Université, Université Laval, Québec, QC, G1V0A7, Canada, ilyess.bachiri.1@ulaval.ca
Jonathan Gaudreault, Brahim Chaib-draa, Claude-Guy Quimper

Combinatorial optimization problems are often hard to solve and the search strategy applied has a great influence over the solver's performance. We introduce an algorithm (RLBS) that learns to efficiently backtrack when searching non-binary trees. RLBS applies reinforcement learning to learn which areas of the search space contain good solutions. RLBS is evaluated for a scheduling problem. It outperforms non-adaptive search strategies (DFS, LDS) as well as an adaptive branching strategy (IBS).

3 - Solving Binary Quadratic Programming Problems with Binary Decision Diagrams
David Bergman, Assistant Professor, University of Connecticut, 1 University Place, Stamford, CT, 06901, United States of America, david.bergman@business.uconn.edu, Andre Cire

Binary decision diagrams (BDDs) have recently been proposed as a mechanism for solving discrete optimization problems. This talk discusses an extension of this work to the binary quadratic programming problem. A set of instances is described for which the BDD technique outperforms existing state-of-the-art techniques.

4 - Combining CP and Discrete Ellipsoid-Based Search to Solve the Exact Quadratic Knapsack Problem
Wen-Yang Ku, University of Toronto, 5 King's College Rd., Toronto, ON, M5S3G8, Canada, wku@mie.utoronto.ca
Chris Beck

We propose an extension to the discrete ellipsoid-based search (DEBS) to solve the exact quadratic knapsack problem (EQKP), an important class of optimization problem with a number of practical applications. For the first time, our extension enables DEBS to solve convex quadratically constrained problems with linear constraints. We show that adding linear constraint propagation to DEBS results in an algorithm that is able to outperform both CPLEX and the semi-definite programming solver.

■ SC13

13-Level A, Musset

Pricing and Revenue Management

Cluster: Contributed Sessions

Invited Session

Chair: Sajjad Najafi, PhD candidate, University of Toronto, 5 King's College Road, RS206, Toronto, ON, M5S3G8, Canada, snajafi@mie.utoronto.ca

1 - Pricing Game with Customer Choice Based on the Price-Performance Ratio
Yangyang Xie, Mr., City University of Hong Kong, Rm 5106, AC 2, CityU, Hong Kong, Hong Kong - PRC, jieyy11@mails.tsinghua.edu.cn, Lei Xie, Meng Lu, Houmin Yan

We propose a customer choice criterion based on the price-performance ratio of products. The choice model is a variation of McFadden's random utility model. We derive the customer choice probability among n products as well as the unique close-form equilibrium for n retailers' pricing game. We investigate how pricing, market share and revenue change between static and dynamic games, decentralized and centralized models. We consider the scenario when a new product enters the market as well.

2 - Venture Capital Syndicate Network and Technology Innovation: An Analysis Based on Strength of Ties
Heyin Hou, Associate Professor, School of Economics and Management, Southeast University, Jiangning District, Nanjing, Jiangsu, 211189, China, heyinhou@hotmail.com, Yunbo Wang

Venture Capital Syndicate Network is a typical social network, derived from the syndicate investment in the venture capital industry, an engine of technology innovation. Through constructing and solving an asymmetric-information dynamic game model, embedded the technology innovation parameter, our paper gets venture capitalists' optimal efforts and knowledge transfer, and the optimal strength of ties. Then, we analyze how the strength of ties influence the technology innovation in the network.

3 - Joint Dynamic Pricing of Multiple Substitutable Products in the Presence of Sales Volume Milestones
Sajjad Najafi, PhD candidate, University of Toronto, 5 King's College Road, RS206, Toronto, ON, M5S3G8, Canada, snajafi@mie.utoronto.ca, Chi-Guhn Lee

We study a dynamic pricing problem of a seller who sells limited inventories of multiple substitutable products, and is subject to a set of sales constraints that should be met at different time points over a finite horizon. The seller can make a trade-off between the risk and the revenue by changing the milestone constraints. A computationally efficient algorithm has been developed by applying the KKT conditions and implementing structural properties of the optimal policy.

4 - Supply Chain Risk: Competition And Cooperation
Tulika Chakraborty, Concordia University, 1455 de Maisonneuve, Montréal, Canada, jum.tulika@gmail.com
Satyaveer S. Chauhan, Mustapha Ouhimmou

We present a supply chain model of one retailer and two suppliers with supply disruptions. Depending on the competitive and cooperative pricing behavior we propose two decentralized models. We establish the sufficient conditions for the existence of the equilibrium solutions under uniform demand distribution. Finally we propose coordination mechanisms.

■ SC14

14-Level B, Salon A

Electrical Markets

Cluster: Contributed Sessions

Invited Session

Chair: David Fuller, Professor, University of Waterloo, Management Sciences, Waterloo, Canada, dfuller@uwaterloo.ca

1 - Security of Supply in Electricity Markets: A Framework
Sebastian Osorio, HEC, Université de Lausanne, Batiment Anthropole, Lausanne-Dorigny, Switzerland, sebastian.osorio@unil.ch, Ann van Ackere, Erik R. Larsen

The Security of Electricity Supply (SoES) is under threat in many regions. We develop a comprehensive but flexible framework to assess the SoES of a region, with two aims: (i) provide a snapshot of the situation to understand current weaknesses and determine what actions are required; (ii) capture the evolution over time to identify progress and discover new problem areas, thus providing an indicator of the effectiveness of current actions and of the need to adapt.

2 - German Electricity Generation and Storage System Development under Electricity Grid Restrictions
Tobias Heffels, KIT-IIP, Hertzstr. 16, Karlsruhe, 76187, Germany, tobias.heffels@kit.edu, Russell McKenna, Wolf Fichtner

An integrated bottom-up optimisation model of the German electricity generation and storage system performs capacity planning and unit commitment. A timely decomposition with myopic and rolling-horizon approaches enables both a long time horizon and high temporal resolution. This paper analyses the effects of varied model parameters on the solution time and robustness. A foresight of 24 hours and a combination of load change costs and part load efficiency offer the most practical compromise.

3 - How Local Electricity Markets can Help to Face Challenges in the Distribution Grid

Johannes Schäuble, Karlsruhe Institut of Technology (KIT), Hertzstr.16, Karlsruhe, 76187, Germany, johannes.schaeuble@kit.edu, Patrick Jochem, Wolf Fichtner

Increasing feed-in of electricity produced by renewables and rising demand of electric vehicles challenge today's electricity systems. Local coordination mechanisms to balance generation and demand in the distribution grid provide an opportunity to avoid grid congestion and to exploit load shifting potentials. In this paper we analyze the effects of introducing local markets by using agent based simulation and linear programming. Two case studies complement the analysis.

■ SC15

15-Level B, Salon B

Maintenance Optimization

Cluster: Special Invited

Invited Session

Chair: Sharareh Taghipour, Ryerson University, 350 Victoria Street, Toronto, Canada, sharareh@ryerson.ca

1 - An Optimal Maintenance Policy for a Two-Unit Series System using Bayesian Control Approach

Leila Jafari, University of Toronto, 5 King's College, Toronto, Canada, ljafari@mie.utoronto.ca, Viliam Makis

In this paper, we propose an optimal maintenance policy for a two-unit series system with economic dependence. We consider jointly condition-monitoring information from unit 1 and age information for unit 2. Unit 1 deterioration process is modeled as a 3-state continuous time hidden semi-Markov process. We apply the Bayesian control approach to obtain the optimal maintenance policy which is a highly novel and effective approach to maintenance control of multi-unit series systems.

2 - Optimal Condition-Based Maintenance Policy with Two Sampling Intervals

Farnoosh Naderkhani, University of Toronto, 5 King's College Road, Toronto, M5S 3G8, Canada, farnoosh@mie.utoronto.ca Viliam Makis

We propose CBM policy with two sampling intervals for a system subject to condition monitoring described by the Cox's proportional hazards model.We start monitoring the system with longer sampling interval.When the hazard rate exceeds warning limit,observations are taken more frequently.Preventive maintenance is performed when either hazard rate exceeds maintenance threshold or the system age exceeds a given limit.The optimal maintenance policy is obtained using the semi-Markov decision process.

3 - Non-Periodic Inspection Optimization of a Multi-Component System using Genetic Algorithm

Yassin Hajipour, Ryerson University, 350 Victoria Street, Toronto, ON, M5B 2K3, Canada, yassin.hajipour@ryerson.ca Sharareh Taghipour

We construct a model to find the optimal non-periodic inspection for a multi-component system.The components are either minimally repaired or replaced when they fail. We formulate the model to find the optimal non-periodic inspection scheme which results in the minimum expected total cost. We develop a simulation model to find the expected values required in the objective function, and then couple the simulation model with the genetic algorithm to obtain the optimal inspection scheme.

4 - Optimal Inspection and Maintenance for a Multicomponent System with Evident and Hidden Failures

Vladimir Babishin, Ryerson University, 350 Victoria Street, Toronto, ON, M5B 2K3, Canada, vbabisin@ryerson.ca Sharareh Taghipour

We aim to find both the optimal maintenance policy and inspection interval for a multicomponent system with hidden and evident failures. We first obtain the optimal replacement ages for the components with evident failures, and the optimal number of minimal repairs before replacement for the components with hidden failures. We then find the optimal periodic inspection interval for the system minimizing its total expected lifecycle cost.

■ SC16

16-Level B, Salon C

Environment

Cluster: Contributed Sessions

Invited Session

Chair: Dan Lane, Professor, Telfer School of Management, University of Ottawa, 55 Laurier Avenue East, Ottawa, ON, K1N 6N5, Canada, dlane@uottawa.ca

1 - Adaptive Management Strategies in Canada's Boreal Ecosystem

Harry Kessels, Telfer School of Management, 55 Laurier Avenue East, Ottawa, ON, K1N6N5, Canada, HKESS057@uottawa.ca

This research focuses on adaptive management strategies in support of wildfire risk mitigation decisions in the Nechako Lakes District in central British Columbia, Canada. Community profiles are assessed in terms of their vulnerability to wildfires, by using spatial analyses to quantify spatial correlations and probability distributions of wildfires based on historic data from the Canadian National Fire Database along with topographical and land use data.

2 - Dynamic Positioning of Patrol Tugs in the Northern Norwegian Coastline

Brice Assimizele, Aalesund University College, Asebøen 9, Aalesund, 6017, Norway, bras@hials.no

To safeguard the marine environment from potential oil spills from vessel grounding accidents, the Norwegian coastal administration administers one of its vessel traffic service centers located in Vardø, the extreme northeastern part of Norway. One of the main tasks of the operators is to command a fleet of tugboats such that the risk of oil tanker grounding accidents is minimized. We propose a nonlinear mixed integer programming model to minimize the expected cost of accidents.

3 - System Dynamics Modelling of Collaborative Community Response to Extreme Environmental Events

Dan Lane, Professor, Telfer School of Management, University of Ottawa, 55 Laurier Avenue East, Ottawa, ON, K1N 6N5, Canada, dlane@uottawa.ca, Rick Moll, Shima Beigzadeh

Coastal community response to emergencies is modelled using system dynamics. STELLA models community population, land use, production, and social capital. The model simulates severe storm events, environmental, economic, social dynamics (collaboration, wellness, social networking). Measurability is demonstrated for community response, resilience. Examples are from EnRiCH and C-Change. Collaboration, wellness, and social networking are illustrated for the coastal community of Charlottetown, PEI.

■ SC17

17-Level 7, Room 701

Quantitative Finance

Sponsor: Financial Services Section

Sponsored Session

Chair: Samim Ghamami, Economist, Board of Governors of the Federal Reserve System, Washington, DC, United States of America, samim.ghamami@frb.gov

1 - Systemic Risk and Central Counterparty Clearing

Hamed Amini, EPFL, Quartier UNIL-Dorigny, Extranef 249, Lausanne, 1015, Switzerland, hamed.amini@epfl.ch

This paper studies financial networks in a stochastic framework. We apply a coherent systemic risk measure to examine the effects on systemic risk and liquidation losses of multilateral clearing via a central clearing counterparty (CCP). We provide sufficient conditions in terms of the CCP's fee and guarantee fund policy for a reduction of systemic risk. This is joint work with Damir Filipovic and Andreea Minca.

2 - Derivatives Pricing under Bilateral Counterparty Default Risk

Samim Ghamami, Economist, Board of Governors of the Federal Reserve System, Washington, DC, United States of America, samim.ghamami@frb.gov

We consider derivatives pricing under bilateral counterparty default risk in a setting similar to that of Duffie and Huang [1996]. The probabilistic valuation formulas derived under this framework cannot be used for pricing due to their recursive path dependencies. By imposing restrictions on the dynamics of the short rate and credit spreads, we develop path-independent probabilistic valuation formulas that have closed form solution or can lead to computationally more efficient pricing schemes.

3 - A Simulation Measure Approach to Monte Carlo Methods for Default Timing Problems

Alex Shkolnik, UC Berkeley, 339 Evans Hall, Berkeley, CA, 94720, United States of America, ads2@berkeley.edu, Kay Giesecke

Reduced-form models of name-by-name default timing are widely used to measure portfolio credit risk and to analyze securities exposed to a portfolio of names. Monte Carlo (MC) simulation is a common computational tool in such settings. We introduce a new change of measure perspective for MC simulation for default timing problems. The perspective provides the means of analyzing current methods and suggests a new MC algorithm which outperforms a widely used and standard technique.

■ SC18

18-Level 7, Room 722

Decision Analysis

Cluster: Contributed Sessions

Invited Session

Chair: Magda Gabriela Sava, PhD Student, University of Pittsburgh, Joseph M. Katz Graduate School of Business, 241 Mervis Hall, Pittsburgh, PA, 15216, United States of America, mgsava@katz.pitt.edu

1 - The Correlation Between Major Criteria of Ahp for Government R&D Program in Korea

Dong-Guen Kim, Associate Research Fellow, Korea Institute of S&T Evaluation and Planning (KISTEP), Dongwon Industry Bldg., 275 Yangjae-dong, Seoul, Korea, Republic of, dgkim@kistep.re.kr

The preliminary feasibility study (PFS) is carried for the newly proposed large-scaled government programs in Korea since 1998. In case of a PFS on R&D programs, there are three major criteria about technology, policy and economic effects. In this study, the correlation between three major criteria and overall score is analyzed. The results show that the major criteria of preliminary feasibility study have correlation and the difference on feasible and infeasible programs is existed.

2 - Sensitivity Analysis for Analytic Network Models (ANP) – Two and Three Dimensional Cases

Magda Gabriela Sava, PhD Student, University of Pittsburgh, Joseph M. Katz Graduate School of Business, 241 Mervis Hall, Pittsburgh, PA, 15216, United States of America, mgsava@katz.pitt.edu, Luis G Vargas, Jerrold H. May

We propose an extension of the sensitivity for Analytic Network Models previously developed by May et al. (2013). We study ANP models to understand how preference regions are created, and how boundaries can be characterized as the number of criteria increase. We use optimization methods to find the best approximations to the boundaries between the preference regions, and define the appropriate stability regions for the cases with two/three criteria and an arbitrary number of alternatives.

■ SC19

19-Grand Ballroom West

Tutorial: Green Vehicle Routing

Cluster: Tutorials

Invited Session

Chair: Tolga Bektas, University of Southampton, Highfield Campus, Southampton, SO171BJ, United Kingdom, T.Bektas@soton.ac.uk

1 - Green Vehicle Routing

Tolga Bektas, University of Southampton, Highfield Campus, Southampton, SO171BJ, United Kingdom, T.Bektas@soton.ac.uk

In this talk, I will discuss ways in which emissions can be accounted for in freight transportation planning, and in particular vehicle routing, using mathematical modelling and optimisation. I will describe the pollution-routing problem and variants, and present results that shed-light on the tradeoffs between various parameters such as load, speed and total cost, and offer insight on economies of environmental-friendly transportation.

Sunday, 3:30pm - 5:00pm

■ SD02

02-Level 3, Drummond West

Dynamic Problems in Healthcare II

Cluster: Healthcare

Invited Session

Chair: Antoine Legrain, Polytechnique Montreal, 2500, chemin de Polytechnique, Montreal, Canada, antoine.legrain@polymtl.ca

1 - Stochastic Optimization of the Scheduling of a Radiotherapy Center

Antoine Legrain, Polytechnique Montréal, 2500, chemin de Polytechnique, Montréal, Canada, antoine.legrain@polymtl.ca Marino Widmer, Marie-Andrée Fortin, Nadia Lahrichi, Louis-Martin Rousseau

Cancer treatment facilities can improve their efficiency for radiation therapy by optimizing the utilization of linear accelerators and taking into account patient priority, treatment duration, and preparation of the treatment (dosimetry). The future workloads are inferred: a genetic algorithm schedules future tasks in dosimetry and a constraint program verifies the feasibility of a dosimetry planning. This approach ensures the beginning of the treatment on time and thus avoids cancellations.

2 - Dynamic Kidney Exchange: Reducing Waiting Times in Heterogeneous Sparse Pools

Maximilien Burq, PhD Student, MIT, 70 Pacific St., Cambridge, MA, 02139, United States of America, burq.maximilien@gmail.com, Itai Ashlagi, Patrick Jaillet, Vahideh Manshadi

Growing numbers of highly sensitized patients is an important challenge in current Kidney exchange programs. We develop an online model that takes into account the heterogeneity of patients. We prove that ensuring a fraction of easy-to-match patients in the pool greatly reduces waiting times for hard-to-match patients, and reduces the length of non-simultaneous chains. We then provide simulations showing how priorities increase hospital participation, and improve overall efficiency.

3 - Dynamic Optimization of Chemotherapy Outpatient Scheduling with Uncertainty

Michael Carter, Professor, University of Toronto, Mechanical & Industrial Engineering, 5 King's College Rd., Toronto, ON, M5S 3G8, Canada, mike.carter@utoronto.ca, Shoshana Hahn-Goldberg, Chris Beck

Chemotherapy outpatient scheduling is a complex problem. We address dynamic uncertainty that arises from requests for appointments that arrive in real time and uncertainty due to last minute scheduling changes. We propose dynamic template scheduling, a novel technique that combines proactive and online optimization. We create a proactive template of an expected day in the chemotherapy centre using a deterministic optimization model and a sample of appointments.

■ SD03

03-Level 3, Drummond Centre

Finalists of the 2015 David Martell Student Paper Prize in Forestry

Cluster: Applications of OR in Forestry

Invited Session

Chair: Jean-Francois Audy, Professor of Operations Management, Universite du Quebec a Trois-Rivieres, 3351 des Forges Blvd., P.O. Box. 500, Trois-Rivieres, QC, QC G9A5H7, Canada, jean-francois.audy@uqtr.ca

1 - Strategic Optimization of Forest Residues to Bioenergy and Biofuel Supply Chain

Claudia Cambero, UBC, 2943-2424 Main Mall, Vancouver, BC, V6T1Z4, Canada, cambero.claudia@gmail.com

Forest residues are renewable materials for bioenergy conversion that have the potential to replace fossil fuels beyond electricity and heat generation. A challenge hindering the intensified use of forest residues for energy production is the high cost of their supply chain. Previous studies on optimal design of forest residue supply chains focused on biofuel or bioenergy production separately, mostly with a single time period approach. We present (...)

2 - Value-Adding through Silvicultural Flexibility: An Operational Level Simulation Study

Shuva Hari Gautam, Université Laval, 2405, rue de la Terrasse, Pavillon Abitibi-Price, bureau 2125, Québec, QC, G1V 0A6, Canada, shuva-hari.gautam.1@ulaval.ca

Forest products industry's competitiveness is influenced by the agility of wood procurement systems in delivering raw material to support downstream manufacturing activities. However, in a hierarchical forest management planning context, silvicultural treatments are prescribed and set as constraints for supply chain managers, restricting supply flexibilityandconsequently value-adding potential. This study was conducted (...)

3 - Tactical Supply Chain Planning for a Forest Biomass Power Plant Under Supply uncertainty

Shabani Nazanin, UBC, UBC, Canada, nshabani@interchange.ubc.ca

Uncertainty in biomass supply is a critical issue that needs to be considered in the production planning of bioenergy plants. Incorporating uncertainty in supply chain planning models provides improved and stable solutions. In this paper, (...)

■ SD04

04-Level 3, Drummond East

OR in Mine Planning I

Cluster: Applications of OR in the Mining Industry

Invited Session

Chair: Ryan Goodfellow, Research Associate, McGill University - COSMO Laboratory, 3450 University Street, FDA Bldg Room 108, Montreal, QC, H2V 1Z7, Canada, ryan.goodfellow@mail.mcgill.ca

1 - A Dynamic-Ore-Price Based Approach for Mineral Value Chain Optimization with Uncertainty

Jian Zhang, Research Associate, McGill University - COSMO Laboratory, 3450 University Street, FDA Bldg Room 109, Montréal, QC, H3A 2A7, Canada, jian.zhang9@mail.mcgill.ca
Roussos Dimitrakopoulos

An integrative mine production and processing stream optimization method is developed to maximize the mining complex's overall expected net present value with uncertainties in both ore supply and the commodity market. The proposed approach is tested through a small-scale hypothetical case and the results show that the proposed method significantly increases the mining complex's overall expected net present value.

2 - MineLink: A Framework for Optimization in Open-Pit Block Scheduling

Nelson Morales, Delphos Mine Lab, AMTC & University of Chile, Av. Tupper 2069, Santiago, Chile, nelson.morales@amtc.cl
Pierre Nancel-Penard, Enrique Jelvez

New researchers in OR applied to mine planning often have to start from scratch to develop the computational tools to set up the problems and to test their ideas. In this presentation we introduce MineLink, a set of data structures and algorithms that have been developed to help reduce this gap by providing already tested and efficient structures and utilities, as well as problem definitions for the area. We also present some simple examples and research case studies carried on using MineLink.

3 - Key Performance Indicators for Electricity Conservation in Open Pit Mining

Roger Yu, Professor, Thompson River University, 900 McGill Dr., Kamloops, BC, V2C0C8, Canada, Yu@tru.ca
Long Wen, Alex Russell-Jones, Craig Haight

KPI is a crucial tool to measure one's progress towards pre-defined objectives. We work with Teck's Highland Valley Copper (HVC) to develop HVC specific energy conservation KPIs. The research produced several promising statistical models examining the relationships between mill throughput and electrical intensity, along with other mining parameters such as blast energy, blast type and ore hardness. The model correlates better with actual mill performance than the current predictive model.

4 - Stochastic Optimization of Open Pit Mining Complexes with Capital Expenditures

Ryan Goodfellow, Research Associate, McGill University - COSMO Laboratory, 3450 University Street, FDA Bldg Room 108, Montréal, QC, H2V 1Z7, Canada, ryan.goodfellow@mail.mcgill.ca
Roussos Dimitrakopoulos

Stochastic global optimization of open pit mining complexes aims to holistically optimize a mining complex, from the production schedule to the products sold, and simultaneously manages the inherent risk within the value chain. Existing models assume that the bottlenecks in the mining complex have been defined a-priori. This work focuses on the integrating capital expenditure decisions into the optimization model to simultaneously design the bottlenecks or constraints in the value chain.

■ SD05

05-Level 2, Salon 1

Transportation and Routing

Cluster: Contributed Sessions

Invited Session

Chair: W. Y. Szeto, The University of Hong Kong, Pokfulam Road, Hong Kong, Hong Kong - PRC, ceszeto@hku.hk

1 - Rescheduling for Capacitated Arc Routing Problem

Ingrid Marcela Monroy Licht, École Polytechnique de Montréal, 2500, chemin de Polytechnique, Montréal, Canada, marcela.monroy@polymtl.ca, Ciro Alberto Amaya, André Langevin, Louis-Martin Rousseau

This problem arises when a failure of a vehicle happens after all vehicles have started their schedules in the Capacitated Arc Routing Problem. The failure requires long repair time and the dispatcher has to re-schedule the routes as soon as possible. In the re-scheduled plan, the dispatcher considers operating and scheduling disruption costs. We present different scenarios and solution methods based on mixed integer linear programming and heuristics.

2 - Nhtsa Cafe Compliance Cost Optimization

Yohan Shim, Sr. Analyst, Scenaria, Inc, 47603 Halyard Drive, Plymouth MI 48170, United States of America, yohan.shim@scenaria.com, Frederic Jacquelin, Christopher Mollo, Travis Tamez

The United States National Highway Traffic Safety Administration (NHTSA) has issued in August 2012 final rules and regulations for Corporate Average Fuel Economy (CAFE) for model years 2017 and beyond. NHTSA sets national CAFE standards under the Energy Policy and Conservation Act to improve fuel economy for passenger cars and light trucks. We present a mathematical program model and efficient heuristics to support vehicle manufacturer's long-term strategic decisions on CAFE credit utilization.

3 - A Taxi Customer-Search Model: The Cell-Based Logit-Opportunity Approach

W. Y. Szeto, The University of Hong Kong, Pokfulam Road, Hong Kong, Hong Kong - PRC, ceszeto@hku.hk, S.C. Wong, Ryan C.P. Wong

This paper proposes a cell-based model to predict local customer-search movements of vacant taxi drivers which incorporates the modeling principles of the logit and the intervening opportunity models. The local customer-search movements were extracted from the global positioning system data of 460 Hong Kong urban taxis and input into a cell-based taxi operating network to calibrate the model and validate the modeling concepts. The model can be used to simulate the taxi operation.

■ SD06

06-Level 2, Salon 2

Optimization via Simulation: Ranking and Selection, and Multiple Comparisons

Sponsor: Simulation

Sponsored Session

Chair: Peter Frazier, Assistant Professor, Cornell University, 232 Rhodes Hall, Ithaca, NY, 14853, United States of America, pf98@cornell.edu

1 - Asymptotic Validity of the Bayes-Inspired Indifference Zone Procedure

Saul Toscano, Cornell University, 113 Lake Street, Ithaca, NY, 14850, United States of America, st684@cornell.edu

This talk considers the indifference-zone (IZ) formulation of the ranking and selection problem. Conservatism leads classical IZ procedures to take too many samples in problems with many alternatives. The Bayes-inspired Indifference Zone (BIZ) procedure, proposed in Frazier (2014), is less conservative than previous procedures, but its proof of validity requires strong assumptions. In this talk, we present a new proof of asymptotic validity that relaxes these assumptions.

2 - Ranking and Selection: Be Careful Where You Sample!

Michael Fu, University of Maryland, Smith School of Business, College Park, United States of America, mfu@isr.umd.edu
Jian-Qiang Hu, Chun-Hung Chen, Yijie Peng

For statistical ranking & selection, it is natural to suppose that more sampling leads to better results, but we show that this need not be the case for several commonly used metrics such as the probability of correct selection (PCS). In particular, we give a scenario where the PCS decreases when popular sampling allocation procedures are followed. We identify the source of non-monotonicity, provide a new sampling allocation method to eliminate it, and present numerical examples and extensions.

3 - Parallel Bayesian Policies for Multiple Comparisons with a Known Standard

Peter Frazier, Cornell University, 295 Rhodes Hall, Ithaca, NY, 14853, United States of America, wh343@cornell.edu
Weici Hu

We consider the problem of multiple comparisons with a known standard, in which we wish to allocate simulation effort across a finite number of simulated systems to decide which ones have mean output above a known threshold. We assume parallel machines and a fixed budget, and formulate the problem as a stochastic dynamic program in a Bayesian setting. We provide a computationally tractable upper bound on the value of the Bayes-optimal policy and an index policy motivated by these upper bounds.

■ SD07

07-Level 2, Salon 3

Operations/ Marketing Interface

Cluster: Contributed Sessions

Invited Session

Chair: Tianjiao Qiu, Associate Professor, California State University Long Beach, 1250 N. Bellflower Blvd., Long Beach, Ca, 90840, United States of America, tianjiao.qiu@csulb.edu

1 - Effects of Downstream Entry in a Supply Chain with Spot Market

Xuan Zhao, Associate Professor, Wilfrid Laurier University, 877 Creekside Dr., Waterloo, On, N2V2S7, Canada, xzhao@wlu.ca
Qi Zhang, Liming Liu, Wei Xing

This paper investigates the effect of downstream entry on a two-echelon supply chain with risk-averse players in the presence of a spot market. We find that the manufacturers consider three factors in deciding contract procurement quantities: production, demand-hedging and speculation. Downstream entry might not always benefit the supplier and hurt the incumbent manufacturers, but it enhances the hedging effect of the contract channel.

2 - Consumer Motives for Purchase of Cotton (Lawn) as Fashion Statement - Pakistani Female Sentiment

Yasmin Zafar, Assistant Professor, Institute of Business Administration, Main Campus, University Enclave, University Road,, Karachi, Sd, 75270, Pakistan, yzafar@iba.edu.pk

Consumer motives for purchase of cotton (lawn) fabric are of growing interest for all Pakistani marketers. The fashion trends and expanded roles of female consumers are instrumental behind this tsunami climate. This paper investigates functional and emotional stimuli as predominant motivators for purchase through quantitative measures and qualitative analysis.

3 - When Does Better Quality Imply Higher Price?

Régis Chenavaz, Kedge Business School, Marseille, Marseille, France, r.chenavaz@gmail.com

This article analyses the conditions under which better quality implies higher or lower price. It stresses the influence of quality on price through the effects of cost (positive), sales (negative), and markup (positive). This paper shows that the firm, while maximising the profit, may decrease the price despite quality and cost increase, because of the sales effect.

4 - The Effect of Marketing Capability on Firm Operational Capability

Tianjiao Qiu, Associate Professor, California State University, Long Beach, 1250 N Bellflower Blvd, Long Beach, Ca, 90840, United States of America, tianjiao.qiu@csulb.edu

The study empirically examines how firm marketing capability, as demonstrated by market orientation and three customer connections: customer-product, customer-service, and customer-financial accountability connections work together to impact firm operational capability in input control, product development, manufacturing methods and channel distribution through structural equation model with survey responses from 348 marketing managers.

■ SD08

08-Level A, Hémon

Parallel Methods for DFO

Cluster: Derivative-Free Optimization

Invited Session

Chair: Stefan Wild, Argonne National Laboratory, Lemont Illinois, US wild@argonne.com

Co-Chair: Jeffrey Larson, Argonne National Laboratory, 9700 S Cass Ave, Bldg 240, Argonne, IL, 60439, United States of America, jmlarson@anl.gov

1 - A Subspace Decomposition Framework for Nonlinear Optimization

Zaikun Zhang, Dr., CERFACS-IRIT joint lab, F 325, IRIT, 2 rue Camichel, Toulouse, 31071, France, zaikun.zhang@irit.fr
Luis Nunes Vicente, Serge Gratton

We present a parallel subspace decomposition framework for nonlinear optimization, which can be regarded as an extension of the domain decomposition method for PDEs. A feature of the framework is that it incorporates the restricted additive Schwarz methodology into the synchronization phase of the algorithm. We establish the global convergence and worst case iteration complexity of the framework and illustrate how this framework can be applied to design parallel derivative-free algorithms.

2 - Ordering Evaluations and Opportunism in NOMAD

Christophe Tribes, Research Associate,École Polytechnique de Montréal, C.P. 6079, Succ. Centre-ville, Montréal, H3C 3A7, Canada, christophe.tribes@polymtl.ca

We consider the Mesh Adaptive Direct Search (MADS) algorithm implemented in NOMAD for solving blackbox optimization problems. During a Poll step of MADS, a list of trial points near the current best solution is produced. The algorithm has the opportunity to jump to the next step and drop un-evaluated points if at least one point is a success. The performance of MADS depends on how evaluations are ordered. In this work, we compare several ordering strategies on a series of test cases.

3 - Finding Multiple Optima of Particle Accelerator Simulations

Jeffrey Larson, Argonne National Laboratory, 9700 S Cass Ave, Bldg 240, Argonne, IL, 60439, United States of America, jmlarson@anl.gov, Stefan Wild

We present an algorithm for identifying multiple local optima of computationally expensive, simulation-based functions. Our multi-start algorithm exploits concurrent evaluations of the simulation to efficiently search the domain. We develop a set of tests employed by the algorithm to determine when to pause a local optimization run, thus allowing other portions of the domain to be searched. Numerical tests highlight when the proposed tests are most useful in practice.

■ SD09

09-Level A, Jarry

Assigning and Predicting Aviation Network Delays

Sponsor: Aviation Applications

Sponsored Session

Chair: Vikrant Vaze, Assistant Professor, Dartmouth College, 14 Engineering Drive, Hanover, NH 03755, United States of America, Vikrant.S.Vaze@dartmouth.edu

1 - Modeling and Prediction of Air Traffic Network Delays

Hamsa Balakrishnan, Massachusetts Institute of Technology, 77 Massachusetts Ave, 33-328, Cambridge, MA, 02139, United States of America, hamsa@mit.edu, Zebulon Hanley

We present a model for predicting air traffic system delays, considering both temporal and spatial features. We use clustering to characterize typical delay states, as well as types-of-day. The models are used to predict the delays on various links in the air traffic network, and the type-of-day that is likely to materialize. The predictive performance of the proposed models are evaluated using data from the Department of Transportation, for different lengths of prediction horizon.

2 - Comparison of Major Airports in Terms of Delay Generation and Propagation

Husni Idris, Principal Research Engineer, Engility Corporation, 900 Technology Park Drive, Suite 201, Billerica, MA, 01821, United States of America, husniidris@yahoo.com

When demand exceeds capacity, airports generate delays that propagate through their network. Historical data analysis is used to rank US airports in terms of causing delay. Throughput saturation and queuing delay are used to identify locally generated delay. Passing is used to separate delays caused from downstream effects. Network propagation is identified by measuring delay relative to schedule. The analysis highlighted airports that generate delays locally and ones that cause network effects.

3 - A Stochastic Program for Ground Delay Program Planning

Alex Estes, University of Maryland, 9322 Cherry Hill Road, Apartment 201, College Park, MD, 20740, United States of America, asestes1@gmail.com, Michael Ball

We present a multistage stochastic integer programming model to address the problem of assigning delays to flights when demand at an airport exceeds capacity. We provide conditions which guarantee that the SIP has an integral extreme point. Computational results are discussed.

4 - Analyzing Flight Delay Propagation Due to Crew Scheduling Constraints

Vikrant Vaze, Assistant Professor, Dartmouth College, 14 Engineering Drive, Hanover, NH, 03755, United States of America, Vikrant.S.Vaze@dartmouth.edu, Keji Wei

We aim to understand the extent and nature of flight delays caused due to crew unavailability. Toward this end, we develop a parameterized optimization model for crew pairing generation wherein the parameters themselves are chosen to maximize the similarity between the pairings output by the model and the actual crew pairings generated by the airlines. We validate our results against a small sample of proprietary airline data. We present the model development process and some early results.

■ SD10

10-Level A, Joyce

From American Put Options to Wartime Portfolios

Cluster: Stochastic Optimization

Invited Session

Chair: Remica Aggarwal, Bits Pilani, Visya Vihar Pilani, Pilani, India, remica_or@rediffmail.com

1 - Pricing American Put Options using Malliavin Calculus with Localization Function

Mohamed Kharrat, PhD, Faculty of Pharmacy of Monastir, Road Menzl Chaker Impasse ElFirma km 1.5, Sfax, 3072, Tunisia, mohamed.kharrat08@gmail.com

The aim of this paper is to elaborate a theoretical methodology based on the Malliavin calculus with localization function in order to calculate the following conditional expectation $E(Pt(Xt)|(Xs))$ for $s = t$ where the only state variable follows a J-process. The theoretical results are applied to the American option pricing,in order to studied the influence of the localization function. The introduction of the aforesaid process assures the skewness and the kurtosis effects.

2 - NSGA for Chance Constraints Based Dynamic Stochastic Multi-Objective Supplier Selection Problem

Remica Aggarwal, Bits Pilani, Visya Vihar Pilani, Pilani, India, remica_or@rediffmail.com

In today's dynamic global environment,selection of appropriate suppliers, who can offer the best and economical under changing economic conditions and operational risk uncertainties,becomes crucial. Present work models such a Dynamic Stochastic Multi-objective Supplier Selection Problem (DSMOSSP) using Chance Constraints. The problem is practically solved using Non-dominated Sorting Genetic Algorithm (NSGA II)taking a case example .

■ SD11

11-Level A, Kafka

COMEX: Combinatorial Optimization: Metaheuristics and EXact Methods II

Cluster: Network Design

Invited Session

Chair: Bernard Fortz, Prof., Université Libre de Bruxelles, GOM CP212, Bld du Triomphe, Brussels, 1050, Belgium, bernard.fortz@ulb.ac.be

1 - Lagrangian Relaxation for the Time-Dependent Combined Network Design and Routing Problem

Enrico Gorgone, Dr, Université Libre de Bruxelles, GOM CP212, Bld du Triomphe, Brussels, 1050, Belgium, egorgone@ulb.ac.be Bernard Fortz, Dimitri Papadimitriou

In communication networks, the routing decision process remains decoupled from the network design process. To keep both processes together, we propose a distributed optimization technique aware of distributed nature of the routing process by decomposing the optimization problem. We propose a Lagrangian approach for computing a lower bound by relaxing the flow conservation constraints. This approach is more robust than any LP solvers and it always returns some solutions.

2 - Integer Programming Formulations for Survivable Hop Constrained Network Design

Markus Leitner, Université Libre de Bruxelles, GOM CP212, Blvd du Triomphe, Brussels, 1050, Belgium, markus.leitner@ulb.ac.be Ivana Ljubic, Luis Gouveia

We study the Survivable Hop Constrained Network Design Problem (HCNDP). Given is an undirected graph, a set of commodities and two hop limits. Solutions of the HCNDP must contain a path of length at most H for each commodity and one of length at most H' after removing an edge. We show that the HCNDP is not equivalent to the hop constrained survivable network design problem (HSNDP). We propose integer programming formulations and analyze if the solutions are different from those of the HSNDP.

3 - Scheduling Locks on Inland Waterways

Ward Passchyn, KU Leuven, naamsestraat 69, Leuven, Belgium, ward.passchyn@kuleuven.be, Dirk Briskorn, Frits C.R. Spieksma

Locks are typical bottlenecks along rivers and canals. We consider a system of multiple locks arranged in a sequence, a setting that occurs naturally along many inland waterways. To optimize the decision-making of these locks, we present different mathematical programming formulations, focusing on the travel time objective as well as the emission of pollutants. We then use these models to investigate the potential gains in performance, and the trade-off between the different objectives.

4 - An Iterated Local Search Algorithm for Water Distribution Network Design Optimisation

Annelies De Corte, PhD, Universiteit Antwerpen, Prinsstraat 13, Antwerpen, 2000, Belgium, annelies.decorte@uantwerpen.be Kenneth Sörensen

This mixed-integer, non-linear optimisation problem concerns finding the optimal pipe configuration out of a discrete set of available pipe types in terms of investment cost, with respect to hydraulic principles, energy conservation laws, material limitaions and customer requirements. This combinatorial optimisation problem is NP-hard, therefore, a metaheuristic technique, iterated local search, is applied to find satifysing solutions in a reasonable time.

■ SD12

12-Level A, Lamartine

Constraint Programming I

Cluster: Constraint Programming

Invited Session

Chair: Claude-Guy Quimper, Professor, Université Laval, Université Laval, Québec, Canada, claude-guy.quimper@ift.ulaval.ca

1 - Stochastic Decision Diagrams

J.N. Hooker, Carnegie Mellon University, jh38@andrew.cmu.edu

Relaxed decision diagrams have recently proved effective as a solution technology for discrete optimization problems that can be given a dynamic programming formulation. We extend the idea to stochastic decision diagrams (SDDs) and define relaxation for them. This leads to a rigorous concept of relaxation for stochastic dynamic programming that provides valid bounds. We illustrate how relaxed SDDs can be used to solve stochastic optimal control problems in a branch-and-bound framework.

2 - Introducing the Markov Transition Global Constraint (MTC)

Michael Morin, Université Laval, Université Laval, Québec, Qc, Canada, michael.morin.3@ulaval.ca, Claude-Guy Quimper

We present a novel global constraint to model Markov chains in constraint programming (CP). We discuss, along with the constraint definition, two filtering algorithms for that constraint. The first filtering algorithm is based on the fractional knapsack problem whereas the second filtering algorithm is based on linear programming. Both algorithms compare favorably to the filtering performed by CP solvers when decomposing an MTC into arithmetic constraints.

3 - Model Combinators for Hybrid Optimization

Daniel Fontaine, Univ. of Connecticut, 2 Martin Trl, Wallingford, CT, 06492, United States of America, daniel.fontaine@gmail.com
Laurent Michel, Pascal Van Hentenryck

Recent research has made progress in automating the generation of hybrid solvers. This work has pushed hybrid-generation further, introducing the concepts of model combinators and algorithmic templates. Model combinators provide principled model compositions while algorithmic templates define a generic algorithmic framework for solvers. Such techniques have enabled the automation of complex solvers including Logic-Based Benders and Lagrangian Relaxation using various solver technologies.

4 - The Balance Constraint Family

Émilie Picard Cantin, PhD Student, Université Laval, 2325 Rue de l'Université, Québec, Qc, G1V 0A6, Canada, emilie.picard-cantin.1@ulaval.ca, George Katsirelos, Emmanuel Hebrard, Zeynep Kiziltan, Claude-Guy Quimper, Christian Bessiere, Toby Walsh

The BALANCE constraint introduced by Beldiceanu ensures solutions are balanced. We show that achieving domain consistency on BALANCE is NP-hard. We introduce ALLBALANCE with similar semantics that is polynomial to propagate. We consider various forms of ALLBALANCE and focus on ATMOSTALLBALANCE. We provide a specialized propagation algorithm, and a powerful decomposition both of which run in low polynomial time. Experimental results demonstrate the promise of these new filtering methods.

■ SD13

13-Level A, Musset

Revenue/ Yield Management

Cluster: Contributed Sessions

Invited Session

Chair: Michael Li, Professor, Nanyang Business School, Nanyang Technological University, Nanyang Avenue, Singapore, 639798, Singapore, zfli@ntu.edu.sg

1 - The Optimal Use of Groupon

Kyle Maclean, UWO, 112 North Centre Rd #34, London, On, n5xOG9, Canada, k.d.maclean@gmail.com, John Wilson

Groupon, the largest online "deal" site, is a frequently used option to sell excess inventory by retailers. We research the problem of how to optimally use Groupon when there exists the option to sell through the firm's own sales channels simultaneously. We formulate the problem using stochastic demands, and investigate under what conditions a retailer should use Groupon and how much inventory should be dedicated. Unimodality results are presented and managerial insights are discussed.

2 - A Metaheuristic for Service Network Design with Revenue Management for Freight Intermodal Transport

Yunfei Wang, PhD Student, LAMIH - Université de Valenciennes, Le Mont Houy, Valenciennes, 59300, France, yunfei.wang@univ-valenciennes.fr, Teodor Gabriel Crainic, Ioana Bilegan, Abdelhakim Artiba

Revenue management is seldom considered when planning consolidation-based freight transport services. We introduce new neighbourhood structures for metaheuristics addressing scheduled service network design problems with asset management and revenue management considerations. The structures are based on service-cycles, producing high-quality solutions quickly. Experimental results obtained by applying the approach to a barge intermodal transportation system are presented.

3 - Dynamic Pricing with Service Unbundling

Michael Li, Professor, Nanyang Business School, Nanyang Technological University, Nanyang Avenue, Singapore, 639798, Singapore, zfli@ntu.edu.sg

With the emergence of LCCs, unbundling has become a common practice. In this paper, we investigate this issue when an airline dynamically prices the seat, while separating fixed-priced add-ons. We characterize the optimal dynamic unbundling pricing policy and investigate its structural properties. A major finding is that among most cases where unbundling outperforms bundling, the correlation coefficient is non-negative. But the inverse is not true in general.

■ SD14

14-Level B, Salon A

Electrical Markets - Renewable Energy

Cluster: Contributed Sessions

Invited Session

Chair: Hamed Amini, EPFL, Quartier UNIL-Dorigny, Extranef 249, Lausanne, 1015, Switzerland, hamed.amini@epfl.ch

1 - Including Ramping Constraints in the Electric Capacity Expansion Model

Sarah Sleiman, Graduate Student, University of Waterloo, Management Sciences, Waterloo, ON, N2L 3G1, Canada, s2sleima@uwaterloo.ca, David Fuller

As the penetration of non-dispatchable renewables into the grid increases, fluctuations in net demand are also expected to increase. Generators will therefore need to have higher ramping capabilities in order to respond to the intermittency of renewables. While ramping constraints are traditionally ignored in capacity expansion models, our work illustrates that the inclusion of these short term constraints in the long term model may result in a more realistic power output and capacity mix.

2 - Precautionary Dispatch for Systems with High Penetration of Renewable Energy

Parth Pradhan, PhD Student, Lehigh University, 19 Memorial Dr W, Elec. & Comp. Eng., Packard Lab, Bethlehem, PA, 18015-3006, United States of America, pap212@lehigh.edu
Shalinee Kishore, Alberto Lamadrid

We propose a framework to determine the optimal level of precautionary dispatch, which is withholding a portion of the expected power output to provide reserves and therefore enhance certainty in the energy delivered. Our model includes using a spatial and temporal forecast model and the estimation of Locational Marginal Prices as input for the renewable energy producer to quantify the opportunity costs of participating in real time markets.

3 - Artelys Crystal City: Software Designed for The Optimization Of Local Energy Strategies

Maxime Fender, Optimization Consultant, Artelys Canada Inc., 2001 rue University, #1700, Montréal, QC, H3A 2A6, Canada, maxime.fender@artelys.com, Rébecca Aron, Bertrand Omont

Artelys Crystal City is a decision-support software that helps local authorities define sustainable and cost-effective urban energy strategies. Leaning on the set-up of an overall model of the energy system, it provides quantitative elements to assess energy opportunities and environmental impacts of local public policies. During this talk, I will present the software and its features through its application to the city of Cesena (Italy), and to the ISEUT project lead in with Lorient (France).

4 - Location Privacy Preserving Based Information Flow for Modern Transportation System
Mohammadhadi Amini, PhD Fellow, Carnegie Mellon University, SYSU-CMU Joint Institute of Engineering, 5700 Centre Ave APT 317, Pittsburgh, PA, 15206, United States of America, amini@cmu.edu, Orkun Karabasoglu, Kianoosh G. Boroojeni, Marija D. Ilic

Future power system, will enable a reliable, secure, sustainable and environmentally-friendly power system. One of the most influential elements of smart grid is modern electrified transportation. In a related context, electric vehicles are inevitable players in modern transportation development. We introduce a probabilistic location privacy preserving mechanism for communication of EVs and other agents. A reliable stochastic mechanism is proposed to achieve acceptable level of location privacy.

■ SD15

15-Level B, Salon B

Multicriteria Analysis and Applications

Cluster: Special Invited

Invited Session

Chair: Mohamed Dia, Full Professor, Operations Management, Faculty of Management, Laurentian University, 935 Ramsey Lake Road, Sudbury, ON, P3E 2C6, Canada, mdia@laurentian.ca

1 - Supported and Non-Supported Solutions for the Multi-Objective RCPSP
Matthias P. Takouda, Faculty of Management, Laurentian University, Sudbury, Canada, mtakouda@laurentian.ca
Oumar Kone, Kouassi Hilaire Edi

This paper introduces discrete time and event based formulations of the multi-criteria Resource-Constrained Project Scheduling Problem. Scalarization methods, and in particular the Two-Phase method proposed by Przybylski, Gandibleux and Ehrgott, are developed to obtain supported and non-supported Pareto solutions. We assess and compare the performance of the two formulations.

2 - Impacts of the Subprime Crisis on the Retailing Industry: An Assessment via DEA
Mohamed Dia, Full Professor, Operations Management, Faculty of Management, Laurentian University, 935 Ramsey Lake Road, Sudbury, ON, P3E 2C6, Canada, mdia@laurentian.ca
Matthias P. Takouda

The 2008 Global Financial Crisis, caused by the sub-prime mortgage boom and house price bubble in the USA, had far-reaching effects on North-American economies. This paper assesses the effects of the recession on Canadian retailers. The analysis is performed by computing their relative efficiency using tools from Data Envelopment Analysis.

3 - Technical Efficiency of Socially Responsible Mutual Funds in Canada
Abdelouahid Assaidi, Assistant Professor, Laurentian University, Ramsey Lake Road, Sudbury, ON, P3E2C6, Canada, aassaidi@laurentian.ca, Mohamed Dia

Socially responsible assets managed in Canada have increased by 120% between 2006 and 2013 to pass from 459.53 billion to 1010.79 billion. In this research, we study the performance of socially responsible Canadian mutual funds using DEA and we compare them with traditional mutual funds.

■ SD16

16-Level B, Salon C

Game Theory

Cluster: Contributed Sessions

Invited Session

Chair: Slim Belhaiza, Assistant Professor, KFUPM, Mail Box 492 KFUPM Campus, Dhahran, 31261, Saudi Arabia, slim.belhaiza@gerad.ca

1 - Four Models of Near Equilibrium for a Centrally Dispatched Pool Market with Nonconvexities
David Fuller, Professor, University of Waterloo, Management Sciences, Waterloo, Canada, dfuller@uwaterloo.ca, Emre Celebi

An electricity market operator solves a social welfare maximization model to determine market prices and generation. If the cost functions include binary variables, linear prices generally do not exist such that all firms agree that the market operator's generation instructions are optimal. We define a model which selects market prices and generation to minimize the total of all firms' apparent loss of profit. We compare it with theoretical results and examples to three other models.

2 - Can Significant Retail Power Lead to Assortment Reduction?
Hedayat Alibeiki, McGill University, 1001 Sherbrooke St., West, Montréal, QC, H3A 1G5, Canada, hedayat.alibeiki@mail.mcgill.ca
Shanling Li, Ramnath Vaidyanathan

Many big-box retailers are known to reduce their assortment in certain categories more than other retailers. In this study, we consider a game-theoretic competition between two retailers and investigate whether or not an increase in any sort of retail power (product cost advantage and market dominance) can lead to assortment reduction. Our results show that higher product cost advantage can result in assortment reduction only if the power retailer is the price leader in the market.

3 - Cooperative Promotions in the Distribution Channel
Salma Karray, UOIT, 2000 Simcoe Street North, Oshawa, Canada, salma.karray@uoit.ca

We study horizontal (HJP) and vertical (VJP) joint promotions in competing channels. Retailers HJP with decentralized and centralized structured partners is considered. We find that the profitability of HJP depends on the structure of the partnering channel. Also, HJP leads to changes in VJP rates that depend on competition levels.

4 - On Polymarix Games Perfect and Proper Nash Equilibria
Slim Belhaiza, Assistant Professor, KFUPM, Mail box 492 KFUPM Campus, Dhahran, 31261, Saudi Arabia, slim.belhaiza@gerad.ca

In this paper we show that polymatrix games, which form a particular class of n-player games, verify the undominance property. This result is used to set a new characterization of perfect Nash equilibria for polymatrix games. This paper generalizes also the notion of epsilon-proper equilibria to polymatrix games. We use 0-1 mixed quadratic and linear programming optimization results to identify proper and non-proper Nash equilibria.

■ SD17

17-Level 7, Room 701

Financial Engineering

Sponsor: Financial Services Section

Sponsored Session

Chair: Abel Cadenillas, Professor, University of Alberta, Department of Mathematical Sciences, Edmonton, AB, T6G2G1, Canada, abel@ualberta.ca

1 - Government Debt Management: Optimal Currency Portfolio and Payments
Abel Cadenillas, Professor, University of Alberta, Department of Mathematical Sciences, Edmonton, AB, T6G2G1, Canada, abel@ualberta.ca, Ricardo Huaman-Aguilar

We develop a theoretical model for optimal currency government debt portfolio and debt payments, which allows both government debt aversion and jumps in the exchange rates. We obtain a realistic stochastic differential equation for public debt, and then solve explicitly the optimal currency debt problem.

2 - Systemic Influences on Optimal Equity-Credit Investment
Christoph Frei, Associate Professor, University of Alberta, Mathematical and Statistical Sciences, Edmonton, AB, T6G2G1, Canada, cfrei@ualberta.ca, Agostino Capponi

We introduce an equity-credit portfolio framework taking into account the structural interaction of market and credit risk, along with their systemic dependencies. We derive a closed-form expression for the optimal investment strategy in stocks and credit default swaps (CDSs). We analyze why and how systemic influences affect optimal investment decisions. We show that systemic influences are statistically significant when the model is fitted to historical time series of equity and CDS data.

3 - High Frequency Asymptotics for the Limit Order Book
Peter Lakner, Associate Professor, New York University, Stern School of Business, New York University, New York, NY, 10012, United States of America, plakner@stern.nyu.edu
Josh Reed, Sasha Stoikov

We model the limit order book as a measure-valued process in a high frequency regime in which the rate of incoming orders is large and traders place their sell orders close to the current best price. We provide weak limits for the price process and the scaled limit order book process. We characterize the limiting process as the solution to a measure-valued stochastic differential equation. We then provide an analysis of both the transient and long-run behavior of the limiting order book process.

■ SD18

18-Level 7, Room 722

Decision Making

Cluster: Contributed Sessions

Invited Session

Chair: Akram Khaleghei, University of Torontoto, University of Toronto, 5 King's College, Toronto, ON, M5S 3G8, Canada, akhalegh@mie.utoronto.ca

1 - Heterogeneous Evidential Chains-Based Reasoning for Multi-Attribute Group Decision Making

Haiyan Yu, Tianjin Univeristy, College of Management and Economics, 92 Weijin Road, Nankai District, Tianjin, 300072, China, yhy188@tju.edu.cn

The heterogeneity of entities causes a lot diffculties for multi-attribute group decision making, thus a novel evidential chains-based reasoning method was proposed. Positive semi-definite matrix quadratic optimization model was built with the derived similarity matrix, sharing the knowledge among the experts. The combined belief of the distinct information sets was obtained with Dempster's rule. The numerical experiments of benchmark datasets with heterogeneous entities verified this method.

2 - Examination of Benefits and Costs Associated with a New Research Reactor for Canada

Herb Hanke, Section Head Operations Research, Canadian Nuclear Laboratories, Chalk River, Chalk River, on, K0J1J0, Canada, herb.hanke@cnl.ca

Quantifying the costs and benefits of nuclear research is required to support a decision to construct a new research reactor in Canada. Benefits considered include the social return associated with R&D spending, societal value associated with Highly Qualified People, job creation, etc. The impact of uncertainty is examined through sensitivity and probabilistic analysis.

3 - Making Decisions under Weather Uncertainty: Action Research for Sailing Competition in Pan Am Games

Amaury Caruzzo, PhD Student, Technological Institute of Aeronautics (ITA), Praca Mel. Eduardo Gomes, 50, GEAD, Sao Jose dos Campos, SP, 12288-900, Brazil, acaruzzo@gmail.com
Paul Joe

Some weather events can produce hazardous conditions and repercussions in outdoor activities and/or cause loss of human lives. However, the choice of action under weather uncertainty can be a difficult process. To discuss this problematic situation, we analyzed the decision-making for international sailing competition. The decision model was built with five criteria and four weather scenarios and could be useful to represent the decision makers' preferences regarding the weather forecast.

4 - Optimal Maintenance Policy for a Partially Observable System

Akram Khaleghei, University of Torontoto, University of Toronto, 5 King's College, Toronto, ON, M5S 3G8, Canada, akhalegh@mie.utoronto.ca, Viliam Makis

Maintenance policy for a partially observable system is investigated considering cost minimization. The system's condition is classified into two unobservable operational states, and an observable failure state. Vector data that is stochastically related to the system state is obtained through condition monitoring. It is assumed that the state process follows a hidden semi-Markov model and the posterior probability that the system operates in warning state is used for decision making.

■ SD19

19-Grand Ballroom West

Tutorial: Clearing the Jungle of Stochastic Optimization

Cluster: Tutorials

Invited Session

Chair: Warren Powell, Professor, Princeton University, Dept of Operations Research and Financia, Princeton, NJ, 08540, United States of America, powell@princeton.edu

1 - Clearing the Jungle of Stochastic Optimization

Warren Powell, Professor, Princeton University, Dept of Operations Research and Financia, Princeton, NJ, 08540, United States of America, powell@princeton.edu

Mathematical programming is a widely used canonical framework for modeling deterministic optimization problems, but the treatment of sequential stochastic problems is fragmented into different fields such as stochastic programming, dynamic programming, robust optimization and optimal control. I will provide a simple canonical framework for sequential stochastic optimization, and describe four classes of policies, any one of which may be best, illustrated with a range of applications.

Monday, 9:00am - 10:30am

■ MA01

01-Level 4, Salon 8

Practice Award

Cluster: CORS Functions

Invited Session

Chair: Michel Gendreau, Professor, École Polytechnique de Montréal, C.P. 6079, succ. Centre Ville, MONTREAL, QC, H3C 3A7, Canada, michel.gendreau@cirrelt.net

1 - CORS Practice Prize Final

The session features the finalists of the 2015 CORS Practice Prize competition to recognize the challenging application of the OR approach to the solution of applied problems. The main criteria considered are project impact to the client organization, contribution to the practice of OR, quality of analysis, degree of challenge and quality of written and oral presentation. A jury selects the winner after the session and the results are announced at the CORS Banquet.

■ MA02

02-Level 3, Drummond West

Health Services Outside the Hospital

Cluster: Healthcare

Invited Session

Chair: Valérie Bélanger, HEC Montreal, 3000 chemin de la Cote-Sainte-Catherine, Montreal, Canada, valerie.belanger@cirrelt.ca

1 - Pattern-Based Decompositions for Human Resource Planning in Home Health Care Services

Semih Yalcindag, HEC Montréal, Pavillon Andre-Aisenstadt, 2920, Chemin de la tour, Montreal, MONTREAL, Qu, Canada, semih.yalcindag@cirrelt.net, Paola Cappanera, Maria Grazia Scutella, Evren Sahin, Andrea Matta

Home Care services play a crucial role in reducing the hospitalization costs due to the increase of chronic diseases of elderly people. They also represent a means to improve the patients' quality of life. Recently mathematical models that jointly address assignment, scheduling and routing decisions have been proposed. However their solution is not affordable for big instances. In this study we propose a series of two-phase decomposition approaches and we test them on real instances.

2 - Selective Vehicle Routing for a Mobile Blood Donation System

Feyza Guliz Sahinyazan, McGill University, Faculty of Management, 1001 Sherbrooke Street West, Montréal, Canada, feyza.sahinyazan@mail.mcgill.ca
Bahar Yetis Kara, Mehmet Rustu Taner

In this study, a mobile blood collection system is designed to increase blood collection levels, while keeping logistic costs low. The proposed system consists of bloodmobiles and a shuttle that visits the bloodmobiles in the field each day and transfers the blood to the depot to prevent spoilage. We propose a model (extension of Selected VRP) to determine the routes and stay lengths of vehicles. Pareto optimum solutions are generated based on blood levels and costs for Ankara and Istanbul data.

3 - The Dynamic Relocation and Pre-Assignment Problem in Real-Time Management of Ambulance Fleets

Valérie Bélanger, HEC Montréal, 3000 chemin de la Cote-Sainte-Catherine, Montréal, Canada, valerie.belanger@cirrelt.ca
Angel Ruiz, Patrick Soriano

This study focuses on modeling and analyzing the dynamic relocation and pre-assignment problem (DRAP) arising in the real-time management of ambulance fleets. The DRAP aims to determine ambulance location as well as an ordered list of ambulances that can be dispatched to each demand zone while maximizing the system preparedness and minimizing relocation costs. To analyze and validate the model, a set of experiments based on a real-life application context is solved by means of CPLEX 12.5.

■ MA03

03-Level 3, Drummond Centre

Forest Management Planning

Cluster: Applications of OR in Forestry

Invited Session

Chair: Shuva Hari Gautam, Université Laval, 2405, rue de la Terrasse, Pavillon Abitibi-Price, bureau 2125, Québec, QC, G1V 0A6, Canada, shuva-hari.gautam.1@ulaval.ca

1 - Can both Woodland Caribou and Timber Production Coexist on Boreal Forest Landscapes?

Jonathan Ruppert, Post-Doctoral Research Fellow, University of Toronto, 33 Willcocks Street, Toronto, ON, M5S3B3, Canada, jonathan.ruppert@utoronto.ca, David Martell, Eldon Gunn, Marie-Josèe Fortin

Woodland caribou, a threatened species in Canada, requires contiguous mature conifer stands to survive, putting it in conflict with the timber industry's economic needs. We develop a harvesting heuristic that balances the objectives of woodland caribou conservation and wood production. Comparing harvesting strategies we find that an ecologically-tuned harvesting heuristic better addresses the need to maintain woodland caribou habitat while preserving current wood supply levels.

2 - Can Sustainable Forest Management Help Mitigate Climate Change?

Sophie D'Amours, Université Laval, 1045 avenue de la Médecine, Quebec City, QC, G1V 0A6, Canada, sophie.damours@gmc.ulaval.ca, Marc-André Carle, Martin Simard

In the past decade, carbon concentration in the atmosphere has increased significantly. The potential of forests to help mitigating climate change has been widely acknowledged. This talk presents several modeling strategies for incorporating carbon accounting and sequestration into strategic forest management models. The impacts of alternative forest management strategies on carbon will be presented and discussed. The proposed models are tested on a case study from an area in western Quebec.

3 - Aligning Spatial Forest Objectives with Supply-Chain Economics using a Web-Based LP Framework

Andrew Martin, Dalhousie University, 5269 Morris Street, Room 208, Halifax, NS, B3H 4R2, Canada, Andrew.B.Martin@Dal.Ca Eldon Gunn

Together with the Nova Scotia Department of Natural Resources, we investigate a web-based LP framework aimed at aligning spatial forest objectives with supply-chain economics. This framework, called Eco, allows large-scale forest management planning with spatial resolution that causes other planning software to "blow-up" to be performed efficiently. We present an application to a large Acadian forest where we optimize spatial forest objectives and supply-chain economics, simultaneously.

4 - A Mathematical Model to Help Develop a Strategy for Ontario's Seed Orchards and Seed Production

Dirk Kloss, Ontario Ministry of Natural Resources & Forestry, ON, Canada, dirk.kloss@ontario.ca

Ontario manages seed orchards to produce the seeds required for forest renewal. Strict rules ensure that seedlings planted on a given management unit are raised from seed sources near the management unit. Different management actions affect seed production levels as well as orchard longevity. New orchards can also be established. A MIP model was developed to determine the least-cost mix of actions for existing orchards and the location of new orchards to meet anticipated demand for seed.

■ MA04

04-Level 3, Drummond East

OR in Mine Planning II

Cluster: Applications of OR in the Mining Industry

Invited Session

Chair: Nelson Morales, Delphos Mine Lab, AMTC & University of Chile, Av. Tupper 2069, Santiago, Chile, nelson.morales@amtc.cl

1 - Underground Mine Planning Considering Geological Uncertainty

Michel Gamache, Professor, Professor, École Polytechnique, Edouard Montpetit Boulevard, Montréal QC, Canada, michel.gamache@polymtl.ca, Sabrina Carpentier, Roussos Dimitrakopoulos

A mathematical model to optimize underground mine long term scheduling is presented. The mathematical model aims to maximize net present value while reducing geological risks. The model must also select the best cut-off grade for each lens to be mined, which will affect the ore tonnage and average grade of the lens. As outputs, we obtain the lenses to be mined, their cut-off grade, the starting time of their extraction and their production rate.

2 - Adaptive Allocation of Mined Material using Approximate Dynamic Programming

Cosmin Paduraru, Postdoctoral Fellow, McGill University, Frank Dawson Adams Building, Room 123A, 3450 University Street, Montréal, QC, H3A0E8, Canada, cosmin.paduraru@gmail.com Roussos Dimitrakopoulos

This talk addresses the problem of computing policies for assigning extracted material in a mining complex. We show how formulating the problem as a Markov decision process (MDP) allows us to compute policies that progressively adapt to new information. We also show how tree-ensemble-based approximate dynamic programming can be used to approximate the optimal MDP policy. An application using a gold-copper deposit illustrates the behaviour of the proposed method.

3 - UDESS – A Multipurpose Scheduling Problem for Mine Planning

Nelson Morales, Delphos Mine Lab, AMTC & University of Chile, Av. Tupper 2069, Santiago, Chile, nelson.morales@amtc.cl Winston Rocher, Pierre Nancel-Penard, Gonzalo Nelis, Juan Quiroz

Optimization models for mine planning are often very specific to the case study itself. For example in underground mining, it is common that the model applies only to a given method or deposit. In this work we present a scheduling model that has been applied in scenarios, including massive and selective underground methods, open-pit mines and even combination of these. We present these and other applications, with the aim to motivate the study of this problem and resolution techniques.

4 - A Stochastic Optimization Formulation for the Transition from Open-Pit to Underground Mining

James Macneil, COSMO Laboratory, McGill University, 3450 University Street, Montréal, QC, H3A 0E, Canada, james.macneil@mail.mcgill.ca, Roussos Dimitrakopoulos

As open-pit mining of a deposit deepens, the cost of extraction may increase up to a threshold where transitioning to mining through underground methods is more profitable. A stochastic integer program is developed that decomposes the problem into several candidate transition depths and then identifies which is optimal.

■ MA05

05-Level 2, Salon 1

Logistics, Transportation and Distribution I

Sponsor: Transportation Science & Logistics

Sponsored Session

Chair: Leandro Callegari Coelho, Assistant Professor, CIRRELT and Université Laval, 2325 de la Terrasse, Quebec, QC, G1V0A6, Canada, Leandro.Coelho@fsa.ulaval.ca

1 - Optimization of a Biomedical Sample Analisys Network

Jacques Renaud, Universite Laval, Faculty of Business Administration, Quebec, Canada, Jacques.Renaud@fsa.ulaval.ca Ana Maria Anaya Arenas, Angel Ruiz

Biomedical sample management plays a central role in an efficient healthcare system. Based on our collaboration with the Quebec's MinistËre de la Santé et des Services sociaux, this article describes this challenging transportation problem. It is modeled as a variant of the multi-trip VRP. We propose and evaluate two alternative mathematical formulations, as well as fast heuristics, to minimize total transportation distances. The performance of the proposed methods is assessed over a case study.

2 - Solving an Inventory Routing Problem with Stock Outs for the Automatic Teller Machine Industry

Homero Larrain, Pontificia Universidad Catolica de Chile, Vicuña Mackenna 4860, Santiago, Chile, larrain@gmail.com Leandro Callegari Coelho

The inventory-routing problem (IRP) combines vehicle routing and inventory management in a multi-period time horizon. We study a variation of this problem where stock-outs are allowed, but penalized in order to be avoided. We formulate a mixed integer problem for the IRP with stock-outs and solve it using branch-and-cut. Our algorithm is tested using an instance set for IRP, and applied on real-world problem arising in the automatic teller machine (ATM) industry in Chile.

3 - Parallelization Strategies for the L-Shaped Method Applied to the Stochastic Network Design Problems

Ragheb Rahmaniani, PhD candidate, CIRRELT, Université de Montréal,André Aisenstadt, CP 6128, Succursale Centre-ville, H3T1J4, montreal, Canada, ragheb.rahmaniani@gmail.com
Teodor Gabriel Crainic, Michel Gendreau, Walter Rei

We describe parallelization strategies for the L-shaped method applied to the two-stage stochastic mixed-integer network design problems with recourse. In particular, we examine sequential, master-slave, and cooperative versions of the L-shaped method. We study the degree of centralization and synchronization as well as the convergence properties of our methodologies. Theoretical findings and encouraging numerical results on a wide range of test problems from the literature are presented.

■ MA06

06-Level 2, Salon 2

Quasi-Monte Carlo Methods for Simulation

Sponsor: Simulation

Sponsored Session

Chair: Pierre L'Ecuyer, Professor, University of Montreal, DIRO, Pavillon Aisenstadt, Montreal, QC, Canada, lecuyer@iro.umontreal.ca

1 - Nonuniform Randomized Quasi Monte Carlo

David Munger, Université de Montréal, C.P. 6128, Succ. Centre-Ville, Montréal, QC, H3C 3J7, Canada, mungerd@iro.umontreal.ca
Antoine Saucier, Michel Gendreau, Pierre L'Ecuyer, Julien Keutchayan

Randomized quasi-Monte Carlo (RQMC) replaces the independent random values in (0,1) used in Monte Carlo integration with mutually dependent structured values to produce an estimator with a smaller variance. Existing RQMC structures sometimes perform poorly to integrate (even smooth) functions of nonuniform variates. To create RQMC structures better adapted to such functions, we extend existing RQMC theory and observe that importance sampling naturally arises. We present exploratory results.

2 - Generation of Scenario Trees Based on Randomized Quasi-Monte Carlo for Solving Stochastic Programs

Julien Keutchayan, Ecole Polytechnique de Montréal, 2900 Boulevard Edouard-Montpetit, Montréal, H3T1J4, Canada, julien.keutchayan@cirrelt.ca, Michel Gendreau, David Munger, Mootez Ben Nasr

The construction of scenario trees is a very important question to consider in order to solve multistage stochastic programs with a continuous state space stochastic process. We will show a new framework for generating scenario trees based on randomized quasi-Monte Carlo and improved by the addition of ANOVA Functional Decomposition method and Importance Sampling. An illustration of this framework with numerical results and comparison with other methods will be shown.

3 - General Software Tool for Constructing Rank-1 Polynomial Lattice Rules

Mohamed Hanini, PhD Student, École Polytechnique de Montréal, 10 Saint Jacques, app704, Montréal, Canada, mohamed.hanini@gmail.com

In this talk we introduce a new software tool and library named Polynomial Lattice Builder, written in C++, that implements a variety of construction algorithms for good rank-1 polynomial Lattice rules, which is one of the best methods to estimate integrals with large dimensions. Component by Component construction leads the optimization of the parameters. We give a valuation of an Asian option as a numerical illustration.

4 - Comparison of Sorting Strategies for the Array-RQMC Method

Pierre L'Ecuyer, Professor, University of Montréal, DIRO, Pavillon Aisenstadt, Montréal, QC, Canada, lecuyer@iro.umontreal.ca

Array-RQMC is a method that simulates an array of n dependent realizations of a Markov chain, in a way to provide a more accurate approximation of the exact state distribution at any step than with independent simulations. At each step, the method reorders the states based on a sorting strategy. When the state has more than one dimension, the performance may depend strongly on the choice of sort strategy. We examine this and make empirical comparisons.

■ MA07

07-Level 2, Salon 3

Inventory Routing

Cluster: Contributed Sessions

Invited Session

Chair: Guy Desaulniers, Polytechnique Montréal and GERAD, 2500 chemin de Polytechnique, Montréal, QC, Canada, guy.desaulniers@gerad.ca

1 - Assembly Inventory Routing Problem (AIRP)

Masoud Chitsaz, CIRRELT, 2920, chemin de la Tour, QC H3T 1J4 CANADA, Montréal, Canada, masoud.chitsaz@cirrelt.net
Jean-François Cordeau, Raf Jans

The Assembly Inventory Routing Problem integrates the production planning of a single end item at a plant with the inbound distribution planning of several components sourced from different suppliers. The decisions relate to the production and routing plans. We propose a mathematical formulation and present some initial computational results.

2 - A Hybrid Heuristic Method for Periodical Inventory Routing Problem (IRP)

Stella Sofianopoulou, Professor, University of Piraeus, 80 Karaoli & Dimitriou str, Piraeus, 18534, Greece, sofianop@unipi.gr
Ioannis Mitsopoulos

A two-part metaheuristic algorithm for the periodical IRP is proposed. The first part is a Memetic Algorithm which provides initial solution(s) to the following Local Search algorithm. This hybridization provides high quality solutions and proves useful when the solution space of the problem hinders Local Search exploitation efforts or when solution quality is of primary importance.

3 - Inventory Routing: Minimizing the Logistics Ratio

Guy Desaulniers, Polytechnique Montréal and GERAD, 2500 chemin de Polytechnique, Montréal, Qc, Canada, guy.desaulniers@gerad.ca, Claudia Archetti, Grazia Speranza

Inventory routing consists of determining when to deliver to each customer, the quantity in each delivery, and the delivery vehicle routes required in every period. Typically, the objective aims at minimizing total routing and inventory costs. Here, we rather consider the nonlinear objective of minimizing the logistics ratio, i.e., the total routing costs divided by the total delivered quantity. We propose a solution algorithm based on branch-and-price and report computational results.

■ MA08

08-Level A, Hémon

Recent Research in DFO (constrained problems and exploiting structure)

Cluster: Derivative-Free Optimization

Invited Session

Chair: Andrew R. Conn, IBM Research, YorkTown Heights, United States of America, arconn@us.ibm.com

1 - A New Derivative-Free Optimization Method for Partially Separable Functions

Laurent Dumas, Professeur, Laboratoire de Mathématiques de Versailles, Versailles, France, laurent.dumas@uvsq.fr
Benjamin Marteau, Didier Ding

We present a new DFO method for partially separable functions. At each iteration, a quadratic interpolation model is minimized in a dynamic trust region. The partial separability of the function is used to reduce the cost of the model update. By exploiting a self-correcting property of the geometry, a theoretical proof of the local convergence is given. Some numerical tests are also performed. They show that the cost is linked to the separability level of the function and not to its dimension.

2 - A New Model-Based Trust-Region Derivative-Free Algorithm for Inequality Constrained Optimization

Mathilde Peyrega, PhD Student, École Polytechnique de Montréal, C.P. 6079, succ. Centre-ville, Montréal, Qc, H3C 3A7, Canada, mathilde.peyrega@gerad.ca
Charles Audet, Andrew R. Conn, SÈbastien Le Digabel

We present a new model-based trust-region algorithm to treat derivative-free optimization (DFO) problems with bounds and inequality constraints. We consider inequality constraints which can be evaluated at infeasible points, but for which their derivatives are not available. The basic models use interpolation and regression. We discuss the management of sample sets, choice of models and approaches to handling constraints, as well as numerical aspects.

3 - Development of a RBF Model-Based Algorithm for Nonlinearly Constrained Derivative-Free Optimization

Stefan Wild, Argonne National Laboratory, Argonne, United States of America, wild@mcs.anl.gov, Rommel Regis

We present our experiences with CONORBIT, a trust-region algorithm using radial basis function models and designed to solve optimization problems where derivatives of the constraints are unavailable. We discuss a number of features in CONORBIT designed to improve its empirical performance on problems where the constraint and/or objective functions are computationally expensive to evaluate.

■ MA09

09-Level A, Jarry

Flight Plan Optimization

Sponsor: Aviation Applications

Sponsored Session

Chair: Wissem Maazoun, Ph.D student, École Polytechnique de Montréal, 2500, chemin de Polytechnique, Montréal, QC, H3T1J4, Canada, wissem.maazoun@polymtl.ca

1 - Cost-Index Optimisation for Minimal-Cost Airplane Flights

Mootez Ben Nasr, Master Student, École Polytechnique de Montréal, Montréal (Quebec) Canada, 2500, chemin de Polytechnique, Montréal, QC, H3T 1J4, Canada, mootez.ben-nast@polymtl.ca, Antoine Saucier, François Soumis

In aeronautics, the cost-index (CI) is a constant fictional fuel cost that is added to the actual fuel cost. The CI is used to take into account all the costs that are not related to fuel, e.g. salaries and late arrival costs. In this presentation, we examine the problem of choosing the CI to minimise the global flight cost. We show how the choice of the CI is related to fuel cost and late arrival cost, and we show how the CI influences the airplane global trajectory.

2 - Design and Analysis of a System for Flight Plans Optimization

Wissem Maazoun, Ph.D Student, École Polytechnique de Montréal, 2500, chemin de Polytechnique, Montréal, QC, H3T1J4, Canada, wissem.maazoun@polymtl.ca, Charles Pestieau, Antoine Saucier, Steven Dufour

The optimal trajectory minimizes all costs. It is obtained by applying a shortest path algorithm on all possible trajectories on a 3D graph. We compute fuel consumption on each edge of the graph, ensuring that each arc has a minimal cost and is covered in a realistic way from the point of view of control. The aerodynamic model used is that proposed by Eurocontrol. Calculations on each arc are done by solving a system of differential equations. To consider the cost of the time, we use the CI.

3 - Building a Generic Commercial Aircraft Model for Flight Paths Optimization

Caroline Dietrich, Polytechnique Montréal, 908-1101, rue Rachel Est, Montréal, QC, H2J2J7, Canada, caroline.dietrich@supaero.isae.fr, Steven Dufour, David Saussié

Flight path optimization remains a challenging issue due to capacity imposition, performance and security requirements. The Base of Aircraft Data (BADA), an aircraft performance model developed by Eurocontrol, provides a useful tool to compute consumption for a given flight path, but is not accurate enough for optimizing a mission trajectory from end to end. This project aims at building a new BADA-based airplane model, which can be used for the formulation of the operations research problem.

4 - Designing an Optimal Route in Terminal Maneuvering Area (TMA)

Jun Zhou, Ecole Nationale de l'Aviation Civile, LB218, 7Av Edouard Belin, 31055, Toulouse, France, junzhou@recherche.enac.fr, Sonia Cafieri, Daniel Delahaye, Mohammed Sbihi

This research focuses on generating 3D departure/arrival routes (SID/STAR) in TMA at a strategic level. The constraints in TMA make it one of the most complex types of airspace. To deal with the difficulty of the problem, we start with optimizing an individual route that avoids the obstacles. To such extent, we propose a Branch and Bound method whose branching strategy is adapted to the considered problem in that it reflects three ways to avoid obstacles, including the use of level flight.

■ MA10

10-Level A, Joyce

Recent Developments in Stochastic Programming Algorithmics

Cluster: Stochastic Optimization

Invited Session

Chair: Ruediger Schultz, University of Duisburg-Essen, Thea-Leymann-Str. 9, Faculty of Mathematics, Essen, D-45127, Germany, ruediger.schultz@uni-due.de

1 - Decision Making under Uncertainty for Unit Commitment with AC Load Flow

Tobias Wollenberg, University of Duisburg-Essen, Thea-Leymann-Strafle 9, Faculty of Mathematics, Essen, D-45127, Germany, tobias.wollenberg@uni-due.de, Ruediger Schultz

In this talk we address unit commitment under uncertainty of infeed from renewables and customers' power demand in alternating current (AC) power systems. The presence of uncertain data leads us to (risk averse) two-stage stochastic programs. To solve these programs to global optimality a recent semidefinite programming approach to the optimal power flow problem is used. This results in specific mixed integer semidefinite stochastic programs for which a decomposition algorithm is presented.

2 - Combining Hessian Approximations in Estimation Problems

Fabian Bastin, University of Montréal, fabian.bastin@cirrelt.ca Tien Mai, Michel Toulouse, Cinzia Cirillo

Estimation problems can be seen as special instances of the sample average approximation framework. If the models are correctly specified, it is possible to exploit asymptotic properties to speed-up computations. Such approaches can be disastrous in case of misspecifications, but convergence can be restored by combining various Hessian approximations. We report experiments on maximum likelihood problems and consider the use of copulas to capture correlations between marginal distributions.

3 - A Mixed-Policy Recourse for the Vehicle Routing Problem with Stochastic Demands

Majid Salavati, Universite de Montréal, C.P. 6128, succ. Centre-ville,, Montréal, Qc, Canada, majid.salavati@cirrelt.ca Michel Gendreau, Walter Rei, Ola Jabali

We consider the variant of the vehicle routing problem in which customer demands are stochastic. Because of that, planned routes may fail due to cumulative demands that exceed vehicle capacity. In this talk, we present recourse strategies for vehicles that trigger returns to the depot based on the risk of failure and the distance to travel from the current customer to the depot. We propose an exact solution methodology to obtain the optimal routing and effective recourse decisions.

4 - Clustering Techniques for Partial Decomposition of Stochastic Integer Programs

Dimitri Papageorgiou, Research Associate, ExxonMobil Research and Engineering Company, 1545 Route 22 East, Annandale, NJ, 08801, United States of America, dimitri.j.papageorgiou@exxonmobil.com

Partial decomposition (PD) was introduced by Crainic et al. as a way of accelerating solution times and improving dual bounds over traditional decomposition schemes for two-stage stochastic integer programs. We present clustering techniques for PD that help determine both the number of scenarios and the particular scenarios that should be retained in the master problem. Computational experiments on a capacitated facility location problem illustrate the benefits of these clustering methods.

■ MA11

11-Level A, Kafka

Models and Methods for Network Design

Cluster: Network Design

Invited Session

Chair: Bernard Gendron, Université de Montréal and CIRRELT, 2920, Chemin de la Tour, Montreal, Canada, Bernard.Gendron@cirrelt.ca

1 - Improved Integer Linear Programming Formulations for the Job Sequencing and Tool Switching Problem

Luis Gouveia, Dept. Statistics and OR, Faculty of Sciences U. Lisboa, Campo Grande Bloco C6, Lisbon, 1749-016, Portugal, legouveia@fc.ul.pt, Martine Labbé, Daniele Catanzaro

We develop new and stronger integer linear programming formulations for the job Sequencing and tool Switching Problem (SSP), a NP-hard combinatorial optimization problem arising from computer and manufacturing systems. The SSP can be viewed as variant of the TSP and in fact. Computational experiments show that the lower bounds obtained by the linear programming relaxation of the new formulations improve, on average, upon those currently described in the literature.

2 - A Supply Chain Network Design Model with Inventory Deployment Decisions

Walid Klibi, KEDGE Business School, 680 Cours de la Libération, Talence, Pl, 33405, France, walid.klibi@kedgebs.com Mehdi Amiri-Aref, Zied Babai

This work deals with a supply chain network (SCN) design problem considering inventory deployment decisions. The SCN design model considers a two-echelon network structure, multiple periods, and an uncertainty on the demand and the replenishment lead-time. The modeling approach proposes the inclusion of inventory deployment decisions under a reorder point order-up-to-level (s,S) policy. This gives rise to a large scale two-stage scenario-based stochastic program that is solved heuristically.

3 - Valid Inequalities for Multilayer Network Design Problem

Mohammad Rahim Akhavan Kazemzadeh, PhD Student, Université de Montréal, Chemin de la Tour, Pavillon André Aisenstadt, Montréal, Canada, akhavanm@iro.umontreal.ca Bernard Gendron, Teodor Gabriel Crainic

Multilayer network design (MLND) has interesting applications in the fields of telecommunications and transportation. In MLND, the network consists of multiple parallel layers that have to be optimized using a single model. This integration outperforms the sequential optimization of single layers. We propose a generalized formulation and three different valid inequalities for MLND. We show that these cuts improve the LP relaxation lower bound and are useful in a branch-and-cut structure.

4 - A New Modeling Approach for Service Network Design using Continuous Time

Fatma Gzara, Assistant Professor, University of Waterloo, 200 University Avenue W, Waterloo, Canada, fgzara@uwaterloo.ca Amin Hosseininasab

We present a new model for the service network design (SNDP) problem that uses continuous time. SNDP constructs a schedule of vehicles to pick up and deliver services within specified times. All models in the literature assume periodic time and represent the problem on a periodic network. We present a new network representation and a new mixed integer programming model. We develop strategies to reduce the network and the model and propose a Benders decomposition solution method.

■ MA12

12-Level A, Lamartine

Constraint Programming II

Cluster: Constraint Programming

Invited Session

Chair: Gilles Pesant, Department of Computer Engineering, Polytechnique Montréal, P.O. Box 6079, Station Centre-ville, Montréal, Canada, gilles.pesant@polymtl.ca

1 - Using Interval Constraint Solving Techniques to Solve Dynamical Systems

Martine Ceberio, Associate Professor, University of Texas at El Paso, 500 West University Avenue, El Paso, TX, 79968, United States of America, mceberio@utep.edu Miguel Argaez, Leobardo Valera, Luis Gutierrez

In this work, we use numerical constraint solving techniques to identify the initial conditions of dynamical systems, such as Fitz-Hugh Nagumo's equations. We study the feasibility of this approach w.r.t. the dimension of the system (how large can systems be and remain solvable) and its prediction capability (how accurate is the IC computation to be used for predictions). We present our preliminary results and discuss future directions for our approach to be used on truly large systems.

2 - Counting Constrained Permutations for Solution-Density Branching in Constraint Programming

Rachid Cherkaoui El Azzouzi, Graduate Student, Ecole Polytechnique de Montréal, 7225 Durocher #ss2, Montréal, Qc, H2N3Y3, Canada, rachid.cherkaoui-el-azzouzi@polymtl.ca Gilles Pesant

At the core of many combinatorial problems (e.g. scheduling, routing) we must build a valid or optimal permutation of the elements of some set, with additional constraints. In this paper we propose exact and heuristic algorithms that compute solution densities for such a purpose. We then show how branching heuristics derived from such information can be effective on some disjunctive scheduling problems.

3 - Solution Counting for the Inter-Distance Constraint

Pierre Ouellet, PhD Student, Polytechnique de Montréal, 2900 Boul.Edouard Montpetit, Montréal, Qc, H3T 1J4, Canada, pierre.ouellet@polymtl.ca, Gilles Pesant

Search heuristics play an important role to solve problems efficiently in constraint programming. Recent efforts at designing heuristics that exploit the number of solutions at the constraint level have led to impressive results. This paper proposes an algorithm that approximates the number of solutions for the Inter-Distance constraint, which ensures that the difference between the values taken by any pair of variables in its scope is greater or equal to a given threshold.

4 - Achieving Domain Consistency and Counting Solutions for Spread and Deviation Constraints

Gilles Pesant, Department of Computer Engineering, Polytechnique Montréal, P.O. Box 6079, Station Centre-ville, Montréal, Canada, gilles.pesant@polymtl.ca

The spread and deviation constraints express balance among a set of variables by constraining their mean and their overall deviation from the mean. Currently the only practical filtering algorithms known for these constraints achieve bounds consistency. We improve that filtering by presenting an efficient domain consistency algorithm that applies to both constraints. We also extend it to count solutions so that it can be used in counting-based search.

■ MA13

13-Level A, Musset

Competitive Pricing

Sponsor: Pricing & Revenue Management

Sponsored Session

Chair: Mikhail Nediak, Queen's University, 143 Union Str., Kingston, ON, Canada, mikhail.nediak@queensu.ca

1 - Pricing in Seasonal Competitive Markets

Steven Shugan, McKethan-Matherly Professor and Eminent Scholar, University of Florida, 201 Bryan Hall, Campus Box 117155, Gainesville, FL, 32611-7155, United States of America, sms@ufl.edu, Haibing Gao

We model optimal pricing strategy in competitive seasonal markets. In the Bertrand-Nash seasonal equilibrium, our model predicts that high seasons increase the firm's ability to increase profits with price discrimination mechanisms. To test our model's predictions, we use lodging data for seven international beach cities exhibiting conspicuous seasonal demand fluctuations. We confirm our model predictions and find an interesting interaction effect.

2 - Price Competition in the Presence of Social Comparison and Demand Uncertainty

Yun Zhou, Rotman School of Management, University of Toronto, 105 St. George Street, Toronto, Canada, Yun.Zhou13@Rotman.Utoronto.Ca, Ming Hu

We consider a duopoly that engages in price competition of differentiated substitutable products under additive demand uncertainty, and in which the members of the duopoly make profit comparisons with each other. We demonstrate how opposite-directional social comparisons interact with demand variability to change competitive behaviour.

3 - Capacity and Price-Matching Competition with Strategic Consumers
Mikhail Nediak, Queen's University, 143 Union Str., Kingston, ON, Canada, mikhail.nediak@queensu.ca
Yossi Aviv, Andrei Bazhanov, Yuri Levin

Price matching (PM) is important to all market participants since PM can not only mitigate the loss from strategic customer behavior but even lead to gains from higher levels of this behavior under competition. Retailer profit with PM can be less than the worst profit without PM. Manufacturer never benefits from PM except for branded products when the sales at reduced prices are undesirable. On the other hand, policymakers may encourage PM since it can improve the aggregate welfare.

■ MA14

14-Level B, Salon A

Energy Systems I

Cluster: Energy

Invited Session

Chair: Diego Klabjan, Northwestern University, 2145 Sheridan Road, IEMS, Evanston,IL, United States of America, d-klabjan@northwestern.edu

1 - Probabilistic Criteria for Power System Reliability Management
Efthymios Karangelos, Universite de Liège, 10 Grande Traverse, Liege, 4000, Belgium, e.karangelos@ulg.ac.be, Louis Wehenkel

In today's power systems, uncertainty is growing along with the growth of renewable generation and the ageing of the infrastructure. While technological opportunities to manage such uncertainty also advance, the inefficiency of the deterministic N-1 reliability management criterion is being recognized. In this setting, we propose novel probabilistic criteria considering threat probabilities, corrective control and its possible failure, and, the socio-economic impact of service interruptions.

2 - Optimization of Time-Varying Electricity Rates
Diego Klabjan, Northwestern University, 2145 Sheridan Road, IEMS, Evanston, IL, United States of America, d-klabjan@northwestern.edu, Jacob Mays

The recent spread of advanced metering infrastructure has led many utilities to consider extending variable-rate electricity pricing to smaller commercial and residential customers. We consider the optimal design of Time-of-Use and Critical Peak Pricing schemes and quantify their potential benefits in comparison to Real Time Pricing.

3 - Approximate Stochastic Dynamic Programming for Hydroelectric Production Planning
Bernard F. Lamond, Professor, Universite Laval, Dep. Operations & Systemes de Decision, 2325, rue de la Terrasse #2620, Quebec, QC, G1V 0A6, Canada, Bernard.Lamond@fsa.ulaval.ca
Luckny Zephyr, Pascal Lang, Pascal Coté

We present a simplicial decomposition of the state space for approximating the value function, where the vertices define an irregular grid. Bounds on the true value function are used to refine the grid. We develop analytical forms for the expectation using a "uni-bassin" feature shared by many reservoir systems. The methodology is experimented on an actual hydroelectric utility.

4 - Fast Near-Optimal Heuristic for the Short-Term Hydro-Generation Planning Problem
Alexia Marchand, PhD Student, Ecole Polytechnique de Montréal, 2900 boulevard Edouard-Montpetit, Montréal, QC, H3T 1J4, Canada, alexia.marchand@polymtl.ca, Michel Gendreau, Marko Blais, Grégory Emiel

Short-term hydro-generation planning can be modeled as a mixed integer linear program. However, for Hydro-Quebec's system, the resulting MILP is too big to be solved in a reasonable time with commercial solvers. We developed a three phases heuristic based on spatial decomposition that yields to fast near-optimal solutions. We will present this approach and give numerical illustrations on real problem instances.

■ MA15

15-Level B, Salon B

Applications in Scheduling

Cluster: Practice

Invited Session

Chair: Anne Mercier, GIRO inc., 75, rue de Port-Royal Est, bureau 500, Montréal, QC, Canada, anne.mercier@giro.ca

1 - Simultaneous Operating Theatre Planning and Patient Selection
Hamideh Anjomshoa, Research Scientist, IBM Research Australia, level 5, Lygon street,, Carlton, Vic, 3053, Australia, hamideh.a@au.ibm.com
Irina Dumitrescu, Olivia Smith

Managing operating theatres has a crucial role in hospitals. In this talk, we describe a mixed integer programming approach to simultaneously allocate operating theatre time to surgery units, and select patients to be treated from waiting lists. We take into account resource constraints and financial considerations. This work has been done for a public hospital in Melbourne. Computational experiments are presented.

2 - Dockworkers and Screening Officers
Louis-Philippe Bigras, Horasphere, louis-philippe.bigras@horasphere.com

In this presentation, we are going to present two scheduling problems that we have encountered during our practice and we will show how we have tackled them using classical (but not necessarily textbook) o.r. techniques.

3 - Optimal Order Splitting on a Multi-Slot Machine in the Printing Industry
Norbert Trautmann, Professor, University of Bern, Schuetzenmattstrasse 14, Bern, 3012, Switzerland, norbert.trautmann@pqm.unibe.ch, Philipp Baumann, Salome Forrer

The planning situation we deal with comes from a swiss-based SME. In order to imprint customer-specific designs on napkin pouches, given customer orders are to be split among several slots of printing plates such that the total costs are minimized. We present two alternative MILP formulations which eliminate symmetric solutions implicitly or explicitly, respectively, from the search space. The implicit formulation solves more instances to feasibility, and the average integrality gap is smaller.

4 - A Hybrid Goal Programming Approach for Staff Assignment
Philipp Baumann, UC Berkeley, Etcheverry Hall, Berkeley, United States of America, philipp.baumann@berkeley.edu
Tom Rihm

We introduce a hybrid goal programming approach for staff assignment problems with a large number of requirements related to work laws and preferences of employees. The approach allows more accurate specification of trade-offs between requirements than existing goal programming approaches. We applied the approach to real world instances provided by a Swiss developer of workforce scheduling software. The resulting schedules compare favorably to schedules obtained by the developer's software.

■ MA16

16-Level B, Salon C

Tutorial: Planning and Control of Container Terminals Operations

Cluster: Tutorials

Invited Session

Chair: Iris F.A. Vis, Professor of Industrial Engineering, University of Groningen, Faculty of Economics and Business, P.O. Box 800, Groningen, Netherlands, i.f.a.vis@rug.nl

1 - Planning and Control of Container Terminals Operations
Iris F.A. Vis, Professor of Industrial Engineering, University of Groningen, Faculty of Economics and Business, P.O. Box 800, Groningen, Netherlands, i.f.a.vis@rug.nl

Container terminals worldwide continuously focus on improving their processes to retain their level of competitiveness. In this tutorial an overview of operations in container terminals will be given. For a variety of decision problems occurring at the berth, storage yard and internal transportation processes models and solution approaches will be shown. New avenues for academic research based on current trends and technological developments in the container terminal industry will be discussed.

■ MA17

17-Level 7, Room 701

Real Options

Sponsor: Financial Services Section

Sponsored Session

Chair: Dharma Kwon, University of Illinois at Urbana-Champaign, Department of Business Administration, Champaign, United States of America, dhkwon@illinois.edu

1 - Impact Of Spillover In Research And Develpment Competition

Wenxin Xu, University of Illinois, wxu9@illinois.edu
Dharma Kwon, Jovan Grahovac

Why are some firms willing to disclose their intellectual properties to their competitors while others are not? To answer this, we investigate a game theoretic duopoly model to examine the impact of spillover on R&D investment strategies when the R&D completion times are uncertain. We find that spillover may or may not hurt the more efficient firm. We identify the conditions under which the more efficient firm benefits from spillover.

2 - American Contracts for Power System Balancing

Jan Palczewski, University of Leeds, Woodhouse Lane, Leeds, LS2 9JT, United Kingdom, J.Palczewski@leeds.ac.uk
John Moriarty, David Szabo

We study utilisation of storage for balancing of power systems. This is formulated as repeated issuance of American-type real options on physical delivery/consumption of power. Using methods of optimal stopping we derive analytically optimal strategies for management of the installed storage and assess its profitability for power system balancing. We depart from the usual monetary description of the market in favour of modelling physical imbalance between supply and demand.

3 - Competitive Investment in Shared Supplier under Spillover and Uncertainty

Youngsoo Kim, PhD Student, University of Illinois at Urbana-Champaign, 350 Wohlers, 1206 S. Sixth, Champaign, Il, 61820, United States of America, ykim180@illinois.edu
Dharma Kwon, Anupam Agrawal, Suresh Muthulingam

We consider two competing buyers who can invest into their common supplier under spillover and uncertainty. One firm's investment could be spilled to the other through the shared supplier. Moreover, return on investment is unknown to the buyers though it can be learned based on the supplier's performance. Modeling as real option game, we find two equilibria, one of which has been rarely studied in literature, and we characterize the conditions under which the investment is hastened or delayed.

4 - On an Optimal Variance Stopping Problem

Pekka Matomaki, University of Turku, Rehtorinpellonkatu 3, Turku, 20014, Finland, pjsila@utu.fi, Kamille Gad

I will discuss quite comprehensively about optimal stopping of a variance of a linear diffusion. Especially, I will reveal its close connection to a game theory. Also, I will show that the optimal solution might follow a genuine mixed strategy policy. This variance stopping problem reveals phenomena and suggests solution methods that could be helpful when facing more complex non-linear optimal stopping problems - E.g. it could shed some new light into the mean-variance optimization problem.

■ MA18

18-Level 7, Room 722

Decision Making and Manufacturing

Cluster: Contributed Sessions

Invited Session

Chair: Komal Khalid, Assistant Professor, King Abdulaziz University, Jamia, Faculty of Ec & Admin, Postbox 42804, Jeddah, Je, 21551, Saudi Arabia, komalkhalidbhatti@gmail.com

1 - Operational Research Assisted 3-D Printing and Additive Manufacturing

Vassilis Dedoussis, Professor, University of Piraeus, 80 Karaoli & Dimitriou st, Piraeus, 18534, Greece, vdedo@unipi.gr
Vassilios Canellidis, John Giannatsis

3D Printing or Additive Manufacturing is a new manufacturing technique capable of fabricating complex shaped physical parts by gradual material addition. The need for their most efficient utilization is evident. In this paper various heuristic techniques based on evolutionary algorithms for optimizing the selection of built parameters and the process planning-phase are described and compared in ëreal-world' test cases. This paper is partly supported by Univ. of Piraeus Research Center.

2 - Fuzzy Developed Tool for Assessing Risk of Failure of Lean Implementation

Ahmed Deif, Assistant Professor, California Polytechnic State University, 1 Grand Ave, San Luis Obispo, CA, 93407, United States of America, adeif@calpoly.edu, Hosam Mostafa

This paper introduces a new tool that measures the risk of lean implementation failure inside enterprises. The tool LIFRAT (Lean Implementation Failure Risk Assessment) is designed based on a proposed model that manipulated fuzzy logic to measure the risk of lean failure. LIFRAT takes input from users for preset multiple indicators that measure different aspect of lean inside the enterprise. The indicators cover four major lean success categories namely; managerial indicators, functional indicators, human factors indicators and external indicators.A sensitivity analysis was carried out to investigate the impact of the selected four main categories of lean indicators and the associated risk of failure. The developed tool was further demonstrated using four hypothetical cases of enterprises at four different stages of business life cycle. Results illustrated the ability to quantify the risk of lean implementation failure. In addition, they showed that the risk of failure to implement lean system depends on the life cycle stage of the enterprise as well as the different weights allocated for the previous mentioned indicators. The developed tool and the presented results aim to aid managers in successful transformation/implementation of lean polices via reducing the risk of failure of such process.

3 - Influence of Employee Cynical Behavior on Employee Retention: In the Context of Employee Mentoring

Nailah Ayub, Assistant Professor, King Abdulaziz University, Jamia, Faculty of Ec & Admin, Postbox 42804, Jeddah, Je, 21551, Saudi Arabia, ayubnailah@gmail.com, Komal Khalid

Purpose of the research study is to analyse the influence of employee mentoring on the relationship of employee cynical behavior and employee turnover intention from Pharmaceutical and banking sectors. In banking ECB influence ETI but mentoring function can reduce this influence while in pharmaceutical mentoring influencing this relationship comparatively less.

4 - Glass Ceiling Beliefs and Career Opportunities in Pakistani Women

Komal Khalid, Assistant Professor, King Abdulaziz University, Jamia, Faculty of Ec & Admin, Postbox 42804, Jeddah, Je, 21551, Saudi Arabia, komalkhalidbhatti@gmail.com, Nailah Ayub

We explored the glass ceiling beliefs of women in Pakistan (i.e., denial, resilience, acceptance, and resignation) and their relationship with opportunities at work. There was more resilience followed by resignation, acceptance and then denial. The more pessimistic the beliefs, the less the opportunities were perceived. Qualification, however, moderated this relationship.

■ MA19

19-Grand Ballroom West

Tutorial: Deep Learning

Cluster: Tutorials

Invited Session

Chair: Yoshua Bengio, Full Professor, Université de Montréal, 2920 chemin de la Tour, Dept. IRO, suite 2194, Montreal, QC, H3T1J4, Canada, yoshua.bengio@gmail.com

1 - Deep Learning

Yoshua Bengio, Full Professor, Université de Montréal, 2920 chemin de la Tour, Dept. IRO, suite 2194, Montréal, Qc, H3T1J4, Canada, yoshua.bengio@gmail.com

Deep learning methods are machine learning approaches based on learning multiple levels of representation. Deep learning has already been extremely successful in speech recognition, computer vision and is quickly rising as a major tool for natural language processing. We motivate deep learning and review recent results regarding the optimization challenge involved, as well as the probabilistic and geometric interpretation of unsupervised deep learning methods based on auto-encoders.

Monday, 11:00am - 12:00pm

■ MB20

20-Grand Ballroom Centre

Monday Plenary

Cluster: Plenary Talks

Invited Session

Chair: Michel Gendreau, Professor, École Polytechnique de Montréal, C.P. 6079, succ. Centre Ville, Montréal, QC, H3C 3A7, Canada, michel.gendreau@cirrelt.net

1 - IFORS Distinguished Lecture - Practical Optimization – Certainly Uncertain

Ruediger Schultz, University of Duisburg-Essen, Thea-Leymann-Str. 9, Faculty of Mathematics, Essen, D-45127, Germany, ruediger.schultz@uni-due.de

"Go West, young man, get yourself involved in planning under uncertainty." In an interview in 1999 George Dantzig said that this probably would have been his message to the INFORMS crowd that was to gather on the occasion of his 85th birthday. By sheer coincidence, my talk will start in the East addressing a practical optimization problem under uncertainty where, as will be seen, there has not much been left for optimization but still something for planning. Both practical need and inner mathematical thirst for knowledge have mutually stimulated research in optimization under uncertainty, of which the talk will address its stochastic branch. Simple problems con?rm that only the presence of uncertainty makes them nontrivial, yet requires optimization at all. Stochastic programming problems that easily can be formulated have initialized substantial algorithmic innovation beyond the traditional convex models in continuous variables. This went hand in hand with practical paradigm changes, such as deregulation and unbundling, which will be illustrated at cases from the power and gas industries. Getting back to the interview where George Dantzig confirmed considering himself a mathematician and denied there is a difference between pure and applied mathematics, I will make an attempt to support this by pointing to fruitful interaction of stochastic programming not only with the mathematical disciplines forming its name but also with topics from algebra and analysis for which interaction might come as a surprise.

Monday, 1:30pm - 3:00pm

■ MC01

01-Level 4, Salon 8

Student Paper Prize 1

Cluster: CORS Functions

Invited Session

Chair: Michel Gendreau, Professor, École Polytechnique de Montréal, C.P. 6079, succ. Centre Ville, Montréal, QC, H3C 3A7, Canada, michel.gendreau@cirrelt.net

1 - CORS Student Paper Prize Final 1

The sessions feature finalists of the 2015 CORS student paper competition that recognizes the contribution of a paper either directly to the field of operational research through the development of methodology or to another field through the application of operational research. Prizes are awarded in two categories: Undergraduate and Open.

■ MC02

02-Level 3, Drummond West

Hospital Operations

Cluster: Healthcare

Invited Session

Chair: Manaf Zargoush, McGill University, 3421 Drummond, Apt. 117, Montréal, H3G1X7, Canada, zargoush@gmail.com

1 - A Predictive Model for Advance Appointment Cancellations

Shannon L. Harris, University of Pittsburgh, 241 Mervis Hall, Pittsburgh, PA, 15213, United States of America, sharris@katz.pitt.edu, Jerrold H. May, Luis G Vargas

Predicting appointment cancellations in advance are challenging, because the models need to consider binary (e.g., cancellation yes/no) and continuous (e.g., lead time before cancellation) variables. We developed a model that predicts both variables in a one-step model and compare the results with those of two-step hierarchical models. We illustrate the model with data from a Veteran's Administration outpatient clinic.

2 - Hypertension Management under Noise-Free Measurement: Insights to the Optimal Treatment

Manaf Zargoush, McGill University, 3421 Drummond, Apt 117, Montréal, H3G1X7, Canada, zargoush@gmail.com, Mehmet Gumus, Vedat Verter, Stella Daskalopoulou

We formulate the antihypertensive prescription problem as a Markov Decision Process, and we explore the structure of optimal treatment policies. We show how our modeling paradigm can be used to personalize the treatment decisions. Using our personalized modeling, we also investigate the impact of several risk factors including age, blood pressure level, gender, smoking status and diabetes on the optimal policies. We finally compare our results with the current medical guidelines.

3 - Reimburse Obstetricians to Eliminate Unnecessary Caesarean Sections

Cheng Zhu, PhD Candidate, McGill University, Bronfman Building, 1001 Sherbrooke West, Montréal, QC, H3A 1G5, Canada, cheng.zhu@mail.mcgill.ca, Beste Kucukyazici

Rate of C-section, which exposes potential harms on mothers and newborns as well as heavy economic burden, has been increasing constantly and this growth raises some concerns for the policy makers. This research focuses on optimizing the financial incentives, i.e. choosing best payment scheme and optimizing how to reimburse obstetricians under this scheme, in order to reduce the C-section rates without sacrificing birth quality while alleviating economic burden for overall health care system.

■ MC03

03-Level 3, Drummond Centre

Big Data in Forest Decision Support Systems

Cluster: Applications of OR in Forestry

Invited Session

Chair: Mikael Rönnqvist, Université Laval, 1065, avenue de la Médecine, Quebec, QC, G1V 0A6, Canada, mikael.ronnqvist@gmc.ulaval.ca

1 - Big Data: Challenges and Opportunities in the Forest Sector

Sophie D'Amours, Université Laval, 2320 rue des Bibliothèques, Québec, Qc, Canada, sophie.damours@vrr.ulaval.ca

The incredible amount of information and data that is available today opens up huge opportunities when developing decision support systems. For example, it provides the true analytical capacity for stochastic, multi-objective and anticipative planning. This presentation will present a comprehensive framework to describe big data challenges and opportunities within the forest sector. It will illustrate how decision theaters could build on big data and support decision making in the sector.

2 - Planning of Wood Supply in the Swedish Forestry Sector Today and Tomorrow

Lennart Rådström, Skogforsk, lennart.radstrom@skogforsk.se

The Swedish forestry sector has a strong tradition in planning of wood supply, which comprises solving of supply and demand problems for different mills, including sourcing of wood, harvesting planning and logistics, where logging and transport are key components. We describe how planning and control of logging and transport operations have developed over time and the shift from operations efficiency and costs, to total wood supply efficiency including costs and revenues. We also show how a company works today, to achieve wood supply efficiency, and discuss trends for the future.

■ MC04

04-Level 3, Drummond East

OR in Mine Planning III

Cluster: Applications of OR in the Mining Industry

Invited Session

Chair: Amina Lamghari, McGill University, 3450, University Street, Room 113, Montreal, QC, H3A 2A7, Canada, amina.lamghari@mcgill.ca

1 - Optimization of Feasible Mining Pushbacks for Long-Term Open Pit Strategic Planning

Xiaoyu Bai, École Polytechnique, 12-3360 Cote-Sainte-Catherine, Montréal, QC, H3T1C6, Canada, xiaoyu.bai@polymtl.ca
Denis Marcotte, Michel Giamache, Damian Gregory, Alain Lioret

An algorithm based on mathematical morphology operators is developed to transform open pit mining pushbacks to be mineable geometries. Applying the algorithm on the nested optimal parametric pits creates initial feasible pushbacks. Then a tabu search method is used to improve the NPV and maintain the geometric and tonnage constraints. New feasible pushbacks are generated by exchanging blocks between different pushbacks and then modifying the geometries.

2 - MIP-Based Heuristics to Optimize Block Scheduling: Improving Known Solutions in MineLib

Enrique Jelvez, PhD Student Mining Engineering, Universidad de Chile, Avenida Tupper 2069, Santiago, 8370451, Chile, ejelvez@ug.uchile.cl, Nelson Morales, Pierre Nancel-Penard

In open-pit mine planning, the block scheduling problem consists of getting an extraction sequence that maximizes the NPV of the extracted blocks, subject to technical and economical constraints. Due to this problem is very hard, how to produce good feasible solutions is an active research topic. In turn, it has been published a library of open-pit mining problems named Minelib. In this work, we present a heuristic that produces better feasible solutions than the ones published in MineLib.

3 - A Multi-Neighborhood Tabu Search Metaheuristic for Stochastic Production Scheduling

Renaud Senecal, Graduate Student, McGill University, 4070-3 Gertrude, Verdun, Qc, H4G 1R8, Canada, renaud.senecal2@mail.mcgill.ca, Roussos Dimitrakopoulos

A multi-neighborhood metaheuristic solution for open pit mine production scheduling with multiple destinations and supply (geological) uncertainty is presented. The optimization process provides the period (year) of extraction and a destination for materials mined from the deposit. A case study shows the computational advantages of the methods.

4 - An Adaptive Large Neighborhood Search Heuristic for a Stochastic Mine Production Scheduling Problem

Amina Lamghari, McGill University, 3450, University Street, Room 113, Montréal, QC, H3A 2A7, Canada, amina.lamghari@mcgill.ca, Roussos Dimitrakopoulos

We consider a variant of the open-pit mine production scheduling problem, accounting for metal uncertainty and multiple destinations for the mined material. The problem is formulated as a two-stage stochastic problem with recourse, and an adaptive large neighborhood search heuristic is developed to solve this formulation. Numerical results are provided to indicate the efficiency of the proposed solution method and its superiority over recent algorithms from the literature.

■ MC05

05-Level 2, Salon 1

Logistics, Transportation, and Distribution II

Sponsor: Transportation Science & Logistics

Sponsored Session

Chair: Leandro Callegari Coelho, Assistant Professor, CIRRELT and Université Laval, 2325 de la Terrasse, Quebec, QC, G1V0A6, Canada, Leandro.Coelho@fsa.ulaval.ca

1 - Solving the Vehicle Routing Problem with Lunch Break Arising in the Furniture Delivery Industry

Leandro Callegari Coelho, Assistant Professor, CIRRELT and Université Laval, 2325 de la Terrasse, Quebec, Qc, G1V0A6, Canada, Leandro.Coelho@fsa.ulaval.ca
Jacques Renaud, Angel Ruiz, Jean-Philippe Gagliardi

We solve the Vehicle Routing Problem with Lunch Break (VRPLB) as it appears in the furniture delivery industry. We evaluate the performance of a new mathematical formulation for the VRPLB. In order to tackle large instances provided by an industrial partner, we propose a fast local search-based heuristic tailored for the VRPLB, which is shown to be very efficient.

2 - Heuristics and Exact Methods for Order Picking in Narrow Aisles

Thomas Chabot, PhD Student, Université Laval, 2325 Rue de l'Université, Québec, QC, G1V 0A6, Canada, thomas.chabot.1@ulaval.ca, Jacques Renaud, Leandro Coelho, Jean-François Coté

Order picking is one of the most important operations in warehouse management. Working with an industrial partner from the furniture delivery industry, we model their 3D narrow aisles warehouse as a vehicle routing problem through a series of distance transformations. Through extensive computational experiments, we compare our solutions with those of the company, showing that significant improvements can be obtained by using our approach.

3 - Exact Formulations and Algorithm for the Multi-Depot Fleet Size and Mix Vehicle Routing Problem

Rahma Lahyani, Postdoctoral fellow, Laval University, 2325, rue de la Terrasse, Quebec, Qu, G1V 0A6, Canada, rahma.lahyani@cirrelt.ca, Leandro Callegari Coelho, Jacques Renaud

In this paper we model and solve a complex variant of the VRP called the Multi-depot Fleet Size and Mix VRP. We propose four mixed-integer linear programming formulations and we introduce known and valid inequalities. We then describe a branch-and-cut algorithm. We assess the performance of the algorithm on various instances. We provide lower and upper bounds and we present a computational comparison of all linear formulations in terms of the instance sizes and solution quality.

■ MC06

06-Level 2, Salon 2

Stochastic Modeling and Optimization in Call Centers and Service Systems

Sponsor: Simulation

Sponsored Session

Chair: Pierre L'Ecuyer, Professor, University of Montréal, DIRO, Pavillon Aisenstadt, Montréal, QC, Canada, lecuyer@iro.umontreal.ca

1 - Simulation-Based Scheduling of Agents using Forecast Call Arrivals in Call Centers

Marie Pelleau, Postdoctoral Fellow, University of Montréal, marie.pelleau@gmail.com, Pierre L'Ecuyer, Louis-Martin Rousseau

The call center managers need to deliver both low operating costs and high service quality. Their task is especially difficult because they need to handle a large workforce while satisfying an incoming demand that is typically both time-varying and uncertain. The current techniques for determining the employees schedule according to the forecast call volumes are often unreliable, and there is a need for more accurate methods. In this paper, we focus on the multi-activity shift scheduling problem

2 - Real-Time Waiting Time Predictor in Multi-Skill Call Centers

Mamadou Thiongane, PhD Student, University of Montréal, Montréal, Canada, mamadou.thiongane@umontreal.ca
Pierre L'Ecuyer

We develop real-time delay predictors for multi-skill call centers based on the system state at the customer arrival and on the waiting time of the last served customer. These delay predictors can be used to make delay announcements. We conduct computer simulations to show that the proposed predictors perform better than the existing predictor in multi-skill call centers.

3 - Chance-Constrained Staffing with Recourse for Multi-Skill Call Centers with Arrival-Rate Uncertainty

Wyean Chan, Postdoctoral Fellow, Université de Montréal, Pavillon André-Aisenstadt, DIRO, Montréal, Canada, chanwyea@iro.umontreal.ca, Pierre L'Ecuyer

We consider a two-stage stochastic staffing problem for multi-skill call centers. The objective is to minimize the cost of agents under a chance constraint, defined over the randomness of the arrival rates, to meet all the service level targets. First, we find an initial staffing based on imperfect forecast. Then, this staffing is corrected by applying recourse when the forecast becomes more accurate. We present a method that combines simulation with integer programming and cut generation.

■ MC07

07-Level 2, Salon 3

Pickup and Delivery

Cluster: Contributed Sessions

Invited Session

Chair: Sin C. Ho, Aarhus University, Fuglesangs Allé 4, Aarhus, Denmark, sinho@econ.au.dk

1 - Branch-Price-and-Cut Algorithms for the Pickup and Delivery Problem with Multiple Stacks

Marilène Cherkesly, École Polytechnique de Montréal, GERAD, 3000, ch. de la Cote-Sainte-Catherine, Montréal, QC, H3T 2A7, Canada, marilene.cherkesly@gerad.ca
Stefan Irnich, Guy Desaulniers, Gilbert Laporte

We model and solve the pickup and delivery problem with time windows and multiple stacks. Each stack is rear-loaded and is operated in a last-in-first-out (LIFO) fashion. To solve this problem, we propose two different branch-price-and-cut algorithms. Computational results and a comparison between both algorithms will be presented.

2 - Relief Vehicle Routing under Uncertainty

Yinglei Li, Binghamton University, P.O. Box 6000, Binghamton, NY, United States of America, yli90@binghamton.edu
Sung Hoon Chung

We explicitly consider uncertainty in designing a vehicle route for delivering critical supplies after a large disaster. We propose the robust optimization approach to minimize the impact of uncertainty and eventually to achieve enhanced resilience in the aftermath of disasters. We also explore several numerical methods and algorithms such as interior point methods and heuristics to solve the robust vehicle routing problem in the context of humanitarian relief.

3 - GRASP with Path Relinking for the Selective Pickup and Delivery Problem

Sin C. Ho, Aarhus University, Fuglesangs Allé 4, Aarhus, Denmark, sinho@econ.au.dk, W. Y. Szeto

We study the selective pickup and delivery problem and present a GRASP with path-relinking for solving the problem. Experimental results show that this simple heuristic can generate high quality solutions using small computing times.

■ MC08

08-Level A, Hémon

Dynamic Scaling, Evolution Strategies and Application of DFO

Cluster: Derivative-Free Optimization

Invited Session

Chair: Yves Lucet, Associate Professor, University of British Columbia, ASC 350, Computer Science unit 5, 3187 University Way, UBC Okanagan, Kelowna, BC, V1V 1V7, Canada, yves.lucet@ubc.ca

1 - Derivative-Free Bilevel Optimization in Road Design

Yves Lucet, Associate Professor, University of British Columbia, ASC 350, Computer Science unit 5, 3187 University Way, UBC Okanagan, Kelowna, BC, V1V 1V7, Canada, yves.lucet@ubc.ca
Sukanto Mondal, Warren Hare

We split the road design problem (building the cheapest road that satisfies safety and regulation constraints) in 2 subproblems: the horizontal alignment (computing a satellite view of the road), and the vertical alignment and earthwork (determining where to cut or fill material and deciding what material to move where). We report numerical results on using derivative-free optimization for the former and a mixed-integer linear program for the later.

2 - Dynamic Scaling in the Mesh Adaptive Direct Search (MADS) Algorithm for Blackbox Optimization

Charles Audet, Professor, École Polytechnique de Montréal, C.P. 6079, succ. Centre-ville, Montréal, Qc, H3C 3A7, Canada, Charles.Audet@gerad.ca

We propose a way to dynamically scale the mesh, which is the discrete spatial structure on which MADS relies, so that it automatically adapts to the characteristics of the problem. This allows to dynamically adapt the mesh in an anisotropic way. The main idea is that when a new incumbent solution is found, the mesh is coarsened only with respect to the variables that varied significantly. A nonsmooth convergence analysis and numerical results on a supersonic jet design problem are presented.

3 - Evolution Strategies for Continuous Black-Box Optimization

Alexandre Chotard, Université Paris Sud, Projet TAO, INRIA Saclay - Ile de France, LRI, BatÓment 490 Université Paris-Sud, Orsay, 91400, France, alexandre.chotard@gmail.com

Evolution Strategies (ES) are derivative-free stochastic optimization algorithms tailored for the optimization of black-box problems. ES are known in practice to converge geometrically fast. In some contexts proofs of their geometric convergence have been established using ODE or Markov chain theory. We will discuss the latter method after having introduced ES algorithms, results achieved through it and how they are relevant in practice.

■ MC09

09-Level A, Jarry

Optimization in Air Traffic Control I

Sponsor: Aviation Applications

Sponsored Session

Chair: Jérémy Omer, Postdoctoral Fellow, École Polytechnique Montréal - Group for Research in Decision Analysis, GERAD - HEC Montréal, 3000, CÙte Sainte Catherine, Montréal, QC, H3T 2A7, Canada, jeremy.omer@gmail.com

1 - Robust Aircraft Separation under Wind Uncertainty

Jérémy Omer, Postdoctoral Fellow, Ecole Polytechnique Montréal - Group for Research in Decision Analysis, GERAD - HEC Montréal, 3000, CÙte Sainte Catherine, Montréal, QC, H3T 2A7, Canada, jeremy.omer@gmail.com

The optimization of air traffic control aims at increasing the airspace capacity and flexibility of use. Meteorological forecast and trajectory predictions being inexact, uncertainty is an important issue. More specifically, there must be a guarantee that the air traffic remain safe in any realistic scenario. A robust programming method is thus†developed to explicitly include errors on wind predictions and speed measures when separating conflicting†aircraft.

2 - A New Any-Angle Approach for 2D Path Planning

Omar Souissi, Dr, Université de Valenciennes, Campus Mont Houy, Valenciennes, 59300, France, souiomar@hotmail.com
Mladenovic Marco, Rabie Benatitallah, David Duvivier, Abdelhakim Artiba

In the last two decades the continuous improvement in robotics and video games led to extraordinary intelligent systems. The key requirement for progress in such areas is undoubtedly the path planning. In this context, we propose a new approach "The 2D Active A*" which combines the use of the Quadtree environment modeling method with a new any-angle path planning algorithm. We show that our new approach produces paths in the same speed order as the A* while improving the quality of the solution.

3 - Mechanism Design for the Resolution of Air Traffic Conflicts

Jérome Le Ny, Assistant Professor, Polytechnique Montréal and GERAD, 2500 ch. de Polytechnique, A-429.13, Pavillon Principal, Montréal, QC, H3T1J4, Canada, jerome.le-ny@polymtl.ca
Jérémy Omer

We consider the conflict resolution problem in air traffic control, in a setting where airlines can provide individual cost functions for their aircraft to a centralized trajectory optimization procedure. Since the airlines could lie about their costs to gain a strategic advantage, we use mechanism design techniques to attempt to extract their true cost profiles. We discuss how such a scheme could be implemented in practice, and illustrate its benefits via simulations.

4 - Optimization of Engine Out Takeoff Trajectory

Bastien Talgorn, GERAD, 3000, Cote-Sainte-Catherine Rd, Montréal, Canada, bastientalgorn@yahoo.fr, Serge Laporte

Aircraft Maximum TOW is calculated on the SID (Standard Instrument Departure) in the case of engine failure, in order to respect regulatory constraints. In case of mountainous landscape, an alternative trajectory (Engine Out SID) can be designed to reduce obstacle clearance constraints. The EOSID is only used in the case of an engine failure. The aim of this study is to develop a software to optimize EOSID lateral path to maximize the regulatory TOW.

5 - 3D Flight Plan Rescheduling

Zineb Baklouti, 1, UVHC, Université de Valenciennes, Valenciennes, 59300, France, zeineb.baklouti@univ-valenciennes.fr, Abdelhakim Artiba, Omar Souissi, Rabie Benatitallah, David Duvivier

Nowadays, ensuring a safe flight mission is a key-differentiator in the aviation sector. It comes to save the equipment and human lives. However, current assistance systems are not appropriate to ensure the security requested level. Our research concerns the flight plan rescheduling based on 3D algorithms able to avoid obstacles and meet time constraints while offering a high autonomy level to the system. In this article, we will present state-of-the-art of 3D path planning methods.

■ MC10

10-Level A, Joyce

Stochastic Mixed-Integer and Nonlinear Programming for Power Systems Applications

Cluster: Stochastic Optimization

Invited Session

Chair: Jean-Paul Watson, Distinguished Member of Technical Staff, Sandia National Laboratories, P.O. Box 5800, MS 1326, Albuquerque, NM, 87185, United States of America, jwatson@sandia.gov

1 - PH and DDSIP

David Woodruff, University of California - Davis, dlwoodruff@ucdavis.edu

The PH algorithm proposed by Rockafellar and Wets and the DDSIP algorithm proposed by Caroe and Schultz can both be thought of as primal-dual algorithms and both can be used to address stochastic mixed-integer programs. In this talk I describe work with numerous co-authors to use the two algorithms together. In addition we describe an algebraic modeling language (Pyomo) interface to DDSIP.

2 - A Scalable Solution Framework for Stochastic Transmission and Generation Planning Problems

Francisco Munoz, Postdoctoral Appointee, Sandia National Laboratories, 1700 Indian Plaza Dr NE APT 5, Albuquerque, NM, 87106, United States of America, fdmunoz@sandia.gov
Jean-Paul Watson

Current commercial software tools for investment planning have limited stochastic modeling capabilities. We describe a scalable decomposition algorithm to solve stochastic transmission and generation planning problems based on a variant of the Progressive Hedging (PH) algorithm. The results indicate that large-scale problems can be solved to a high degree of accuracy in at most two hours of wall clock time.

3 - Parallel Decomposition of the Contingency-Constrained ACOPF Problem

Carl Laird, Associate Professor, School of Chemical Engineering, Purdue University, 480 Stadium Mall Dr., West Lafayette, IN, 47907, United States of America, carl.d.laird@gmail.com
John Siirola, Jean-Paul Watson, Anya Castillo

Maintaining performance reliability in the electrical grid requires operation that considers potential contingencies that may be encountered through failure of transmission elements. We formulate and solve a large-scale, nonlinear stochastic programming formulation to determine optimal AC operation while considering all N-1 contingency scenarios. We implement this problem in Pyomo with PySP and show a decomposition strategy that can efficiently solve this problem in parallel.

4 - Lower and Upper Bounding for Large-Scale Stochastic Unit Commitment

Jean-Paul Watson, Distinguished Member of Technical Staff, Sandia National Laboratories, P.O. Box 5800, MS 1326, Albuquerque, NM, 87185, United States of America, jwatson@sandia.gov

We describe advanced parallel scenario-based decomposition approaches, based on progressive hedging, for solving large-scale stochastic unit commitment problems. The developed algorithms are able to obtain solutions in tractable run-times (no more than 15 minutes), with tight (less than 0.1%) optimality gaps. We discuss both primal and dual configurations of the algorithm.

■ MC11

11-Level A, Kafka

Telecommunications Network Design

Cluster: Network Design

Invited Session

Chair: Bernard Gendron, Université de Montréal and CIRRELT, 2920, Chemin de la Tour, Montreal, Canada, Bernard.Gendron@cirrelt.ca

1 - Branch-Price-and-Cut for Multicommodity Network with Capacity Expansion Costs

Souhaïla El Filali, PhD Student, CIRRELT, 2920, chemin de la Tour, bureau 3441, Montréal, QC, H3T 1J4, Canada, souhaila.elfilali@gmail.com

We focus on the multicommodity capacitated network design problem with capacity expansion costs. It consists in deciding how many facilities (of a given capacity) to open on each arc of a directed network in order to meet the demand of multiple commodities. The objective is to minimize transportation costs and capacity expansion costs. We propose to solve this problem with branch-and price-and-cut. Numerical results show that the method performs well, especially for large-scale instances.

2 - Formulating and Solving the Coverage Constrained P-Tree Problem

Vinicius Morais, PhD Student in Computer Science, Universidade Federal de Minas Gerais, Av. Antònio Carlos 6627, Belo Horizonte, MG, 31270-010, Brazil, vwcmorais@gmail.com
Geraldo R. Mateus, Bernard Gendron

We consider a problem arising in the design of wireless sensor networks. The Coverage Constrained P-Tree Problem aims to maximize the network lifetime by minimizing the clustering and routing costs, while ensuring coverage constraints. We introduce formulations based on directed cutset constraints and multicommodity flow model. Additionally, branch-and-cut and branch-and-price-and-cut methods are also investigated. Computational experiments on a set of randomly generated instances are presented.

3 - Stochastic Planning of Environmentally Friendly Telecommunication Networks using Column Generation

Jonas C. Villumsen, Research Scientist, IBM Research, IBM Technology Campus, Bldg. 3, Damastown, Dublin 15, Ireland, jonasvil@ie.ibm.com, Joe Naoum-Sawaya

We present the network planning problem of an LTE cellular network with switchable base stations, ie. where the configuration of the antennae is dynamic, depending on demand. This is formulated as a two-stage stochastic program under demand uncertainty with integers in both stages. We develop its Dantzig-Wolfe reformulation and solve it using column generation. Preliminary results confirm the efficiency of the approach. Interestingly, the reformulated model often has a tight LP-gap.

■ MC12

12-Level A, Lamartine

Constraint-Based Scheduling

Cluster: Constraint Programming

Invited Session

Chair: Andre Cire, University of Toronto Scarborough, 1265 Military Trail, Toronto, ON, M1C-1A4, Canada, acire@utsc.utoronto.ca

1 - Linear Time Filtering Algorithms for the Disjunctive Constraint

Hamed Fahimi, Université Laval, 105-1755 Blvd. Henri-Bourassa, Québec, Canada, hamed.fahimi.1@icloud.com,
Claude-Guy Quimper

We present three new filtering algorithms for the Disjunctive constraint that all run in linear time. The algorithms are for the overload check, detectable precedences and time-tabling techniques. We introduce the new data structure time-line, which provides constant time operations that were previously implemented in logarithmic time. Experiments show that our new algorithms are competitive even for a small number of tasks and outperform existing algorithms as the number of tasks increases.

2 - Hybrid Optimization for Time-Dependent Sequencing

Willem-Jan van Hoeve, Carnegie Mellon University, Pittsburgh, PA, United States of America, vanhoeve@andrew.cmu.edu,
Andre Cire, Joris Kinable

In time-dependent sequencing problems the goal is to optimally sequence a set of tasks, in the presence of position-dependent setup times. We propose a hybrid optimization method based on a constraint programming representation that uses a limited-width decision diagram as discrete relaxation. We strengthen the bound from the decision diagram with information from a continuous linear programming relaxation via additive bounding. We computationally compare our approach to pure CP and MIP models.

3 - A Benders Decomposition Approach for Multiactivity Tour Scheduling

Maria-Isabel Restrepo-Ruiz, PhD Student, Polytechnique Montréal and CIRRELT, 2900 Boulevard Edouard-Montpetit, Montréal, QC, H3T 1J4, Canada, maria-isabel.restrepo-ruiz@polymtl.ca
Louis-Martin Rousseau, Bernard Gendron

We present a Benders decomposition approach to solve multiactivity tour scheduling problems when employees have the same skills. The solution approach iterates between a master problem that links daily shifts with tour patterns and a set of daily subproblems which assign work activities and breaks to the shifts. Due to its structure, the master problem is solved by column generation. We exploit the expressiveness of context-free grammars and work with implicit models to solve the subproblems.

4 - A Comparative Study of MIP and CP Formulations for the B2B Scheduling Optimization Problem
Louis-Martin Rousseau, Professor, École Polytechnique de Montréal, C.P. 6079, succ. Centre-ville,, Montréal, QC, H3C 3A7, Canada, louis-martin.rousseau@polymtl.ca
Gilles Pesant, Gegory Rix

The Business-to-Business Meeting Scheduling Problem consists of scheduling meetings between given pairs of participants to an event while taking into account participant availability and accommodation capacity. The challenging aspect of this problem is that breaks in a participant's schedule should be avoided as much as possible. In this paper we use this challenging problem to study different formulations adapted either for MIP or CP solving.

■ MC13

13-Level A, Musset

Marketing-Operations Interface

Sponsor: Pricing & Revenue Management

Sponsored Session

Chair: Ceren Kolsarici, Assistant Professor and Ian R. Friendly Fellow of Marketing, Queen's University, 143 Union Street, Kingston, On, k7l3n6, Canada, ckolsarici@business.queensu.ca

1 - Bundling of Movie Tickets and Popcorn: Improving Profitability
Vinay Kanetkar, Associate Professor, University of Guelph, College of Business and Economics, Guelph, ON, N1G2W1, Canada, vkanetka@uoguelph.ca

In this paper, puzzle about theatrical presentation of movie is presented. It is noted that margin associated with concession (popcorn, soft drinks) is around 90% while movie ticket margin is around 50%. Surprising, consumers are less price sensitive to price of concession than ticket prices. This would suggest some sort of price bundling could lower consumer price sensitivity than selling both services independently. Incidence of bundling in this industry is surprisingly very low.

2 - A Dynamic Segmentation Model in a Multichannel Environment
Tanya Mark, Assistant Professor, University of Guelph, 50 Stone Road, Marketing and Consumer Studies Dept., Guelph, ON, N1G 2W1, Canada, markt@uoguelph.ca, Rakesh Niraj, Jan Bulla, Ingo Bulla

We develop a dynamic segmentation framework that considers a customer's channel choice and purchase frequency, while simultaneously accounting for customer heterogeneity and responses to direct mail. Our findings suggest that direct mail increases the likelihood of a purchase in the telephone channel, but only for the first purchase incidence. For active customers, this instrument is effective for increasing the likelihood of additional purchases across various channels.

3 - Rival Firm Competitive Advertising Response to Horizontal Mergers and Acquisitions
Aaron Zhou, PhD Student, Queen's School of Business, Queen's University, Goodes Hall, Room 219, Kingston, On, K7L 3N6, Canada, aaron.zhou@queensu.ca, Jacob Brower

We investigate the drivers of advertising by rival firms as a response to a horizontal M&A. We develop a full taxonomy of competitive advertising responses including over-reaction, under-reaction, passive and zero reactions. A multinomial logistic regression shows that deal size, market power, prior performance and innovativeness are the main drivers for a rival firm's preference for a type of response. Our results have implications for the strategies of both merging firms and competing rivals.

■ MC14

14-Level B, Salon A

Energy Systems II

Cluster: Energy

Invited Session

Chair: Boris Defourny, Assistant Professor, Lehigh University, 200 W Packer Ave, Bethlehem, PA, 18015, United States of America, defourny@lehigh.edu

1 - A MIP Model and Several Approaches to Schedule Maintenance in Wind Farms on a Short-term Horizon
Aurelien Froger, PhD Student, Polytechnique Montréal, 2900 Boulevard Edouard-Montpetit, Montréal, H3T 1J4, Canada, Aurelien.Froger@cirrelt.ca, Jorge Mendoza, Eric Pinson, Louis-Martin Rousseau, Michel Gendreau

Taking into account wind prediction when scheduling maintenance on wind turbines can lead to potential gains. Preemption, transfer times for resources, and outsourcing are considered in this problem. The objective is concerned with maximizing the difference between the profits of wind farms related to the estimated production and the costs associated with outsourcing and resources transfers. A MIP model, a benders decomposition technique and a constraint programming approach are proposed.

2 - Dynamic Capacity Profile for Demand Side Management
Juan Alejandro Gomez Herrera, École Polytechnique Montréal, 2900 Boulevard Edouard-Montpetit, Montréal, Canada, juan.gomez@polymtl.ca, Miguel F. Anjos

This work presents an approach for building power capacity profiles for residential users in the smartgrid. In a first step a forecast module computes the day ahead load profile considering residential loads and user preferences. In the second step, a multi-objective program decides one hour ahead, the amount of power to trade in the demand response market. The results show that a dynamic profile has a peak shaving effect in congested hours and allows the end user to profit from off-peak prices.

3 - Demand Response for Electric Water Heaters to Balance the Load in the Presence of Renewables
Adham I. Tammam, École Polytechnique de Montréal, 2900 Boulevard Edouard-Montpetit, Montréal, Canada, adham.Ismail@gerad.ca, Miguel F. Anjos, Michel Gendreau

With the increasing penetration of renewable energy resources on the electrical power grid, demand response via thermostatic appliances is a promising means to support the operation of the power system. We propose a multi-stage stochastic optimization model that computes the optimal day-ahead trajectory for the mean thermal energy of hot water of an aggregate model of electric water heaters. The optimization aims to mitigate fluctuations of renewables and minimize the peaks of the load curve.

4 - Estimating a Bid Stack Sensitive to Fuel Costs using High-Frequency Market Data
Boris Defourny, Assistant Professor, Lehigh University, 200 W Packer Ave, Bethlehem, PA, 18015, United States of America, defourny@lehigh.edu

We study the problem of identifying bids from power generators using electricity price data, load data, and gas price data to identify bids sensitive to gas prices. We discuss results obtained with an inverse optimization approach based on the wholesale electricity spot price formation mechanism.

■ MC15

15-Level B, Salon B

Science at JDA Innovation Labs

Cluster: Practice

Invited Session

Chair: Marie-Claude Coté, Manager, Data Science, JDA Software, 4200 Saint-Laurent #407, Montréal, Canada, marie-claude.cote@jda.com

1 - Optimization Approach for Supply Chain Planning.
Eric Prescott-Gagnon, Operational Researcher, JDA Software, Eric.PrescottGagnon@jda.com, Vincent Raymond, Louis-Martin Rousseau, Marc Brisson

Generating efficient, effective supply and manufacturing plans that maximize customer service in a large supply chain is a big challenge. We present our latest work to solve integrated supply chain planning problems for real-life applications with a lot of side constraints and multiple hierarchical objectives.

2 - Inventory Optimization for Slow Movers
Yossiri Adulyasak, Data Mining Researcher, JDA Software, Yossiri.Adulyasak@jda.com, Nicolas Chapados, Marie-Claude Coté, Thierry Moisan

Predicting and optimizing the inventory planning for slow moving products are challenging tasks. In this context, assuming a certain standard demand distribution and deriving an inventory policy based on that would produce undesirable results. We propose an optimization approach based on the Markov decision process (MDP) to deal with such problem together with several enhancements to deal with practical issues in inventory planning.

3 - A Data Analytics Framework for Transferable Demand Analysis
Christian Hudon, Data Mining Researcher, JDA Software, Christian.Hudon@jda.com, Yossiri Adulyasak

In this talk, we discuss a framework to compute demand transferability among items in a new assortment particularly in the context of apparels. The main challenge in this application is the availability of the data for a new set of products which are not introduced to the market. We employ a data analytics approach to predict demand transfer ability based on the product attributes. This approach, however, is not only limited to apparels and could also be extended to other types of products.

4 - Constraint Based 3D Loading
Marc Brisson, Manager, Optimization, JDA Software, Marc.Brisson@jda.com, John Ye, Louis-Martin Rousseau, Philippe Grangier

Tire manufacturers are currently spending a lot of time and effort on manually planning the load of delivery trucks. We will present the latest results of a new approach based on constraint programming that improves this process while capturing the 3D load constraints of very large tires.

■ MC16

16-Level B, Salon C

Tutorial: Administration and Grading of Online Exams for Analytics Courses

Cluster: Tutorials

Invited Session

Chair: Armann Ingolfsson, Associate Professor of Operations Management, University of Alberta, University of Alberta, 4-30K Business, Edmonton, AB, T6G 2R6, Canada, armann.ingolfsson@ualberta.ca

1 - Administration and Grading of Online Exams for Analytics Courses
Armann Ingolfsson, Associate Professor of Operations Management, University of Alberta, University of Alberta, 4-30K Business, Edmonton, AB, T6G 2R6, Canada, armann.ingolfsson@ualberta.ca

We have given online exams in several large and small analytics-related courses for about 20 years. First, we discuss exam administration. Second, we describe a Blackboard tool for posting mark breakdowns. Third, we discuss semi-automated marking of problems where students report an array of numerical values, such as decision variables for an optimization problem. We describe a structured way of giving partial credit for such answers, based on consistency, feasibility, and optimality.

■ MC17

17-Level 7, Room 701

Recent Advances in Financial Engineering and Insurance

Sponsor: Financial Services Section

Sponsored Session

Chair: Hongzhong Zhang, Assistant Professor, Columbia University, 1255 Amsterdam Ave, New York, NY, 10027, United States of America, hz2244@columbia.edu

1 - Optimal Multiple Stopping with Negative Discount Rate and Random Refraction Times under Levy Models
Hongzhong Zhang, Assistant Professor, Columbia University, 1255 Amsterdam Ave, New York, NY, 10027, United States of America, hz2244@columbia.edu
Tim Leung, Kazutoshi Yamazaki

We study an optimal multiple stopping problem driven by Levy processes. Our model allows for a negative effective discount rate, which arises in a number of financial applications such as stock loans and real options. Moreover, successive exercise opportunities are separated by i.i.d. random refraction times. Under a wide class of Levy models, we rigorously show that the optimal strategy to exercise successive call options is uniquely characterized by a sequence of up-crossing times.

2 - Robust Utility Maximization with Extremely Ambiguity-Loving or Ambiguity-Aversion Preferences
Bin Li, Assistant Professor, University of Waterloo, 200 University Avenue West, M3 Building, Waterloo, ON, N2L 3G1, Canada, b226li@uwaterloo.ca, Lihe Wang, Dewen Xiong

In this paper, we investigate the robust utility maximization problems under both preferences of extremely ambiguity loving and ambiguity aversion. Different with previous works in this line, we consider the case that the set of prior probability measures has finite elements, which represents a decision-making group of individual agents.

3 - Optimization of Covered Calls
Roy Kwon, Associate Professor, University of Toronto, 5 King's College Road, Toronto, Canada, rkwon@mie.utoronto.ca
Mauricio Diaz

We consider the problem of determining how many European call options should be sold on an underlying asset while the underlying asset is being held long. The problem is posed as an optimization problem where the underlying asset is assumed to follow a geometric Brownian motion under different risk measures. We present the structure of optimal portfolios and find that the buy-write ratio is not always 1.

4 - Joint Mixability and Risk Aggregation
Ruodu Wang, Assistant Professor, University of Waterloo, 200 University Ave, Waterloo, On, N2L 3G1, Canada, wang@uwaterloo.ca

We focus on a class of optimization problems on the aggregation of risks. Basic (but still yet open) questions are: Given the marginal distributions of some random variables, what can we say about the distribution of their sum (e.g. minimum and maximum of distribution function, Value-at-Risk, moments...)? The key tool to analytically solve the above questions is joint mixability. Recent developments in joint mixability and their relevance in the above questions will be discussed.

■ MC18

18-Level 7, Room 722

Queueing and Stochastic Models

Cluster: Queueing

Invited Session

Chair: Myron Hlynka, Professor, University of Windsor, Math & Stat Dept., University of Windsor, Windsor, ON, N9B 3P4, Canada, hlynka@uwindsor.ca

1 - On the Service Time in an M/G/1 Queue with Bounded Workload
Percy Brill, Professor Emeritus, University of Windsor, 401 Sunset Avenue, Windsor, ON, Canada, brill@uwindsor.ca

We consider a workload-barrier M/G/1 queue where service times that overshoot the barrier are truncated. We derive the pdf (probability density function) and expected value of an arbitrary service, the expected number served in a busy period, and related quantities.

2 - Sensitivity Analysis for Rare-Event Splitting Simulations of a Tandem Queue
John Shortle, George Mason University, United States of America, jshortle@gmu.edu

This talk considers implementation issues in simulating a tandem queue using the rare event technique of splitting. To implement splitting, one must make several decisions, such as choosing an importance function and choosing the locations of levels. We evaluate the relative significance of such parameters for tandem queues in which the rare-event probability is fixed at some small value. The most difficult problems are systems with small state spaces and low utilizations.

3 - Comparing Transplant Waiting Times in Stable and Unstable Regimes
David Stanford, Professor, Western University, Statistical & Actuarial Sciences, 1151 Richmond St. N., London, ON, N6A 5B7, Canada, stanford@stats.uwo.ca, Kristiaan Glorie, Joris van de Klundert

Transplant queues are examples of queues which over time may be operating for alternating periods in stable and unstable regimes. The stationary waiting time is a common measure for the former, while the transient waiting time is the usual assessment of delay in the latter. We compare these scenarios, and observe a fundamental difference: whereas the proportion of the population belonging to a given blood group has an impact in the former, it does not in the latter.

4 - Queueing Analysis of a 2-Class Polling Model with Jockeying and Reneging Customers
Steve Drekic, University of Waterloo, Dept. of Statistics & Actuarial Science, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, sdrekic@uwaterloo.ca

We consider a 2-class, single-server polling model operating under a k_i-limited service rule. Arrivals follow a Poisson process with exponentially distributed service times. Within each queue, customers are impatient and either switch queues or abandon the queue if the time before entry into service exceeds an exponentially distributed patience time. We compute the steady-state joint queue length distribution and the marginal waiting time distribution via the use of matrix analytic techniques.

■ MC19

19-Grand Ballroom West

Tutorial: Airline Schedule Development

Cluster: Tutorials

Invited Session

Chair: Sergey Shebalov, Sabre Holdings, Southlake, TX, sergey.shebalov@sabre.com

1 - Airline Schedule Development

Sergey Shebalov, Sabre Holdings, Southlake, TX, sergey.shebalov@sabre.com

Schedule is the main product an airline offers to consumers. Careful design and management of the schedule generation is vital for airline profitability. This process is very complex due to unpredictable external and internal factors, multiple conflicting objectives and numerous regulations it must satisfy. We will describe major phases of schedule development process, operation research models that currently support them and challenges that still remain to be addressed.

Monday, 3:30pm - 5:00pm

■ MD01

01-Level 4, Salon 8

Student Paper Prize 2

Cluster: CORS Functions

Invited Session

Chair: Michel Gendreau, Professor, Ecole polytechnique de Montréal, C.P. 6079, succ. Centre Ville, Montréal, QC, H3C 3A7, Canada, michel.gendreau@cirrelt.net

1 - CORS Student Paper Prize Final 2

The sessions feature finalists of the 2015 CORS student paper competition that recognizes the contribution of a paper either directly to the field of operational research through the development of methodology or to another field through the application of operational research. Prizes are awarded in two categories: Undergraduate and Open.

■ MD02

02-Level 3, Drummond West

Improving Delays

Cluster: Healthcare

Invited Session

Chair: Nadia Lahrichi, Professor, Polytechnique Montréal, CP6079 succ Centre-Ville, Montréal, QC, H3C3A7, Canada, nadia.lahrichi@polymtl.ca

1 - Specialist Care: From Emergency Department Consultation to Hospital Ward Discharge

Michael G. Klein, PhD Candidate, McGill University, Desautels Faculty of Management, Montréal, QC, Canada, michael.klein2@mail.mcgill.ca, Brian G. Moses, Hughie F. Fraser, Vedat Verter

Patients often wait for admission to inpatient wards, boarding on stretchers in hallways. These delays are the key contributor to Emergency Department (ED) crowding, resulting in adverse effects including higher mortality. We consider the ED boarding problem from the perspective of specialists. We focus on Internal Medicine at two hospitals in Nova Scotia, Canada. We propose a stochastic dynamic programming model to analyze current practice and identify strategies for improvement.

2 - Optimizing Public Access Defibrillator Availability to Improve Cardiac Arrest Coverage

Christopher Sun, University of Toronto, Mechanical and Industrial Engineering, 5 King's College Road - RS308, Toronto, ON, M5S 3G8, Canada, christopher.sun@mail.utoronto.ca

Out of hospital cardiac arrests (OHCAs) are a major health concern for societies worldwide. Automated External Defibrillator (AED) use can significantly reduce the delay in time of treatment, and increase the number of those treated. However, strategies for AED placement are not well defined. Here we examine the effects of AED accessibility on OHCA coverage and propose a novel optimization methodology which uses both geographical and temporal information to further develop placement strategies.

3 - Online Service Reservation with Customer Preferences

Van Anh Truong, Columbia University, 500 West 120th St, New York, NY, 10027, United States of America, vt2196@columbia.edu
Xinshang Wang

We study web- and mobile-based applications such as MyChart and OpenTable that are used to make advance service reservations, from medical appointments to restaurant reservations. We propose new high-fidelity models for these applications. We give online, data-driven algorithms with performance guarantees that can be used to power these applications.

■ MD03

03-Level 3, Drummond Centre

Value Chain Optimization Research Network: Moving Forward

Cluster: Applications of OR in Forestry

Invited Session

Chair: Mikael Rönnqvist, Université Laval, 1065, avenue de la Médecine, Quebec, QC, G1V 0A6, Canada, mikael.ronnqvist@gmc.ulaval.ca

1 - A Novel Wiki Methodology and its Application in VCO Collaborative Research Program Development

Yan Feng, Universite Laval, 1065, avenue de la Médecine, Quebec City, QC, G1V 0A6, Canada, Yan.Feng@cirrelt.ca
Jean-Francois Audy, Mikael Rönnqvist, Mustapha Ouhimmou, Paul Stuart

We present the development of a novel semantic Wiki methodology for the collaborative development of research program for the Canadian Forest Value Chain Optimization (VCO) Network. This web based Wiki application allows the members of the VCO community to add, edit, publish, share knowledge based contributions, search information, and participate on-line discussions. The outcomes of the VCO White Paper Wiki will be demonstrated.

2 - Value Chain Optimization Network: The Path Forward

Paul Stuart, Ecole Polytechnique de Montréal, P.O. Box 6079, Station Centre-ville, Montréal, Canada, paul.stuart@polymtl.ca
Mikael Rönnqvist, Mustapha Ouhimmou, Yan Feng

The Value Chain Optimization (VCO) Network aims to provide industry and policy makers with advanced planning and decision support systems to design and deploy optimized forest bioeconomy strategies. Understanding that a renewed and more-ambitious vision will be needed to move forward and support FPInnovations and forest industry, this presentation will outline the novel methodology of Wiki used across VCO Network, the outcomes and VCO path forward with discussions.

■ MD04

04-Level 3, Drummond East

OR in Mine Planning IV

Cluster: Applications of OR in the Mining Industry

Invited Session

Chair: Kadri Dagdelen, Professor, Colorado School of Mines, Mining Engineering Department, Colorado School of Mines, Golden, Co, 80401, United States of America, kdagdelen@mines.edu

1 - Optimal Mining Rates Revisited: Managing Mining Equipment and Geological Risk at a Given Mine Setup

Maria Fernanda Del Castillo, COSMO - Stochastic Mine Planning, McGill University Laboratory, 3450 University Street, Montréal, H3A 2A7, Canada, maria.delcastillo@mail.mcgill.ca
Roussos Dimitrakopoulos

The paper aims to minimize risk incurred in optimizing mine production rates so that production targets are met under geological uncertainty. To do this, the concept of Stable Solution Domain is introduced, which provides all feasible combinations of ore and waste extraction for a given ultimate pit limit. The proposed formulation provides an optimal annual mining rate as well as fleet utilization and acquisition program and a case study on a gold deposit is presented.

2 - Optimizing Mining Complexes with Geological Uncertainty
Luis Montiel Petro, Posdoctoral Fellow, COSMO - Stochastic Mine Planning Laboratory, 3450 University Street, Room 112, Montréal, Qc, H3A 2A7, Canada, luis.montiel@mail.mcgill.ca
Roussos Dimitrakopoulos

A mining complex is a value chain where raw materials are extracted, blended, transformed and transported to final stocks or ports as saleable products. Optimizing a mining complex demands the simultaneous optimization of all its components. This paper presents a method that uses simulated annealing to optimize a mining complex while considering geological uncertainty. Case studies show the ability of the method to generate higher value with less risk.

3 - Stope Optimization with Concavity Constraints
Gonzalo Nelis, University of Chile, Chile, gonza.nelis@gmail.com
Xiaoyu Bai, Denis Marcotte, Michel Gamache

A new algorithm for the optimal stope design problem is proposed. It is based on a methodology developed by Bai (2013) where a cylindrical coordinate system is used to find the optimal stope. The new algorithm extends this work with an Integer Program formulation and additional constraints to solve geomechanical issues of the original methodology. The new formulation is compared with Bai's methodology, achieving more stable designs and generating feasible stopes for real use.

4 - Developments on Stochastic Mine Production Scheduling Optimization
Kadri Dagdelen, Professor, Colorado School of Mines, Mining Engineering Department, Colorado School of Mines, Golden, Co, 80401, United States of America, kdagdelen@mines.edu
Ady Van-Dunem

Recently, the field of strategic mine planning has seen a flurry of developments in new stochastic mine production scheduling optimization (SMPSO) models. In this paper, we review some of technical literature in the field. We start with the deterministic approach, address original approaches to SMPSO and discuss current trends in theory, methodology and practice. Throughout, we highlight landmark achievements and finalize by presenting some of the most exciting directions for future research.

■ MD05

05-Level 2, Salon 1

Logistics and Supply Chain Optimization

Sponsor: Transportation Science & Logistics

Sponsored Session

Chair: Guoqing Zhang, Professor, University of Windsor, 401 Sunset Avenue, Windsor, Canada, gzhang@uwindsor.ca

1 - Evaluation of Supply Chain Performance for Taiwan's Shipping Industry by Using AHP Method
Yuan Feng Wen, Associate Professor, National Kaohsiung Marine University, No.142, Haijhuan Rd., Nanzih Dist., Kaohsiung City, 81157, Taiwan - ROC, ywen@webmail.nkmu.edu.tw

This study aims to develop a measurement instrument supply chain performance (SCP) in shipping industry by using Analytic Hierarchy Process (AHP) method. The assessment of SCP in shipping industry is based on validated measures of the SCP construct in previous research, which was developed on the basis of the SCOR model. To make more practical use of SCP measures in shipping industry, AHP method is firstly applied to find out their relative importance in this study.

2 - An Oligopolistic Emissions Trading System With Uncertain Demand
Alireza Tajbakhsh, McMaster University, 1280 Main Street, West, Hamilton, Canada, alirezt@mcmaster.ca, Elkafi Hassini

We propose a static Cournot oligopoly game to investigate a perfectly competitive market in which supply chains compete in a non-cooperative manner in their product markets. Partners of each supply chain engage in a cooperative triopoly game where initial permit allocations of the pollutants are given on the basis of their sustainability performance that is derived from a data envelopment analysis model.

3 - The Distribution Free Multi-Product Newsboy Problem with Quantity Discount and a Constraint
Jian-Cai Wang, Beijing Institute of Technology, 5 South Zhongguancun Street, Haidian, Beijing, China, wangjiancai@bit.edu.cn, Wensi Zhang

We consider a distribution free newsvendor problem where multiple items compete for a scarce resource with each enjoying quantity discount. This problem is formulated as mixed integer programming model and can be solved by a Lagrangian relaxation approach. Numerical examples examine the conservativeness of the result.

4 - Optimal Integrated Inventory-Location with Lost Sales and Soft Service Time
Fatma Gzara, Assistant Professor, University of Waterloo, 200 University Avenue W, Waterloo, Canada, fgzara@uwaterloo.ca

We present an exact solution methodology based on Logic-based Benders decomposition for the integrated inventory-location problem with service constraints. Inventory is managed using a base stock policy with lost sales and aggregate service levels. Service constraints ensure that overall customer orders are delivered within the service time window with a given probability but allow individual orders to occur outside of the window. We present valid benders cuts and encouraging results.

5 - An Integrated Warehouse Production Planning and Layout Policy with RFID
Guoqing Zhang, Professor, University of Windsor, 401 Sunset Avenue, Windsor, Canada, gzhang@uwindsor.ca, Fawzat Alawneh

Motivated by a real production warehouse case, a mixed integer programming model was proposed to integrate the production planning and the warehouse assignment problem. The objective was to minimize the production and warehouse costs, which includes the production cost, setup, holding, and handling cost, taking advantage of the state of art technologies in the warehouse operations such as RFID, we proposed a randomized storage assignment policy to tackle the problem.

■ MD06

06-Level 2, Salon 2

Simulation

Cluster: Contributed Sessions

Invited Session

Chair: Yusuf Kuvvetli, Research Assistant, Cukurova University, Cukurova University Industrial Engineer., Dep. Saricam, ADANA, 01330, Turkey, ykuvvetli@cu.edu.tr

1 - An Agent-Based Simulation of the Diffusion of Multiple Computer Generations in Germany
Markus Günther, J. Prof., Bielefeld University, Universitaetsstr. 25, Bielefeld, 33615, Germany, markus.guenther@uni-bielefeld.de
Christian Stummer

Our agent-based simulation approach aims at investigating the diffusion of new products from multiple successive technology generations. The model accounts for novel product features in each generation, normative influences, and a social network that reflects both spatial and social proximity between consumers. In order to illustrate the approach we have replicated the diffusion of computers (PCs, notebooks, tablets) on the German market from 1994 to 2013.

2 - Integration of Order Acceptance Decisions into Optimization-Based Order Release Models
Stefan Haeussler, University of Innsbruck, Universitaetsstrasse 15, Innsbruck, 6020, Austria, stefan.haeussler@uibk.ac.at

An important goal in manufacturing planning and control systems are short and predictable flow times. One approach to address this problem is the workload control concept. A common assumption of the literature on optimization based order release models is that all orders received by the shop will be accepted, regardless of shop conditions. In this paper, we analyze the impact of integrating order acceptance decisions into optimization based order release models by using a simulation study.

3 - Simulation-Based Study of Aircraft Spare Parts Forecasting Accuracy
Albert Lowas, PhD Candidate, Wright State University, 3640 Colonel Glenn Hwy, Dayton, OH, 45435, United States of America, lowas.2@wright.edu, Frank Ciarallo

This study provides insights into the reasons for low accuracy in aircraft spare parts demand forecasting. The study models the typical probabilities of failure over time for aircraft spare parts. Using this model, a Monte Carlo simulation is performed of demands for aircraft parts. Contemporary forecasting methods are used on these resulting simulated demand streams. The study demonstrates that low accuracy spare parts forecasts should be expected for small fleets with high reliability parts.

■ MD07

07-Level 2, Salon 3

Heuristics for Delivery Problems

Cluster: Contributed Sessions

Invited Session

Chair: Mona Hamid, PhD Student, University of Edinburgh, 29 Buccleuch Place, Edinburgh EH8 9JS, United Kingdom, m.hamid-2@sms.ed.ac.uk

1 - An Adaptive Generic Construction Heuristic for Stochastic TSPs
Pascal Wissink, PhD Student, University of Edinburgh, 29 Buccleuch Place, Room 3.02, Edinburgh, EH8 9JS, United Kingdom, Pascal.Wissink@ed.ac.uk, Jamal Ouenniche

The purpose of this paper is to unify a class of construction heuristics for the TSP with stochastic customers, namely savings procedures, into a single generalized and parameterized framework that embeds the existing savings procedures as special instances and includes new ones. We refer to this proposed framework as GENS. In addition, we propose an adaptive implementation using a hyperheuristic framework and refer to it as GENS-A. Finally, we empirically test the merits of GENS and GENS-A.

2 - Two-Echelon Capacitated Electric Vehicle Routing Problem with Battery Swapping Stations
Wanchen Jie,Huazhong University of Science & Technology, 1037 Luoyu Road, Wuhan, China, Wuhan, China, wanchenjie@hust.edu.cn

In this paper, we present a two-echelon capacitated electric vehicle routing problem, which aims to determine the delivery strategy under the battery driving range limitations. The electric vehicles have different load capacities, battery driving ranges, power consumption rates and battery swapping costs in the two-level system. we propose an integer programming formulation and improve the adaptive large neighborhood search heuristic for the problem.

3 - A Generic Dual Search Methodology for Routing Problems
Mona Hamid, PhD Student, University of Edinburgh, 29 Buccleuch Place, Edinburgh, EH8 9JS, United Kingdom, m.hamid-2@sms.ed.ac.uk, Jamal Ouenniche

Routing problems have been at the origin of the design of many optimal and heuristic solution frameworks such as branch-and-bound algorithms, branch-and-cut algorithms, local search methods, metaheuristics, and hyperheuristics. In this research, we propose a generic dual search methodology for routing problems and customize it to solve the traveling salesman problem. Computational results suggest that the proposed dual search framework is a promising one.

■ MD08

08-Level A, Hémon

Algorithm Designs and Selection Methods for Grey-Box DFO

Cluster: Derivative-Free Optimization

Invited Session

Chair: Stefan Sremac, University of British Columbia, Kelowna, Canada, stefanosremac@gmail.com

1 - A Trust Region Method for Solving Grey-Box Mixed Integer Nonlinear Problems
Andrew R. Conn, IBM Research, Yorktown Heights, NY United States of America, arconn@us.ibm.com
Delphine Sinoquet, Claudia D'Ambrosio, Leo Liberti

We present theoretical and numerical results on a derivative free trust region method for mixed integer nonlinear problems with binary variables which modifies the trust region by imposing local branching type constraints on the binary variables. The term grey-box in the title refers to the fact that some terms in applications of interest to us, rather than being black-box, can be exploited directly in closed form.

2 - Parallel DFO Techniques for Nonlinearly Constrained Optimization Problems
Ubaldo Garcia-Palomares, Prof., Universidade de Vigo, (TELECO) Rua Maxwell s/n, Campus de Vigo, Vigo, Po, 36310, Spain, ubaldo@gti.uvigo.es, Pedro Rodrìguez-Hernàndez, Ildemaro Garcia-Urrea

The non linear constraints are aggregated as exact penalty functions to the objective function and at each iteration the linear constraints, other than bounds on the variables, are transformed into bounds with an appropriate linear transformation. The original problem is solved by iteratively solving box constrained subproblems, and the artillery of new promising parallel DFO techniques can be used for solving these optimization models.

3 - A Rubric for Algorithm Selection in Black-Box Optimization
Stefan Sremac, University of British Columbia, Kelowna, Canada, stefanosremac@gmail.com

We consider optimizing a black-box function where the user knows the input dimension, the average time to obtain a function value, and the user has access to several different optimization algorithms. Recognizing that most solvers have strengths and limitations, we create a rubric to assist in selecting an appropriate solver for the given function. Our rubric is based on experiments from 3 algorithm categories: heuristic methods, derivative-free optimization, and Bayesian global optimization.

■ MD09

09-Level A, Jarry

Optimization in Air Traffic Control II

Sponsor: Aviation Applications

Sponsored Session

Chair: Thibault Lehouillier, École Polytechnique Montréal - Group for Research in Decision Analysis, GERAD - HEC Montréal, 3000, Cote Sainte Catherine, Montréal, QC, H3T 2A7, Canada, thibault.lehouillier@gerad.ca

1 - A Flexible Framework for Solving the Air Traffic Collision Detection and Resolution Problem
Thibault Lehouillier, École Polytechnique Montréal - Group for Research in Decision Analysis, GERAD - HEC Montréal, 3000, CÙte Sainte Catherine, Montréal, QC, H3T 2A7, Canada, thibault.lehouillier@gerad.ca

We present a new formulation for the air traffic collision detection and resolution problem. Given the planned trajectories of a set of aircraft, we identify the maneuvers avoiding all possible conflicts and minimizing fuel costs. We design a graph whose vertices correspond to discretized values of maneuvers linked if conflict free. A solution is a clique of minimum weight and maximum cardinality in the graph. We formulate this search as a MILP and present our results on extensive simulations.

2 - Resilience and Traffic Reorganization in the National Airspace under Perturbations
Aude Marzuoli, Georgia Institute of Technology, 270 Ferst Drive, Atlanta, GA, 30313, United States of America, aude.marzuoli@gatech.edu, Eric Feron, Emmanuel Boidot

The resilience of the National Airspace is often threatened by severe perturbations and their ripple effects : diversions, cancellations and delays. Through several case studies, such as the Asiana Crash and the Chicago ARTCC closure, the propagation of disturbances, the reorganization of traffic patterns and far-reaching consequences on the passenger journeys are analyzed. Recommendations advocating better information sharing and Collaborative Decision Making at the network level are provided.

3 - On Multi-Objective MINLP Optimization for the Aircraft Conflict Detection and Resolution Problem
F. Javier Martin-Campo, Universidad Complutense de Madrid, Campus de Somosaguas, F. CC. Economicas, Pozuelo de Alarcon, Madrid, Spain, javier.martin.campo@ccee.ucm.es
Antonio Alonso-Ayuso, Laureano F. Escudero

The aircraft conflict resolution problem consists of providing a configuration for an aircraft set flying in an air sector, such that every conflict situation is avoided. A MINLP multi-objective model and a heuristic approach are presented jointly with a broad computational experiment to assess the goodness of the heuristic.

4 - Deconflicting Wind-Optimal Aircraft Trajectories in North Atlantic Oceanic Airspace
Olga Rodionova, ENAC (L'École Nationale de l'Aviation Civile), 7 Avenue Edouard Belin, Toulouse, 31400, France, rodionova@recherche.enac.fr, Mohamed Sbihi, Daniel Delahaye, Marcel Mongeau

In this work we consider improving the air traffic situation in North Atlantic oceanic airspace at the strategic level by introducing the free-flight concept. Given wind-optimal trajectories, we apply simulated annealing to decide delays and local route modifications in order to reduce the number of expected flight conflicts. Computational experiments on real data involving up to 1000 flights show that our approach is viable.

■ MD10

10-Level A, Joyce

Stochastic Optimization, Innovations, and Applications

Cluster: Stochastic Optimization

Invited Session

Chair: Shohre Zehtabian, PhD Student, University of Montréal, DIRO, Montréal, QC, Canada, zehtabis@iro.umontreal.ca

1 - A Hybrid Scenario Cluster Decomposition Algorithm for Multi-Stage Stochastic Mixed-Integer Programs

Omid Sanei Bajgiran, Concordia University, 1455 De Maisonneuve Blvd. W., Montréal, Canada, o_sane@encs.concordia.ca, Mustapha Nourelfath, Masoumeh Kazemi Zanjani

We propose a Hybrid Scenario Cluster Decomposition algorithm to large-scale multi-stage stochastic mixed-integer models with no special structure. This algorithm decomposes the original problem into smaller scenario cluster sub-problems where each scenario cluster sub-model can be solved by two efficient heuristic algorithms: an accelerated Lagrangian Relaxation and a Variable-Fixing Heuristic.

2 - Replenishment Policies for Two-Echelon Inventory Systems with Lost Sales

Marco Bijvank, Haskayne School of Business, University of Calgary, 2500 University Drive NW, Calgary, AB, T2N 1N4, Canada, marco.bijvank@haskayne.ucalgary.ca

A two-echelon inventory system with a central warehouse and multiple retail locations is studied. A balanced stock rationing policy is used for stock outs at the DC, whereas excess demand in stores is lost. A heuristic procedure is developed to set the replenishment base-stock levels based on service level constraints. This policy is compared against optimal policies and the best base-stock policies.

3 - Adaptive Progressive Hedging Algorithm for Convex Stochastic Optimization Problems

Shohre Zehtabian, PhD Student, University of Montréal, DIRO, Montréal, Qc, Canada, zehtabis@iro.umontreal.ca, Fabian Bastin

The Progressive Hedging Algorithm (PHA) is a decomposition method based on the augmented Lagrangian approach aiming to progressively enforce the nonanticipativity constraints. In this talk, we analyze the different choices for penalty parameter and present an adaptive PHA to speed up the numerical performance. Empirical results are also presented.

■ MD11

11-Level A, Kafka

Hub and Facility Location

Cluster: Contributed Sessions

Invited Session

Chair: Sibel Alumur Alev, Assistant Professor, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, sibel.alumur@uwaterloo.ca

1 - Location Planning of Recharging Stations for Electric Vehicles in Carsharing Industries

Elnaz Moein, Master of Applied Science Student, Concordia University, 1455 De Maisonneuve Blvd. W., Montréal, QC, H3G 1M8, Canada, el.moein1384@gmail.com

Electric-vehicles in carsharing industry are a substitute to fuel vehicles that lead to lower fuel emissions. Efficient facility planning is a response to some barriers in this industry like battery power limitation and lack of sufficient infrastructure. In this study, we use two optimization approaches namely branch-and-cut algorithm in CPLEX and Genetic Algorithm in order to improve a facility planning problem proposed for recharging stations of EVs and compare their performance together.

2 - Endogeneous Effects of Hub Location Decisions

Mehmet Rustu Taner, TED University, Industrial E.,Ziya Gokalp Cad. 48, Kolej, Ankara, Turkey, mehmet.taner@tedu.edu.tr Bahar Yetis Kara

We propose a new approach, inspired by the Bass diffusion model, to forecast the change in demand patterns in a hub network as a result of the placement of new hubs. This new model is used in the context of the p-hub median problem to investigate endogenous attraction, caused by present hubs, on future hub location decisions. Computational results indicate that location and allocation decisions may be greatly affected when these forecasts are considered in the selection of future hub locations.

3 - The Multi-Level P-Median Problem as the Maximization of a Submodular Function

Camilo Ortiz-Astorquiza, Concordia University, 1455 De Maisonneuve Blvd. W., Montréal, qc, Canada, camiloortiza@gmail.com, Ivan Contreras, Gilbert Laporte

In this presentation we introduce the multi-level p-median problem and study some of its structural properties used for the development of approximation algorithms. In particular, we show how this problem can be stated as the maximization of a submodular set function with cardinality constraints. We use this representation to prove the worst-case bound for a greedy algorithm and show its relationship with the bounds for the particular case of the p-median problem.

4 - The Design of Capacitated Intermodal Hub Networks with Different Vehicle Types

Sibel Alumur Alev, Assistant Professor, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, sibel.alumur@uwaterloo.ca, Elif Zeynep Serper

We develop a mixed-integer programming formulation for this hub location and hub network design problem. The aim of the model is to minimize total costs while determining the location of hubs, the allocation of non-hub nodes to hubs, which hub links to establish, and how many vehicles to operate on each hub link to route the demand between given origin-destination pairs. We propose a local search heuristic and present extensive computational analysis on the CAB and Turkish network data sets.

■ MD12

12-Level A, Lamartine

Integer Programming

Cluster: Contributed Sessions

Invited Session

Chair: Iman Dayarian, University of Toronto, 5 King's College Road, Toronto, ON, M5S 3G8, Canada, iman@mie.utoronto.ca

1 - Data Center Location for Internet Services in the Province of Quebec

Hibat Allah Ounifi, Student, École de technologie Supérieure (ÉTS), 425 Rue la montagne, app.4110B, Montréal, QC, H3C 0J9, Canada, hibat-allah.ounifi.1@ens.etsmtl.ca, Mustapha Ouhimmou, Marc Paquet, Julio Montecinos

We introduce an efficient algorithm based on mixed integer linear programming (MILP) for the "data center location" problem. This model defines the data center locations under Internet services demands and, at the same time, ensures a low energy consumption of information technology (IT) equipment. The data center location has a direct impact on the Internet services response time and costs. Model validation and results are proved via experimentation example and numerical study.

2 - A Branch-and-Price Algorithm for the Bin Packing Problem

Masoud Ataei, York University, N507 Ross Building, 4700 Keele St., Toronto, ON, M3J3K8, Canada, mataei@mathstat.yorku.ca, Michael Chen

The Bin Packing Problem examines the minimum number of identical bins needed to pack a set of items of various sizes. Employing branch-and-bound and column generation usually requires determination of the k-best solutions of knapsack problem at level kth of the tree. Instead, we present a new approach to deal with the pricing problem of the column generation which includes the use of two-dimensional knapsack problem and reduces the computational time of the algorithm.

3 - The Bus Driver Rostering Problem with Fixed Day Offs

Safae Er-Rbib, PhD Student, Ecole polytechnique de Montréal and GERAD, 2500 Chemin polytechnique, Montréal, Canada, safae.errbib@gmail.com, Issmail El Hallaoui, Guy Desaulniers

We consider the problem of assigning duties to bus driver rosters in order to balance as much as possible to weekly working time among the rosters while satisfying various working rules concerning mostly the rest periods between two working days. We model this problem as an integer program and we report computational results obtained on real-world instances.

4 - A Branch-and-Price Algorithm for a Production-Routing Problem with Short-Lifespan Products

Iman Dayarian, University of Toronto, 5 King's College Road, Toronto, ON, M5S 3G8, Canada, iman@mie.utoronto.ca Guy Desaulniers

We study an integrated production-routing problem with time windows arising in catering services. The production consists of assembling the meals to deliver. The production is restricted by release dates (derived from the maximum span between delivery and production) and due dates (derived from route departure times). The total cost is minimized using a cutting-edge branch-and-price approach.

■ MD13

13-Level A, Musset

Pricing Impacts and Algorithms for Dynamic and Uncertain Demand

Sponsor: Pricing & Revenue Management

Sponsored Session

Chair: Samuel Kirshner, Queen's University, 143 Union Street, Kingston, ON, Canada, skirshner@business.queensu.ca

1 - A Non-parametric Approach To Dynamic Pricing With Demand Learning

Guyves Achtari, Queen's School of Business, 143 Union Street West, Kingston, ON, K7L3N6, Canada, 11ga10@queensu.ca
Yuri Levin, Mikhail Nediak

In many industries, firms have the capability of observing both sales and the refusal to buy from their customers. In situations where demand is unknown, firms may use early sales data to forecast demand. We consider a situation where the firm does not know demand, but can observe arriving customers refuse or accept to buy a product at a given price. We formulate a dynamic program which aims to dynamically adjust the price of the product in order to maximize the firm's total expected revenue.

2 - Due Date Quotation in Dual Channel Supply Chain

Nooshin Nekoiem, University of Windsor, 401 Sunset Avenue, Windsor, Canada, nekoiem@uwindsor.ca, Guoqing Zhang, Esaignani Selvarajah

In this paper we study reliable due date quotation in two echelon dual channel supply chain when there is a threshold on quoted due dates. we adopt online optimization perspective and perform competitive analysis to evaluate the performance of online algorithms for e-tail customers with dynamic demand. The objective is to maximize total profit of completed orders. We provide parametric bounds on the competitive ratio of a specific online algorithm for a single-type e-tail channel orders.

3 - Dynamic Pricing with Social Learning and Risk-Sensitive Consumers

Jue (Joey) Wang, Queen's University, Room 200, 143 Union Street, Kingston, ON, K7L 3N6, Canada, 12jw89@queensu.ca
Mikhail Nediak, Tanya Levin, Yuri Levin

We study a dynamic pricing model for a monopolist selling an experience good to risk-sensitive consumers who rely on social learning to infer the true quality. We test the model on recent movie data and confirm that social learning does happen. Numerical study shows that dynamic pricing generates 2-6% more revenue than static one, and making incorrect assumptions about consumer behaviors incurs substantial losses. Five-level reviews tends to confuse consumers and protect low-quality product.

4 - Quantity Competition in a Multi-Product Exchange Market with Dynamic Consumer Preferences

Samuel Kirshner, Queen's University, 143 Union Street, Kingston, ON, Canada, skirshner@business.queensu.ca
Yuri Levin, Mikhail Nediak

This paper develops an exchange market for substitute products with strategic consumers. The consumers are differentiated by their preference and price sensitivities for products, which are dynamic over time. The consumers maximize surplus by participating in the exchange market deciding the quantity of products to purchase and sell in each period. We study how the equilibrium prices and quantities traded change with the preference dynamics, strategicness of consumers, and product availability.

■ MD14

14-Level B, Salon A

OR Applications in Energy and Routing

Cluster: Energy

Invited Session

Chair: Lindsay Anderson, Assistant Professor, Cornell University, 316 Riley Robb Halll, Ithaca, NY, 14853-5701, United States of America, landerson@cornell.edu

1 - Incorporating Regulatory Risk in Energy Real Options Models

Matt Davison, Professor, Western University, Dept Stats Act Sci, London, On, NGA5B7, Canada, mdavison@uwo.ca
Christian Maxwell

Energy Infrastructure is long lived and must persist through cycles of feast and famine: infrastructure is idled during 'lean years' and run flat out during 'fat years'. When price variability drives the economics, real options models may be complicated but are well understood. But energy projects also face significant regulatory risk. In this talk we will describe our recent efforts to incorporate regulatory risk into real options models using a case study corn ethanol plants.

2 - A Stochastic Model for Optimal Day-Ahead Power Commitment: Case Study of a Kenyan Wind Farm

Maureen Murage, PhD Candidate, Cornell University, Ithaca, NY, United States of America, mwm88@cornell.edu
Lindsay Anderson, M. Gabriela Martinez

The Lake Turkana Wind Power (LTWP) project is a wind farm in northern Kenya. When complete, it will contribute to approximately 20% of current installed generation capacity. At high wind power penetration levels, accurately estimated day-ahead wind power commitment is essential for secure planning and operation of the power system. In this study, we combine the LTWP wind farm with a storage unit and seek to determine the optimal day-ahead power commitment of the system using a stochastic model.

3 - A Direct Method for High Dimensional Energy Storage Valuation and Optimization

Matt Thompson, Associate Professor, Queen's University, 143 Union, Kingston, On, Canada, mthompson@business.queensu.ca

This paper presents a new technique for energy storage optimization under general market model forward curve assumptions in dozens of dimensions. The outputs of the method are a series of analytic value functions that allow for analytic risk neutral expectation calculation and can also be used to price the counter-party credit risk of storage leases. The methodology eliminates the need for heuristic approaches to the energy storage problem.

4 - Outer Approximations of Polytopic Load Aggregates

Suhail Barot, PhD. Student, University of Toronto, 10 King's College Road, SF 1016A, Toronto, ON, M5S3G4, Canada, suhail.barot@mail.utoronto.ca, Josh Taylor

Concise representations of demand response resource aggregations are needed by utilities and system operators. We develop an approximate framework, using the Minkowski sum, for such load aggregations, where loads are modeled as generic polytopes. This type of load formulation can model electric vehicles, thermostatic loads, and more. Computational and error performance results of the framework are also discussed.

■ MD15

15-Level B, Salon B

Practical OR Models used in the Context of Crew Scheduling

Cluster: Practice

Invited Session

Chair: Norbert Lingaya, AD OPT, A Division of Kronos, 3535 Queen Mary, Suite 5500, Montreal, QC, H3V 1H8, Canada, nlingaya@gmail.com

1 - Using Optimization to Forecast Crew Requirements

Remy Gauthier, AD OPT, A Division of Kronos, 3535 Queen Mary, Suite 500, Montréal, QC, H3V 1H8, Canada, remy.gauthier@kronos.com

Manpower planning at airlines is a complex process that uses many assumptions. In most airlines, this process is performed by relying on a staffing model that is implemented in a spreadsheet application such as Microsoft Excel. This presentation will show how optimization can be used to better manage and forecast crew levels in airlines.

2 - Forecasting Crewmembers Career Choices Based on a Behavioral Model

Jose Gomide, AD OPT, A Division of Kronos, 3535 Queen Mary, Suite 500, Montréal, QC, H3V 1H8, Canada, Jose.gomide@kronos.com

Long term manpower planning is a complex problem bringing a variety of challenges. One of them being that for a plan to be of any use it has to compatible with choices the workforce is allowed to make, as per their collective agreement. In this talk we focus on a way to forecast how crewmembers use their options based on a behavioral model.

3 - Balancing Block Hours Monthly as Well as Yearly in Crew Scheduling

Norbert Lingaya, AD OPT, A Division of Kronos, 3535 Queen Mary, Suite 5500, Montréal, QC, H3V 1H8, Canada, nlingaya@gmail.com

In a fair share crew scheduling context where crewmembers are paid proportionally to the number of block hours flown, one wants a fair distribution of the work amongst the crew. In the same time, when crew have rolling 12-month quota but unequal accumulated hours one also wants to avoid the situation where some crew run out of hours. We discuss an approach we have implemented to balance these two objectives that can conflict.

4 - Integer Solution Driven Column Generation for Bidline Scheduling Problem
Hatem Ben Amor, AD OPT, A Division of Kronos, 3535 Queen Mary, Suite 5500, Montréal, QC, H3V 1H8, Canada, hatem.benamor@kronos.com

The bidline scheduling problem, that consists of building anonymous monthly blocks, is solved by column generation embedded in a branch-and-price scheme. We propose to use integer solutions to drive column generation from the oracle. This aims at favouring the production of good integer solutions early in the solution process in order to reduce the B&B search tree that may prove to be huge in large problems. Results for real-word problems will be shown.

■ MD16

16-Level B, Salon C

Tutorial: Introduction to Optimization in Radiation Therapy

Cluster: Tutorials

Invited Session

Chair: Dionne Aleman, University of Toronto, 5 King's College Road, Toronto, Canada, aleman@mie.utoronto.ca

1 - Introduction to Optimization in Radiation Therapy
Dionne Aleman, University of Toronto, 5 King's College Road, Toronto, Canada, aleman@mie.utoronto.ca

This tutorial introduces the basics of radiation therapy treatment planning techniques. Specifically, optimization and machine learning methods to design external beam radiotherapy plans will be presented. There are numerous competing theories on the appropriateness of various approaches, and the merits and challenges of each approach will be examined. Participants will gain an understanding of a broad range of ideologies regarding radiotherapy optimization techniques.

■ MD17

17-Level 7, Room 701

Heuristics

Cluster: Contributed Sessions

Invited Session

Chair: Jose Santos, University of Coimbra, Departamento de Matematica da FCTUC, Apartado 3008, EC Santa Cruz, Coimbra, Co, 3001 ñ 501, Portugal, zeluis@mat.uc.pt

1 - New Heuristic Approach to the Set Covering Problem
Amnon Gonen, Holon Institute of Technology - HIT, 52 Golomb St., Holon, Israel, agonen@hit.ac.il
Uriel Israeli

In this study, we have to cover N sites by allocating a minimum number of servers. Each server covers a predefined subset of the N sites. The New Heuristic Algorithm presented here looks, at each iteration, for the most "problematic" site to be covered and selects the best server that covers it. The study compares the algorithm with the Greedy algorithm. The results show that in many cases, the proposed algorithm finds a better solution (more than 10,000 problems were tested).

2 - The Multi-Period Tourist Trip Design Problem with Time Windows
Serhan Kotiloglu, PhD Student, Stevens Institute of Technology, 1 Castle Point, Hoboken, NJ, 07030, United States of America, skotilog@stevens.edu, Theodoros Lappas, Konstantinos Pelechrinis, Panagiotis Repoussis

A novel version of tourist trip design problem with mandatory and optional attractions is the focus of this paper.Given that the duration of the trip is known, a plan covering all the mandatory and maximum optional attractions is generated considering the time and cost limits, attractions to be visited for each category and the time windows for the availability of the attractions.An exact algorithm is developed for small instances and a metaheuristic algorithm is proposed for larger instances.

3 - Algorithms for Solving the Static Rebalancing Problem in G.P.S. Based Bike Sharing Systems
Aritra Pal, Doctoral Student, University of South Florida, Tampa, 4202 East Fowler Avenue, ENB 118, Tampa, Fl, 33620, United States of America, aritra1@mail.usf.edu, Yu Zhang

This presentation is about various heuristic algorithms for solving the static rebalancing problem in G.P.S. based bike sharing systems.

4 - New Constructive Heuristics for the Travelling Salesman Problem
Jose Santos, University of Coimbra, Departamento de Matematica da FCTUC, Apartado 3008, EC Santa Cruz, Coimbra, Co, 3001 – 501, Portugal, zeluis@mat.uc.pt, André Oliveira

This work focuses on new constructive heuristics for travelling salesman problem on general graphs. The proposed methods are also able to complete an initial partial solution, making them useful tools to be applied in other techniques such as metaheuristics, tour improvements, local search and branch-and-bound. The computational results on benchmark instances presented in the work shows the superiority of the new methods compared with traditional constructive heuristics in the literature.

■ MD18

18-Level 7, Room 722

Control and Analysis of Queueing Systems

Cluster: Queueing

Invited Session

Chair: Douglas Down, Professor, McMaster University, Department of Computing and Software, ITB 216, Hamilton, ON, Canada, downd@mcmaster.ca

1 - Dynamic Control of Patient Flow with Deteriorating Patients
Mark Lewis, Professor, Cornell University, 221 Rhodes Hall, Ithaca, NY, 14853, United States of America, mark.lewis@cornell.edu, Douglas Down, Carri Chan

We consider the case of dynamic resource allocation in a hospital emergency department with patients deterioration. The decision-maker would like to clear patients without letting them deteriorate, while adhering to the needs of more sickly patients. From a technical perspective the fact that the rate of deterioration is dependent on the number of patients in the system makes finding said balance difficult. We consider the cases with and without patient arrivals.

2 - Analysis and Routing in Parallel Queues with Class-Based Redundancy
Leela Nageswaran, Tepper School of Business, Carnegie Mellon University, Pittsburgh, PA, 15213, United States of America, lnageswa@andrew.cmu.edu, Alan Scheller-Wolf

We study the performance of two parallel queues when some customers are redundant: a redundant customer joins both queues and is considered served when any one of his requests finishes service, instantly removing the other one. We examine the policy other (non-redundant) customers to join a queue upon arrival. We find that while joining the shortest queue does not always minimize delay if the entire system state information is available, it is optimal if only the queue lengths are observable.

3 - Stability of Multi-Dimensional Markov Chains: Theory and Applications
Seva Shneer, Heriot-Watt University, V.Shneer@hw.ac.uk

We will look at multi-dimensional Markov chains where the components may be dependent but one of them has a predictable behaviour (is, in some sense, stable). We will be focused on finding conditions sufficient for the other components (or the entire chain) to be positive recurrent. Processes with the properties described in this talk appear naturally in a number of applications in wireless communication networks and economics, and we will discuss examples of these applications.

4 - Resource Allocation Policies to Provide Differentiated Service Levels to Customers
Sanket Bhat, McGill University, 1001 Sherbrooke Street West, Room 520, Montréal, QC, H3A 1G5, Canada, sanket.bhat@mcgill.ca, Ananth Krishnamurthy

We analyze resource allocation decisions for component manufacturers who supply components to several original equipment manufacturers (OEMs). OEMs differ in their demand variability and service level expectations. We derive policies that provide differentiated service to OEMs depending on their demand variability. Under the dynamic programming framework, we investigate the value of these policies to component manufacturers.

■ MD19

19-Grand Ballroom West

Tutorial: Models for Passenger Railway Planning and Disruption Management

Cluster: Tutorials

Invited Session

Chair: Leo Kroon, Erasmus University Rotterdam, P.O. Box 1738, Rotterdam, 3000 DR, Netherlands, lkroon@rsm.nl

1 - Models for Passenger Railway Planning and Disruption Management

Leo Kroon, Erasmus University Rotterdam, P.O. Box 1738, Rotterdam, 3000 DR, Netherlands, lkroon@rsm.nl

Passenger railway systems are based on an extensive planning process: the network, the timetable, the rolling stock circulation, and the crew duties are planned with various planning horizons. This presentation describes optimization models that were developed for supporting the planning processes of Netherlands Railways. These models were developed further for also supporting disruption management processes, when the timetable, the rolling stock, and the crew duties must be rescheduled quickly.

Tuesday, 9:00am - 10:30am

■ TA01

01-Level 4, Salon 8

Online Information Search

Sponsor: eBusiness

Sponsored Session

Chair: Animesh Animesh, Associate Professor, McGill University, 1001 rue Sherbrooke Ouest, Montreal, QC, H3A1G5, Canada, animesh.animesh@mcgill.ca

1 - The Fallacy of Fraudulent Reviews

Wael Jabr, Assistant Professor, Georgia State University, Robinson College of Business, 35 Broad St, Atlanta, GA, 30303, United States of America, wjabr@gsu.edu

Online customers place an overwhelming trust in user reviews. Research has shown the impact of such reviews in influencing product perception and sales. Online user reviews thus turned into a hot commodity in the business of selling products and services. In response, a market for fraudulent reviews seems to be created. This paper argues that the prevalent argument that review forums are plagued by such engineered reviews ultimately diluting the quality of information is nothing but a fallacy.

2 - Does First-Mover Advantage Pay Off in Online Review Platform?

Qianran Jenny Jin, McGill University, 1001 Sherbrooke Street West, Montréal, Canada, qianran.jin@mail.mcgill.ca
Animesh Animesh

While first-mover advantage has been widely studied at firm-level, our research focus on individual-level first-mover advantage in online review platform. We study whether posting reviews early can pay off. We answer three questions. 1.Do first-movers have advantage in online review platform? 2.Does the first-mover advantage differ across different types of reviewers? 3.Are reputation-seeking reviewers aware of the first-move advantage? We analyze the model using Amazon.com review data.

3 - When Online Word of Mouth Meets Disintermediation

Brian Lee, University of Connecticut, 2100 Hillside Rd, Storrs, CT, United States of America, brian.lee@business.uconn.edu
Xinxin Li

With the recent advance in digital technology, creators of intellectual products can now sell their work directly to consumers without the help of producers. In this study, we construct an analytical model to examine the role of eWoM in this trend of disintermediation. Our results suggest that eWoM may make creators more likely to reintermediate producers for high quality work. Our model makes predictions on when eWoM benefits producers and for what types of products it has the most impact.

■ TA02

02-Level 3, Drummond West

Large-scale Optimization and Computing for Operating Room Planning and Scheduling

Cluster: Healthcare

Invited Session

Chair: Vahid Roshanaei, PhD Candidate, University of Toronto, 5 King's College Road, Toronto, On, Canada, vroshana@mie.utoronto.ca

1 - Coalitional Operating Room Planning and Scheduling via a Bi-Cut Logic-Based Benders Decomposition

Vahid Roshanaei, PhD Candidate, University of Toronto, 5 King's College Road, Toronto, On, Canada, vroshana@mie.utoronto.ca
Dionne Aleman, Curtiss Luong, David Urbach

We study the problem of coalitional operating room planning and scheduling (CORPS), where a pool of patients, surgeons, and ORs are collaboratively planned amongst a coalition of hospitals. To solve the resulting mixed-integer model, we develop a novel logic-based Benders decomposition. We demonstrate that CORPS results in 30.12% cost-savings. We also use a game theoretic approach to redistribute the payoff acquired from a coalition of hospitals in UHN in Toronto, Ontario, Canada.

2 - Operating Room Scheduling using Branch-and-Check

Curtiss Luong, MASc, University of Toronto, Toronto, Canada, curtiss@mie.utoronto.ca, Vahid Roshanaei, Dionne Aleman

We study a operating room scheduling problem, where patients and ORs are planned and scheduled across a group of hospitals. Given a set of patients, the minimum number of hospitals and ORs to open is determined such that the most patients can be scheduled efficiently. We formulate the problem and solve using a branch-and-check solution method.

3 - Accounting for Variability in Surgical Scheduling

Jonathan Patrick, Telfer School of Management, University of Ottawa, 55 Laurier Avenue East, Ottawa, ON, K1N 6N5, Canada, patrick@telfer.uottawa.ca, Shirin Gerenmayeh

In partnership with a local hospital, we used MIP and simulation to determine the optimal block schedule in order to minimize peak loads in the wards. We incorporate the variability in recovery time and explore the impact of opening operating rooms on the weekend. We use simulation to determine the potential impact on bed availability for medical patients.

■ TA03

03-Level 3, Drummond Centre

OR in the Forest Products Sector

Cluster: Applications of OR in Forestry

Invited Session

Chair: Mustapha Ouhimmou, Professor, École de Technologie Supérieure (…TS) Share, 1100, rue Notre-Dame Ouest, Montreal, QC, H3C 1K3, Canada, Mustapha.Ouhimmou@etsmtl.ca

1 - Improving the Optimization Model of a Cutting System for Hardwood Flooring

Jonathan Gaudreault, Professor, Université Laval, Université Laval, Québec, Canada, jonathan.gaudreault@ift.ulaval.ca
André Thomas, Jean Wèry, Philippe Marier

We present an optimizer that we developed for hardwood floor cutting operations. As this operation is a stochastic process, we use historical production data to first train the optimizer through simulation. We then use linear programming to find the planning that will best meet with the factory customer needs and will maximize the value of the production.

2 - Process Improvement at a Parallam Mill

Luke Opacic, MSc Graduate Student, UBC Faculty of Forestry - Industrial Engineering Research Group, 2943-2424 Main Mall, Vancouver, BC, V6T 1Z4, Canada, luke.opacic@shaw.ca
Taraneh Sowlati

In this project simulation is used to analyze improvements in the process flow within a Parallam wood composite manufacturing facility. The analysis involves evaluating the impact of investments in new machinery, and operational changes involving specialty and custom pieces.

3 - Modelling Crown Wood Allocation to Facilities in Ontario, Canada using ONFLOW

Wenbin Cui, Forest Modelling Specialist, Ontario Ministry of Natural Resources and Forestry, 70 Foster Drive, Sault Ste. Marie, ON, P6A 6V5, Canada, wenbin.cui@ontario.ca

We use ONFLOW, an agent based model, to simulate/optimize wood allocation to the major facilities in Ontario under various policy scenarios. The policy objectives 1)To assess the effectiveness of current wood allocations to facilities, 2)To identify barriers to full utilization, 3)To assess potential options to improve the efficiency of existing wood allocations, and 4)To develop a basis for monitoring and assessing facility allocations and considering changes to existing facility allocations.

4 - Multi-Criteria Multi-Period Approach for Project Selection in Sustainable Development Context

Anissa Frini, Professor, Université du Québec - Rimouski, 1595 Boulevard Alphonse Desjardins, Lévis, QC, G2E 5V4, Canada, anissa_frini@uqar.ca, Sarah BenAmor

This work proposes two novel multi-criteria multi-period approaches for project selection under sustainable development context. The first approach expands the use of multi-criteria synthesizing methods to the multi-period context. The second approach utilizes outranking methods with a distance measure between pre-orders to solve the problem. The first (resp. second) approach is illustrated with TOPSIS (resp. ELECTRE II) for choosing the best compromised sustainable forest management options.

■ TA04

04-Level 3, Drummond East

Transportation and Wood Handling

Cluster: Applications of OR in Forestry

Invited Session

Chair: Bernard Gendron, Université de Montréal and CIRRELT, 2920, Chemin de la Tour, Montreal, Canada, Bernard.Gendron@cirrelt.ca

1 - Towards a Regional Logistical Center: Design and Management

François Sarrazin, Université Laval, Pavillon Abitibi-Price, 2405, rue de la Terrasse, # 2125, Québec, QC, G1R3Z3, Canada, Francois.Sarrazin@forac.ulaval.ca

The studied project consists of developing and testing a profit maximization model to identify the conditions for the success of a logistical center comprising wood transportation planning and sorting operations. This center would be serving multiple forest companies in a given region. A sensitivity analysis has been conducted on a number of costs and factors in order to compare several scenarios and identify some key parameters in regard to the profitability of such a structure.

2 - Simple Algorithms to Find Many-to-Many Shortest Paths in a Forest Network

Marc-Andre Menard, Student, Universite Laval, 1065 avenue de la Médecine, Quebec City, Canada, marc-andre.menard.2@ulaval.ca, Jonathan Gaudreault, Claude-Guy Quimper

We study the problem of finding the shortest paths in a forest network between all cut blocks and factories. When there are multiple cut blocks and factories, a computer that does not fully exploit the properties of the basic shortest-path algorithms can be highly inefficient. We used well-known algorithms in computer science, but took advantage of the parallelism and the many non-cyclical parts that characterize a forest network to obtain a speedup of 99.38 % compared to our first approach.

3 - Real-Time Transportation Planning and Control in Forestry

Amine Amrouss, Université de Montréal, 2920, chemin de la Tour, Montréal, QC, H3T1J4, Canada, amrouss.amine@gmail.com Michel Gendreau, Bernard Gendron

When wood is transported from forest areas to plants, several unforeseen events may perturb planned trips (e.g., because of weather conditions, forest fires, or the occurrence of new loads). When such events take place, possible recourse actions depend on the supply chain characteristics such as the presence of auto-loading trucks and the transport management policies of forest companies. We present 3 different application contexts as well as models and solution methods adapted to each context.

4 - Strategic and Tactical Multimodal Network Design in the Forest Industry

Anis Kadri, Ph.D Student, CIRRELT, Université de Montréal, Pavillon André Aisenstadt, bureau 3520, 2920, chemin de la Tour, Montréal, Qc, H3T 1J4, Canada, anis.kadri@umontreal.ca

An efficient and adequate planning provides an important reduction in the transportation cost, in particular by combining different modes of transport. Many countries showed the considerable advantage of using railway and maritime transportation, as well as combining them with roadways. We consider problems dealing with strategic and tactical multimodal network design. We formulate our problems as a mixed-integer programs that take into account the particular context of the forest industry.

■ TA05

05-Level 2, Salon 1

Strategic and Tactical Issues in Transportation Systems

Sponsor: Transportation Science & Logistics

Sponsored Session

Chair: Manish Verma, Associate Professor, McMaster University, 1280 Main Street West, Hamilton, ON, L8S4M4, Canada, mverma@mcmaster.ca

1 - A Metaheuristic-Based Solution Technique for Protection Planning in a Rail-Truck Intermodal Network

David Tulett, Associate Professor, Memorial University of Newfoundland, Faculty of Business, St. John's, A1B 3X5, Canada, dtulett@mun.ca, Hassan Sarhadi, Manish Verma

The importance of the critical infrastructure of rail-truck intermodal transportation necessitates the development of careful planning for the possibility of disruptions. In this presentation, an efficient solution technique for solving the problem of protection planning in a rail-truck intermodal transportation network against worst-case disruptions will be elaborated. The results show the competency of the proposed solution technique in solving problems of realistic size.

2 - Recovery from Railroad Disruptions: An Optimization Framework and a Case Study

Nader Azad, Postdoctoral Research Fellow, DeGroote School of Business, McMaster University, 1280 Main Street West, McMaster Universi, Hamilton, ON, L8S 4M4, Canada, nazad@mcmaster.ca Elkafi Hassini, Manish Verma

We propose an optimization framework for recovery from disruptions in service legs and train services in a railroad network. An optimization model is used to evaluate a number of what-if scenarios. This data is used to construct a predictive model for disruption and design proper mitigation strategies. Through the aid of a realistic size case study based in mid-west United States, we illustrate how the proposed framework can be used to design networks that can handle disruptions efficiently.

3 - A Portfolio Management Approach to Planning Crude Oil Tanker Fleet

Manish Verma, Associate Professor, McMaster University, 1280 Main Street West, Hamilton, ON, L8S4M4, Canada, mverma@mcmaster.ca, Atiq Siddiqui

Crude oil suppliers usually meet intercontinental demand through a fleet of ocean tankers, which not only have very high fixed and operating costs but also carry considerable financial risks because of the volatilities in oil demand and spot freight rate markets. We propose a simulation-optimization based framework that minimizes the chartering costs and the associated financial risks and then used it to study a number of realistic problem instances generated using network of an oil supplier.

4 - The Designated Driver Problem: Model Formulation and Solution Approaches

Jordan Srour, Assistant Professor, Lebanese American University, School of Business, Beirut, Lebanon, jordan.srour@lau.edu.lb Johan Oppen, Niels Agatz

We present a routing problem where customers are transported in their own vehicles by chauffeurs. This occurs when a customer wants to use his/her own car to go home, but cannot drive because he/she has been drinking. We study how chauffeurs should be transported to customer pickup locations and from customer drop-off locations in order to minimize costs, serving as many requests as possible. We present models and solution methods, as well as numerical results based on real-world data.

5 - Collaboration Planning of Stakeholders For Sustainable City Logistics Operations

Anjali Awasthi, Concordia University, Montréal, Canada, anjali.awasthi@concordia.ca, Taiwo Adetiloye, Mostafa Badakhshian

The importance of city logistics has been growing, especially with its role in minimizing traffic congestion and freeing up of public space. We investigate the problem of collaboration planning of stakeholders to achieve sustainable city logistics operations. Two categories of models are proposed. At the macro level, we have the collaboration square models and at the micro level we have the operational level models.Numerical experimentation is provided.

■ TA06

06-Level 2, Salon 2

Accounting for Choice Behavior in Revenue Management

Cluster: Special Invited

Invited Session

Chair: Gustavo Vulcano, New York University, 44 West Fourth St, Suite 8-76, New York, NY, 10012, United States of America, gvulcano@stern.nyu.edu

1 - Revenue Management for Railways Services: A Discrete Choice Approach.

Cinzia Cirillo, University of Maryland, 3250 Kim Bldg, College Park, MD, 20742, United States of America, ccirillo@umd.edu
Kartik Kaushik

The aim of this paper is to integrate discrete choice of consumers into the problem of revenue management for railways where reservations are made close to the scheduled departure. We propose various customer arrival processes while the available capacity is broken down into two fare classes, two subclasses within each class, differentiated by the application of restrictions on the customers' purchase choice sets. The final model will be optimized using an expectation maximization algorithm.

2 - A Semi-Compensatory Model with Soft Cut-Offs to Account for Attributes Non-Attendance

Elisabetta Cherchi, Associate Professor, DTU Transport, Bygningstorvet 116V, Kgs. Lyngby, 2800, Denmark, elich@transport.dtu.dk

Standard discrete choice models assume that individuals evaluate all the attributes and trade them off assuming unlimited substitutability. But individuals do not consider all the information available in the decision problem and preferences are often linear only within a specific domain. In this paper we use a semi-compensatory model where the thresholds on some attribute affect the individual's attendance of other attributes in the utility function.

■ TA07

07-Level 2, Salon 3

Vehicule Routing Problem

Cluster: Contributed Sessions

Invited Session

Chair: Diego Pecin, Postdoctoral researcher, Polytechnique Montreal, GERAD, Montreal, QC, H3T 1J4, Canada, diegopecin@gmail.com

1 - Exact Algorithms for the Pollution Routing Problem

Qie He, Assistant professor, University of Minnesota, 111 Church Street SE, Minneapolis, MN, 55455, United States of America, qhe@umn.edu, Yongjia Song, Ricardo Fukasawa

We propose exact formulations and algorithms for the pollution routing problem. Preliminary computational results show that some benchmark instances from the PRPLIB can be solved to optimality for the first time.

2 - A Modified Ant Colony Algorithm for the Multi Compartment Vehicle Routing Problem

Mohamed Abdulkader, PhD Student, University of Manitoba, Department of Mechanical Engineering, 75A Chancellors Circle, Winnipeg, Ma, R3T 5V6, Canada, abdulka3@myumanitoba.ca
Yuvraj Gajpal, Tarek ElMekkawy

Multi Compartment Vehicle Routing Problem is an extension of the basic Capacitated Vehicle Routing Problem when different products are transported together but handled in separated compartments. We proposed a modified Ant Colony Optimization algorithm to solve the problem and compared with the existing ant colony algorithm. Numerical experiments are performed on newly generated benchmark problem instances. The proposed ant colony algorithm gives better results as compared to the existing one.

3 - A New Branch-Cut-and-Price Algorithm for the Vehicle Routing Problem with Time Windows

Diego Pecin, Postdoctoral Researcher, Polytechnique Montréal, GERAD, Montréal, QC, H3T 1J4, Canada, diegopecin@gmail.com
Claudio Contardo, Guy Desaulniers, Eduardo Uchoa

This talk introduces a new Branch-Cut-and-Price algorithm for the VRPTW that combines recent techniques for VRPs, such as: ng-routes, bidirectional pricing, strong branching, variable fixing, route enumeration, robust cuts, limited-memory Subset Row Cuts (lm-SRCs) – a relaxation of the SRCs that is more friendly with the labeling algorithms used to solve the pricing. Our results show that all the 100-customer Solomon and several 200-customer Homberger instances can now be solved to optimality.

■ TA08

08-Level A, Hémon

DFO Methods for Multiobjective and Constrained Problems

Cluster: Derivative-Free Optimization

Invited Session

Chair: Francesco Rinaldi, Department of Mathematics - University of Padua, via Trieste, 73, Padua, Italy, rinaldi@math.unipd.it

1 - Parallel Hybrid Multiobjective Derivative-Free Optimization

Joshua Griffin, SAS Institute Inc., 100 SAS Campus Drive, Cary, IN, United States of America, Joshua.Griffin@sas.com
Steven Gardner

We present enhancements to a SAS high performance procedure for solving multiobjective optimization problems in a parallel environment. The procedure, originally designed as a derivative-free solver for black-box single objective MINLP, has now been extended for multiobjective problems. In this case the procedure returns an approximate Pareto-optimal set of nondominated solutions to the user. We will discuss the software architecture and algorithmic changes made, providing numerical results.

2 - Path-Augmented Constraints in Derivative-Free Nonlinear Programming

Florian Augustin, Massachusetts Institute of Technology, 77 Massachusetts Avenu, Cambridge, United States of America, fmaugust@mit.edu, Youssef Marzouk

We present the derivative free algorithm NOWPAC (Nonlinear Optimization With Path-Augmented Constraints) for computing local solutions to nonlinear constrained optimization problems. The method is based on a trust region framework and works with surrogates for the objective and the constraints. We augment the constraints by an offset function, the inner-boundary path, to compute feasible trial steps. We show the efficiency of NOWPAC on several numerical examples.

3 - Combining Global and Local Derivative-Free Strategies for Black-Box Multiobjective Problems

Francesco Rinaldi, Department of Mathematics - University of Padua, via Trieste, 73, Padua, Italy, rinaldi@math.unipd.it
Giampaolo Liuzzi, Stefano Lucidi

We describe a new method combining global and local derivative-free methods for solving black-box multiobjective problems coming from real-world applications. In particular, we use a DIRECT-type approach for the global phase, while, for the local phase, we include both line-search and model-based methods. We further report some numerical results proving the effectiveness of the proposed approach.

■ TA09

09-Level A, Jarry

Airline Transportation

Sponsor: Aviation Applications

Sponsored Session

Chair: Atoosa Kasirzadeh, GERAD & Ecole Polytechnique de Montreal, André-Aisenstadt Building, 2920, Chemin de la Tour, 4th floor, Montreal, Canada, atoosa.kasirzadeh@gerad.ca

1 - Simultaneous Optimization of Personalized Integrated Cockpit Scheduling

Atoosa Kasirzadeh, GERAD & École Polytechnique de Montréal, André-Aisenstadt Building, 2920, Chemin de la Tour, 4th floor, Montréal, Canada, atoosa.kasirzadeh@gerad.ca

We deal with integrated personalized crew scheduling problem. In this case, personal preferences result in different monthly schedules for the crew. To maintain the robustness of the schedules under perturbation at the operational level, cockpit must have similar pairings when possible. We present a heuristic algorithm that alternates between the pilot and copilot scheduling problems to obtain similar pairings. We conduct computational experiments on a set of instances from a major US carrier.

2 - Solving the Monthly Aircrew Pairing Problem via Dynamic Constraint Aggregation

Mohammed Saddoune, Professor, GERAD and École Polytechnique de Montréal, 3000, ch. de la Cote-Sainte-Catherine, Montréal, H3T 2A7, Canada, mohammed.saddoune@gmail.com, François Soumis

Recently, Saddoune et al. (2013) showed that the rolling-horizon heuristic produced better solutions than the three-phase approach to solve the monthly crew pairing problem. For flexibility and to take into account some special features of the planning, flight schedules have recently become less regular. This paper shows that solving this problem globally using an exact method based on dynamic constraint aggregation produces solutions that are cheaper and more robust.

3 - Improving Branching in Airline Crew Pairing Problem with Base Constraints

Frédéric Quesnel, PHD Student, GERAD, 2900 Boulevard Edouard-Montpetit, Montréal, H3T 1J4, Canada, frederic.quesnel@gerad.ca, François Soumis, Guy Desaulniers

In the context of crew pairing, many of the real-world crew pairing solvers consider restrictions on the total number of working time at each crew base. These base constraints have not been often studied academically. We propose a Danzig-Wolfe decomposition formulation for crew pairing problem that includes base constraints. We show how they degrade the resolution of the problem. We propose different branching schemes to improve the computational time and the objective value of our instances.

4 - Including Fatigue Measures in Crew Pairing Optimization

Fatma Gzara, Assistant Professor, University of Waterloo, 200 University Avenue W, Waterloo, Canada, fgzara@uwaterloo.ca
Samir Elhedhli, Burak Yildiz

Crew fatigue is one of the main causes for mishaps in airline operations. Traditionally, crew fatigue is accounted for implicitly by enforcing rules on legal pairings. We propose a new crew pairing optimization model that considers crew fatigue explicitly. Preliminary results are provided.

■ TA10

10-Level A, Joyce

Theory and Applications of Robust Optimization

Cluster: Stochastic Optimization

Invited Session

Chair: Amir Ardestani-Jaafari, PhD Candidate, HEC Montreal, 3000 Cote-Sainte-Catherine Road Montréal, Montreal, QC, Canada, amir.ardestani-jaafari@hec.ca

1 - The Value of Flexibility in Robust Location - Transportation Problem

Amir Ardestani-Jaafari, PhD Candidate, HEC Montréal, 3000 Cote-Sainte-Catherine Road Montréal, Montréal, QC, Canada, amir.ardestani-jaafari@hec.ca, Erick Delage

We propose a set of conservative tractable approximations to two-stage robust location-transportation problem that each exploits to a different extent the idea of reducing the flexibility of the delayed decisions. All of these approximations will outperform previous approximation models that have been proposed for this problem. We will also demonstrate that full flexibility is often unnecessary to reach nearly, or even exact, optimal robust decisions for the problem.

2 - Continuity of Robust Optimization Problems with Respect to the Uncertainty Set

Philip Mar, PhD Candidate, University of Toronto, RS 308 Dept. of Mech. and Ind. Eng., 5 King's College Road, Toronto, ON, M5S 3G8, Canada, philip.mar@mail.utoronto.ca

Robust Optimization (RO) is widely used for handling uncertainty in continuous mathematical programming problems. One important aspect of Robust Optimization is the choice of uncertainty set and how this choice can affect the performance of the robust solution. We will discuss the stability of Robust Optimization problems, namely, quantitative estimates of how much the optimal value of the robust solution changes when the uncertainty set is arbitrarily perturbed.

3 - On the Adaptivity Gap in Two-Stage Robust Linear Optimization under Uncertain Constraints

Brian Lu, PhD Candidate, Columbia university, Mudd 313, 500 W 120th St, New York, NY, 10025, United States of America, yl2662@columbia.edu, Vineet Goyal

We consider a two-stage robust linear optimization problem with uncertain packing constraints. We study the performance of static solutions and give a bound on the adaptivity gap. We show that for a fairly general class of uncertainty sets, a static solution is optimal. Furthermore, when a static solution is not optimal, we give a tight approximation bound on the performance of the static solution that is related to the geometric properties of the uncertainty set.

4 - Robust Optimization Methods For Breast Cancer Radiation Therapy

Houra Mahmoudzadeh, University of Toronto, 5 King's College Road, Toronto, Canada, houra@mie.utoronto.ca
Thomas Purdie, Timothy Chan

We explore robust optimization methods for improving the quality of treatment in left-sided breast cancer radiation therapy. Our robust models take into account breathing uncertainty and minimize the dose to the organs at risk while meeting the clinical dose-volume limits on the cancerous target. We use clinical data from several breast cancer patients and compare the outcomes of our robust models with those of the current clinical methods.

■ TA11

11-Level A, Kafka

Facility Location - Network Design

Cluster: Contributed Sessions

Invited Session

Chair: Ahmed Saif, PhD Candidate, University of Waterloo, 200 University Avenue West, Waterloo, Canada, asaif@uwaterloo.ca

1 - Rapid Transit Network Design with Competition

Gabriel Gutiérrez-Jarpa, Pontificia Universidad Catolica de Valparaìso, Avenida Brasil 2241, School of Industrial Engineering,, Valparaìso, Chile, gabriel.gutierrez@ucv.cl
Vladimir Marianov, Luigi Moccia, Gilbert Laporte

We present a multi-objective MILP for the rapid transit network design problem with modal competition. Previous discrete formulations eluded modal competition for realistic size problems because of the excessive complexity of modeling alternatives for each flow in the network. We overcome this difficulty by exploiting a pre-assigned topological configuration. A case study for a metro proposal in ConcepciÜn, Chile, shows the method's suitability.

2 - Facility Location, Demand Allocation and Inventory Control in Delayed Product Differentiation Based Supply Chain Design

Sachin Jayaswal, Assistant Professor, Indian Institute of Management Ahmedabad, Vastrapur, Ahmedabad, Gu, 380015, India, sachin@iimahd.ernet.in, Navneet Vidyarthi, Sagnik Das

We study the problem of integrated facility location, demand allocation and inventory control in the design of a delayed product differentiation based supply chain. We formulate the problem as a nonlinear mixed integer programming model, and present linearization schemes for the nonlinear components of the problem. We present an exact solution approach for small-medium instances, and Lagrangean heuristics for solving large scale of the problem.

3 - Locating Recycling Facilities for IT-Based Electronic Waste in Turkey

Necati Aras, Bogazici University, Bebek, Istanbul, Turkey, arasn@boun.edu.tr, Aybek Korugan

Turkey has a WEEE directive that is in effect since May 2013. It requires to locate recycling facilities that will handle unused products. We develop a multi-period capacitated facility location-allocation model with the objective of minimizing the total cost of opening facilities, operating them, and transporting the e-waste. Since there is uncertainty in the number of e-waste, we generate a set of scenarios to obtain a minmax regret solution associated with different scenarios.

4 - Design of a Centralized System for Medical Sterilization

Ahmed Saif, PhD Candidate, University of Waterloo, 200 University Avenue West, Waterloo, Canada, asaif@uwaterloo.ca
Samir Elhedhli

We consider the problem of designing a network of centralized sterilization centers to serve the stochastic demand of a set of hospitals. The problem is modeled as a concave mixed integer program, taking into consideration both strategic and tactical decisions. Economies of scale and risk pooling effects are incorporated in the model through concave functions. We propose a Lagrangian decomposition approach embedded in a B&B to solve the problem. Managerial insights are drawn from the results.

■ TA12

12-Level A, Lamartine

Dynamic Programming

Cluster: Contributed Sessions

Invited Session

Chair: Ernie Love, Professor Emeritus, Simon Fraser University, 8888 University Drive, Burnaby, BC, V5A1S6, Canada, love@sfu.ca

1 - Portfolio Choice with Predictable Non-Gaussian Returns

Siyang Wu, PhD Candidate, HEC Montréal, 3000 chemin de la Cote-Saint-Catherine, Montréal, QC, H3T2A7, Canada, siyang.wu@hec.ca, Michel Denault, Jean-Guy Simonato

In this paper, we examine multi-period portfolio choice problems of an investor with CRRA utility function in an incomplete market with non-Gaussian returns. The non-Gaussian case studied is the Johnson-Su distribution. It can capture important features of stock returns such as negative skewness and high kurtosis. And as a monotonic transformation of the Gaussian, the Johnson-Su allows one to use Gauss-Hermite quadrature to compute expectations, which increases computation speed and accuracy.

2 - Finite State Approximation of POMDPs

Jalal Arabneydi, McGill University, 3480 University Street, Montréal, QC, CA, Montréal, QC, Canada, Aditya Mahajan

A novel approach for approximate solutions to Partial Observable Markov Decision Processes (POMDP) is presented. First, the POMDP is converted to a countable-state Markov Decision Process (MDP). Then, the countable-state MDP is approximated by a finite-state MDP. The error associated with this approximation is bounded and converges to zero exponentially fast.

3 - A Semi-Markov Model to Determine Repair/Replacement under a Trend-Renewal Failure

Ernie Love, Professor Emeritus, Simon Fraser University, 8888 University Drive, Burnaby, BC, V5A1S6, Canada, love@sfu.ca

The failure repair process of a repairable system is modeled as a trend-renewal process permitting imperfect repairs. The state of such a system can be characterized by the real age of the system and the failure count permitting a two-state semi-Markov model to be used to determine optimal time to renew the system. Threshold type policies are established.

■ TA13

13-Level A, Musset

Pricing & Revenue Management I

Sponsor: Pricing & Revenue Management

Sponsored Session

Chair: Peter Bell, Ivey Business School at Western University, London, ON, N6G 0N1, Canada, PBell@Ivey.ca

1 - Price Guarantees using Loyalty Programs and Swap Structures

Fredrik Odegaard, Ivey Business School, Western University, 1255 Western Road, London, ON, N6G 0N1, Canada, fodegaard@uwo.ivey.ca, Daero Kim, Matt Davison

Dynamic pricing is an effective revenue management strategy. However, price uncertainty and volatility may inhibit purchase from some customers. Motivated by gasoline prices, which exhibit great long- and short-term variability, we discuss a price guarantee model based on loyalty programs and financial swap structures. The paper presents optimal refueling strategies, analysis of the optimal swap contracts and pricing strategies, and an illustration using empirical data of US gasoline market.

2 - Selling to Strategic Customers When There is a Non-Deceptive Counterfeiter

Hubert Pun, Ivey Business School, Western University, London, ON, Canada, hpun@Ivey.ca, Greg Deyong

We consider a manufacturer that sells products to strategic customers over two periods. After the end of the first period, a counterfeiter that is capable of producing a non-deceptive counterfeiting product decides whether or not to enter into the market. The manufacturer decides an investment in advertisement, and the retail prices are decided at each period.

3 - Dynamic Matching in a Two-Sided Market

Yun Zhou, Rotman School of Management, University of Toronto, 105 St. George Street, Toronto, Canada, Yun.Zhou13@Rotman.Utoronto.Ca, Ming Hu

We consider a framework of dynamically matching supply with demand by an intermediary firm. With a multi-period setting, different types random supply and demand arrive in each period. The intermediary firm decides the matching quantity between the types to maximize the total expected reward. In this research, we explore the structure of the optimal matching policy and heuristic methods.

4 - Profit Maximization is More Important than Revenue Maximization

Peter Bell, Ivey Business School at Western University, London, ON, N6G 0N1, Canada, PBell@Ivey.ca

Revenue managers often claim that a 10% price increase "goes straight to the bottom line" leading to a much greater profit increase. However, this presentation will use data from a real firm to demonstrate that a price increase that increases revenues may actually reduce profits, and also that a cost cutting exercise may have the opposite of the intended affect.

■ TA14

14-Level B, Salon A

Energy Systems III

Cluster: Energy

Invited Session

Chair: Fuzhan Nasiri, Concordia University, 1455 De Maisonneuve Blvd. W., Montreal, QC, H3G 1M8, Canada, fuzhan.nasiri@concordia.ca

1 - Optimization of a Real Hydropower System: A Short-Term Model

Pascal Coté, Operations Research Engineer, Rio Tinto Alcan, 1954 Davis, Jonquiere, Qc, G7S 4R5, Canada, pascal.cote@riotinto.com Charles Audet, Sara Séguin

We solve the short-term unit commitment and loading problem of a hydropower system. DP computes power outputs of plants and a two-phase optimization is employed : a NLMIP and an IP model. The goal is to maximize energy. Start-ups are penalized and a demand constraint is met.

2 - Comparison of Explicit and Implicit Stochastic Optimization: Study on the Kemano Hydropower System

Quentin Desreumaux, University of Sherbrooke, Sherbrooke, QC, Canada, quentin.desreumaux@usherbrooke.ca Matteo Giuliani, Andrea Castelletti, Pascal Coté, Robert Leconte

We compare two different algorithms used for optimizing the operating policy of the multi-purpose Kemano water reservoir: stochastic dynamic programming (SDP) and evolutionary multi-objective direct policy search (EMODPS), respectively classified as explicit and implicit stochastic methods. We focus on the representation of the stochastic process and inclusion of exogenous information in both algorithms and how it impacts the results.

3 - Integrating Biomass Boilers into Non-Domestic Buildings: A System Dynamics Analysis

Fuzhan Nasiri, Concordia University, 1455 De Maisonneuve Blvd. W., Montréal, QC, H3G 1M8, Canada, fuzhan.nasiri@concordia.ca Fereshteh Mafakheri

This study proposes a whole life cycle costing model using system dynamics for integration of biomass boilers into non-domestic buildings. The model aims at identifying the optimal energy generation plans along with the optimal levels of biomass purchase and storage. Through a case study, the sensitivity of the outcomes are then analyzed subject to changes in source, types and pricing of biomass materials as well as the choice of technologies and their cost and performance profiles.

4 - Updating Reservoir Management Policies in Northern Regions with Ensemble Streamflow Prediction

Alexandre Martin, University of Sherbrooke, 2500 boul. de l'Université, Sherbrooke, QC, Canada, Alexandre.Martin@USherbrooke.ca Pascal Coté, Robert Leconte

We evaluate the impact of updating reservoir management policies at every time step by using Ensemble Streamflow Prediction (ESP) and Stochastic Dynamic Programming on a basin subject to large streamflow volumes due to snowmelt. ESP are simulated with a deterministic hydrological model using historical meteorological sequences. Policies are updated using two different state variables : maximum snow water equivalent and median streamflow volume prediction.

■ TA15

15-Level B, Salon B

Practical Revenue Management

Cluster: Practice

Invited Session

Chair: Morad Hosseinalifam, Lead revenue management and operations research specialist, ExPretio Technologies, 200 Laurier Avenue West. Suite 400, Montreal, QC, H2T 2N8, Canada, morad.hosseinalifam@expretio.com

1 - Practical Revenue Management: Adaptability, Productivity and Competitiveness

Simon Boivin, Operations Research Software Developer, Technologies Expretio, 200, Ave Laurier Ouest, bureau 400, Outremont, QC, H2T2N8, Canada, simon.boivin@expretio.com

Transportation companies are under pressure to increase their profitability. In this context, revenue management is an interesting possibility to achieve this objective. In this presentation, we talk about challenges in practical revenue management. We present solutions to tackle those challenges and we introduce Appia: an intelligent revenue management and optimization solution. We show how our technologies may be easily applied to railroad industries.

2 - Better Demand Forecasting through Customer Choice Modeling

Kim Levy, Machine Learning Specialist, ExPretio Technologies, 200 Laurier Ouest, Montréal, PQ, H2T 2N8, Canada, kim.levy@expretio.com

Customers are offered several travel options on a daily basis. So our ability to understand and predict customer behavior is crucial in optimizing seat allocations. Since historical bookings are observed for a single seat availability scenario; the potential demand for a higher fare products are not directly observable. Through customer choice modelling, we are able to estimate the potential demand and identify buy-up opportunities across products and travel options, thus maximizing revenue.

3 - Choice-Based Revenue Optimization and Intelligence Applied to the Railway Industry

Morad Hosseinalifam, Lead Revenue Management and Operations Research Specialist, ExPretio Technologies, 200 Laurier Avenue West. Suite 400, Montréal, QC, H2T 2N8, Canada, morad.hosseinalifam@expretio.com

We present a new-generation of Revenue Optimization tools to meet the demands of railway operators. We integrate powerful customer behavior models into a large-scale optimization framework to face this dynamic and competitive environment. The framework developed by Expretio allows operators to optimally manage their seat inventory and set fares, as well as other product attributes, across channels and customer profiles while taking into account passenger purchase habits and competitors' actions.

■ TA16

16-Level B, Salon C

Algorithms for Nonconvex Optimization Problems

Cluster: Mixed-Integer Nonlinear Optimization

Invited Session

Chair: Miguel F. Anjos, Professor and Canada Research Chair, Mathematics & Industrial Engineering, Polytechnique Montreal, Montreal, Canada, miguel-f.anjos@polymtl.ca

1 - New Alternate Direction Methods (ADM) for Nonconvex Quadratic Optimization

Jiming Peng, University of Houston, Department of Industrial Engineering, Houston, United States of America, jopeng@uh.edu

ADMs have been widely used for QPs. However, for non-convex QPs, existing ADMs converge only to a stationary point. In this talk, we first cast any QP as a specific bi-convex derived from the KKT conditions. Then we propose new ADMs based on the new bi-convex QP which converge to an approximate local minimum of the problem. A new line search technique procedure is introduced to find the global optimal solution to classes of non-convex QP.

2 - AMPL-LGO Solver for Global-Local Nonlinear Optimization: Key Features and Performance

Janos D. Pinter, PhD, DSc, PCS Inc., 114 Stoneybrook Court, Halifax, NS, B3M 3J7, Canada, janos.d.pinter@gmail.com
Victor Zverovich

AMPL is a language for mathematical programming that enables optimization model development in a natural, concise, and scalable fashion. AMPL supports the seamless invocation of various solver engines to handle the resulting optimization models. LGO is an integrated solver suite for general nonlinear (constrained global and local) optimization. We review the features and usage of the AMPL-LGO solver engine, and illustrate its performance based on a substantial collection of nonlinear models.

3 - An RLT Approach for Solving the Discretely Constrained Mixed Linear Complemmentarity Problem

Franklin Djeumou Fomeni, Postdoctoral Fellow, Ecole Polytechnique Montréal, Universite de Montréal, Pavillon Andre A, Pavillon Andre Aisenstadt,, Montréal, QC, H3T 1J4, Canada, franklin.djeumou@gerad.ca, Steven A. Gabriel, Miguel F. Anjos

The DC-MLCP is a formulation of the MLCP in which some variables are restricted to be integer. The presence of discrete variables in the DC-MLCP makes it even more difficult to solve. We present a novel approach in which we first relax the problem and then replace all the complementary constraints with linear equations without losing the feasibility of the problem. We will present some computational results to show the usefulness and the effectiveness of this novel approach.

■ TA17

17-Level 7, Room 701

Innovative Analytics Solutions

Sponsor: Analytics

Sponsored Session

Chair: Ozgur Turetken, Professor, Ryerson University, turetken@ryerson.ca

1 - Modeling Digital Billboard Advertising Networks in the Era of Big Data

Parisa Lak, Ryerson University, 1 Park Brook Place, Thornhill, Canada, parisa.lak@ryerson.ca, Akram Samarikhalaj, Ceni Babaoglu, Akin Kocak, Pawel Pralat, Ayse Bener

The availability and accessibility of tremendous amount of information has changed companies routines. One of the attributes that affects performance is pricing. Therefore, companies applied dynamic pricing in order to adopt to dynamic environment in big data era. This study assess a dynamic pricing system in the digital billboard industry.

2 - The Impact of Sentiment Analysis on Decision Outcomes

Ozgur Turetken, Professor, Ryerson University, turetken@ryerson.ca, Parisa Lak

Consumers regularly face a trade-off between the cost of acquiring information and the decline in decision quality caused by insufficient information. Consumers need to decide what subset of available information to use. Star ratings are excellent cues as they provide a quick indication of the tone of a review. Sentiment analysis automatically detects the polarity of text. In this study, we investigate the impact of sentiment scores on purchase decisions.

3 - Testing the Efficacy of Self-Service Analytics using a Dimensional Model Management Warehouse

David Schuff, Professor, Temple University, United States of America, david.schuff@temple.edu
Karen Corral, Greg Schymik, Robert St. Louis

To truly leverage the power of analytics, sophisticated model building techniques must be accessible to the average business professional.This study describes the design of an experiment to test the effectiveness of a document warehouse to enable knowledge workers with limited statistical expertise to build analytical models. The study will compare the effectiveness of subjects' models who used the warehouse without analytics training to subjects' models who only received analytics training.

■ TA18

18-Level 7, Room 722

Recent Advances in Accumulating Priority Queues

Cluster: Queueing

Invited Session

Chair: David Stanford, Professor, Western University, Statistical & Actuarial Sciences, 1151 Richmond St. N., London, ON, N6A 5B7, Canada, stanford@stats.uwo.ca

1 - Waiting Times for Nonlinear Accumulating Priority Queues

Na Li, PhD Student, Statistical & Actuarial Sciences, UWO, 1151 Richmond St. N., London, ON, N6A 5B7, Canada, nli66@uwo.ca
Ilze Ziedins, David Stanford, Peter Taylor

This paper presents a multi-class APQ with general service times and a group of nonlinear priority accumulation functions, which goes well beyond the power-law case considered by Kleinrock & Finkelstein (1967), who determined the mean waiting time for each customer class. We show that an equivalent linear system can be found under suitable conditions. If parameters are chosen properly, the waiting time distributions in such nonlinear APQs can be found directly from Stanford et al (2014).

2 - A New Patient Selection Strategy to Minimize Expected Excess Waiting Time

Azaz Sharif, PhD Student, Statistical & Actuarial Sciences, UWO, 1151 Richmond St. N., London, ON, N6A 5B7, Canada, asharif9@uwo.ca, David Stanford, Richard Caron

Service systems often adhere to a set of Key Performance Indicators, which stipulate the fraction of customers to be seen by specified time limits. Such an approach gives no consideration to the consequences for customers whose waiting time exceeds the delay limit. We present an optimization model for APQ systems which seeks to minimize various weighted averages of the expected excess waiting times for the classes of customers.

3 - A General Mixed Priority Queue with Server Discretion

Andrei Fajardo, University of Waterloo, Dept. of Statistics & Actuarial Science, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, va2fajardo@uwaterloo.ca, Steve Drekic

We study a single-server queueing system with N priority classes that are classified into 2 distinct types: urgent (classes which have preemptive priority over at least 1 lower priority class) and non-urgent (classes which only have non-preemptive priority among lower priority classes). While urgent customers have preemptive priority, the ultimate decision on whether to interrupt a current service is based on certain discretionary rules. An accumulating prioritization is also incorporated.

4 - The Heterogeneous Multi-Server Accumulating Priority Queue

David Stanford, Professor, Western University, Statistical & Actuarial Sciences, 1151 Richmond St. N., London, ON, N6A 5B7, Canada, stanford@stats.uwo.ca, Na Li

Waiting time distributions for multi-server APQ with a common exponential service time distribution were obtained in Sharif et al (2014). It can be the case that servers (be they humans or machines) serve at differing rates. This paper presents a multi-server APQ model whose service times are exponentially distributed, but with differing service rates for different servers. Numerical illustrations for the waiting time distribution are presented.

■ TA19

19-Grand Ballroom West

Tutorial: Dynamic Games Played over Even Trees

Cluster: Tutorials

Invited Session

LATE CANCELLATION

Chair: Georges Zaccour, Professor, HEC Montréal, 3000 Cote-Sainte-Catherine, Montreal, QC, H3T 2A7, Canada, georges.zaccour@hec.ca

1 - Dynamic Games Played over Even Trees

Georges Zaccour, Professor, HEC Montréal, 3000 Cote-Sainte-Catherine, Montréal, QC, H3T 2A7, Canada, georges.zaccour@hec.ca

I introduce the class of stochastic games where the uncertainty is described by an event tree. These games are a natural methodological framework to deal with situations where the players repeatedly compete over time, with decisions being taken under uncertainty. After defining the main elements of such games, I will discuss the computation of their equilibria under different information assumptions and provide illustrative examples in energy markets, competition in R&D and marketing.

Tuesday, 11:00am - 12:00pm

■ TB20

20-Grand Ballroom Centre

Tuesday Plenary

Cluster: Plenary Talks

Invited Session

Chair: Michel Gendreau, Professor, Ecole polytechnique de Montréal, C.P. 6079, succ. Centre Ville, MONTREAL, QC, H3C 3A7, Canada, michel.gendreau@cirrelt.net

1 - The Simpler the Better: Thinning out MIP's by Occam's Razor

Matteo Fischetti, Professor, Operation Research at the Department of Information Engineering of the University of Padua, Padua, Italy

This lecture is delivered by the winner of the Harold Larnder Prize, awarded annually to an individual who has achieved international distinction in operational research. Matteo Fischetti will deliver this year's Harold Larnder Lecture. Harold Larnder was a well-known Canadian in wartime OR. He played a major role in the development of an effective, radar based, air defence system during the battle of Britain. He returned to Canada in 1951 to join the Canadian Defence Research Board, and was President of CORS in 1966-67.

Tuesday, 1:30pm - 3:00pm

■ TC01

01-Level 4, Salon 8

Learning by Working in Online Business Environment

Sponsor: eBusiness

Sponsored Session

Chair: Chul Ho Lee, Associate Professor, Harbin Institute of Technology, 92 West Dazhi Street , Nan Gang District, Haerbin, 150001, China, irontigerlee@hit.edu.cn

1 - Understanding Doctor's Intention in using Online Healthcare Communities: The Role of Social Capital

Xitong Guo, Professor, Harbin Institute of Technology, 92 West Dazhi Street , Nan Gang District, Harbin, 150001, China, xitongguo@hit.edu.cn, Shanshang Guo, Yulin Fang, Doug Vogel

This study offers a new theoretical foundation for the intention in participating online healthcare communities (OHCs) by reconceptualizing social capital in an investment perspective. We develops an integrated model to understand key process of doctor knowledge sharing intentions through constructs prescribed by the established social capital model, and test with both online and offline evidence.

2 - How does the Online Health Social Network Affect User's Healthy Behaviors

Xiangbin Yan, Professor, Harbin Institute of Technology, 92 West Dazhi Street , Nan Gang District, Harbin, 150001, China, xbyan@hit.edu.cn

Human behavior is the largest source of variance in health-related outcome. Online health social network(OHSN) is widely used to promote healthy behavior and health outcome. From the view of social influence, social support and the social network structure, we explored how the OHSN affect user's healthy behaviors with the real dataset, and we also explored the effect of the different social relationship on healthy behaviors.

3 - Learning by Working Together in Cooperative Service Tasks: The Moderating Role of Task-Level Goal Conflict and Task Complexity

Tianshi Wu, Assistant Professor, Harbin Institute of Technology, 92 West Dazhi Street , Nan Gang District, School of Management, Harbin, 150001, China, thethreeshiwo@gmail.com
Chris Forman, Sridhar Narasimhan, Sandra Slaughter

Many tasks are completed by dyads rather than by an individual. In this setting, the individuals not only need to acquire knowledge about the task, but also have to learn to work with each other. Thus, individuals' experience may have significant performance implications for dyads. However, this effect remains unexamined, especially when there are conflicts. In this study, we theorize how a dyad's experience influences the dyad's task performance.

4 - Understanding Dynamic Interaction in Online Word-of-Mouth and Management Response

Jongmin Kim, PhD Student, University of Texas at Dallas, 800 W. Campbell Road, Richardson, TX, 75080, United States of America, jxk101020@gmail.com, B.P.S. Murthi

More platform providers allow firms to respond to customer reviews. The new service is characterized by intertwined relationships. This paper studies how the reviews and the response are dynamically related. We conduct sentimental analysis and content analysis and apply the panel vector autoregressive approach. First we show that positive user-generated contents affects consumer rating and sentiment; second identify how management response strategies are related to future flow of word-of-mouth.

■ TC02

02-Level 3, Drummond West

Optimization Methods for Cancer Therapy

Cluster: Healthcare

Invited Session

Chair: Houra Mahmoudzadeh, University of Toronto, 5 King's College Road, Toronto, Canada, houra@mie.utoronto.ca

Co-Chair: Taewoo Lee, Department of Mechanical and Industrial Engineering University of Toronto, 5 King's College Road, Toronto, ON, M5S 3G8, Canada, taewoo.lee@mail.utoronto.ca

1 - Optimizing Global Liver Functionality in Liver SBRT Planning

Victor Wu, PhD Student, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI, 48105, United States of America, vwwu@umich.edu, Edwin Romeijn, Martha Matuszak, Randall Ten Haken, Mary Feng, Hesheng Wang, Yue Cao, Marina Epelman

In this work, we compare our treatment planning model that accounts for liver functionality information with a gold standard that does not account for such information. We plan treatment using voxel-based dose response information: post-treatment liver functionality depends on its pre-treatment functionality and the dose delivered. Our model's objective is to maximize liver functionality with respect to dose. We apply these models retrospectively to real patient cases.

2 - Using Robust Optimization to Measure Patient's Sensitivity in IMRT

Ali Goli, Department of Mechanical and Industrial Engineering, University of Toronto, 5 King's College Road, Toronto, ON, M5S 3G8, Canada, goli@mie.utoronto.ca, Taewoo Lee, Justin Boutilier, Timothy Chan

Using multi-objective optimization models to produce sets of IMRT plans is well studied. A challenging phase of the planning process is to determine the objective weights in the forward problem. It turns out that there exist a class of sensitive patients for which slight changes in the objectives' weights can dramatically affect the planning quality. In this work, we propose a roust optimization framework for detecting and quantifying sensitivity in IMRT.

3 - Inverse Planning using Radiofrequency Ablation in Cancer Therapy

Shefali Kulkarni-Thaker, Graduate Student, University of Toronto, Department of Mechanical and Industrial, 5 King's College Road, RS304, Toronto, On, M5S 3G8, Canada, shefali@mie.utoronto.ca Dionne Aleman, Aaron Fenster

We develop inverse treatment plans for cancer therapy using radiofrequency ablation, where target is ablated with high temperatures due to current passed through the needles inserted into the target. First, we identify needle position and orientation, referred to as needle orientation optimization, and then perform linearly-relaxed thermal dose optimization to compute optimal treatment time using various thermal damage models. We present experimental results on three clinical case studies.

■ TC03

03-Level 3, Drummond Centre

Operations Management in the Forest Sector

Cluster: Applications of OR in Forestry

Invited Session

Chair: Marc-Andre Carle, Université Laval, FORAC, 1045 avenue de la Médecine, Quebec, Canada, marc-andre.carle@forac.ulaval.ca

1 - Improving Economies of Scale for Forest Biorefining through Production of Intermediates

Jean Blair, Queen's University, 99 University Ave, Kingston, ON, Canada, mjeanblair@gmail.com, Warren Mabee

A major challenge related to the development of forest biorefineries is the inability to reach satisfactory economies of scale due to the high transportation cost of feedstock. To address this issue, it may be possible to produce densified intermediate products in smaller scale facilities close to the fibre source. This paper looks at the economics of producing intermediate products in forestry clusters (see Blair et al. JFOR (3:5), 2014) to feed a larger centralized biorefinery.

2 - A New Formulation of the Integrated Forest Harvest-Scheduling and Road-Building Model

Nader Naderializadeh, Faculty of Natural Resources Management, Lakehead University, 955 Oliver Road, Thunder Bay, ON, P7B 5E1, Canada, nnaderia@lakeheadu.ca, Kevin Crowe

The integrated forest harvest-scheduling and road building-model supports forest management decisions at the tactical scale. We present a new formulation of this model through which the role of transportation costs can be explored. The model is solved using the branch and bound algorithm. Results from applying this model to a small problem will be presented and discussed.

3 - Solving the Integrated Forest Harvest-Scheduling and Road Building Model using Simulated Annealing

Melika Rouhafza, Faculty of Natural Resources Management, Lakehead University, 955 Oliver Road, Thunder Bay, ON, P7B 5E1, Canada, mrouhafz@lakeheadu.ca, Kevin Crowe

The integrated forest harvest-scheduling and road building-model supports forest management decisions at the tactical scale. We present a formulation of this model which satisfies more realistic constraints on road locations. The model is solved using the simulated annealing algorithm. Results from applying this model to a case study in Northwestern Ontario will be presented and discussed.

4 - Building SharedValue Park to Develop Sustainable Biorefinery Business Model in the Forestry Industry

Marie-Philippe Naud, PhD Student, Université Laval, 1065, avenue de la Médecine, Québec, Canada, marie-philippe.naud.1@ulaval.ca, Paul Stuart, Marc-André Carle, Sophie D'Amours

With the integration of forest biorefineries in existing pulp and paper mills, different forms of partnerships are expected in order to build sustainable business models. This paper presents the SharedValue Park where infrastructures, resources and investments are shared between partners from many companies as well as the value created. This paper explores how OR can be used to evaluate the economic benefits of integrating SharedValue Parks in a global forest biorefineries value chain.

■ TC04

04-Level 3, Drummond East

OR Applications in Forestry

Cluster: Applications of OR in Forestry

Invited Session

Chair: Mikael Rönnqvist, Universite Laval, 1065, avenue de la Médecine, Quebec, QC, G1V 0A6, Canada, mikael.ronnqvist@gmc.ulaval.ca

1 - Strategic Planning of Investments in Forest Roads

Victor Asmoarp, Researcher, The Forestry Research Institute of Sweden, Uppsala Scince Park, Uppsala, Sweden, victor.asmoarp@skogforsk.se, Mikael Rönnqvist, Mikael Frisk, Patrik Flisberg

Forest wood supply is dependent on a well-functioning road network. Lack of bearing capacity on roads and year-around availability causes increased costs for transport and storage. RoadOpt is a DSS for planning of road upgrade investments developed at the Forestry Research Institute of Sweden. In a recent case study, for a Swedish forest company, a strategic approach on the problem is tested where one critical question is how to distribute road investments between different wood supply areas.

2 - Wood Chip Procurement and Transportation for a Network of Paper Mills
Mikael Rönnqvist, Universite Laval, 1065, avenue de la Médecine, Quebec, QC, G1V 0A6, Canada, mikael.ronnqvist@gmc.ulaval.ca
Marc-André Carle, Patrik Flisberg, Vincent Monbourquette

In this seminar, we describe a wood chip procurement and transportation problem for a network of 37 sawmills and 9 paper mills. While cost minimization is important, optimization models must consider additional components and constraints to provide relevant solutions for decision-making purposes; these are included in the models. We describe the models and solution approaches used and report on the performance of the model against manual planning performed by the company.

3 - Machine Learning and the Log Breakdown Problem
Michael Morin, Université Laval, Université Laval, Québec, Qc, Canada, michael.morin.3@ulaval.ca, François Laviolette, Amélie Rolland, Frédérik Paradis, Jonathan Gaudreault

Simulations are used in sawmill modeling for decision making. The inputs are the sawmill model and the scans of the available logs. We may simulate various pairs of sawmill model and scan set to determine an efficient sawmill design in terms of product outputs. The approach tends to be slow and requires fine-tuning. We propose to use machine learning to predict the result of a log breakdown activity. While being faster, prediction enables us to tackle complex variants of the problem.

4 - The Selection of Harvest Areas and Wood Allocation Problem – Multiobjective Optimization
Azadeh Mobtaker, École de Technologie Supérieure, 1100 Rue Notre-Dame Ouest, Montréal, QC, H3C 1K3, Canada, azadehmobtaker@gmail.com
Mustapha Ouhimmou, Mikael Rönnqvist, Marc Paquet

The tactical level of planning in forest management involves the selection of harvest areas over a horizon of five years and allocates them to specific mills to fulfill certain demand. At this level, forest managers need to include several optimization criteria to fulfill new sustainable forest management policies. Both government and industry face these challenging problems and we propose a decision support system to enable an efficient tactical planning process of the wood supply chain.

■ TC05

05-Level 2, Salon 1

Supply Chain Management and Sustainability

Sponsor: Transportation Science & Logistics

Sponsored Session

Chair: M. Ali Ulku, Associate Professor, Dalhousie University, Rowe School of Business, 6100 University Ave., Halifax, NS, B3H4R2, Canada, ulku@dal.ca

1 - Green Logistics: An Outlook on Canada and the U.S.
Daniel F. Lynch, Associate Professor, Dalhousie University, Rowe School of Business, 6100 University Avenue, Halifax, NS, Canada, daniel.lynch@dal.ca, M. Ali Ulku

Sustainability has emerged as a vital objective in business today. Logistics activities account for the majority of the costs and opportunities in the supply chain. This talk gives an overview of what has been accomplished, and what remains to be achieved in terms of a "greener" supply chain, from the perspective of North American business.

2 - Operations Management And Sustainability for The Exploration And Production of Oil and Natural Gas
Alexander Engau, Assistant Professor, University of Colorado Denver, 1201 Larimer Street, Denver, CO, 80204, United States of America, alexander.engau@ucdenver.edu, Casey Moffatt, Wesley Dyk

This talk presents a recent case study with an energy provider in the Denver-Julesburg Basin in Northeastern Colorado, one of the largest natural gas deposits in the United States. A multi-period, multi-objective mixed-integer programming model is developed to support the company's business decisions for its sustainable current and future sales and transportation operations. The validity and success of our model will be demonstrated using a small theoretical analysis and a few numerical results.

3 - Shipment Consolidation for Third-Party Logistics: A Multi-Agent Approach
Cenk Sahin, Phd, Cukurova University, Department of Industrial Engineering, Adana, 01330, Turkey, cenksahin@cu.edu.tr
M. Ali Ulku

Shipment Consolidation (SCL), a powerful and environmentally friendly logistics strategy, may enable truckloads of savings for Third-Party Logistics (3PL) providers. In a dynamic and negotiation-based SCL setting, we study the problem of maximizing the profit of a 3PL provider. We employ a multi-agent system approach, and provide managerial insights from the simulation results.

4 - Integrating Environmental Sustainability to Shipper-Base Selection in Contract Logistics
Vahit Kaplanoglu, Assistant Professor, Gaziantep University, Department of Industrial Engineering, Gaziantep, 27310, Turkey, kaplanoglu@gantep.edu.tr, M. Ali Ulku, Cenk Sahin

In addition to economical considerations, to what extend, if at all, do contract-logistics providers use the environmental attributes of the shippers they serve? How does the type of freight impact the terms of the negotiation? Using fuzzy-ranking method, we develop a comprehensive decision framework for a logistics company in choosing its shipper base.

5 - Sustainability, Customer Returns, and Modular Products: A Formal Modeling in a Dyadic Supply Chain
M. Ali Ulku, Associate Professor, Dalhousie University, Rowe School of Business, 6100 University Ave., Halifax, NS, B3H4R2, Canada, ulku@dal.ca, Juliana Hsuan, Dennis Yu

Consider a retailer-manufacturer setting in which the demand for a modular product depends on both price and the product return policy. For the retailer, we first develop a profit-maximizing newsvendor-type and customer-driven model, and then we derive optimal expressions for the order quantity and the price. Drawing upon our structural and numerical results, we offer managerial insights as to how customer returns and product modularity have impact on the management of sustainable supply chains.

■ TC06

06-Level 2, Salon 2

Choice Based Revenue Management Systems in Transportation

Cluster: Special Invited

Invited Session

Chair: Shadi Sharif Azadeh, Associate Researcher, EPFL, Route Cantonale, Lausanne, 1015, Switzerland, shadi.sharifazadeh@epfl.ch

1 - Airline Passenger Behavior Modeling in Revenue Management Systems
Shadi Sharif Azadeh, Associate Researcher, EPFL, Route Cantonale, Lausanne, 1015, Switzerland, shadi.sharifazadeh@epfl.ch, Patrice Marcotte

Estimating demand is crucial in RMS. Usually choice parameters are assumed known a priori. However, in reality, the only information at hand is the registered transactions. We estimate product utilities for different customer segments as well as daily potential demand using registered bookings. We introduce an algorithm that takes availability constraints into account via a non-parametric mathematical representation.

2 - Implementation of MNL Choice Models in PODS
Emmanuel Carrier, Delta, emmanuel.carrier@delta.com
Larry Weatherford

LATE CANCELLATION

This presentation summarizes results of Passenger Origin-Destination Simulator (PODS) research on how to implement our MNL choice model in a large "domestic" network with two airlines competing in 482 O&D markets. Based on the choice model parameter estimates, a new MNL path forecast is created. Revenue results are presented when comparing this new MNL forecaster vs. classic methods like leg standard, path standard and hybrid forecasting, under both leg and network optimization.

3 - Practical Performance of CCM in Airline Demand Forecasting
Sergey Shebalov, Sabre Holdings, Southlake, TX
sergey.shebalov@sabre.com

Customer choice models have been one of the popular tools for airlines for predicting demand in both strategic and tactical applications. While being fairly complex and requiring careful maintenance they are very flexible and can be extended into multiple practical applications. We will describe major features of the models used today, compare them with other existing techniques, share examples of their performance in real scenarios and propose several directions for future development.

■ TC07

07-Level 2, Salon 3

Supply Chain Management

Cluster: Contributed Sessions

Invited Session

Chair: Junsong Bian, Dr., Odette School of Business, University of Windsor, 401 Sunset Avenue, Windsor, ON, N9B3P4, Canada, bianj@uwindsor.ca

1 - Impact of Lead Time Variability in Supply Chain Risk Management

Dia Bandaly, Assisstant professor, Lebanese American University, P.O. Box 36, Byblos, Lebanon, dia.bandaly@lau.edu.lb
Latha Shanker, Ahmet Satir

We study the impact of lead time variability (LTV) on risk management performance of supply chain under commodity price risk and demand uncertainty, managed with operational methods and financial derivatives. Simulation-based optimization is used to solve the problem. Findings reveal changes in the hedging strategies and products flows. LTV does not always deteriorate the supply chain performance. Managerial insights are argued based on experimental design findings.

2 - Basic Insights Into Contagion Risk In Supply Chain

Alireza Azimian, Wilfrid Laurier University, 55 Hickory St,E, waterloo, On, N2J 3J5, Canada, azim9110@mylaurier.ca
Hamid Noori

Some adverse events at firm-level shift demand or supply curves, or raise operating costs at industry-level, causing all firms in the industry to suffer, a "contagion" effect. This research explores the behavior of stakeholders as a channel of contagion, and conceptualizes the relation between contagion risk and the involved entities' characteristics.

3 - Intelligent Agents for Supply Chain Management

Riyaz Sikora, UT-Arlington, P.O. Box 19437, Arlington, TX, 76019, United States of America, rsikora@uta.edu, Yoonsang Lee

The objective of this study is to find the critical factors for supply chain management agent and to suggest the enhanced mechanisms for automated intelligent software agent in e-commerce and decision support situation.

4 - Distribution Channel Strategies under Environmental Taxation

Junsong Bian, Dr., Odette School of Business, University of Windsor, 401 Sunset Avenue, Windsor, ON, N9B3P4, Canada, bianj@uwindsor.ca, Xiaolei Guo, Kevin W. Li

This paper studies distribution channel strategies under environmental tax policy. We discuss two scenarios: channel strategies in a single supply chain and channel strategies in two competing supply chains. Considering environmental taxation enables us obtain very interesting results that sharply different from previous studies.

■ TC08

08-Level A, Hémon

Applications of DFO

Cluster: Derivative-Free Optimization

Invited Session

Chair: Charles Audet, Professor, École Polytechnique de Montréal, C.P. 6079, succ. Centre-ville, Montreal, QC, H3C 3A7, Canada, Charles.Audet@gerad.ca

1 - Automated Process to Correct Meteorological Data

Kenjy Demeester, Rio Tinto Alcan, Montréal, Qc, Canada, kenjy.dem@gmail.com, Pascal Coté

To reproduce evolution of outflow over time, hydrological models have been developed by a mathematical process using meteorological data as inputs. Despite of computation efficiency, these simulations won't be exactly representative of observation outflow. In order to increase hydrological performance, a new concept has been developed to correct meteorological data from weather stations with a black box algorithm.

2 - A Hybrid Algorithm for Efficient Optimization of Computationally Intensive Hydrological Models

Pierre-Luc Huot, École de Technologie Supérieure, Montréal, Qc, Canada, pierre-luc.huot.1@ens.etsmtl.ca, Annie Poulin, Stéphane Alarie, Charles Audet

The calibration of hydrological models is a blackbox optimization problem and can become computationally intensive. An efficient algorithm should therefore be chosen to solve it. In this paper, a new effective optimization hybrid technique merging both convergence analysis and robust local refinement from the Mesh Adaptive Direct Search algorithm (MADS) and global exploration capabilities from heuristic strategies used by the Dynamically Dimensioned Search algorithm (DDS) will be presented.

3 - Modelling of a Solar Thermal Power Plant with Central Receiver for Blackbox Optimization

Mathieu Lemyre Garneau, École Polytechnique de Montréal, C.P. 6079, succ. Centre-ville, Montréal, Qc, H3C 3A7, Canada, mathieu.lemyre-garneau@polymtl.ca, Charles Audet, Sébastien Le Digabel

Very few blackbox optimization test problems are publicly available to the optimization community. Concentrating solar power (CSP) technologies consists of using mirrors to focus sunlight in order to produce high temperatures and drive thermodynamic cycles typically used to produce electricity. A new model and code are proposed in the form of a blackbox to serve both as a simulator for this type of solar power plant and for blackbox optimizers benchmarking.

■ TC09

09-Level A, Jarry

Applications of Column Generation

Cluster: Contributed Sessions

Invited Session

Chair: Brigitte Jaumard, Professor, Concordia University, 1455 de Maisonneuve Blvd. West, Montreal, Canada, bjaumard@cse.concordia.ca

1 - Column Generation Approach for Vehicle Routing in Disaster Area

Takoua Mastouri, CIRRELT/Université Laval, 2325, 2325, rue de la Terrasse, PAP-2637, Québec, G1V0A6, Canada, takoua.mastouri.1@ulaval.ca, Monia Rekik, Mustapha Nourelfath

This study deals with a rich Vehicle Routing Problem that distributes humanitarian aid to earthquake affected zones. The objective is to minimize maximum delivery time depending on both travelling and loading and unloading times while allowing split delivery. We develop a column generation approach to solve the optimization model. A pricing sub-problem generates the most promising routes by specifying the sequence of demand points to visit and the amount of humanitarian aid to be carried.

2 - Column Generation for the Cross-Dock Door Assignment Problem

Wael Nassief, PhD Candidate, Concordia University, 1455 Boulevard de Maisonneuve Ouest, Montréal, QC, H3G1M8, Canada, w.nassief@gmail.com, Brigitte Jaumard, Ivan Contreras

In this talk we study a Cross-dock door assignment problem in which the assignment of incoming trucks to strip doors and outgoing trucks to stack doors must be determined, with the objective of minimizing the material handling cost. We present a new formulation that has an exponential number of variables, and we use a column generation approach to exploit the structure of the problem to obtain bounds on the optimal solution value. Numerical results on a set of benchmark instances are reported.

3 - A Generalized Dantzig-Wolfe Decomposition Algorithm for Mixed Integer Programming Problems

Xue Lu, London Business School, Sussex Place, Regent's Park, London, NW1 4SA, United Kingdom, xlu@london.edu
Zeger Degraeve

We propose a generalized Dantzig-Wolfe decomposition algorithm for mixed integer programming. By generating copy variables, we can reformulate the original problem to have a diagonal structure which is amendable to the Dantzig-Wolfe decomposition. We apply the proposed algorithm to multi-level capacitated lot sizing problem and production routing problem. Rigorous computational results show that our algorithm provides a tighter bound of the optimal solution than all the existing methods.

4 - Capacitated p-Median Facility Location Problem under Disruption

Brigitte Jaumard, Professor, Concordia University, 1455 de Maisonneuve Blvd. West, Montréal, Canada, bjaumard@cse.concordia.ca, Mostafa Badakhshian

Because of today's globalized threats that comes in addition to, e.g., failures resulting from harsh weather conditions, there has been a renewed interest in resilient facility location. We propose to revisit the p-median location under disruptions with a column generation formulation. Also, we include capacity constraints as well as a shared backup resource scheme. Intensive numerical experiments complete the paper, with some comparisons with previously proposed models.

■ TC10

10-Level A, Joyce

Stochastic Programming Applications from Industry

Cluster: Stochastic Optimization

Invited Session

Chair: Alan King, IBM Research, P.O. Box 218, Yorktown Heights, NY, 10598, United States of America, kingaj@us.ibm.com

1 - Stochastic Optimization of Wind Hydro Integration in Quebec Interconnection

Ali Koc, Senior Software Engineer, ITM TJ Watson Research Center, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States of America, akoc@us.ibm.com
Soumyadip Gosh, Louis Delorme, Innocent Kamwa

Renewable energy is receiving increasing attention from both energy suppliers and customers. We study daily generation and transmission planning of a pure hydro-power system with large-scale wind power integration. We propose a two-stage stochastic program addressing wind power intermittency to reduce reserve levels. We use "range of operation" approach to allow decoupling of commitment and flow decisions that are linked through time periods. We present use cases from Quebec Interconnection.

2 - An Efficient Decomposition Algorithm for Superquantile Regression

Dharmashankar Subramanian, Research Staff Member, IBM Research, 1101 Kitchawan Rd, Rte 134, Yorktown Heights, NY, 10598, United States of America, dharmash@us.ibm.com
Pavithra Harsha

A regression technique known as Superquantile regression, proposed by Rockafellar, Royset and Miranda 2013, is a method to estimate superquantile, well known as conditional value at risk, of a random variable that depends on covariates. The proposed linear program to estimate the coefficients of the regression fails to scale even for reasonably small instances. We present an efficient decomposition method to solve this problem even for large instances with computational results.

3 - Distribution Shaping and Scenario Bundling for Stochastic Programs with Endogenous Uncertainty

Marco Laumanns, IBM Research, Saeumerstrasse 4, Rueschlikon, Switzerland, MLM@zurich.ibm.com, Ban Kawas, Steven D. Prestwich

A new approach to handle endogenous uncertainty in stochastic programs will be presented, which allows an efficient polyhedral characterization of decision-dependent probability measures and thus a reformulation of the original nonlinear stochastic MINLP as a stochastic MIP. The effectiveness of the approach will be demonstrated for stochastic PERT networks where the probability of activity delays can be reduced by investing additional resources in order to minimize expected project duration.

4 - Multistage Project Portfolio Optimization in the Oil and Gas Industry

Bruno Flach, Research Staff Member, IBM Research, av Pasteur 138/146, Rio de Janeiro, Brazil, bflach@br.ibm.com
Marko Hans Weber

Oil & gas companies are constantly required to determine how to best allocate their budgets given a – potentially vast – range of investment opportunities. Difficulties associated with this complex process are compounded by the decision-dependent nature of the gradual resolution of uncertainties regarding the future performance of different assets. In this work, we study a stochastic programming approach to tackle such problem and provide preliminary illustrative computational results.

■ TC11

11-Level A, Kafka

Facility Location

Cluster: Contributed Sessions

Invited Session

Chair: Abdelhalim Hiassat, University of Waterloo, 271-350 Columbia St. W., Waterloo, ON, N2L6P7, Canada, ahhiassa@uwaterloo.ca

1 - Dynamic Content Replication and Placement as Multi-Commodity Capacitated Facility Location Problem

Dimitri Papadimitriou, Alcatel-Lucent, Copernicuslaan 50, Antwerp, 2018, Belgium, dimitri.papadimitriou@alcatel-lucent.com

The dynamic content replication and placement problem generalizes the capacitated FLP to multiple commodities as various content objects of different size may be available at each facility. Demands dynamics leads to consider content replication or assignments other than the closest facility depending on the capacity allocation model and associated constraints. We compare different formulations and resolution methods of the multi-commodity capacitated FLP together with numerical experiments.

2 - Solutions to the Facility Location Problem with General Bernoulli Demands

Elena Fernandez, Universitat Politecnica de Catalunya-Barcelonatech, Campus Nord C5-208., Jordi Girona 1-3, Barcelona, Spain, e.fernandez@upc.edu
Maria Albareda, Francisco Saldanha da Gama

In this presentation we address the facility location problem with general Bernoulli demands. Extended formulations are proposed for two different outsourcing policies, which allow using sample average approximation for estimating optimal values. In addition, solutions are obtained heuristically and their values compared with the obtained estimates. Numerical results of a series of computational experiments are presented and analyzed.

3 - The Competitive Congested Facility Location Problem: A Choice-Based Bilevel Formulation

Teodora Dan, DIRO, Université de Montréal, Université de Montréal, C.P. 6128, succursale centre-ville, Montréal, QC, H3C 3J7, Canada, teodora.dan@umontreal.ca, Patrice Marcotte

The facility location problem has multiple practical applications. While it has been extensively studied, very few models combine competition, congestion and user choice issues. We address the facility location problem in a competitive environment, in which users choose the facility to patronize based on the waiting and travel time. Congestion arises at facilities and is captured in the form of queueing equations. We present the model and discuss computational approaches.

4 - Reliable Facility Location Model with Customer Preference

Abdelhalim Hiassat, University of Waterloo, 271-350 Columbia St. W., Waterloo, ON, N2L6P7, Canada, ahhiassa@uwaterloo.ca
Osman Yalin Ozaltin, Fatih Safa Erenay

We formulate a reliable facility location model, where facilities are subject to failure. Customers patronize available facilities based on their preferences. We decompose the problem into customer subproblems and propose a Lagrangian-based branch-and-bound method. Our computational results show the efficiency of the solution approach and the significance of incorporating customer preferences into the model.

■ TC12

12-Level A, Lamartine

Machine Learning

Cluster: Contributed Sessions

Invited Session

Chair: Mojtaba Maghrebi, Reseach Associate, University of New South Wales (UNSW), 111, School of Civil Engineering, UNSW, Sydney, NS, 2216, Australia, maghrebi@unsw.edu.au

1 - Aggregate State Forecasting for a Population of Electric Loads with Learning Capabilities

Md Salman Nazir, Research Assistant, McGill University, McConnell Engineering Building, 3480 University Street, Room 010, Montréal, Qu, H3A 0E9, Canada, md.nazir@mail.mcgill.ca
Francois Bouffard, Doina Precup

Machine learning techniques have been applied to a large population of electric loads with storage capabilities, such as electric water heaters, space heating/cooling systems and electric vehicles. Using unsupervised learning, an individual device learns its physical characteristics and the user behavior. From these, we then develop the aggregate Markov dynamics of a heterogeneous population. Finally, Markov Chain Monte Carlo simulations have been carried out to forecast the aggregate states.

2 - Stacking Learning Approach for Predicting the Reliability of Roads

Mojtaba Maghrebi, Reseach Associate, University of New South Wales (UNSW), 111, School of Civil Engineering, UNSW, Sydney, NS, 2216, Australia, maghrebi@unsw.edu.au

Predicating the reliability of urban roads is a very demanding issue as well as challenging, because a huge number of effective parameters are involved. In this paper it is tried to cover to train some stacked learning algorithms with a wide range of parameters including traffic monitoring data, weather conditions and road conditions to more precisely predict the reliability of urban roads.

■ TC13

13-Level A, Musset

Innovations in Revenue Management

Sponsor: Pricing & Revenue Management

Sponsored Session

Chair: Aurelie Thiele, Visiting Associate Professor, M.I.T., 77 Massachusetts Ave., Rm. E40-121, Cambridge, MA, 02142, United States of America, aut204@lehigh.edu

1 - Impact of Licensing and Threat of Imitation on Sustainable Product and Process Innovations

Stanko Dimitrov, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, sdimitro@uwaterloo.ca Jenyi Chen

We characterize the equilibrium process and product investment decisions a sustainable manufacturer makes in the presence of a traditional manufacturer that may license or imitate innovation. We show that all licensing or imitation decisions are all or nothing type decisions, and the sustainable manufacturer is best off not licensing any innovation. We also show that the sustainable manufacturer engages in preemptive strategies that deter the traditional manufacturer from entering the market.

2 - Service Revenue Management in the Presence of Grouping Complementarities

Mohammedreza Farahani, University of Waterloo, 200 University Ave, Waterloo, ON, n2l3g1, Canada, m3faraha@uwaterloo.ca Michael Pavlin

This paper analyses the impact of conformityócustomers' utilities increase when they jointly receive the serviceóon the revenue of a congested service provider. We examine when and how service differentiation strategies can exploit idiosyncratic preferences and counteract congestion from conforming customers grouping together.

3 - Simultaneous vs. Sequential Crowdsourcing Contests

Lu Wang, Rotman School of Management, Lu.Wang12@Rotman.Utoronto.Ca, Ming Hu

In a crowdsourcing contest, innovation is outsourced to an open crowd. We consider two alternative mechanisms. One is to run a simultaneous contest, where the best solution is selected from the single solution simultaneously submitted by each contestant. The other is to run multiple sequential sub-contests, with each dedicated to one attribute. While both mechanisms have different advantages, comparison depends on several conditions.

4 - Robust Pricing for Capacitated Resources

Aurelie Thiele, Visiting Associate Professor, M.I.T., 77 Massachusetts Ave Rm E40-121, Cambridge, MA, 02142, United States of America, aut204@lehigh.edu, Shuyi Wang

We investigate robust pricing strategies for capacitated resources in the presence of demand uncertainty. We consider uncertainty sets of the type proposed by Bertsimas and Bandi (2012) to incorporate moderate amounts of distributional information, provide theoretical insights and discuss extensions to dynamic pricing policies.

■ TC14

14-Level B, Salon A

OR Methods in Hydroelectricity Generation Planning

Cluster: Energy

Invited Session

Chair: Michel Gendreau, Full Professor, P.O. Box 6079, Station Centre-ville, Montreal, QC, H3C3A7, Canada, michel.gendreau@cirrelt.ca

1 - A Stochastic Programming Model for the Risk Averse Reservoir Management Problem

Charles Gauvin, PhD Student, MAGI, École Polytechnique de Montréal, C.P. 6079, succ. Centre-ville, Montréal, QC, H3C 3A7, Canada, charles.gauvin@polymtl.ca, Michel Gendreau, Erick Delage

This talk presents a dynamic multiobjective model for the reservoir management problem with stochastic inflows. We focus on the inherent risk aversion of decision makers by evaluating a multidimensional risk measure associated with floods and droughts. Using recent advances in robust optimization and stochastic programming, we formulate this model as a large linear program. We then compare various decision rules: piece-wise constant, affine and affine on a lifted space.

2 - Hydro-Power Optimization by Simulation and Regression

Jean-Philippe Olivier-Meunier, HEC Montréal, 3000 chemin de la Cote-Sainte-Catherine, Montréal, Canada, jean-philippe.olivier-meunier@hec.ca, Jean-Guy Simonato, Michel Denault

A simulation-and-regression approach to stochastic dynamic programming is applied to a realistic (and real) two-dam system. Using simulations allows a great level of flexibility in the modeling of the stochastic variables. Regressions account for the conditional expectations in a friendly manner. The approach scales better than classical dynamic programming techniques.

3 - SDDP Method to Solve Mid-Term Hydropower Scheduling Problem with Convex Hydro Generation Functions

Mouad Faik, M.Sc. Student, MAGI, École Polytechnique, C.P. 6079, succ. Centre-ville, Montréal, QC, H3C 3A7, Canada, mouad.faik@polymtl.ca, Michel Gendreau

Stochastic Dual Dynamic Programming (SDDP) is a well-known method to approach the mid-term hydropower generation scheduling problem. It alleviates the curse of dimensionality one faces in pure dynamic programming approach by avoiding the discretization of the state variables. In this talk, some results are shown from applying SDDP to a real case, especially we use a convex approximation of hydro plants generation functions that considers head effects.

4 - A Numerical Comparison of State Space Sampling Procedures in Stochastic Dynamic Programming (SDP)

Stéphane Krau, Researcher, Université de Sherbrooke/Ouranos, 550 Sherbrooke West, West Tower, 19th, Montréal, Canada, krau.stephane@ouranos.ca, Michel Gendreau, James Merleau, Mouad Faik, Grégory Emiel

SDP suffers from the curse of dimensionality. In convex settings, value function dual approximation schemes are often used. The state space however has to be sampled, usually with random simulations like the SDDP approach. In Krau et al. [2015], a B&B approach allows to sample where the current approximation error on the Value function is the highest. Numerical results show the differences between this approach and SDDP-alike sampling on a hydro-system.

■ TC15

15-Level B, Salon B

Operations Research Applications in Home Delivery

Cluster: Practice

Invited Session

Chair: Mariam Tagmouti, Clear Destination, 4000, St-Ambroise, Suite 389, Montréal, H4C 2C7, Canada, mtagmouti@cleardestination.com

1 - Direct Ship-to-Home Fulfillment of Large Items

Christian Lafrance, President, Clear Destination, 4000 Saint Ambroise #389, Montréal, Canada, Clafrance@cleardestination.com, Mariam Tagmouti

Clear Destination has just launched its Ship To Home technology, which consolidates home deliveries of large household items like furniture and appliances. It creates an extensive network of retailers, vendors and carriers all over Canada, allowing home delivery providers to comingle different retailers' products in the same truck.

2 - Managing Evolving Constraints in Industrial Optimization Algorithms

Guillaume Blanchet, Operations research analyst, Clear Destination, 4000 St-Ambroise, #389, Montréal, Qu, h4c2c7, Canada, gblanchet@cleardestination.com, Mariam Tagmouti

Optimization algorithms from literature are always a good start to solve an industrial problem. But having a good algorithm for a class of problems is not enough from an industrial perspective. The algorithm must be extensible over time, allow new parameters, changes in objective functions and keep its performances. We will cover some tricks with practical examples to achieve such designs.

3 - Heuristics for Time Slot Management: A Periodic Vehicle Routing Problem View

Florent Hernandez, Post Doctoral, Ecole Polytechnique de Montréal, C.P. 6079, succ. Centre Ville, Montréal, QC, H3C 3A7, Canada, florent.hernandez@cirrelt.net, Michel Gendreau, Jean-Yves Potvin

In this study, we consider a tactical problem where a time slot combination for a delivery service over a given planning horizon must be selected in each zone of a geographical area. Based on the selected time slot combinations the routing plan is constructed. This plan serves as a blueprint for the following operational problem where the availability of the selected time slot combinations must be updated as real customer orders occur. We propose two heuristics for solving the tactical problem.

■ TC16

16-Level B, Salon C

Conic Optimization: Algorithms and Applications

Cluster: Mixed-Integer Nonlinear Optimization

Invited Session

Chair: Miguel F. Anjos, Professor and Canada Research Chair, Mathematics & Industrial Engineering, Polytechnique Montreal, Montreal, Canada, miguel-f.anjos@polymtl.ca

1 - Improved LP-Based Algorithms for Testing Copositivity and Other Properties

Akiko Yoshise, University of Tsukuba, 1-1-1 Tennnoudai, Tsukuba, Ib, 305-8573, Japan, yoshise@sk.tsukuba.ac.jp, Akihiro Tanaka

In the paper \cite{aTANAKA14}, the authors introduced some subcones of the copositive cone and showed that one can detect whether a given matrix belongs to one of those cones by solving linear optimization problems. They also provided an LP-based algorithm for testing copositivity using the subcones. In this talk, we investigate the properties of the subcones more precisely and propose improved algorithms for testing these properties and copositivity.

2 - SOCP and Piecewise Approximation for a Class of Nonlinear Facility Location Problems

Samir Elhedhli, Professor and Chair, University of Waterloo, 200 University Avenue West, Department of Management Sciences, Waterloo, ON, N2L 3G1, Canada, elhedhli@uwaterloo.ca
Yan Wang

We study a class of facility location problems with economies of scale and congestion that are modelled as nonlinear mixed integer programs with concave and convex terms in the objective. We propose solution approaches based on piecewise approximation and SOCP. Numerical results are provided.

3 - Combining Semidefinite Relaxations and NLP Solvers for Improved Feasible Solutions of QPLCC

Patricia Gillett, PhD Candidate, Mathematics & Industrial Engineering, Polytechnique Montréal, Montréal, QC, Canada, patricia-lynn.gillett@polymtl.ca, Miguel F. Anjos, Joaquim Júdice

We present a semidefinite programming (SDP) relaxation technique for quadratic programs with linear complementarity constraints (QPLCC). The technique applies when the quadratic objective function is convex or nonconvex. We show how the solution of the SDP relaxation can be used to warmstart a feasible solution of the QPLCC using common local and global NLP solvers. We report some numerical results demonstrating the quality of the SDP bound and the effectiveness of the warmstarting procedures.

■ TC17

17-Level 7, Room 701

Industrial Analytics Applications

Sponsor: Analytics

Sponsored Session

Chair: Muhammad Mamdani, Director, Applied Health Research Centre, Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, ON, Canada, mamdanim@smh.ca

1 - Big Data Applications to Improve Clinical Outcomes

Muhammad Mamdani, Director, Applied Health Research Centre, Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, ON, Canada, mamdanim@smh.ca

Health care routinely collects large volumes of data for patient care and administrative management but has a poor history of leveraging this data to guide practice for the purposes of improving patient outcomes and maximizing operating efficiencies. This talk will be on how 'big data' can influence changes in clinical practice and health policy to impact patient outcomes in a meaningful way.

■ TC18

18-Level 7, Room 722

Queueing Systems – Solutions and Approximations

Cluster: Queueing

Invited Session

Chair: Javad Tavakoli, Dr., UBC Okanagan, 3333 University Way, Kelowna, BC, V1V 1V7, Canada, javad.tavakoli@ubc.ca

1 - Two Demand Queueing Model

Javad Tavakoli, Dr., UBC Okanagan, 3333 University Way, Kelowna, BC, V1V 1V7, Canada, javad.tavakoli@ubc.ca

In 1984, L. Flatto and S. Hahn analyzed the double queue with two servers and they present closed form solutions for the equilibrium probabilities for the length of queues. The fundamental equation corresponding to these probabilities was considered on a Riemann surface of genus 1 which can be parametrized by a pair of elliptic functions. In this talk we discuss these solutions by using the technique of Boundary Value Problems.

2 - Explicit Solutions for Two-Dimensional Queuing Systems in Terms of BVP

Yiqiang Zhao, Professor, Carleton University, 1125 Colonel By Drive, 4328 Herzberg Laboratories, Ottawa, On, K1S 5B6, Canada, zhao@math.carleton.ca

Solutions in terms of Boundary Values Problems (BVP) have shown renewal interests in the queueing community. In the literature, we can find special cases, which can be solved explicitly or semi-explicitly, such as the 2X2 switch, the joint-shortest-queue model, and the Jackson tandem queues etc. In this talk, we provide a brief discussion on properties, with which one may obtain an explicit solution using BVP. This talk is based on joint research with J. Tavakoli and C. Wang.

3 - Revisit of a Voter Model - Tail Asymptotics through a Kernel Method

Hui Li, Professor, Mount Saint Vincent University, 166 Bedford Highway, Halifax, NS, B3M 2J6, Canada, Hui.Li@msvu.ca

In this talk, we revisit a voter model previously considered in the literature. Through using a kernel method, we present a tail asymptotic property of the model, previously obtained. This kernel method does not require a determination of the unknown transformation for the probabilistic quantity of the interest, which is the key advantage over other methods. This talk is based on the joint research with Y. Song and Y. Zhao.

4 - Convergence to Equilibrium for Brownian Queueing Models

Rob Wang, Stanford University, Department of Managment Science and Engi, Stanford, CA, 94305, United States of America, robjwang@stanford.edu, Peter W. Glynn

We discuss the convergence to equilibrium for queueing systems modeled as one-dimensional reflected Brownian motion (RBM) with negative drift. As part of this discussion, we consider the spectral representation for RBM and the eigenstructure of the infinitesimal generator of RBM. We then examine the implications of our results for the performance analysis and planning of steady-state queueing simulations. This is joint work with Prof. Peter W. Glynn.

■ TC19

19-Grand Ballroom West

Tutorial: Humanitarian Logistics

Cluster: Tutorials

Invited Session

Chair: Ozlem Ergun, Northeastern University, 360 Huntington Avenue, Boston, MA 02115, United States of America, o.ergun@neu.edu

1 - Humanitarian Logistics

Ozlem Ergun, Northeastern University, 360 Huntington Avenue, Boston, MA 02115, United States of America, o.ergun@neu.edu
Pinar Keskinocak, Julie Swann

In preparing for, responding to, and recovering from sudden-onset disasters and addressing long-term development issues, humanitarian logistics plays an important role. Humanitarian logistics problems involve many challenges such as conflicting objectives from multiple stakeholders, coordination and collaboration difficulties, high uncertainty, and scarcity of resources. We provide an introduction to humanitarian logistics and its main application areas while outlining current research trends.

Tuesday, 3:30pm - 5:00pm

■ TD01

01-Level 4, Salon 8

Social Media and Marketing

Sponsor: eBusiness

Sponsored Session

Chair: Sunghun Chung, Lecturer (Assistant Professor), University of Queensland, UQ Business School, Brisbane, 4072, Australia, s.chung@business.uq.edu.au

1 - Investigating the Factors of Knowledge Adoption from Online Service Reviews in the Tourism and Hospitality Industry

Kyung Young Lee, Assistant Professor, Bishop's University, Williams School of Business, Lenoxville, QC, J1M1Z7, Canada, klee@ubishops.ca, Minwoo Lee, Soo-il Shin, Kimin Kim

Nowadays, user-generated online service reviews (OSRs) have become important knowledge sources for tourism and hospitality service providers. This study proposes a research model on how cognitive, emotional, and peripheral characteristics of OSRs influence knowledge adoption and sharing activities by managers in the tourism and hospitality industry. The research model will be tested with objective and content analysis data from OSRs posted in tripadvisor.ca, using structural equation modeling.

2 - Relationship between Audience Engagement on Social Media and Broadcast Media Ratings

Sangun Park, Kyonggi University, 154-42, Gwanggosan-ro, Suwon, Korea, Republic of, supark@kyonggi.ac.kr
Juyoung Kang, Kunsoo Han

People share their impressions about TV shows with other viewers through social media such as blogs and Twitter. As such, broadcast media, especially TV, lead to audience engagement on social media, and the audience engagement, in turn, impacts broadcast media ratings. In this study, we analyze the subjects of the audience engagement on social media about specific TV dramas through topic modeling, and examines the relationship between changes in the topics and viewer ratings of the TV dramas.

3 - Firms' Social Media Efforts, Consumer Behavior, and Firm Performance: Evidence from Facebook

Sunghun Chung, Lecturer (Assistant Professor), University of Queensland, UQ Business School, Brisbane, 4072, Australia, s.chung@business.uq.edu.au, Animesh Animesh, Alain Pinsonneault, Kunsoo Han

This study theorizes and empirically examines how firm's social media efforts influence consumer behavior and firm performance. Using detailed data collected from Facebook pages, we find that richness and responsiveness of a firm's social media efforts are significantly associated with the firm's market performance, captured by abnormal return and Tobin's q. Interestingly, the intensity of firm's social media effort is not significantly associated with firm performance.

■ TD02

02-Level 3, Drummond West

Optimization Methods for Radiation Therapy Treatment Planning

Cluster: Healthcare

Invited Session

Chair: Houra Mahmoudzadeh, University of Toronto, 5 King's College Road, Toronto, Canada, houra@mie.utoronto.ca

Co-Chair: Taewoo Lee, Department of Mechanical and Industrial Engineering University of Toronto, 5 King's College Road, Toronto, ON, M5S 3G8, Canada, taewoo.lee@mail.utoronto.ca

1 - A Novel Heuristic Approach to Treatment Plan Optimization in Volumetric Modulated Arc Therapy (VMAT)

Mehdi Mahnam, École Polytechnique de Montréal, 2900, boul. Édouard-Montpetit, 2500, chemin de Polytechnique, Montréal, QC, H3T 1J4, Canada, mehdi.mahnam@polymtl.ca
Louis-Martin Rousseau, Michel Gendreau, Nadia Lahrichi

In this presentation, we propose a novel optimization model for the radiation therapy treatment planning in Volumetric-Modulated Arc Therapy (VMAT). In this formulation, the gantry speed, the dose rate, and the MLC leaf trajectories in the treatment plan are optimized simultaneously. For that purpose, a new mixed integer programming model is proposed and then it is solved by a heuristic algorithm. We evaluate the quality and efficiency of the method based on a real prostate case.

2 - Stepwise Inverse Optimization for IMRT Treatment Planning

Daria Terekhov, University of Toronto, Dept. of Mechanical and Industrial Engin, 5 King's College Road, Toronto, Canada, dterekho@mie.utoronto.ca, Taewoo Lee, Timothy Chan

Following an analogy between regression and inverse optimization, this work introduces a framework for stepwise inverse optimization and demonstrates its usefulness for IMRT optimization. Specifically, given a clinical treatment plan, our framework provides a structured approach to determining the set of objective functions that are most influential for treatment plan optimization and their weights.

3 - Learning Trade-offs In Multicriteria Optimization For Radiation Therapy

Taewoo Lee, Department of Mechanical and Industrial Engineering University of Toronto, 5 King's College Road, Toronto, ON, M5S 3G8, Canada, taewoo.lee@mail.utoronto.ca
Timothy Chan, Justin Boutilier

Learning and predicting trade-offs between conflicting criteria is one of the major challenges in the current multicriteria optimization framework in radiation therapy treatment planning. We consider inverse optimization and machine learning techniques to learn trade-off parameters from historical treatments. Results suggest that our approach has the potential to support the development of knowledge-based, automated treatment planning.

4 - Continuous Dose Delivery Treatment Planning for Head-and-Neck Tumours

Kimia Ghobadi, Postdoctoral Fellow, MIT, 100 Main Street, Cambridge, MA, United States of America, kimiag@mit.edu
Dionne Aleman, David Jaffray

In this work we investigate step-and-shoot and continuous dose delivery models and algorithms for head-and-neck patients. We discuss the necessary changes and considerations in the optimization models and algorithms for different tumour sites. We will also present the clinical realization of the plans and compare the obtained clinical results with the simulated treatment plans.

■ TD03

03-Level 3, Drummond Centre

Management of Forest Bioenergy Value Chains

Cluster: Applications of OR in Forestry

Invited Session

Chair: Taraneh Sowlati, Associate Professor, UBC, 2934-2424 Main Mall, Vancouver, BC, Canada, taraneh.sowlati@ubc.ca

1 - Design of Forest Biomass Value Chain under Uncertainty

Foroogh Abasian, Universite Laval, 1065, avenue de la Médecine, beureau 3306, Quebec, Qu, G1V 1W5, Canada, foroogh.abasian.1@ulaval.ca, Mikael Rönnqvist, Mustapha Ouhimmou

We study the design of a forest biomass value chain network which comprises existing mills, harvest areas and potential locations for terminals and new energy mills. We include different uncertain parameters such as demand of fibers and price of energy. A mix integer-programming model is proposed for the problem and a two stage stochastic optimization is used to solve it. Finally, some preliminary results are presented and discussed.

2 - Exploring a Bioenergy Supply Chain Design with a Centralised Biomass Processing Center

Shuva Hari Gautam, Université Laval, 2405, rue de la Terrasse, Pavillon Abitibi-Price, bureau 2125, Québec, QC, G1V 0A6, Canada, shuva-hari.gautam.1@ulaval.ca, Luc LeBel

Forest biomass is a voluminous feedstock characterized by large variability in its calorific value. Logistically, this poses a significant challenge to economically fulfill power generating stations' demand of uniform feedstock. We examine a bioenergy supply chain design incorporating a centralised biomass processing center with an objective to deliver low cost homogeneous feedstock to the final customers.

3 - Bi-Objective Optimization of Integrated Bioenergy/Biofuels Supply Chains using Forest Biomass

Claudia Cambero, UBC, 2943-2424 Main Mall, Vancouver, BC, V6T1Z4, Canada, cambero.claudia@gmail.com

We present a bi-objective optimization model to design integrated bioenergy and biofuels supply chains using forestry by-products. The model integrates technical and economic considerations, as well as life cycle assessment guidelines to generate Pareto optimal solutions that show the trade-offs between economic and environmental objectives: NPV maximization and GHG emissions minimization. A case study in interior British Columbia is presented and analyzed.

4 - Supply Chain Planning for Bioenergy and Biofuel Generation from Forestry Residues

Diana Siller, The University of British Columbia, 2424 Main Mall, Vancouver, Canada, dsillerb@gmail.com

The daily resource allocation for a forest biomass supply chain is simulated. It considers various biomass types, and multiple biomass supply and demand points. The model evaluates the effects of seasonality of supply, productivity curves based on tree characteristics, weather and other delays, and variations in biomass physical characteristics on cost and GHG emissions.

■ TD04

04-Level 3, Drummond East

Forest Management Planning under Uncertainty

Cluster: Applications of OR in Forestry

Invited Session

Chair: Gregory Paradis, Post-doctoral Fellow, Université Laval, Pavillon Abitibi-Price, bureau 2179, Université Laval, Québec, QC, G1V 0A6, Canada, gregory.paradis.1@ulaval.ca

1 - Tactical Harvest Planning Under Uncertainty: A Chilean Case Study

Géraldine Gemieux, Université de Montréal, Montréal, QC, Canada, geraldine.gemieux@umontreal.ca
Andres Weintraub, Bernard Gendron, Jacques A. Ferland

We consider a tactical harvest planning problem driven by final products demands where the objective is to maximize the net present value. However the prices of final products and tree growth are under uncertainty. This uncertainty is modeled by a scenario tree. We use a heuristic solution process based on a decomposition method by scenarios (progressive hedging). Results in Chilean case study will be presented.

2 - Exploring Bilevel Wood Supply Policy Space

Gregory Paradis, Post-doctoral Fellow, Université Laval, Pavillon Abitibi-Price, bureau 2179, Université Laval, Québec, QC, G1V 0A6, Canada, gregory.paradis.1@ulaval.ca
Luc LeBel, Sophie D'Amours, Mathieu Bouchard

We developed a novel bilevel wood supply optimization model, which helps stabilize long-term wood supply by explicitly anticipating industrial fibre consumption behaviour. Using a two-stage rolling-horizon simulation framework and a realistic test dataset, we simulate several alternative bilevel wood supply scenarios. We summarize results from these computational experiments, which provide new insights into wood supply planning policy space.

3 - Long-Term Forest Planning Under Uncertainty: What Makes Sense?

Glen Armstrong, Associate Professor, University of Alberta, Department of Renewable Resources, 751 General Services Building, Edmonton, AB, T6G 2H1, Canada, gwa@ualberta.ca

We all know the future is uncertain. In the forest sector, we face unknown future climate conditions, unknown future demands for products, and unknown future products. Despite this, forest managers in Canada are asked to plan many decades into the future. In the talk, I will present an alternative to long term forest management planning focused on the near future, which may allow for the creation or maintenance of a forest resilient to changes in an unknown future.

4 - Developing Forest Stand Management Policies using Approximate Dynamic Programming

Jules Comeau, Adjunct professor of operations management, Université de Moncton, 18 avenue Antonine-Maillet, Moncton, NB, E1A3S7, Canada, jules.comeau@bellaliant.net, Eldon Gunn

Approximate dynamic programming is a natural framework to study forest stand management under uncertainty. Individual forest stand models include a mix of discrete and continuous state and control variables and the cost-to-go function values must be approximated when using value iteration to solve the DP model while random processes impact state transitions. The resulting policies are very detailed and allow us to do what-if and cause and effect analysis. This paper explores a few possibilities.

■ TD05

05-Level 2, Salon 1

Vehicle Routing

Sponsor: Transportation Science & Logistics

Sponsored Session

Chair: Jean-Yves Potvin, Full professor, Montreal University, P.O. Box 6128, Station Centre-ville, Montreal, QC, H3C 3J7, Canada, potvin@iro.umontreal.ca

1 - A Branch-and-Price Algorithm for a Multi-Attribute Technician Routing and Scheduling Problem

Ines Methlouthi, PhD Student, Montréal University, P.O. Box 6128, Station Centre-ville, Montréal, QC, H3C3J7, Canada, methloui@iro.umontreal.ca, Jean-Yves Potvin, Michel Gendreau

We consider a multi-attribute technician routing and scheduling problem motivated from a real-world maintenance service. This problem is strongly constrained as it must account for the technician's home position, skills, inventory, breaks, etc. Also, multiple time windows are associated with each task. A mixed integer programming model is proposed and solved through a branch-and-price algorithm.

2 - Constraint Programming-Based Large Neighborhood Search for Vehicle Routing with Synchronization

Hossein Hojabri, PhD Student, Montréal University, P.O. Box 6128, Station Centre-ville, Montréal, QC, H3C3J7, Canada, hossein.hojabri@gmail.com, Jean-Yves Potvin, Louis-Martin Rousseau, Michel Gendreau

This paper considers a vehicle routing problem with time windows and synchronization constraints. Here, the arrival of two different types of vehicles at a customer location must be synchronized. This type of problem is often encountered in practice and is computationally challenging because of the interdependency among the vehicle routes. In this work, the problem is addressed with a constraint programming-based adaptive large neighborhood search.

3 - Tactical Time Slot Management with Split Deliveries

Vahid Famildardashti, Universite de Montréal, Pavillon André Aisenstadt,, bureau 3520 2, Montréal, Qu, H3T 1J4, Canada, vahid.dardashti@cirrelt.ca, Michel Gendreau, Jean-Yves Potvin

This talk addresses a Tactical Time Slot Management Problem motivated from attended home delivery services. Here, delivery time windows must be assigned to different geographical zones over a number of periods (days). Vehicle routes are also constructed for each day and the demand of a zone can be split between two or more vehicles in the routing plan. An adaptive large neighborhood search heuristic is proposed to solve this problem.

■ TD06

06-Level 2, Salon 2

Demand Modelling

Cluster: Special Invited

Invited Session

Chair: Emma Frejinger, Université de Montréal and CIRRELT, Pavillon André-Aisenstadt, Saint-Lambert, QC, Canada, emma.frejinger@cirrelt.ca

1 - Mixed Recursive Logit Models for Route Choice Analysis

Tien Mai, PhD Student, University of Montréal, CP 6128 Succursale Centre-Ville, Montréal, QC, H3W1C5, Canada, maitien86@gmail.com

We propose an efficient decomposition (DeC) method for estimating route choice models incorporating random coefficients or additional error terms. The approach is a modification of the recursive logit model proposed by Fosgerau et al. (2013) that allows reuse of computations. Numerical experiments are performed on a real network with more than 3000 nodes and 7000 links, where correlations are introduced using the subnetwork components approach proposed by Frejinger and Bierlaire (2007).

2 - On Estimating Infinite Horizon Intertemporal Decision Problems without Discounting the Future

Anders Karlström, KTH, Stockholm, Sweden, anders.karlstrom@abe.kth.se, Oskar Västberg

Estimating infinite horizon intertemporal decision problems, it is usually assumed that future is discounted. In this paper we discuss estimation models with discount factors >=1. We demonstrate the method on Rust's (1987) bus-engine replacement problem, and discuss the interpretations.

3 - Empirical Study of Heavy Truck Movements using GPS Data
Leonard Ryo Morin, University of Montréal, 28-5545 Chemin de la Cote-Saint-Luc, Montréal, Qc, Canada, leonard.ryo.morin@gmail.com

In this paper, we analyze truck movements from a relatively large dataset of GPS traces in the Greater Montreal area. We analyze characteristics of the tours and relate stops to some important locations in the network such as depots, ports and rail yards.

4 - Estimation of a Dynamic Discrete Path Choice Model with a Mixed Logit Approach
Maelle Zimmermann, KTH, Stockholm, Sweden, maelle.zimmermann@gmail.com, Oskar Blom Västberg, Anders Karlström

This paper addresses the issue of correlation patterns in an activity-based travel demand model which is formulated as a dynamic discrete path choice model. Estimation results reveal that by increasing the dynamic model's state space to keep track of relevant variables, the importance of relaxing IIA in the path choice problem diminishes. In addition, we show and illustrate that using a mixed logit approach for modes accounts even better for the correlation across both alternatives and time.

■ TD07

07-Level 2, Salon 3

Management and Optimization

Cluster: Contributed Sessions

Invited Session

Chair: Mariya Bondareva, University of Rochester, University of Rochester, Simon Business School, Rochester, NY, 14627, United States of America, 2mariyabondareva@gmail.com

1 - 5 Steps to Supply Chain Coordination
Suresh Sethi, Eugene McDermott Professor of Operations Management, University of Texas at Dallas, 800 West Campbell Rd. SM30, Richardson, TX, 75080-3021, United States of America, sethi@utdallas.edu, Tao Li

In supply chain coordination literature, most researchers perform these four steps: 1. Solve the decentralized problem; 2. Solve the corresponding centralized problem; 3. Show double marginalization and hence the need for coordination; 4. Obtain a coordinating contract by equating the follower's best response to the centralized channel's optimal decision. We provide the missing 5th step by showing that the coordinating contract so obtained is indeed an appropriate Stackelberg equilibrium.

2 - Designing Forecasting Accuracy Measures for Coordinating Sales and Production Functions
Ki-Seok Choi, Hankuk University of Foreign Studies, 81 Oedae-ro, Yongin, 449-791, Korea, Republic of, kchoi@hufs.ac.kr

Sales and Production are two of the key functions in a manufacturing company's supply chain. Sales perform the demand forecasting which provides basic information for production planning. When their performance is measured by a metric, it is likely that Sales work for their own interest not the overall company's. In this paper, we discuss how to measure the Sales' forecasting accuracy to help the company coordinate Sales and Production for the company-wide efficiency.

3 - Product Design Outsourcing in a Supply Chain
Jun Shan, Jinan University, 601 Huangpu Avenue West, Guangzhou, China, junshanhk@gmail.com

We consider a one-buyer-one-supplier supply chain in which the buyer introduces two products to a two-segment consumer market. The buyer may choose to keep the design function in-house, or outsource either the design of the low-quality product only or the design of both products to the supplier. By comparing the product design scenarios, we examine how design outsourcing may affect the product qualities and how variations of the business environment may influence the design outsourcing.

4 - Dynamic Relational Contracts for Quality Compliance under Poor Legal Enforcement
Mariya Bondareva, University of Rochester, University of Rochester, Simon Business School, Rochester, NY, 14627, United States of America, 2mariyabondareva@gmail.com
Edieal Pinker

Large multinational companies outsource production to developing countries where both the monitoring of compliance and legal enforcement of penalties are challenging. We offer dynamic relational contracts involving inspections and self-enforcing penalties as a tool to make suppliers comply with sustainability requirements. The optimal contract is characterized by non-decreasing expected profits for suppliers, non-decreasing penalties for quality failures and non-increasing defect rates.

■ TD08

08-Level A, Hémon

DFO using Models

Cluster: Derivative-Free Optimization

Invited Session

Chair: Zaikun Zhang, F 325, IRIT, 2 rue Camichel, Toulouse, 31071, France, zhang@cerfacs.fr

1 - Efficient Subproblem Solution within MADS with Quadratic Models
Nadir Amaioua, PhD Student, École Polytechnique de Montréal, C.P. 6079, succ. Centre-ville, Montréal, QC, H3C 3A7, Canada, nadir.amaioua@polymtl.ca, Sébastien Le Digabel, Charles Audet

A subproblem appears when using the MADS (Mesh Adaptive Direct Search) algorithm with quadratic models, for derivative-free optimization. In this context, we explore different algorithms that exploit the structure of the subproblem: The augmented Lagrangian method, the L1 exact penalty function and the augmented Lagrangian with a L1 penalty term. We implement these algorithms within the NOMAD software package and present their impact on the quality of the solutions.

2 - Numerical Variational Analysis for Finite Max Functions
Warren Hare, University of British Columbia, 3333 University Way, Kelowna, BC, Canada, warren.hare@ubc.ca

Numerical Analysis, the study of approximating analytic properties of a function, has established a variety of formulas for approximating gradients, Hessians, etc. Naturally, these formulas use restrictive smoothness assumptions, making them inapplicable when the objective function is the max of a finite number of smooth functions. In this talk we explore Numerical Variational Analysis, the study of approximating analytic properties of a nonsmooth function, with a focus on finite max functions.

■ TD09

09-Level A, Jarry

Primal Algorithms and Integral Simplex

Cluster: Special Invited

Invited Session

Chair: Samuel Rosat, 3000, ch. de la Cote Sainte Catherine, Montreal, QC, H3T2A7, Canada, samuel.rosat@gerad.ca

1 - Primal Cuts in the Integral Simplex using Decomposition (ISUD)
Samuel Rosat, GERAD Research Center, 3000, ch. de la Cote Sainte Catherine, Montréal, QC, H3T2A7, Canada, samuel.rosat@polymtl.ca, Andrea Lodi, Issmail El Hallaoui, François Soumis

We propose a primal algorithm for the Set Partitioning Problem based on the ISUD algorithm (Zaghrouti et al., 2014). We present the algorithm in a pure primal form, show that cuts can be transferred to the subproblem, and characterize the set of transferable cuts and prove that it is nonempty. We propose efficient separation procedures for primal clique and odd-cycle cuts, and prove that we can restrict their search space. Geometrical interpretation, and numerical results are shown.

2 - A Parallel Integral Simplex Algorithm to Solve the Set-partitioning Problem
Omar Foutlane, GERAD Research Center, 3000, ch. de la Cote Sainte Catherine, Montréal, QC, H3T2A7, Canada, omar.foutlane@polymt.ca, Issmail El Hallaoui, Pierre Hansen

We present an exact parallel integral simplex algorithm to solve large instances of the set-partitioning problem. This algorithm dynamically splits the problem into several subproblems. Subproblems solutions are iteratively combined to obtain an improved global solution till optimality. Computational results on instances from the transportation industry will be presented.

3 - Influence of the Normalization Constraint in the Integral Simplex using Decomposition

François Soumis, Professor, École Polytechnique de Montréal, 2500, chemin de Polytechnique, Montréal, QC, H3T 1J4, Canada, francois.soumis@gerad.ca, Issmail El Hallaoui, Samuel Rosat, Driss Chakour

Since its introduction in 1969, the set partitioning problem has received much attention, and the structure of its feasible domain has been studied in detail. In particular, there exists a decreasing sequence of integer feasible points that leads to the optimum, such that each solution is a vertex of the polytope of the linear relaxation and adjacent to the previous one. Several algorithms are based on this observation and aim to determine that sequence; one example is the integral simplex using decomposition (ISUD) of Zaghrouti et al. (2014). In ISUD, the next solution is often obtained by solving a linear program without using any branching strategy. We study the influence of the normalization-weight vector of this linear program on the integrality of the next solution. We extend and strengthen the decomposition theory in ISUD, prove theoretical properties of the generic and specific convexity constraints, and propose new normalization constraints that encourage integral solutions. A geometrical interpretation of the domain of the augmentation problem, and of the normalization constraint is supplied. Numerical tests on scheduling instances (with up to 500,000 variables) demonstrate the potential of our approach.

4 - Improving Set Partitioning Problems Solutions by Zooming Around an Improving Direction

Abdelouahab Zaghrouti, GERAD Research Center, 3000, ch. de la Cote Sainte Catherine, Montréal, QC, H3T2A7, Canada, abdelouahab.zaghrouti@gerad.ca, Issmail El Hallaoui, François Soumis

We introduce the zooming algorithm, which, at each iteration, improves the current integer solution by zooming around an improving direction. It is an exact primal approach that efficiently controls the combinatorial search within a reduced problem. It rapidely reaches optimal or near-optimal solutions on instances emanating from the transportation industry.

■ TD10

10-Level A, Joyce

Networks and Stochastic Optimization

Cluster: Contributed Sessions

Invited Session

Chair: Nilay Noyan, Assoc. Prof., Sabanci University, Sabanci University, Orhanli, Tuzla, Istanbul, 34956, Turkey, nnoyan@sabanciuniv.edu

1 - Closed-Loop Supply Chain Network Design under Uncertain Quality Status

Mohammad Jeihoonian, PhD Student, Concordia University, 1515, St - Catherine, St. West, EV13.119, Montréal, QC, H3G1M8, Canada, m_jeihoo@encs.concordia.ca
Masoumeh Kazemi Zanjani, Michel Gendreau

The high degree of uncertainty in the quality of used modular-structured products is a critical key element in designing closed-loop supply chains (CLSC). This study presents a 2-stage stochastic programming model for designing such networks. A novel scenario generation approach along with an accelerated L-shaped method for solving the stochastic model are also proposed.

2 - A Learning-Based Heuristic Approach for Stochastic Network Design Problem with Uncertain Demands

Fatemeh Sarayloo, University of Montréal, Université de Montréal P.O. Box 6128, Stat, Montréal, Canada, saraylof@iro.umontreal.ca

Network Design models define an important class of discrete optimization problems that arise in the planning of complex systems such as transportation, logistics and telecommunications. This paper focuses on the stochastic version of classical fixed-charge network design problem with uncertain demands. We propose a heuristic solution methodology that adaptively learns from different demand scenarios to build a single cost-effective design solution in the face of uncertainty.

3 - Reliable Supply Chain Network Design Problem: Supermodularity and a Cutting-Plane Approach

Xueping Li, University of Tennessee, 522 John D. Tickle Building, Knoxville, United States of America, xueping.li@utk.edu

We study the reliable supply chain network design problem with the consideration of unexpected facility failures with probabilities. The goal is to minimize the initial setup costs and expected transportation costs in normal and failure scenarios. We propose a cutting-plane method based on the super modularity of the problem. The proposed approach is capable of solving the reliable supply chain network design problem for independent and correlated failures.

4 - Formulations and Exact Algorithms for Robust Uncapacitate Hub Location

Carlos Zetina, PhD Student, Concordia University

■ TD11

11-Level A, Kafka

Risk Analysis

Cluster: Contributed Sessions

Invited Session

Chair: Marzieh Mehrjoo, Lecturer, Ryerson University, Ted Rogers School of Management, 350 Victoria Street, Toronto, ON, Canada, mmehrjoo@ryerson.ca

1 - Estimating Probability of Default Taking into Account the Reasons for Customers' Non-Payment

Angela De Moraes, PhD Student, University of Edinburgh, 29 Buccleuch Place, Edinburgh, EH8 9JS, United Kingdom, angelarm@mundivox.com.br

Traditional credit scoring models overlook causes of default and use proxies for them. The objective of this paper is to investigate who become delinquent, why they do so and if they recover subsequently. It also seeks to establish the relationship between these reasons, customers' personality traits and financial knowledge

2 - Modelling Operational Risk using Skew-t Copulas via Bayesian Inference

Betty Johanna Garzon Rozo, Miss, The University of Edinburgh, 29 Buccleuch Place, Room 3.02, Edinburgh, EH8 9JS, United Kingdom, s1154454@sms.ed.ac.uk, Jonathan Crook

Operational risk losses are heavy tailed and are likely to be asymmetric and extremely dependent. We propose a new methodology to assess, in a multivariate way, the asymmetry and extreme dependence between severities and to calculate the capital for Operational Risk. This methodology simultaneously uses (i) extreme value theory, (ii) the multivariate skew t-copula applied for the first time and (iii) Bayesian theory. The research analyses an updated data set, SAS Global Operational Risk Data.

3 - The Role of Reusable Knowledge in Security Risk Assessment

Katsiaryna Labunets, PhD Candidate, University of Trento, via Sommarive, 9, Trento, Italy, labunets@disi.unitn.it
Fabio Massacci, Federica Paci

To remedy the lack of security expertise, industrial Security Risk Assessment methods come with catalogues of threats and security controls. We run two studies with novices and professionals in Air Traffic Management to explore the effect of catalogues on the actual and perceived efficacy of a SRA method. The study shows that experts without security background who applied the method with catalogues identified threats and controls of the same quality of security experts without catalogues.

4 - Applying System Dynamics Methodology for Assessing the Risk of Fast Fashion Apparel Supply Chain

Marzieh Mehrjoo, Lecturer, Ryerson University, Ted Rogers School of Management, 350 Victoria Street, Toronto, ON, Canada, mmehrjoo@ryerson.ca, Zbigniew J. Pasek

In fast fashion industry risk effects are compounded by factors such as complex supply chains, short product life-cycles, and volatile market demand which make them highly sensitive to exposure of uncertainty. This study presents a system dynamics model to analyze the behavior and relationships of the fast fashion apparel industry with three supply chain levels. Conditional Value at Risk method is applied to quantitatively analyze the risk associated with the supply chain of this industry.

■ TD12

12-Level A, Lamartine

Network Optimization

Cluster: Contributed Sessions

Invited Session

Chair: Ivan Contreras, Assistant Professor, Concordia University, 1455 de Maisonneuve Blvd. West, Montreal, QC, H3G 1M8, Canada, icontrer@encs.concordia.ca

1 - 2D-Phase Unwrapping Problem (2DPU) via Minimum Spanning Forest with Balance Constraints

Marcus Poggi, PUC-Rio Informatica, R.M.S. Vicente 225, Rio de Janeiro, Brazil, poggi@inf.puc-rio.br, Ian Herszterg, Thibaut Vidal

We propose a new model for the L 0-Norm 2DPU. The discontinuities of the wrapped phase image (residues) are associated to vertices in the plane. These vertices have either positive or negative polarity. The objective is to find a minimum Euclidean cost spanning forest where the trees' vertex set are balanced, i.e. the number of positive and negative residues are equal. We present approximate and exact approaches. Results on benchmark instances show improvement over previous proposed methods.

2 - The Uncertain Steiner Tree Star Problem
M. Gisela Bardossy, Assistant Professor, University of Baltimore, 1420 N. Charles Street, Merrick School of Business, Baltimore, MD, 21201, United States of America, mbardossy@ubalt.edu

In this paper, we study the uncertain Steiner tree star problem and address its robust optimization formulation a la Bertsimas and Sim. We compare the computational time between a flow-based robust compact formulation and Bertsimas and Sim's approach, which solves a family of nominal (and deterministic) problems instead. In addition, we propose strategies to speed up the Bertsimas and Sim approach by limiting the number of nominal problems considered and directing the search within them.

3 - Aircraft Routing with Generalized Maintenance Constraints
Nima Safaei, Senior Specialist, Bombardier, 123 Garratt Boulevard, Toronto, ON, M3K 1Y5, Canada, nima.safaei@aero.bombardier.com

This study proposes a new formulation of the aircraft maintenance routing problem in which maintenance requirements are built as generalized capacity constraints, ensuring sufficient maintenance opportunities are available within the planned routes to satisfy the maintenance demands of individual aircraft. Our new approach suggests minimizing the non-revenue flights and maintenance misalignment as conflicting objectives using an interactive mechanism.

4 - Benders Decomposition for the Optimum Communication Spanning Tree Problem
Ivan Contreras, Assistant Professor, Concordia University, 1455 de Maisonneuve Blvd. West, Montréal, QC, H3G 1M8, Canada, icontrer@encs.concordia.ca, Carlos Luna-Mota, Elena Fernandez

In this talk we present an exact algorithm based on a Benders decomposition of an arc-based formulation for the optimum communication spanning tree problem. The standard algorithm is enhanced through the use of a Benders-branch-and-cut scheme and the generation of strong optimality cuts. Computational experiments are reported.

■ TD13

13-Level A, Musset

Reverse Logistics/ Remanufacturing

Cluster: Contributed Sessions

Invited Session

Chair: Mei-Ting Tsai, Assistant Professor, National Chung Hsing University, 250 Kuo Kuang Rd., Taichung, 40227, Taiwan - ROC, mtsai@nchu.edu.tw

1 - Optimal Core Acquisition and Remanufacturing Decisions with Market-Driven Product Acquisition Policy
Morteza Lalmazloumian, Student, University of Windsor, 780 Ouellette Avenue Apt 126, Windsor, On, N9A 1C5, Canada, lalmazl@uwindsor.ca, Mostafa Pazoki

This paper generates a managerial insight into the combination of product return management (PRM) and production planning of a remanufacturing system with stochastic demand through utilizing a market-driven network. A stochastic programming model is developed and it is shown for a remanufacturer company that an optimal acquisition and remanufacturing decisions should be coordinated in order to maximize the total expected profit of this single-period setting problem.

2 - Global Reverse Supply Chain Design under the Emission Trading Scheme
Amin Chaabane, Professor, Ecole de technologie superieure, 1100, rue Notre-Dame Ouest, Montréal, QC, H3C 1K3, Canada, amin.chaabane@etsmtl.ca

We study the problem of designing a reverse supply chain in the context of global waste recycling and under the emission trading scheme. The problem is modeled as a network optimization problem using mixed integer programing approach. The implementation of this model within the context of plastic waste recycled is presented.

3 - Discrete Event Simulation for Evaluating the Dynamic Deployment of Resources in a Modular Facility
Suzanne Marcotte, Associated professor, ESG-UQAM/CIRRELT, Case Postale 8888, succ. Centre-Ville, Montréal, Qu, H3C 3P8, Canada, marcotte.suzanne@uqam.ca, Benoit Montreuil, Yasmina Maizi

This paper describes the use of discrete event simulation (DES) modelling in order to support the dynamic evaluation of complex systems such as modular facilities with dynamic deployment of production, storage and handling resources. The model evaluates the layout evolution and compares KPIs such as throughput time and resource utilization while the facility is submitted to dynamic and stochastic demand. A computer refurbishing and recycling facility is used as an illustrative case.

4 - A Study Of Stepwise Investment In Remanufacturing using Real Options Approach
Mei-Ting Tsai, Assistant Professor, National Chung Hsing University, 250 Kuo Kuang Rd., Taichung, 40227, Taiwan - ROC, mtsai@nchu.edu.tw, Chi-Yi Shiu

Sustainability is an important issue nowadays. Remanufacturing is one of reverse supply chain activities and it helps decrease the pollution to our environment. The investment is relatively difficult due to the uncertainties inherent in the remanufacturing system. This research aims to use real options approach to evaluate a stepwise investment in remanufacturing. The uncertainty and manageable flexibility are incorporated in the decision model so the investment value will not be underestimated.

■ TD14

14-Level B, Salon A

Electricity Market/Optimization of Energy Systems

Cluster: Energy

Invited Session

Chair: Somayeh Moazeni, Assistant Professor, Stevens Institute of Technology, 1 Castle Point Terrace on Hudson, Hoboken, NJ, 07030, United States of America, smoazeni@stevens.edu

1 - Optimal Scenario Set Partitioning for Multi-Stage Stochastic Programming with Progressive Hedging
Michel Gendreau, Professor, Ecole polytechnique de Montréal, C.P. 6079, succ. Centre Ville, Montréal, QC, H3C 3A7, Canada, michel.gendreau@cirrelt.net, Pierre-Luc Carpentier, Fabian Bastin

We propose a new approach to reduce the total running time of the progressive hedging algorithm (PHA) for solving multi-stage stochastic programs defined on a scenario tree. Instead of using the conventional scenario decomposition scheme, we apply a multi-scenario decomposition scheme and partition the scenario set in order to minimize the number of non-anticipativity constraints (NACs) on which an augmented Lagrangian relaxation must be applied. Our partitioning method is a heuristic algorithm.

2 - A Multi-Prosumer Electricity Cooperative with Learning and Axiomatic Cost Sharing
Babak Heydari, Assistant Professor, Stevens Institute of Technology, 1 Castle Point, Stevens Institute of Technology, Hoboken, NJ, 07030, United States of America, babak.heydari@stevens.edu, Abbas Ehsanfar

This paper introduces a novel autonomous interactive learning cooperative that aggregates commercial and residential consumers with PV distributed generation and participates in the electricity market. An axiomatic approach is proposed to disaggregate the aggregated cost and risk among participating consumers. This scheme shows strong performance in average electricity cost reduction and considerably improves the optimum penetration of PV generation in distribution network.

3 - A Non-Parametric Structural Hybrid Modeling Approach for Electricity Prices
Somayeh Moazeni, Assistant Professor, Stevens Institute of Technology, 1 Castle Point Terrace on Hudson, Hoboken, NJ, 07030, United States of America, smoazeni@stevens.edu
Ismael Arciniegas Rueda, Michael Coulon, Warren Powell

We develop a stochastic model of electricity spot prices, designed to reflect information in fuel forward curves and to handle zonal or regional price spreads. We use a nonparametric model of the supply stack that captures heat rates and fuel prices for all generators in the market operator territory (PJM market in our case), combined with an adjustment term to approximate congestion and other zone-specific behavior. The approach is requires minimal calibration effort.

4 - Bilateral Contract Optimization in Power Markets
Miguel F. Anjos, Professor and Canada Research Chair, Mathematics & Industrial Engineering, Polytechnique Montréal, Montréal, Canada, miguel-f.anjos@polymtl.ca
François Gilbert, Patrice Marcotte, Gilles Savard

We consider an energy broker linking its customers and the power grid through a two-sided portfolio of bilateral contracts. The contracts cover a number of actions taken by the customers on request within specified periods. Managing this portfolio raises a number of modelling and computational issues due to the aggregation of disparate resources. We propose an innovative algorithmic framework that models short-term decisions factoring in long-term information obtained from a separate model.

■ TD15

15-Level B, Salon B

Applications of Operations Research in the Transport Industry

Cluster: Practice

Invited Session

Chair: Charles Fleurent, OR Director, Giro Inc., 75 Port-Royal Est, Suite 500, Montreal, QC, H3L 3T1, Canada, charles.fleurent@giro.ca

1 - Customer Segmentation in Airline Industry
Sergey Shebalov, Sabre Holdings, Southlake, TX, sergey.shebalov@sabre.com

Airlines have been using artificial mechanisms for segmenting demand for over 30 years. Yet they possess a vast amount of information about their customers to make very precise description of their needs, preferences and behavioral features. We describe a framework that applies segmentation techniques and produces detailed picture of airline's consumers. Recommendations generated from this information can be used in the areas such as network design, revenue management and airline retailing.

2 - Queues and Wait Times at Canadian Airports
Patrick Boily, Managing Consultant, Centre for Quantitative Analysis and Decision Support (Carleton University), 1125 Colonel By Drive, 4332 Herzberg Laboratories, Ottawa, On, K1S 5B6, Canada, patrick.boily@carleton.ca, Yiqiang Zhao, Maryam Haghighi, June Lavigne

By providing an efficient and effective pre-board screening, the Canadian Air Transport Security Authority ensures that an appropriate balance is maintained between staffing requirements and the wait times experienced by passengers. We used queuing theory to develop a model which can predict, among other things, the number of servers required to achieve particular service levels based on forecast arrival rates. In this talk, we describe this model and discuss some of its possible refinements.

3 - Optimization in a Public Transport Depot
Charles Fleurent, OR Director, Giro Inc., 75 Port-Royal Est, Suite 500, Montréal, QC, H3L 3T1, Canada, charles.fleurent@giro.ca

Optimization is widespread in large public transport companies for medium-to-long-term scheduling. An area that has often been overlooked is short-term allocation of individual resources, i.e, specific vehicles and drivers to be assigned to theoretical blocks and duties. We present a description of the activities that take place in a depot, from early morning to night. From these, we extract optimization problems and provide case studies of actual implementation in European transport companies.

■ TD16

16-Level B, Salon C

Global Optimization and Mixed-Integer Nonlinear Optimization

Cluster: Mixed-Integer Nonlinear Optimization

Invited Session

Chair: John Chinneck, Carleton University, Systems and Computer Engineering, Ottawa, ON, K1S 5B6, Canada, chinneck@sce.carleton.ca

1 - CCGO: Fast Heuristic Global Optimization
Mubashsharul Shafique, Carleton University, Systems and Computer Engineering, Ottawa, ON, K1S 5B6, Canada, shafique.cit.2@gmail.com, John Chinneck

We present a heuristic multi-start method for global optimization that is highly scalable, especially suitable for nonconvex problems, and is able to find good quality solutions quickly. The core components are: initial sampling, constraint consensus, clustering, direct search, and local solver. Empirical results show the effectiveness of the method. In future, this method will be used within a branch-and-bound framework to solve MINLP problems.

2 - MISO: Mixed-Integer Surrogate Optimization Framework
Juliane Mueller, Postdoc, Lawrence Berkeley National Lab, 1 Cyclotron Road, Berkeley, CA, 94720, United States of America, juliane.mueller2901@gmail.com

We introduce MISO, the Mixed-Integer Surrogate Optimization framework. MISO aims at solving computationally expensive black-box optimization problems with mixed-integer variables. MISO uses surrogate models to approximate the expensive objective function and to guide the search in order to reduce the number of expensive function evaluations. We compare various surrogate models and sampling strategies and we show that a combination of local and global search yields the best solutions.

3 - Convexification of Power Flow Problem over Arbitrary Networks
Javad Lavaei, Columbia University, New York, United States of America, lavaei@ee.columbia.edu
Ramtin Madani, Ross Baldick

Consider an arbitrary power network with PV and PQ buses, where active powers and voltage magnitudes are known at PV buses and active and reactive powers are known are PQ buses. The power flow (PF) problem aims to find the unknown complex voltages. The objective of this work is to show that there is a convex program that solves the PF problem precisely for arbitrary networks as long as voltage angles are small enough.

■ TD17

17-Level 7, Room 701

Analytics Around the World and Future of Analytics

Sponsor: Analytics

Sponsored Session

Chair: Greg Richards, University of Ottawa, 55 Laurier Avenue, Ottawa, Canada, Richards@telfer.uottawa.ca

1 - Quantitative Indicators of Risk
David Coderre, University of Ottawa, Telfer School of Management, Ottawa, ON, Canada, coderre@telfer.uottawa.ca

This paper presents a practical approach to the development and assessment of multiple data-driven indicators for different categories of risk. Risk has long been measured by probability and impact. However, traditional risk assessment methods are not timely – often only assessed on a yearly basis – and too labor intensive to allow management to effectively react to rapidly changing competitive, legal, and technological environments. A data-driven approach, using transactional data from operational systems, is required to address these limitations. From a data-driven perspective, probability will increase when an activity or process has more variability/change and complexity; and impact increases with volume, materiality and size. An increase in variability/change and/or complexity and/or higher volume, materiality or size will be indicative of an increased level of risk for the activity. Each activity can be assessed using transaction-level data-driven risk indicators and an overall risk level determined. In addition, by examining the quantitative risk indicators (QRIs) on an ongoing basis, changing levels of, or emerging, risks can be highlighted proactively.

■ TD18

18-Level 7, Room 722

Queueing and Inventory Models

Cluster: Queueing

Invited Session

Chair: Douglas Down, Professor, McMaster University, Department of Computing and Software, ITB 216, Hamilton, ON, Canada, downd@mcmaster.ca

1 - The Analysis of Cyclic Stochastic Fluid Flows with Time-Varying Periodic Transition Rates
Barbara Margolius, Professor, Cleveland State University, Department of Mathematics, 2121 Euclid Ave, Clevealnd, OH, 44120, United States of America, b.margolius@csuohio.edu
Malgorzata O'Reilly

We consider a stochastic fluid model (SFM) (X(t),J(t)) driven by a continuous-time Markov chain J(t) with a time-varying generator T(t) and cycle of length 1 such that T(t)=T(t+1). We derive theoretical expressions for the key periodic measures, and develop efficient methods for their computation. We illustrate the theory with a numerical example. This work extends the results in Bean, O'Reilly and Taylor for a standard SFM with time-homogeneous generator and extends our own earlier work.

2 - A Queueing Theorist Looks at MCMC
Myron Hlynka, Professor, University of Windsor, Math & Stat Dept., University of Windsor, Windsor, ON, N9B 3P4, Canada, hlynka@uwindsor.ca

We present an approach for MCMC simulation whose development looks more natural to a queuing theorist than the usual development. We use it to simulate the Fibonacci distribution.

3 - Ergodicity of Age-Dependent Inventory Control Systems
Fredrik Olsson, Dr, Lund University, Ole Römers väg 1, Lund, Sweden, fredrik.olsson@iml.lth.se

We consider continuous review inventory systems with general doubly stochastic Poisson demand. The model we treat here generalizes some known inventory models dealing with partial backorders, perishable items, and emergency replenishment. We derive the limiting joint density of the ages of the units in the system by solving partial differential equations. We also answer the question of the uniqueness of the stationary distributions which was not addressed yet in the related literature.

4 - Solving Multi-Server Queues with Impatient Customers as Level-Dependent QBDs
Amir Rastpour, University of Alberta, 1413 8515 112 street, Edmonton, AB, T6G1K7, Canada, amir.rastpour@ualberta.ca
Armann Ingolfsson, Burhaneddin Sandikçi

We investigate the use of level-dependent quasi-birth-death (QBD) processes to analyze priority queues with impatient customers. We will report on attempts to develop error bounds for algorithms to compute performance measures, computational efficiency, and numerical experiments.

■ TD19

19-Grand Ballroom West

Tutorial: Robust Optimization in Healthcare Systems Engineering

Cluster: Tutorials

Invited Session

Chair: Aurelie Thiele, Visiting Associate Professor, M.I.T., 77 Massachusetts Ave Rm E40-121, Cambridge, MA, 02142, United States of America, aut204@lehigh.edu

1 - Robust Optimization in Healthcare Systems Engineering
Aurelie Thiele, Visiting Associate Professor, M.I.T., 77 Massachusetts Ave Rm E40-121, Cambridge, MA, 02142, United States of America, aut204@lehigh.edu, Tengjiao Xiao

This tutorial provides an overview of robust optimization with a focus on the problems that arise in healthcare systems engineering and the types of uncertainty that affect them. We particularly consider Markov Decision Processes with uncertain transition matrices, robust regression techniques and robust choice models. We discuss problem structure, uncertainty modeling, solution techniques and analytical insights to assist decision making in the presence of high uncertainty.

Wednesday, 9:00am - 10:30am

■ WA01

01-Level 4, Salon 8

Disaster and Disruption Management

Cluster: Contributed Sessions

Invited Session

Chair: Anubhuti Parajuli, PhD Student, Concordia University, 7141 Rue Sherbrooke Ouest, Montréal, QC, Montreal, QC, H4B 1R6, Canada, a_paraju@encs.concordia.ca

1 - On the Value of Recovery Time Characteristics in Resilient Design of Supply Flow
Alireza Ebrahim Nejad, Concordia Univesity, 1455 De Maisonneuve Blvd. W., Montréal, H3G 1M8, Canada, a_ebra@encs.concordia.ca, Onur Kuzgunkaya

This research aims to provide a tool achieving resilient supply flow by incorporating strategic stock and contingent sourcing. The problem is to determine optimal strategic stock level and response speed of backup supplier. In order to maintain a resilient supply performance, we consider the production capability of backup supplier during recovery time. The results show improvement in quality of optimal solution by considering randomness associated with available capacity and congestion impacts.

2 - A Stochastic Programming Model for Prepositioning and Distributing Emergency Supplies
Xiaofeng Nie, Assistant Professor, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, Singapore, xiaofengnie@ntu.edu.sg, Aakil Caunhye, Mingzhe Li, Yidong Zhang

We model post-disaster situations as scenarios and propose a two-stage stochastic programming model to preposition and distribute emergency supplies. In the first stage, the model decides where to locate warehouses and how many quantities to stock for prepositioning purposes. In the second stage, the model decides how many quantities to transport to demand sites and the corresponding routing. Furthermore, the issue of equitability is taken into consideration when distributing emergency supplies.

3 - Protecting Flows in a Capacitated Supply Facility Network under Disruption
Anubhuti Parajuli, PhD Student, Concordia University, 7141 Rue Sherbrooke Ouest, Montréal, QC, Montréal, QC, H4B 1R6, Canada, a_paraju@encs.concordia.ca
Navneet Vidyarthi, Onur Kuzgunkaya

Facility disruption reduces the capacity of a supply network to meet demands, often resulting in severe economic and other business impacts. We investigate the problem of supply flow protection through partial recovery of lost demands at facilities. Our model considers response time characteristics and non-instantaneous capacity additions at surviving facilities.

■ WA02

02-Level 3, Drummond West

Queueing and Other Models of Healthcare Systems

Cluster: Healthcare

Invited Session

Chair: David Stanford, Professor, Western University, Statistical & Actuarial Sciences, 1151 Richmond St. N., London, ON, N6A 5B7, Canada, stanford@stats.uwo.ca

1 - A Model for Deceased-Donor Transplant Queue Waiting Times
Steve Drekic, University of Waterloo, Dept. of Statistics & Actuarial Science, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, sdrekic@uwaterloo.ca
Vivian McAlister, David Stanford, Douglas Woolford

In many jurisdictions, organ allocation for transplantation is done on the basis of the health status of the patient, either explicitly or implicitly. This talk presents a self-promoting priority model which takes into account changes in health status over time. Performance measures such as the mean and distribution of the time until transplant are obtained based upon real data from a liver transplant waitlist in a region of Canada.

2 - Finding a Scheme to Maximize Physicians' Satisfaction while Minimizing Patients' Pre-Treatment Phase
Nazgol Niroumandrad, M.Sc. Student, École Polytechnique de Montréal, C.P. 6079, succ. Centre-ville, Montréal, QC, H3C 3A7, Canada, nazgol.niroumandrad@polymtl.ca, Nadia Lahrichi

The objective of this study is determining a task schedule for physicians in order to increase their satisfaction/preferences while improving the patient flow and decreasing patients pre-treatment phase in a radiotherapy center with considering all possible constraints. To reach this objective, we developed an Integer Linear Programming which was a pattern based. In addition, a meta-heuristic approach (Tabu Search) was developed based on physicians' tasks to evaluate the quality of patterns.

3 - Estimating the Time for Referral from Billing Data
David Stanford, Professor, Western University, Statistical & Actuarial Sciences, 1151 Richmond St. N., London, ON, N6A 5B7, Canada, stanford@stats.uwo.ca, Na Li, Amardeep Thind

A key measure of waiting times in health care is the time it takes to be referred to a specialist. We report on a study to estimate the referral time (known in Canada as Wait Time 1) from billing records submitted by the specialist and the referring physician, under a particular constraint: the referring physician's bills do not indicate when referrals are made. We resort to bootstrap simulations to overcome this problem. Illustrative examples will be presented.

■ WA03

03-Level 3, Drummond Centre

Wood Supply Challenges

Cluster: Applications of OR in Forestry

Invited Session

Chair: Eldon Gunn, Professor Emeritus in Industrial Engineering, Dalhousie University, Industrial Engineering, P.O. Box 15000, Halifax, NS, B3H 4R2, Canada, Eldon.Gunn@dal.ca

1 - Future Wood Supply and Climate Change – Insights from a System Dynamics Model

LATE CANCELLATION

Peter Rauch, P.O. Box 10, Feistmantelstrasse 4, Vienna, A-1180, Austria, peter.rauch@boku.ac.at

In order to assess risks and their long-term impacts on value chains of the bio-based industry a System Dynamics model of the Austrian wood supply was developed that includes a stochastic simulation of the main risk agents. Results provide insights on future wood supply security and reveal a contra-intuitive system effect for the climate change scenario. Even though salvaged wood volumes were increasing, supply situation worsens for all roundwood assortments and supply security decreased.

2 - Delineating Forest Fire Management Zones using ZDT

Dongxin Wen, Professor, Faculty of Science, Central South University of Forestry and Technology, 498 Shaoshan Road South, Changsha, HN, 410004, China, 21514851@qq.com
Lifu Shu, Wenbin Cui

We describe a Zone Delineation Tool that can be used to delineate zones based on the user defined criteria. The criteria include not only size, compactness, and continuity of the zones but also multiple use-defined spatial criteria. We use ZDT to delineate forest fire management zones in China. The goal of the delineation is to effectively allocate forest fire management resources for fire prevention and suppression without major reorganization. The resulting zones overall realize the goal.

3 - Supply Strategies in a Timber Auction Context

Raja Ziedi, Université Laval, 2325 Rue de l'Université, Québec, QC G1V, Québec, Canada, raja.ziedi.1@ulalval.ca, Nadia Lehoux, Luc LeBel

The system of timber auction raises many challenges for forest companies. They have to integrate a new source of uncertainty in their wood supply process. We performed a systematic literature review, which revealed the absence of supply strategies in the context of timber auction. Therefore, we propose to explore various supply strategies for a more efficient use of the fibre and profit maximization. Furthermore, it will help forestry companies develop their agility.

4 - Capacity Expansion in an Integrated Forest Value Chain Design in an Uncertain Environment

Narges Sereshti, Dalhousie University, Department of Industrial Engineering, Da, Halifax, NS, Canada, Narges.sereshti@dal.ca
Eldon Gunn

The forestry capacity planning problem, typically dynamic, depends on anticipated product markets and on raw material availability over time. The goal of this research is to develop tools that will enable an examination of strategic options for integrated capacity expansion in Nova Scotia, which is consistent with forest management and robust to market uncertainties. A mixed integer programming model is presented for this problem.

■ WA04

04-Level 3, Drummond East

Sawmill Planning

Cluster: Applications of OR in Forestry

Invited Session

Chair: Jonathan Gaudreault, Professor, Université Laval, Université Laval, Québec, Canada, jonathan.gaudreault@ift.ulaval.ca

1 - Evaluating Order Promising Strategies for the Sawmilling Industry using Simulation

Ludwig Dumetz, PhD Student, FORAC, Pavillon Adrien-Pouliot 1065, av. de la, Québec, G1V0A6, Canada, ludwig.dumetz.1@ulaval.ca, Jonathan Gaudreault, André Thomas, Philippe Marier, Hind Bril El-Haouzi, Nadia Lehoux

Raw material heterogeneity, complex transformation processes, and divergent product flows make sawmilling operations difficult to manage. Most north-American lumber sawmills apply a make-to-stock production strategy. Others accept/refuse orders according to available-to-promise (ATP) quantities. Finally a few uses more advanced approaches like capable-to-promise (CTP). A simulation framework is used to compare these different strategies for various market contexts of the sawmilling industry.

2 - Demand Fulfillment in a Make-to-Stock Environment Based on Mathematical Programming

Maha Ben Ali, Université Laval, FORAC, 1045 avenue de la Médecine, Quebec, Canada, maha.ben-ali.1@ulaval.ca
Jonathan Gaudreault, Marc-Andre Carle, Sophie D'Amours

We propose to evaluate the performance of various demand fulfillment processes including S&OP at the tactical level and different order promising approaches at the operational/execution level. Processes are analyzed through simulations in a network consisting of three sawmills. Then, a multi-level framework will be defined based on a sensitivity analysis conducted to evaluate the impact of many contextual variables, such as forecast accuracy, operating conditions and market structure.

3 - Production Planning with Heuristics and MIP Model Solution Considering Different Planning Horizons

Maria Anna Huka, Dipl.-Ing., University of Natural Resources and Life Sciences, Vienna, Feitmanstelstrasse 4, Vienna, 1180, Austria, maria.huka@boku.ac.at, Manfred Gronalt

Comparing simple heuristics, one period planning, short term multi-period optimization or rolling horizon for production planning at a sawmill leads to different results. Decision making models are formulated as mixed integer programs where not only the net revenue but also the variable costs of the production, inventory costs for raw material and products, the purchasing price for raw material, the backlog costs for products and the stock value at the end of the planning horizon are considered.

4 - Improving the Efficiency of Internal Logistics in a Softwood Sawmill using Discrete Event Simulation

Martin Pernkopf, University of Natural Resources and Life Sciences, Vienna, Feistmantelstrafle 4, Vienna, Austria, martin.pernkopf@gmail.com, Manfred Gronalt

The goal of this simulation study was to find the optimal configuration of production shifts and the optimal usage of the transportation vehicles in a softwood sawmill. Therefore scenarios with varied forklift shifts and operational ranges, altered raw material inputs and production outputs and changed production shifts were investigated. The evaluation of these scenarios led to the definition of an optimal configuration of forklift and production shifts and the reduction of transport distances.

■ WA05

05-Level 2, Salon 1

Rail Transportation

Cluster: Contributed Sessions

Invited Session

Chair: Nitish Umang, CIRRELT, Université de Montréal Pavillon André-Ai, Montreal, Canada, nitish.umang@cirrelt.ca

1 - Scheduling Preventive Maintenance and Renewal Projects of Multi-Unit Systems

Farzad Pargar, PhD Student, University of Twente, Getfertplein 145, Enschede, 7512HK, Netherlands, f.pargar@utwente.nl

We introduce the preventive maintenance and renewal scheduling problem for a multi-unit system over a finite and discretized time horizon. The introduced integer linear programming model tries to minimize the cost of projects by grouping them and simultaneously finding the optimal balance between doing maintenance and renewal. We consider railway track as a case for our study and test the performance of the proposed model on a set of test problems.

2 - The Load Planning Problem for Outbound Double Stacked Railcars at Port Terminals

Nitish Umang, CIRRELT, Université de Montréal Pavillon André-Ai, Montréal, Canada, nitish.umang@cirrelt.ca, Emma Frejinger

In this research, we study the load planning problem at port terminals considering several new constraints including dimensional restrictions, technical constraints, weight capacities and center of gravity restrictions for double stacked platforms. We propose an IP formulation with the objective to minimize the number of cars required to load a given set of containers. The results based on real data suggest that the proposed methodology can lead to significant savings in the operating cost.

■ WA06

06-Level 2, Salon 2

Lot Sizing Problems

Cluster: Contributed Sessions

Invited Session

Chair: Raf Jans, Professor, HEC Montreal, 3000 Chemin de la Cote-St-Catherine, Montreal, Canada, raf.jans@hec.ca

1 - Integrated Capacitated Lot Sizing and Cutting Stock Problem

Gislaine Melega, UNESP - IBILCE, R. Cristovao Colombo, 2265 - Jd Nazareth, São José do Rio Preto, Brazil, gislainemelega@gmail.com, Silvio de Araujo, Raf Jans

The capacitated lot sizing and the one-dimensional cutting-stock problems have an important role in different production sectors, and Generally, they are dealt independently. In this work, we approach both problems in an integrated way. We study two different models for capacitated lot sizing problem and three different models for cutting stock problem. The integrated models are solved by exact methods and by heuristic approaches based on column generation. Computational results are presented.

2 - Solving Lot-Sizing Problems with Genetic Algorithm and Variable Neighbourhood Search

Tiffany Bayley ,University of Waterloo, 200 University Avenue West, Waterloo ON N2L3G1, Canada, tiffany.bayley@uwaterloo.ca, Jim Bookbinder, Haldun Sural

We explore the capacitated joint replenishment problem with multiple product families, in which each item consumes capacity of a shared resource, such as machine time. Lagrangian relaxation is employed, with multipliers being updated through a genetic algorithm enhanced with variable neighbourhood search. The application of metaheuristics in this problem setting allows us to explore the solution space more quickly while maintaining solution quality.

3 - Two-Level Lot-Sizing with Raw Material Perishability and Deterioration: An Extended MIP Formulation

Andres Acevedo, Concordia University and CIRRELT, 1455 De Maisonneuve Blvd. W., Montreal QC H3G 1M8, Canada, acevedo83@gmail.com,, Mingyuan Chen, Ivan Contreras

In many industries, it is common to face significant rates of product deterioration, referring not only to physical exhaustion or loss of functionality, but also obsolescence. We study how raw-material perishability enforces specific constraints on a set of production planning decisions, especially for multi-level product structures. We study a two-level lot-sizing problem with fixed raw-material shelf-life and functionality deterioration. An extended MIP formulation is proposed and evaluated.

4 - An Analysis of Formulations for the Capacitated Lot Sizing Problem with Setup Crossover

Raf Jans, Professor, HEC Montreal, 3000 Chemin de la Cote-St-Catherine, Montreal, Canada, raf.jans@hec.ca, Silvio de Araujo, Diego Fiorotto

The lot sizing problem with setup crossover is an extension of the big bucket capacitated lot sizing problem. The first setup operation of each planning period can already start in the previous period, if there is idle capacity. This provides more flexibility and increases the possibility of finding feasible and better solutions. We provide an extensive computational comparison of existing and new formulations for this problem. Finally, we also quantify the value of this type of flexibility.

■ WA07

07-Level 2, Salon 3

Supply Chain Optimization

Cluster: Contributed Sessions

Invited Session

Chair: Saba Salimi, Concordia University, 1455 De Maisonneuve Blvd. W, Montreal, QC, H3G 1M8, Canada, sab_sali@encs.concordia.ca

1 - Advertising and Pricing Decisions in a Manufacturer-Retailer Channel with Demand and Cost Disruption

Lingxiao Yuan, Miss, Huazhong University of Science & Technology, School of Management , HUST, Wuhan,China, Wuhan, 430074, China, lx_yuan@hust.edu.cn, Chao Yang

We study advertising level, pricing and production decision problems in a supply chain when demand and cost disruptions occur simultaneously. The channel consists of one manufacturer and one retailer where demand depends on retail price and advertising .We examine the case in both cooperative and non-cooperative game. We find the original production plan has some robustness in face of disruptions of demand and cost, while an overall adjustment will be taken when disruptions exceed thresholds.

2 - Confirming Warehouse Financing for Supply Chain Coordination

Xuemei Su, Associate Professor, California State University Long Beach, 1250 Bellflower Blvd, Long Beach, CA, 90840, United States of America, xuemei.su@csulb.edu, Qiang Lin

Confirming Warehouse Financing (CWF) has shown great benefit in overcoming financial constrains in Supply Chain. However, when demand is uncertain and affected by the retailer's sales effort, traditional CWF fails to coordinate the supply chain. This research examines three modified modes of CWF (cash-advance-discount compensation CWF, deposit withholding CWF and two-way compensation CWF), and find only two-way compensation CWF can achieve supply chain coordination.

3 - Integrating Supply Chain Resilience and Flexibility for Risk Mitigation

Sonia Kushwaha, Doctoral Student, IIM Lucknow, IIM Lucknow Prabandh Nagar, Lucknow, UP, 226013, India, fpm12008@iiml.ac.in, Kashi Naresh Singh

In order to maintain the supply chain operations under disruptions, supply chain network needs to be resilient and there is an implicit notion of flexibility in the definition of resilience. In our paper we are modeling supply chain flexibility along with the objective to minimize cost and maximize resilience for a 3-tier supply chain network.

4 - Cooperation between Two Suppliers and a Retailer

Saba Salimi, Concordia University, 1455 De Maisonneuve Blvd. W, Montréal, QC, H3G 1M8, Canada, sab_sali@encs.concordia.ca Satyaveer S. Chauhan, Masoumeh Kazemi Zanjani

In this paper we present a cooperation and collaboration model in a supply chain consisting of two suppliers with a common retailer. We establish the conditions for cooperation in such scenario with popular supply chain contracts.

■ WA08

08-Level A, Hémon

Applications and Robust Optimization in DFO

Cluster: Derivative-Free Optimization

Invited Session

Chair: Bastien Talgorn, GERAD, 3000, CÙte-Sainte-Catherine, Office 5471, Montréal, QC, H3T 1J4, Canada, Bastien.Talgorn@gerad.ca

1 - Robust Optimization of Noisy Blackbox Problems using the MADS Algorithm

Amina Ihaddadene, École Polytechnique de Montréal, C.P. 6079, succ. Centre-ville, Montréal, Qc, H3C3A7, Canada, Amina.Ihaddadene@gerad.ca, Charles Audet, Sébastien Le Digabel

The Mesh Adaptive Direct Search (MADS) algorithm is designed to solve blackbox optimization problems. In this talk, we are interested in problems contaminated with stochastic noise, as often observed in practice. We propose a smoothing technique to eliminate the noise, directly incorporated within the MADS framework. Our results show that this new method gives solutions that are stable under small perturbations in the solution space.

2 - Alloy and Process Design using the Mesh Adaptive Direct Search Algorithm

Aömen Gheribi, Researcher, École Polytechnique de Montréal, C.P. 6079, succ. Centre-ville, Montréal, Qc, H3C 3A7, Canada, aimen.gheribi@polymtl.ca

During alloy and process design, one wishes to identify regions of variables where certain functions have optimal values under various constraints. We report here on the development of a black-box, linked to thermodynamic and properties database system, to perform such calculations. The black-box is optimized by the Mesh Adaptive Direct Search algorithm designed for this type of problems. Numerical results will be presented.

3 - A Decomposition-Based Heuristic for Post-Disaster Relief Distribution

Christophe Duhamel, Associate Professor, LIMOS, CNRS, Université Blaise Pascal, Clermont-Ferrand, France, christophe.duhamel@isima.fr, AndrÈa Cynthia Santos, Daniel Brasil

We consider the problem of setting a supplies distribution system in a post-disaster context. A decomposition approach is used to solve the non-linear model: the master handles the site opening schedule and it is addressed by a non-linear solver (NOMAD). The slave subproblem handles the supplies distribution. It is treated as a black-box embedding a Variable Neighborhood Descent local search. Numerical results are provided on both random instances and on one realistic instance, using scenarios.

■ WA09

09-Level A, Jarry

Military Application 1

Sponsor: Military, Defense, and Security Applications

Sponsored Session

Chair: Amnon Gonen, Holon Institute of Technology - HIT, 52 Golomb St., Holon, Israel, agonen@hit.ac.il

1 - Civilian Personnel - Inventory Projection

Mira Halbrohr, General Military Personnel Research and Analysis (DGMPRA), Defence Research Development Canada (DRD, Ottawa ON, Canada, Mira.Halbrohr@forces.gc.ca,

The Occupational Flow Simulation (OFS) is used to inform civilian Human Resources strategic planning, policy development and career management. It is a stochastic ARENA-based simulation that models individual career progression as employees are hired, promoted to a higher occupational level and leave the Department of National Defence through retirement or resignation. The OFS algorithms and sample OFS analyses are presented.

2 - Forecasting Total Annual Severance Pay for Canadian Armed Forces Personnel

Lynne Serré, General Military Personnel Research and Analysis (DGMPRA), Defence Research Development Canada (DRD, Ottawa ON, Canada, lynne.serre@forces.gc.ca

To assist the Department of National Defence with its budgetary planning processes, a discrete-event simulation model was developed to forecast future annual severance pay costs resulting from a recent policy change. An overview of the modelling approach and forecasting methodology will be presented, as well as the challenges encountered in modelling the career progression and release of all Canadian Armed Forces members in the Regular Force – a population of approximately 68,000 people.

3 - Airborne Search and Rescue Posture Alignment

Etienne Vincent, Defence Research and Development Canada Centre for Operational Research and Analysis (DRDC CORA), Ottawa ON, Canada, etienne.vincent@forces.gc.ca, Bohdan Kaluzny

The Royal Canadian Air Force maintains aircraft and crews ready to respond to Search and Rescue incidents. Certain assets are postured at a state of higher readiness for 40 hours each week. Since 2013, summer season trials have been held to evaluate the impact of shifting the periods of higher readiness from Monday to Friday, 08:00 to 16:00 to better align with the preponderance of Search and Rescue incidents. This presentation discusses the alignment, and the trials held to date.

■ WA10

10-Level A, Joyce

Forecasting and Stochastic Optimization

Cluster: Contributed Sessions

Invited Session

Chair: Majid Taghavi, PhD Student, McMaster University, 100 Bay st. South, 609, Hamilton, ON, L8P3H3, Canada, taghavm@mcmaster.ca

1 - Probabilistic Forecasting of Wind Availability using a Neural Network for Wind Farms

Kostas Hatalis, Research Assistant, Lehigh University, 27 Memorial Dr. W., Bethlehem, PA, 18015, United States of America, kmh511@lehigh.edu, Alberto Lamadrid

We present a novel artificial neural network using particle swarm optimization for calibration and parameter selection for multi-step probabilistic quantile forecasting of power availability in wind farms. We integrate this model into a stochastic program of the decision making by an electricity independent system operator.

2 - Determining the Size, Strategic Mix and Optimal Usage of Military and Civilian Employees

Leo MacDonald, Associate Professor, Coles College of Business, KSU, 560 Parliament Garden Way, Kennesaw, GA, 30144, United States of America, lmacdon4@kennesaw.edu, Jomon Paul

Workforce planning can be challenging in military organizations given the role played by civilian personnel. We develop generic models to estimate demand requirements, and then use it to determine the optimal workforce size and skill-mix, accounting for constraints such as attrition, budget, mentor ratios, experience levels and bounds on workforce levels.

3 - Multi-Stage Stochastic Capacity Expansion of Logistics Networks

Majid Taghavi, PhD Student, McMaster University, 100 Bay st. South, 609, Hamilton, ON, L8P3H3, Canada, taghavm@mcmaster.ca, Kai Huang

We consider capacity expansion of logistics networks under uncertainty via a multi-stage stochastic programming approach. Specifically, we define spot market capacity and contract capacity as different sources of capacity. Then, we introduce a stochastic capacity expansion model defined for a general logistics network. We consider both node and arc capacity expansion in the context of a min-cost flow problem. We propose a Benders decomposition algorithm to solve the model.

■ WA11

11-Level A, Kafka

Enterprise Risk Management

Cluster: Contributed Sessions

Invited Session

Chair: So Young Sohn, Yonsei University, Dept of IIE, Seoul, Korea, Republic of, sohns@yonsei.ac.kr

1 - An Exploratory Study of Enterprise Risk Management: Modeling and Measuring of ERM

Juthamon Sithipolvanichgul, University of Edinburgh, 41 holyrood, Edinbrugh, Eh88FF, United Kingdom, juthamon@hotmail.com, Jake Ansell

Enterprise Risk Management (ERM) implementation lie upon the lack of one universally accepted conceptual framework, which resulted in limitation on how firm can measure the level ERM implementation. This paper is to propose ERM measuring method from integrating well-implemented ERM components where contribution measuring can be standardized by comparing with three different approaches regarding cluster analysis approach, principal components analysis approach and partial least square analysis.

2 - Portfolio Optimization over a Stratified State Space

David Rogers, University of Cincinnati, Operations, Business Analytics, & IS, Carl H. Lindner College of Business, Cincinnati, OH, 45221-0130, United States of America, rogersdf@ucmail.uc.edu, George Polak, Chaojiang Wu

We develop a decision model for risk-return trade-off by considering state stratifications resulting in an efficient frontier over a new risk coefficient corresponding to a measure of entropy. Risk measure extremes result in the optimistic expected value and pessimistic maximin criteria. Intermediate values for the risk coefficient indicate trade-offs between the two criteria. We apply the model to the portfolio optimization area and find that it competes well with Mean-Variance and CVaR models.

■ WA12

12-Level A, Lamartine

Scheduling

Cluster: Contributed Sessions

Invited Session

Chair: Sana Dahmen, Ph.D. Student, CIRRELT/Université Laval, 2325, rue de la Terrasse, PAP-2674, Québec, G1V0A6, Canada, sana.dahmen@cirrelt.ca

1 - ATM Replenishment Scheduling

Yu Zhang, UNC Chapel Hill, 101 Misty Woods Circle Apt R, Chapel Hill, NC, 27514, United States of America, yuzhang@email.unc.edu

We consider an ATM replenishment problem where the bank operates multiple ATMs in the same area. If a customer finds an ATM without any cash available, certain cost will be incurred. The replenishment cost is non-linear in the sense that the bank will pay more money for replenishing multiple ATMs by sending out one truck for each ATM than filling them up altogether. We present structures of the optimal strategy and study a heuristic policy which is easy to implement.

2 - A Solution Approach for Multi-Day Shift Scheduling Problems Allowing Transfers Between Departments

Sana Dahmen, PhD Student, CIRRELT/Université Laval, 2325, rue de la Terrasse, PAP-2674, Québec, G1V0A6, Canada, sana.dahmen@cirrelt.ca, Guy Desaulniers, Monia Rekik, François Soumis

We propose a two-level approach to solve the multi-department shift scheduling problem. In the aggregated level, we solve an approximation of the problem to identify a good transfer scheme between departments. In the disaggregation level, we use this scheme to construct schedules based on some transfer priorities. We identify specific transfer graphs to decompose the problem into a set of tractable sub-problems. These sub-problems are solved sequentially within a rolling horizon procedure.

3 - Proving The Coffman- Sethi Conjecture

Peruvemba S. Ravi, Associate Professor, Operations And Decision Sciences, School of Business & Economics, Wilfrid Laurier University, 75 University Avenue West, Waterloo, ON, N2L3C5, Canada, pravi@wlu.ca, Levent Tuncel

For a set of n independent jobs processed on a set of m identical machines, the problem of minimizing the makespan over the class of all flowtime-optimal schedules is NP-hard. Coffman and Sethi conjectured that a natural extension of LPT list scheduling to this problem, termed the LD algorithm, has a simple worst-case performance bound of (5m-2)/(4m-1). This conjecture has remained unproven for nearly four decades. We achieve significant progress in an attempt to prove this conjecture.

■ WA13

13-Level A, Musset

Reverse Supply Chains

Cluster: Contributed Sessions

Invited Session

Chair: Dua Weraikat, PhD candidate, Concordia University, 1420 Rue Towers Apt 317, Montreal, Canada, d_wer@encs.concordia.ca

1 - A Mathematical Model for Global Closed-Loop Supply Chain Network

Saman Hassanzadeh Amin, Ryerson University, 350 Victoria Street, Toronto, ON, Canada, saman.amin@ryerson.ca, Fazle Baki

In this talk, a mathematical model is introduced for a closed-loop supply chain network by considering global factors. The model is a multi-objective mixed-integer linear programming one under uncertain demand. A solution approach is proposed. Then, the model is applied in a network which is located in Southwestern Ontario.

2 - Modeling an Aerospace Manufacturing/Remanufacturing System

Vesra Hashemi, Sears, 411-485 Rosewell Ave, Toronto, ON, M4R 2J2, Canada, vehash@yahoo.com, Mingyuan Chen, Liping Fang

A mathematical programming model is proposed to formulate a closed-loop network where remanufacturing of customer owned components and transforming of defective components are allowed. A scenario-based analysis is conducted considering demand uncertainty, varying remanufacturing lead-time as well as various defect rates of disassembled components. Further analysis is conducted to reveal insight on effect of input variations on profit and amount of scraps.

3 - Coordinating a Two-Echelon Pharmaceutical Reverse Supply Chain by Offering Incentives to Customers

Dua Weraikat, PhD candidate, Concordia University, 1420 Rue Towers Apt 317, Montréal, Canada, d_wer@encs.concordia.ca Masoumeh Kazemi Zanjani, Nadia Lehoux

In this research, we model and explore the role of providing incentives to customers to return medication leftovers in a pharmaceutical reverse supply chain (RSC). Based on expiry-dates, medications can be sold or donated. The results indicate that introducing incentives increases the RSC's profit. A proper technique is also proposed to share the RSC's savings.

■ WA14

14-Level B, Salon A

Energy Policy and Planning

Cluster: Contributed Sessions

Invited Session

Chair: Olivier Bahn, Professor, HEC Montreal, 3000 chemin de la Cote-Sainte-Catherine, Montreal, QC, H3T2A7, Canada, olivier.bahn@hec.ca

1 - Environmental Agreements and Approaching Catastrophes

Samar Garrab, PhD Student, HEC Montréal, 4948 rue cherrier, laval, QC, H7T 0E8, Canada, samar.garrab@hec.ca Michèle Breton

We consider an N-players dynamic game to solve International Environmental Agreement (IEA) in the presence of a certain threshold. All countries suffer from a common environmental damage that is a result of pollution accumulation. We assume that there exists a threshold for pollution stock, once crossed the nature's absorption rate (natural decay) will decrease.We compare the obtained results to check whether the existence of this threshold enhances the stability of IEAs.

2 - Energy Subsidies Reform under Direct Deposit to Consumers

Hossein Mirzapour, HEC Montréal, 3000, chemin de la Cote-Sainte-Catherine, Dept. of Decision Sciences, Montréal, QC, H3T 2A7, Canada, hossein.mirzapour@hec.ca, Michèle Breton

Reforming energy consumption subsidies have been frequently addressed as a quick-win policy to enhance environmental mitigation. However, one of the most recognized challenges is selling the new energy prices to consumers. Several researches have prescribed any reform supported by a direct compensation mechanism to be feasible enough to raise the necessary public support. By introducing a quantitative model we investigate the feasibility range of a reform policy under such a mechanism.

3 - New Developments and Pilot Runs of Short-Lived Climate Forcers

Marshal Wang, Environtment Canada, 10 Wellington St., Gatineau, Cambodia, cheng-marshal.wang@ec.gc.ca Nick Macaluso

Our Integrated Assessment Model is a hybrid intertemporal model includes domestic and international economy, energy and non-energy related GHG emission, and the global climate module. It can study RCP scenarios combined with other policies like carbon tax, mitigation targets or policies on specific sectors or technologies. In the new developments, the aerosol species, the Bio-energy and Bio with CCS are modeled in order to study Short-Lived Climate Forcers and regional air quality regulations.

4 - Impacts of Adaptation on the Transition towards Clean Energy Systems: Insights from AD-MERGE

Olivier Bahn, Professor, HEC Montréal, 3000 Chemin de la Cote-Sainte-Catherine, Montréal, QC, H3T2A7, Canada, olivier.bahn@hec.ca, Kelly de Bruin, Camille Fertel

Adaptation measures are becoming an important component of climate policies. The aim of this presentation is two-fold. First, we introduce in the MERGE (integrated assessment) model two strategies to adapt to climate changes: reactive (or ëflow') adaptation and proactive (or estock') adaptation. Second, we use the resulting model (AD-MERGE) to study detailed impacts of adaptation strategies on the implementation of mitigation measures (clean energy technologies) in world energy sectors.

■ WA15

15-Level B, Salon B

Airline Operations, Value of Integrated Solutions

Cluster: Practice

Invited Session

Chair: Goran Stojkovic, Jeppesen, 55 Inverness Dr E, Centennial, CO, United States of America, Goran.Stojkovic@jeppesen.com

1 - Fleet Operations - Combining Fleet Recovery and Tail Assignment

Mattias Gronkvist, Jeppesen, a Boeing Company, mattias.gronkvist@jeppesen.com

Fleet recovery is the process of deciding how to operate the aircraft at an airline when operational disruptions happen. Tail assignment is the process of planning the assignment of aircraft to flights from the day of operations and a few days, or weeks, into the future. We will discuss how a combined fleet recovery and tail assignment system gives benefits compared to using separate systems. We will also show how integration with crew tracking and flight planning can give additional benefits.

2 - Airline Fuel Optimization Analytics
Jre de Klerk, Boeing Canada, 200-13575 Commerce Parkway, Richmond, BC, V6V 2L1, jre.deklerk@aeroinfo.com
Elham Boozarjomehri

According to IATA (2014),a 1% reduction in fuel burn across the industry would result in $700 million in savings each year. To address the growing fuel efficiency market, we have produced several proprietary algorithms that leverage advanced analytics and an airline's historical data to reduce total fuel costs by identifying root causes of inefficiencies, providing empirically-driven guidance on optimal flight planning and operations, and tracking progress in achieving fuel saving opportunities.

3 - Airline Inventory Planning - The Right Parts, Right Place, Right Risk, Right Cost
Dawen Peng, Boeing Canada, Canada, dawen.peng@aeroinfo.com
Candice Chan

Boeing Professional Services and the Analytics team worked with an airline to centralize its maintenance operations inventory. We will focus on the inventory spare part allocation work which is projected to save tens of $M. Some key questions answered were: – Where and when to do maintenance – visual & descriptive analysis – How much line maintenance inventory and where to allocate them in the network – Poisson and Monte Carlo Modelling to predict consumption, validation by Discrete Event Simulation

4 - A Matheuristic Optimization Approach to the Airline Manpower Planning Problem
Björn Thalén, Optimization Expert, Jeppesen, Bangardsgatan 17, Göteborg, Sweden, bjorn.thalen@jeppesen.com
Per Sjögren

Manpower planning is the problem of planning promotions, including strict seniority rules, and necessary trainings for the promotions. Other considerations such as vacation distribution, average working hours per pilot/fleet/month and recurrent training distribution also need to be handled. We model the problem as a Mixed Integer Program and will present the multi-step solution process as well as successful applications.

■ WA16

16-Level B, Salon C

Mixed Integer Conic Optimization

Cluster: Mixed-Integer Nonlinear Optimization

Invited Session

Chair: Julio C. Góez, GERAD, Montreal, Canada, jgoez1@gmail.com

1 - Using Disjunctive Conic and Cylindrical Cuts in Solving Quantitative Asset Allocation Problems
Sertalp Cay, PhD Candidate, Lehigh University, 200 W Packer Ave, Bethlehem, PA, 18015, United States of America, sertalp@lehigh.edu, Tamás Terlaky, Julio C. Góez

The novel methodology of disjunctive conic and cylindrical cuts (DCC) was developed recently to solve mixed integer second order cone optimization (MISOCO) problems. First steps are made in implementing this powerful methodology in a Branch-and-Conic-Cut software package. In this study, we explore the use of this novel methodology in solving asset allocation problems. Preliminary numerical results show that DCC have significant positive impact when solving a set of realistic problem instances.

2 - Linear Solution Schemes for Mean-Semivariance Project Portfolio Selection Problems
Luis Zuluaga, Assistant Professor, Lehigh University, 200 West Packer Avenue, Bethlehem, PA, 18015, United States of America, luis.zuluaga@lehigh.edu, Andres Medaglia, Jorge Sefair, Carlos Mendez, Onur Babat

In the mean-semivariance project portfolio selection (MSVP) problem, the objective is to obtain the optimal risk-reward portfolio of non-divisible projects when the risk is measured by the portfolio's NPV semivariance and the reward by the portfolio's expected NPV. The MSVP problem can be solved using MIQP techniques. However, MIQP solvers may be unable to quickly solve large-scale MSVP problems. Here, we propose two quick linear solution schemes to solve the MSVP problem.

3 - Tightening SDP Relaxations for Some Classes of Binary Quadratic Optimization Problems
Elspeth Adams, Mathematics & Industrial Engineering, École Polytechnique de Montréal, Montréal, Canada, elspeth.adams@polymtl.ca, Miguel F. Anjos

k-projection polytope constraints (kPPCs) are a family of constraints that tighten SDP relaxations using the inner description of small polytopes, as opposed to the typical facet description. Within the framework of a cutting plane algorithm we examine how to find violated kPPCs and their impact on the bounds, especially for large instances. Problems satisfying the required projection property, such as the max-cut and stable set problems, will be considered.

4 - Second Order Cone Relaxation for Binary Quadratic Polynomial Problems
Julio C. Güez, GERAD, Montréal, Canada, jgoez1@gmail.com

This work builds on the second order cone relaxation for binary quadratic problems proposed by Ghaddar, Vera and Anjos (2011) who used a polynomial optimization approach. We explore how this relaxation can be strengthened using additional constraints. Also, we explore the relation of disjunctive conic cuts with this relaxation. We present computational results on a test set containing various types of binary quadratic polynomial problems.

■ WA17

17-Level 7, Room 701

Developing Analytics Talent I

Sponsor: Analytics

Sponsored Session

Chair: Richard Self, Senior Lecturer in Analytics and Governance, University of Derby, Kedleston Road, Derby, United Kingdom, r.j.self@derby.ac.uk

1 - Analytics In-Service Training – Vision 2020 Workshop
Richard Self, Senior Lecturer in Analytics and Governance, University of Derby, Kedleston Road, Derby, United Kingdom, r.j.self@derby.ac.uk

Many organisations already have a wide range of highly technical courses for the practitioners who actively use the technologies that support Data Science and Analytics. However, there are very few courses of a non-technical nature that are needed for the effective use and interpretation of the outputs for decision making. Participants of this workshop session will develop curricula for a range of types of in-serviced training courses.

2 - How to Manage Data as an Asset
Jerry Luftman, Managing Director, Global IIM, jluftman@globaliim.com

Annual IT management trends research over the last 15 years has placed big data/business analytics as the number one emerging technology investment around the globe. Recognizing the importance of IT and non-IT organizations working collaboratively is fundamental to the success of these initiatives. While providing education that prepares data scientists is indispensible, providing education for IT and non-IT executives that covers the management/business/leadership considerations is essential.

3 - Big Data Talent Gap Analysis in Canada
Amy Casey, Executive Director, Ryerson University, 350 Victoria, Toronto, Canada, acasey@ryerson.ca, Peggy Steele

Ryerson University has led Canada's first national, multi-sector, and multi-industry project to study the Big Data and Data Analytics Talent Gap in Canada. The primary objective was to determine whether a talent gap exists and, if so, to better understand the breadth and depth of the gap, as well as develop strategies to help close the gap, thereby facilitating continued innovation and economic development in Canada.

4 - Making Talented Analytics Professionals
Alexander Ferworn, Professor, Ryerson Uiversity, Ryerson University, 350 Victoria St., Toronto, On, M5B2K3, Canada, aferworn@scs.ryerson.ca

Data scientists extract, manipulate, and analyze data to create knowledge. This idyllic statement is definitive and ultimately impractical if we can't nurture and employ new talent to seize the opportunity to move us forward. Gaining skills, understanding concepts and developing and embracing ways of thinking are the hallmarks of talented people. Learn how to identify talented people, educate them and create competent data scientists ready to address needs we didn't know we had.

■ WA18

18-Level 7, Room 722

Healthcare Systems

Cluster: Contributed Sessions

Invited Session

Chair: Biao Wang, University of Waterloo, 200 University Avenue West, Waterloo, On, N2L 3G1, Canada, b67wang@uwaterloo.ca

1 - Managing Overcrowding and Hospital Resources: A DES Study in an Emergency Department

Thiago Amaral, Doctor, Federal University of San Francisco Valley, Avenida Antonio Carlos Magalhaes, nſ. 51, Juazeiro, Brazil, prof.thiago.magalhaes@gmail.com

This paper puts forward a method based on Operations Research to identify and correct hospital bottlenecks, as well as to improve patient throughput in Emergency Departments (EDs). The simulation results indentified that the bottleneck in the ED was due to the incorrect levels of emergency physicians. The LOS and the Number of Patients Waiting were both reduced by 43.07% and 89.57% respectively. The model is applicable to other hospital departments to improve their quality of services.

2 - Dynamic Network Analysis of Hospital Acquired Clostridium Difficile Infection Transmission

Biao Wang, University of Waterloo, 200 University Avenue West, Waterloo, On, N2L 3G1, Canada, b67wang@uwaterloo.ca
Kenneth McKay, Josh Morel, William Ciccotelli

We explored the potential of using network statistics for the prediction of the transmission of hospital acquired Clostridium Difficile infections (HA CDIs). An innovative method that combines time series data mining and predictive classification models was introduced for the analysis of these dynamic networks and for the prediction of HA CDI transmission. The results suggest that the network statistics extracted from the dynamic networks might be good predictors for the transmission of HA CDIs.

■ WA19

19-Grand Ballroom West

Tutorial: Value Chain Planning for Natural Resources

Cluster: Tutorials

Invited Session

Chair: Mikael Rönnqvist, Universite Laval, 1065, avenue de la Médecine, Quebec, QC, G1V 0A6, Canada, mikael.ronnqvist@gmc.ulaval.ca

1 - Value Chain Planning for Natural Resources

Mikael Rönnqvist, Universite Laval, 1065, avenue de la Médecine, Quebec, QC, G1V 0A6, Canada, mikael.ronnqvist@gmc.ulaval.ca

There are several industries within natural resources, such as forests, minerals and energy. The underlying value chain for each area is decoupled and divergent. These areas are also important for their social impact, energy production/consumption and the environment. We address a number of applications and discuss their properties, interactions and challenges. We also describe how OR models and methods have been crucial to develop practical decision support tools for the sector.

Wednesday, 11:00am - 12:30pm

■ WB01

01-Level 4, Salon 8

Commerce

Cluster: Contributed Sessions

Invited Session

Chair: ShiKui Wu, Assistant Professor, University of Windsor, 401 Sunset Ave., OB-413, Windsor, ON, N9B 3P4, Canada, skwu@uwindsor.ca

1 - Incorporating Weather Information into Retail Operations Planning

Kai Hoberg, Kühne Logistics University, Grofler Grasbrook 17, Hamburg, HH, 20457, Germany, kai.hoberg@the-klu.org
Sebastian Steinker, Florian Badorf

We analyze the impact of the weather on retail sales and find that weather significantly affects sales, both in an online and offline setting. We develop a methodology that incorporates weather information into sales forecasting and find that the forecasting accuracy can improve by an incremental 62.4% on summer weekends. Our findings have significant implications for operations planning, in particular in warehousing and in retail stores.

2 - Does Communication between Retailers and Customers Turn Showrooming Effect into Profit?

Weiquan Cheng, Illinois Institute of Technology, 3116 S Canal St, Apt 3, Chicago, Il, 60616, United States of America, wcheng15@hawk.iit.edu

This paper exams the competition between online and offline stores while showrooming effect exists. We propose that showrooming effect can be beneficial to both channels, because it reduces competition level. After showrooming, consumers of different valuations of products will self-select into channels. We also demonstrate that through communication, both online and offline retailers can help consumers to better understand their preferences, and benefit from demand and profit increase.

■ WB02

02-Level 3, Drummond West

Simulation Modelling in Healthcare

Cluster: Healthcare

Invited Session

Chair: Michael Carter, Professor, University of Toronto, Mechanical & Industrial Engineering, 5 King's College Rd., Toronto, ON, M5S 3G8, Canada, mike.carter@utoronto.ca

1 - Improving Porter Performance by Developing and Implementing a Generic Simulation Model

Carly Henshaw, University of Toronto, 5 King's College Road, Toronto, ON, M5S3G8, Canada, carly.henshaw@mail.utoronto.ca
Michael Carter

Hospital porters are responsible for transporting patients or items between hospital departments. It has been identified at two Toronto area hospitals that the current porter performance does not meet defined targets which impacts patient flow and hospital functions. This research involves developing a simulation model of the current portering process, followed by a generic simulation model. Improvement scenarios will be tested using these models while evaluating performance metrics.

2 - Redesigning an Outpatient Pharmacy Workflow: An Application of Generic Simulation Model to Maximize a Renovation Opportunity

Janet Izumi, University of Toronto, Canada, janet.izumi@mail.utoronto.ca, Michael Carter

The renovation plans at Princess Margaret Cancer Center (PM) presented an opportunity to redesign the outpatient pharmacy workflow. The goal of this study was to develop a generic simulation model that could be not only used to redesign PM, but also used to improve the efficiency of a pharmacy at a second hospital. The model was used to explore different workflow configurations and assess the impact of introducing automation and upgrading to barcode technology. Recommendations were provided to each hospital on the number of workstations and space required to achieve their goals.

3 - Simulating Hospital Surge Protocols

Carolyn Busby, University of Toronto, 5 Kings College Rd., Toronto, ON, Canada, carolyn.busby@mail.utoronto.ca
Michael Carter

Hospitals respond to demand surges by altering normal procedures, thereby decreasing bed occupancy and ED wait times. These "surge protocols" include ambulance diversion, reduced admissions, reverse triage, expedited discharges, altered nurse to bed ratios, use of unfunded beds, surgery cancelations and altered standards of care. Preliminary work is presented on the creation of a generalized, whole hospital DES model that will examine the effectiveness and influence of this adaptive response.

■ WB03

03-Level 3, Drummond Centre

Forest Fire Management

Cluster: Applications of OR in Forestry

Invited Session

Chair: David Martell, Professor, University of Toronto, 33 Willcocks Street, Toronto, ON, M5S 3B3, Canada, david.martell@utoronto.ca

1 - Protecting Assets from Wildfires: An Integer Programming Approach

James Minas, Wilfrid Laurier University, School of Business and Economics, Waterloo, ON, N2L 3C5, Canada, drjpminas@gmail.com, Martijn van der Merwe, Melih Ozlen, John Hearne

Incident Management Teams (IMTs) are responsible for managing the response to wildfires, with one of their objectives being the protection of assets and infrastructure. Here we present a mixed integer programming model for allocating resources to asset protection activities. Our model extends classic variants of the team orienteering problem with time windows to account for the requirement that resources must on occasion "co-operate" to protect an asset.

2 - Designing Fire Initial Attack Resource Deployment Plan using a Two-Stage Stochastic Program

Yu Wei, Associate Professor, Colorado State University, Department of FRS, Campus delivery 1472, Fort Collins, Co, 80526, United States of America, yu.wei@colostate.edu Michael Bevers, Erin Belval

Wildland fire initial attack (IA) dispatch rules can help shorten IA response times by providing easy to follow recommendations. A stochastic programming model is developed to design dispatch rules and corresponding resource deployment plan to support IA. Historical fire days are used to capture the stochastic nature of this problem. Test results indicate that not accounting for the use of dispatch rules could lead planners to substantially underestimate IA resource requirements.

3 - Decision Support Systems for Daily Aerial Detection of and Response To Wildland Fires in Ontario

Den Boychuk, Aviation, Forest Fire, & Emergency Services, Ministry of Natural Resources, Sault Ste. Marie, Canada, den.boychuk@ontario.ca, Douglas Woolford, David Martell, Colin McFayden, Aaron Stacey

We describe ongoing R&D of a DSS for aerial detection planning. Its submodels include person-caused fire occurrence, lightning fire ignition, public detection probability, aerial detection probability, and values-at-risk. The value of seeing a cell increases with its probability of undetected fire, forecast fire behaviour, values-at-risk, aerial detection probability, and decreasing public detection probability. We then outline an extension of the approach to an interim daily response DSS.

■ WB04

04-Level 3, Drummond East

Educational Tools in OR/MS Applied to the Forest Sector

Cluster: Applications of OR in Forestry

Invited Session

Chair: Jean-Francois Audy, Professor of Operations Management, Université du Quebec a Trois-Rivières, 3351 des Forges Blvd., P.O. Box. 500, Trois-Rivières, QC, QC G9A5H7, Canada, jean-francois.audy@uqtr.ca

1 - Developing Training for Industrial Wood Supply Management

Dag Fjeld, skog + landskap, Norway, dfj@skogoglandskap.no Mikael Rönnqvist

An understanding of supply chain management is a prerequisite for efficient supply operations. This paper presents the structure of training currently used in Sweden to prepare master's-level foresters for managing wood supply operations. Based on a basic framework of professional tasks, eight key learning outcomes are targeted; one focuses on raw material requirements, three on securing supply, three on enabling delivery, and one on control and coordination. Sixteen exercises are used to meet the eight learning outcomes. An overview of the exercises is presented as well as the pedagogical approach used. Current training is focused on developing student understanding of the industrial context as well as competences and skills required to solve typical professional tasks. The paper concludes with a discussion of further development opportunities including a coupling of tasks and learning outcomes with applicable operations research methodology.

2 - Tools for Logistic Teaching

Mikael Rönnqvist, Université Laval, 1065, avenue de la Médecine, Quebec, QC, G1V 0A6, Canada, mikael.ronnqvist@gmc.ulaval.ca

There are several educational tools developed for forest logistics. These includes value chain coordination, collaboration and hierarchical planning. The case studies are based on real industrial cases as well as more simplified instances. We describe a number of these tools and discuss experiences from running them in courses.

3 - An Educational Tool in Value Chain Management – A Case Study Competition in the Forest Sector

Jean-Francois Audy, Professor of Operations Management, Universite du Quebec a Trois-Rivieres, 3351 des Forges Blvd., P.O. Box. 500, Trois-Rivieres, QC, QC G9A5H7, Canada, jean-francois.audy@uqtr.ca, Yan Feng, Sophie D'Amours, Mikael Rönnqvist

We describe an educational tool where interdisciplinary teams must develop, present and defend a regional value chain transformation proposal to its stakeholders played by public/private decision makers together with academics. Based on the television show Dragons' Den (Shark Thank in the US), the winning team is the one most of the stakeholders invest in. We also report outcomes of two runs held during graduated students' summer schools and tool adaptation for use in (un)graduated class.

4 - Integrating Woody Biomass use for Sustaining a Forest Value Chain

Tasseda Boukherroub, Université Laval, 1065, Rue de la Médecine, Pavillon Adrien Pouliot, Québec, QC, G1V 0A6, Canada, Tasseda.Boukherroub@cirrelt.ca Sébastien Lemieux, Luc LeBel

We explore the possibility of implementing a pellet mill within an existing supply chain in northeastern Quebec. Logging wastes, insect-killed trees, and sawmill residues are potential raw materials. Different supply strategies and market scenarios are tested to derive the optimal operational conditions under which the value chain is profitable. The planning model is solved through a spatially explicit optimization platform called LogiLab on the basis of a regional case study.

■ WB05

05-Level 2, Salon 1

Transportation - Operations

Cluster: Contributed Sessions

Invited Session

Chair: Deniz Ozdemir, Yasar University, Universite Caddesi, No:35-37,, Agacli Yol, Bornova, Izmir, IZMIR, 35100, Turkey, deniz.ozdemir@yasar.edu.tr

1 - Identification of Similar Days for Air Traffic Flow Management Initiative Planning

Kenneth Kuhn, Operations Researcher, RAND Corporation, 1776 Main Street, Santa Monica, CA, 90407, United States of America, kenneth.kuhn@gmail.com, Akhil Shah, Chris Skeels

We describe ideal and available data on observed and forecast aviation weather and airline schedules to describe conditions leading to air traffic flow management (ATFM) initiatives. We apply hierarchical clustering techniques to useful data to yield sets of days that are similar when it comes to ATFM planning in the New York area. The result allows comparisons across days. We develop a web-based application; users compare conditions across clusters as well as across days in the same cluster.

2 - Evaluation of Coupling Coordinated Development Degree of Multiple Airport System

Xin Chen, Nanjing University of Finance and Economics, No.3 Wenyuan Road, Xianlin College City, School of Management Science& Engineerin, Nanjing, China, njuechx@163.com

A composite system coupling coordinated development degree evaluation model is investigated with the Yangtze River Delta multi-airport and economic system as a case study. The results show there is a strong correlation between coordinated development degree and airport scale. The airport with higher size has better coordination with economic development. The level of economic development is an important factor affecting the degree of coupling coordinated development.

3 - Comparison between Centralized and Independent Markets of Auction-Based Transportation Procurement

Intissar Ben Othmane, Université Laval, 2204 rue Mackay App 2, Québec, QC, G1V2X1, Canada, intissar.ben-othmane.1@ulaval.ca
Monia Rekik, Sehl Mellouli

The focus is on auction-based transportation procurement services markets. Generally, carriers participate in independent markets through sequential or parallel auctions. We propose a centralized transportation market in which several shippers collaborate and run together a unique auction. Comparison between independent and centralized transportation markets show that centralized markets can provide better results to carriers.

4 - Berth Allocation and Crane Assignment Planning under Multiple Objectives

Deniz Ozdemir, Yasar University, Universite Caddesi, No:35-37, Agacli Yol, Bornova, Izmir,, IZMIR, 35100, Turkey, deniz.ozdemir@yasar.edu.tr, Huseyin Gencer

We present different formulations and solution methods for the integrated berth allocation and crane assignment problem under possible conflicting objectives. We formulate the problem as multi-objective integer programming model embedding realistic issues raised by port authorities and shipping agencies. We provide the non-dominated berth-crane assignment plans as Pareto optimal front that can be used as a decision support tool. We conclude with preliminary results using the case of Izmir Port.

■ WB06

06-Level 2, Salon 2

Project Management

Cluster: Contributed Sessions

Invited Session

Chair: Amir Azaron, Associate Professor, Istanbul Sehir University, Altunizade Mh., Kusbakisi Cd No:27, Istanbul, Turkey, amirazaron@sehir.edu.tr

1 - Integration System for R&D Knowledge Management for Project Management and Tech-Transfer

Deok-Hwan Kim, Senior Researcher, Korea Institute of Energy Research, 152, Gajeong-ro, Yuseong-gu, Daejeon, 305-343, Korea, Republic of, thekan0723@gmail.com

A R&D project creates various forms of R&D knowledge, e.g., documents, records, research note and so on. Conventionally, the knowledge has been saved and managed by the structure forms according to the tastes of each researcher in his personal computer. In this case, inefficiency of knowledge accumulation and reuse and ineffectiveness of technology transfer may be inevitable. This study introduces an integration system for R&D knowledge management, which has been developed in KIER.

2 - A Simulation Solution for the Multi-Mode Double Resource-Constrained Project Scheduling Problem

LATE CANCELLATION

Afar Mohammadchi Shiri, Student, University of Pittsburgh, 3700 Centre Ave., Apt 317, Pittsburgh, PA, 15206, United States of America, ERM83@pitt.edu

In this paper, we have added constraints such as resource vacations in which we face scheduled changes in resource capacity and one double constraint for project budget to the Multi-mode Resource-Constraint Project Scheduling Problem. This problem is more complex than studied MRCPSPs. As a result, we have proposed a novel method using simulation technique that helps us to tackle it while the mode and start time of activities are determined simultaneously.

3 - Resource Allocation in Markovian Multi-Project Networks

Amir Azaron, Associate Professor, Istanbul Sehir University, Altunizade Mh., Kusbakisi Cd No:27, Istanbul, Turkey, amirazaron@sehir.edu.tr, Saeed Yaghoubi

This study develops a multi-objective model for resource allocation problem in dynamic PERT networks with a finite capacity of concurrent projects. It is assumed that new projects are generated according to a Poisson process and activity durations are exponentially distributed. The problem is formulated as a multi-objective model using continuous-time Markov processes with three conflicting objectives to optimally control the resources allocated to service stations.

■ WB07

07-Level 2, Salon 3

Stochastic Operations Management

Cluster: Contributed Sessions

Invited Session

Chair: George Mytalas, Senior Lecturer, NJIT, 257 86Str, New York, 11209, United States of America, mytalas@njit.edu

1 - A Simulation-Based Optimization Approach for a Two-Stage Flow Time Oriented Lot Sizing Model

Simon Jutz, University of Innsbruck, Universitaetsstrasse 15, Innsbruck, 6020, Austria, simon.jutz@uibk.ac.at, Hubert Missbauer

Lot sizes for multi-stage production traditionally are determined based on the trade-off between setup and inventory holding costs. Incorporating the impact of lot sizing on manufacturing flow times has been performed for single-stage production. The resulting decision rules for standard lot sizes are difficult to integrate into a multi-stage environment. By means of simulation based optimization we investigate the interrelation between different lot sizes in a two-stage production system.

2 - An M/G/1 System with Delayed Bernoulli Feedback and Server Vacations

George Mytalas, Senior Lecturer, NJIT, 257 86Str, New York, 11209, United States of America, mytalas@njit.edu

We consider an M/G/1 queueing system with individual arrivals subject to server vacations. Also after completion of the service, customer can join the tail of the queue as a feedback customer after a random time for receiving another service with probability r. Otherwise the customer may depart forever from the system with probability 1 - r. By applying the supplementary variables method, we obtain the steady-state solutions for queuing measures.

3 - Proper Efficiency and Trade-offs In Multiple Criteria and Stochastic Expected-value Optimization

Alexander Engau, Assistant Professor, University of Colorado Denver, CO, 1201 Larimer Street, Denver, CO, 80204, United States of America, aengau@alumni.clemson.edu

This talk exploits the notion of proper efficiency to provide a comprehensive analysis of solution and scenario tradeoffs in stochastic and robust optimization. In particular, our findings demonstrate that stochastic solutions do not always prevent the existence of arbitrarily large tradeoffs or unbounded marginal rates of substitution, and that robust solutions are not always efficient. Practical consequences and implications of these results for decision-making under uncertainty are discussed.

■ WB08

08-Level A, Hémon

Recent Developments in and New Uses of DFO

Cluster: Derivative-Free Optimization

Invited Session

Chair: Genetha Gray, Intel, 1900 Prairie City Rd, Folsom, CA United States of America, genetha.gray@intel.com

1 - Calibration of Driving Behavior Models using the MADS Algorithm and Video Data for Montreal Highways

Laurent Gauthier, École Polytechnique de Montréal, C.P. 6079, succ. Centre-ville, Montréal, Qc, H3C 3A7, Canada, laurent-2.gauthier@polymtl.ca

We propose a calibration of the parameters for the two most important microscopic driver behaviour models in the VISSIM traffic micro-simulation software. The procedure accounts for different traffic conditions and should be generic for the region's highways regardless of specific site geometry. To achieve this calibration, we use the Mesh Adaptive Direct Search (MADS) algorithm to compare simulations and real world data acquired via automated video analysis at three major Montreal highways.

2 - DFO as a Tool for Environmental Modeling

Genetha Gray, Intel, 1900 Prairie City Rd, Folsom, CA United States of America, genetha.gray@intel.com

Environmental modeling is not an exercise that can be accomplished by a cookbook approach. Instead, it requires making reasonable approximations that lead to an approximate, but useful, description of an environmental process for answering a question of interest. In this talk, we will describe how DFO can be used as a tool to help accomplish this process.

3 - Optimization of an Aircraft Anti-Icing System using Statistical Surrogates and Direct Search

Bastien Talgorn, GERAD, 3000, Cote-Sainte-Catherine, Office 5471, Montréal, QC, H3T 1J4, Canada, Bastien.Talgorn@gerad.ca
Sébastien Le Digabel, Michael Kokkolaras, Mahdi Pourbagian, Wagdi Habashi

This talk discusses the use of statistical surrogates in direct search algorithms for blackbox derivative-free optimization. Specifically, we present different formulations for the surrogate problem considered at each search step of the Mesh Adaptive Direct Search (MADS) algorithm using a surrogate management framework. These formulations are based on statistical metrics that enhance global exploration, and they are applied to the optimal design of aircraft electro-thermal anti-icing systems.

■ WB09

09-Level A, Jarry

Military Applications II

Sponsor: Military, Defense, and Security Applications

Sponsored Session

Chair: Amnon Gonen, Holon Institute of Technology - HIT, 52 Golomb St., Holon, Israel, agonen@hit.ac.il

1 - Educating System Thinking through Wargaming

Amnon Gonen, Holon Institute of Technology - HIT, 52 Golomb St., Holon, Israel, agonen@hit.ac.il, Moti Frank

In this study, we describe a concept of wargame that practice students in system thinking. It enables students of system analysis to observe integration of systems into a global war picture. The war game enables students to plan an operational integrated plan and apply it. The war game includes two teams, Red and Blue, that are fighting one against the other. After both teams provide their operational plans, A wargame run is conducted to expose students with possible war picture.

2 - Sensor Deployment Problem for Terrorist, Criminal or Military Threats

Bill Simms, The Royal Military College of Canada, Kingston ON, Canada, simms-b@rmc.ca, Jack Brimberg

The world is increasingly concerned with organizations that are secretive and actively involved in destroying or destabilizing prominent local or global organizational structures. This paper examines the problem of detecting potential threats of a number of perceived or non-perceived 'targets' by agents of such structures. The emphasis will be on examining the nature of the problem in the context of the sensor deployment problem, formulating a general model, and proposing some solution methodologies. Some theoretical and practical results will be presented.

3 - Capturing Value in a Portfolio of Defence Capital Projects

John A. Steele, Defence Research and Development Canada Centre for Operational Research and Analysis (DRDC CORA), Ottawa ON, Canada, John.Steele2@forces.gc.ca

DND has directed that a portfolio be assembled from projects seeking $5M or more in capital funding consisting of critical, viable and affordable projects promising best value for money. A cross-departmental team has developed and populated a value model, annual project cost profiles, and optimisation and visualisation software to do this, allowing interactive portfolio adjustment and re-optimisation. This presentation focusses on future value model innovations and development directions.

■ WB10

10-Level A, Joyce

Metaheuristics for Combinatorial Problems

Cluster: Contributed Sessions

Invited Session

Chair: Akbar Karimi, PhD student, Ecole Polytechnique de Montreal, Université de Montréal Pavillon André-Ai, Montreal, QC, H3T 1K3, Canada, akbar.karimi@polymtl.ca

1 - A New Heuristic for Solving Multiobjective Combinatorial Optimization Problem

Myriam Ait Mehdi, 2900 Edouard-Montpetit, Montréal, H3T 1J7, Canada, myriam_aitmehdi@yahoo.fr, Moncef Abbas

We present a new heuristic method for solving a MOCO problem and its application to the multiobjective knapsack problem. Its basic idea is similar to that of a local search with taking into account the Pareto-dominance's concept. Indeed, at each step, the neighborhood of the current solution is explored to identify, for each objective function, the nearest neighbor that improves it. The obtained solutions are then selected one by one as a new current solution and the procedure starts over.

2 - Model and Algorithm of a Course Timetabling Problem Based on Satisfaction with Course Selection

Yaqing Lu, Huazhong University of Science and Technology, Wuhan, Hubei 430074, PR China., Wuhan, China, yqlu737@126.com, Kunpeng Li

Course selection and timetabling are important parts of educational administration job. This paper concerns on a course timetabling problem for a whole semester based on course selection. A mathematical description of the problem is made and the appropriate model is established, then a three phase approach is described to solve the problem, The objective function is to maximize the students' satisfaction with the result of course selection after timetabling.

3 - Nexus Evolution

Akbar Karimi, PhD Student, Ecole Polytechnique de Montréal, Université de Montréal Pavillon André-Ai, Montréal, QC, H3T 1K3, Canada, akbar.karimi@polymtl.ca, Michel Gendreau, Vedat Verter

A new class of metaheuristic algorithms is introduced for global optimization of continuous functions. Convergence to an "optimal structure" rather than an "optimal point" serves as the central concept in the development. The single and multi-objective versions of the method along with test results and ideas on its extension to other search domains will be presented.

■ WB11

11-Level A, Kafka

Finance - Risk Management

Cluster: Contributed Sessions

Invited Session

Chair: B. Ross Barmish, Professor, University of Wisconsin, ECE Dept, University of Wisconsin, Madison Wi 53706, United States of America, barmish@engr.wisc.edu

1 - On Simultaneous Long-Short Stock Trading

B. Ross Barmish, Professor, University of Wisconsin, ECE Dept, University of Wisconsin, Madison Wi 53706, United States of America, barmish@engr.wisc.edu

This paper will provide an overview of my recent work in collaboration with Primbs involving a new stock trading strategy, called Simultaneous Long-Short (SLS). The SLS scheme is based on feedback control concepts and can be conceptualized by considering two trades on a stock running in parallel: one long and one short. The net position is initially flat. Then, as the stock price evolves, an adaptive mechanism is used to to dynamically adjust each side of the trade based on performance.

2 - How Dynamic Methodologies Compare to Static Ones in Predicting Corporate Failure?

Mohammad Mahdi Mousavi, PhD Candidate, University of Edinburgh, 3.02 Business School, 29 Buccleuch Place, Edinburgh EH89JS, United Kingdom, s1158828@ed.ac.uk, Jamal Ouenniche, Bing Xu

The design of reliable models to predict failure is crucial for many decision making processes. We explore static and dynamic modelling and prediction frameworks and propose new dynamic corporate failure prediction models. Furthermore, a multi-criteria framework is proposed to assess the relative performance of these modelling frameworks in prediction corporate failure for UK firms.

3 - Endogenous Default Model with Firms' Cross-Holdings of Debts and Equities

Kyoko Yagi ,Akita Prefectural University, 84-4 Ebinokuchi, Tsuchiya, Yurihonjo, Akita 015-0055, Japan, yagi@akita-pu.ac.jp, Teruyoshi Suzuki

We study the optimal default boundaries when firms establish cross-holdings of debts and equities and when firms can chooses the time of default so as to maximize their equity values. We show the optimal default boundaries with cross-holdings of debts and equities can be given by the unique solution of a system of equations. We also show that the optimal default boundaries with cross-holdings of debts only, not equities, are given by closed form expressions.

■ WB12

12-Level A, Lamartine

Task Scheduling

Cluster: Contributed Sessions

Invited Session

Chair: Ritu Kapur, Post Graduate Student, NITTTR, Chandigarh, 3266 second floor sector 44-D, Chandigarh, Ch, 160047, India, ritukapur1591@gmail.com

1 - Parts-to-Picker Based Order Processing in a Rack-Moving Mobile Robots Environment

Simon Emde, Friedrich-Schiller-University Jena, Carl-Zeifl-Str. 3, Jena, 07743, Germany, simon.emde@uni-jena.de
Nils Boysen, Dirk Briskorn

We consider a special parts-to-picker based order processing system where mobile robots hoist racks and directly bring them to stationary pickers. This technological innovation is known as the Kiva system, and we tackle the order processing in a picking station, i.e., the batching and sequencing of picking orders and the interdependent sequencing of the racks brought to a station. We formalize the resulting decision problem and provide suitable solution procedures.

2 - Review of Architecture and Optimization Techniques of Task Scheduling in Cloud Computing

Ritu Kapur, Post Graduate Student, NITTTR, Chandigarh, 3266 second floor sector 44-D, Chandigarh, Ch, 160047, India, ritukapur1591@gmail.com

Due to a diverse nature of QoS demanded by various cloud customers and huge workload on cloud, the problem of Optimized resource Allocation and Minimized Response time is becoming center of interest. The purpose of this paper is to review various Optimization Techniques, various Workflow Scheduling Models, Job Scheduling Techniques and Load Balancing Techniques used to further optimize various QoS parameters.

3 - Flow Formulation Based Models for Course Timetabling Problems

Niels-Christian Fink Bagger, Technical University of Denmark, nbag@dtu.dk. Matias Sörensen, Thomas Stidsen, Simon Kristiansen

In this talk the problem of scheduling courses into periods and rooms will be the focus area. The method applied is to use MIP models which are usually formulated by three-indexed binary variables. New formulations will be presented based on network flows which will consist of two-indexed binary variables leading to a significant decrease in the number of binary variables and give better performance for MIP solvers compared to the traditional formulation.

■ WB13

13-Level A, Musset

Operations Management

Cluster: Contributed Sessions

Invited Session

Chair: Mohammad Nikoofal, Assistant Professor, Catolica Lisbon School of Business & Economics, UCP, Palma de Cima, Lisbon, 1649-023, Portugal, mohammad.nikoofal@ucp.pt

1 - Social Media Initiatives and Innovativeness: Do Quality Management Systems Matter?

Hugo Lam, PhD Candidate, Hong Kong Polytechnic University, AG304, Hong Kong Polytechnic University,, Hung Hom, Kowloon, Hong Kong, Hong Kong - PRC, hugo.k.s.lam@connect.polyu.hk, Andy Yeung

Firms' social media initiatives (SMIs) help facilitate information and knowledge exchanges, which may stimulate organizational learning and result in improved innovativeness. But such an informal and unstructured learning environment may also imply the difficulty in leveraging the information and knowledge for innovativeness improvement. We study how firms' quality management systems that represent a more formal and structured learning process can complement SMIs in improving innovativeness.

2 - Analytic Network Process - A Review of Application Areas

Faiz Hamid, Assistant Professor, Indian Institute of Technology, Kanpur, Room No. 310, Department of IME, IIT Kanpur, Kanpur, UP, 208016, India, fhamid@iitk.ac.in, Sonia Kushwaha

An extensive review of the applications of ANP technique (mainly in the areas of Operations Management, Business, Healthcare) published in 255 reputed scholarly journal papers is presented here. The trend of application changed from stand-alone ANP to integrated ANP. This comprehensive survey assures that it can act as a road map and framework for researchers and practitioners in appropriately applying the techniques to extract maximum benefit and also aid in future research work.

3 - Applying Benchmarking and Ishikawa Diagram to Improve Hotel Service Quality

Budi Harsanto, Universitas Padjadjaran, Jl. Dipati Ukur No. 35 Bandung, Bandung, Indonesia, budi.harsanto@feb.unpad.ac.id
Adrian Prayudha

The purpose of this study was to develop quality improvement ideas in Hotel X. As one of the 5 star hotels in Bandung -the third biggest city in Indonesia with culinary and clothing attractiveness- Hotel X needs to improve the quality of service in order to compete in the hospitality industry. The method used were benchmarking and Ishikawa diagram. The study found that there were 11 indicators with negative gap. After analyzed use Ishikawa diagram, retrieved 17 points for improvement.

4 - Supply Diagnostic Incentives in New Product Launch

Mohammad Nikoofal, Assistant Professor, CatÜlica Lisbon School of Business & Economics, UCP, Palma de Cima, Lisbon, 1649-023, Portugal, mohammad.nikoofal@ucp.pt, Mehmet Gumus

We build a dyadic supply chain model with one buyer who contracts the manufacturing of a new product to a supplier. The extent of supply risk is not known to both the buyer and supplier, however, the supplier may invest in a diagnostic test to acquire information about his true reliability, and use this information when deciding on a process improvement effort. Using this setting, we identify benefits and drawbacks of diagnostic test.

■ WB14

14-Level B, Salon A

Environment and Energy

Cluster: Contributed Sessions

Invited Session

Chair: Ming-Che Hu, Associate Professor, National Taiwan University, No. 1, Sec. 4, Roosevelt Rd,, Dept of Bioenvironmental Systems Eng,NTU, Taipei, 10617, Taiwan - ROC, mchu@ntu.edu.tw

1 - Rolling Horizon Planning Methods in Long-Term Energy System Analysis MILP Models

Kai Mainzer, Chair of Energy Economics, Karlsruhe Institute of Technology (KIT), Hertzstr. 16, Karlsruhe, 76187, Germany, kai.mainzer@kit.edu, Russell McKenna, Wolf Fichtner

This work presents a hybrid approach for MILP models in energy system analysis. In each iteration, the complete problem is solved (perfect foresight) while the integer variables for years in the distant future are relaxed and those that have already been solved in previous iterations are fixed. This method should allow for faster calculation times while retaining the perfect foresight assumption and thus prevents rendering the model "blind" for assumed future (e.g. price) developments.

2 - Uncertainty Analysis in Life-Cycle Assessment

Simon Li, Assistant Professor, University of Calgary, 40 Research Place NW, Calgary, AB, T2L 1Y6, Canada, simoli@ucalgary.ca
Xin Cheng

As Monte Carlo simulation is mostly used to analyze data uncertainties in life-cycle assessment (LCA), it is observed that design uncertainties can also be present in the context of eco-design. This research investigates the application of fuzzy numbers for LCA and compares the methodical features between the Monte Carlo and fuzzy approaches.

3 - Parallel Optimisation of Decentralised Energy Systems Modeled as Large-Scale, 2-Stage Stochastic MIP

Hannes Schwarz, Karlsruhe Institute of Technology (KIT), Hertzstrasse 16, Karlsruhe, 76187, Germany, hannes.schwarz@kit.edu

Stochastic modelling techniques enable an adequate consideration of manifold uncertainties of decentralised energy systems. In order to keep MIP problems still feasible, we present a module-based, parallel computing approach using scenario reduction techniques and an approximate gradient-based optimisation for the master problem. It is demonstrated for residential quarters having PV systems in combination with heat pumps and storages. The required input data are simulated by a Markov process.

4 - Kriging-Based Optimization Algorithm for Environmental Models
Ming-Che Hu, Associate Professor, National Taiwan University, No. 1, Sec. 4, Roosevelt Rd,, Dept of Bioenvironmental Systems Eng,NTU, Taipei, 10617, Taiwan - ROC, mchu@ntu.edu.tw

Optimization algorithms are often applied to search best parameters for complex environmental models. Running the complex models to evaluate objective function might be time-consuming. This research proposes a Kriging-based optimization algorithm. Kriging is a method used to interpolate unknown variables based on given data. In the algorithm, Kriging is used to avoid complicate objective function evaluation and then increase searching efficiency.

■ WB15

15-Level B, Salon B

Operations Research in the Natural Resource Industry

Cluster: Practice

Invited Session

Chair: Pascal Coté, Operations Research Engineer, Rio Tinto Alcan, 1954 Davis, Jonquiere, QC, G7S 4R5, Canada, pascal.cote@riotinto.com

1 - Improving Wood Value Along Canadian Supply Chain: A Team Approach by Universities and FPInnovations
Jean Favreau, Research Manager, FP Innovations, Canada, jean.favreau@fpinnovations.ca, Catalin Ristea

The industrial uptake of Value Chain Optimization tools in the Canadian forest sector is more challenging than in other countries. This presentation will focus on the significant opportunities to improve the wood net value along Canadian supply chains through novel collaborative efforts between academia and FPInnovations: a concerted approach to close the gap between fundamental science and practically applicable solutions, which enables better supply, better fibre flow, and agile manufacturing

2 - Analyzing the Costs and Benefits of Power Infrastructure Investments
Guillaume Tarel, Artelys Canada Inc., 2001 Bd. Robert Bourassa, Suite 1700, H3A 2A6 - Montréal QC, Canada, guillaume.tarel@artelys.com

Power transmission projects are of particular importance for countries in the European Union, in an energy context including more and more renewable energies and extending the coupling of its power markets. In particular, interconnections allow for ensuring better security of supply between countries and between geographical areas and a more efficient integration of intermittent renewable energy. In this presentation, we focus on showing practical examples of the use of numerical optimization for assessing the value of power interconnections between countries.

3 - Assessing Stochastic Optimization for Rio Tinto Alcan's Hydropower Systems
Pascal Coté, Operations Research Engineer, Rio Tinto Alcan, 1954 Davis, Jonquiere, Qc, G7S 4R5, Canada, pascal.cote@riotinto.com
Bruno Larouche

Rio Tinto Alcan (RTA) is an aluminium producer that operates powerhouses in Canada. This presentation describes a project that aims to assess the value of using a stochastic optimization solver. The optimization methods were implemented in RTA's system and the results compared with the previous deterministic decision procedure. Methods were compared using a test bench into which were incorporated the characteristics of the facilities and which forecast are updated each time a decision is taken.

■ WB16

16-Level B, Salon C

Optimization Methods and Applications in Control

Cluster: Mixed-Integer Nonlinear Optimization

Invited Session

Chair: Julio C. Góez, GERAD, Montreal, Canada, jgoez1@gmail.com

1 - The Theorems of Alternatives and Invariance Conditions for Dynamical Systems
Tamás Terlaky, Lehigh University, 200 W Packer Ave, Bethlehem, PA, 18015, United States of America, terlaky@lehigh.edu
Zoltán Horváth, Yunfei Song

The Farkas Lemma and the S-Lemma are commonly refereed to as The Theorems of Alternatives. They are fundamental theorems in the theory of optimization. In this talk we demonstrate that they are also fundamental and unifying tools to derive sufficient and necessary conditions for polyhedral and ellipsoidal sets to be invariant for linear discrete dynamical systems. This unified approach allows to derive analogous conditions for continuous dynamical systems.

2 - A Polynomial-Time Rescaled Von Neumann Algorithm for Linear Feasibility Problems
Dan Li, Lehigh University, 200 West Packer Ave, Bethlehem, PA, 18015, United States of America, dal207@Lehigh.edu
Kees Roos, Tam·s Terlaky

We propose a rescaled von Neumann algorithm with complexity O(n^5size(A)). This is the first polynomial-time variant of the von Neumann algorithm. It is based on Chubanov's so called Basic Procedure, whose outcome is an evidence that the solution has at least one small coordinate so that we are able to rescale the linear system without changing the problem. Some numerical experiments are presented as well.

3 - Steplength Thresholds for Invariance Preserving of Discretization Methods of Dynamical Systems
Yunfei Song, Lehigh University, 200 W. Packer Ave., Bethlehem, PA, 18015, United States of America, yus210@lehigh.edu
Zoltan Horvath, Tamas Terlaky

Steplength thresholds for invariance preserving of two discretization methods on a polyhedron are considered. For Taylor approximation type methods, we prove that a valid threshold can be obtained by finding the first positive zeros of a finite number of polynomial functions. Furthermore, an efficient algorithm is proposed to compute the threshold. For rational function type methods, we derive a valid threshold, which can be computed by using the analogous algorithm, for invariance preserving.

■ WB17

17-Level 7, Room 701

Developing Analytics Talent II

Sponsor: Analytics

Sponsored Session

Chair: Michele Fisher, Northwestern University, Masters in Predictive Analytics, Chicago, United States of America, michelejfisher@me.com

1 - Establishing an Operational Analysis Team at the NATO Communications and Information Agency
Sylvie Martel, Chief Operational Analysis, NATO Communications and Information Agency, Oude Waalsdorperweg 61, The Hague, 2597 AK, Netherlands, Sylvie.Martel@ncia.nato.int

NATO reforms have led to the establishment of the NATO Communications and Information (NCI) Agency in 2012, with the creation of a new Operational Analysis (OA) Service Line for which the mandate is to deliver OA analytic support to planners and decision makers within NATO and its member nations. This presentation will highlight the challenges and opportunities from establishing the OA SL in a dynamic multinational environment, operating under a customer funding regime.

2 - INFORMS Analytics Maturity Model: An International Standard for Analytics
Aaron Burciaga, INFORMS Analytics Maturity Model Committee, 4305 Majestic Ln, Fairfax, VA, 22033, United States of America, adburciaga@gmail.com

INFORMS' members and cadre of credentialed analytics professions from across academia, business, and government now update, govern, and operate the new standard for assessing and benchmarking the application of analytics in organizations and across industries – the INFORMS Analytics Maturity Model (IAMM). Come to hear more and contribute toward the approach, features, value case, and future plans.

3 - Building Analytics Teams: From Back of the Envelope to Big Data and Beyond
Michele Fisher, Northwestern University, Masters in Predictive Analytics, Chicago, United States of America, michelejfisher@me.com

Multi-discliplinary teams were important for success in the "back of the envelope" days of early Operations Research. Today we are focussed on a critical shortage of analysts. It seems a luxury to build mutually-supportive and well-rounded teams of analysts and experts. But is it? The structure, composition and position of a team needs to attract and sustain analytics professionals. A holistic approach will enable decision-making to be supported today, tomorrow and beyond.

■ WB18

18-Level 7, Room 722

Capacity Allocation in Healthcare

Cluster: Contributed Sessions

Invited Session

Chair: Michael Zhang, Saint Mary's University, 903 Robie Street, Halifax, NS, B3H 3C3, Canada, michael.zhang@smu.ca

1 - MRI Capacity Assessment in Ontario: A Demand Forecast and Wait Times Estimation Model

LATE CANCELLATION

Saba Vahid, Methodology & Strategic Analytics, Cancer Care Ontario, 505 University Avenue, Toronto, Canada, saba.vahid@cancercare.on.ca, Ali Vahit Esensoy

Reducing wait times (WT) for MRI is part of the Ontario government's strategy to transform healthcare in the province. In this project, a capacity (funded hours) assessment tool at the regional level is delivered to the Ministry of Health and Long term Care. The tool provides regional demand forecasts and a WT estimation model to assess incoming funding requests based on their estimated impact on regional WT. Optimal funding levels are also recommended to reach provincial WT targets.

2 - The Chemotherapy Patient's Bed Allocating Problem in Hospital's Oncology Department

Ming Lv, Xian JiaoTong University, No28,West Xianning Road, Xi'an, China, sharplvming@qq.com, Zhili Zhou

This paper addresses the problem of allocating beds for chemotherapy patients at hospital's oncology department. A mixed integer programming (MIP) model is proposed for this problem in order to maximizing bed occupancy under capacity constraints. The most salient feature of the MIP model is the explicit modeling of specific features of chemotherapy such as treatment protocols. The chemotherapy patient's bed allocate problem is proved to be NP-complete.

3 - Patient's Wait Times Estimation in Walk-In Clinics using Virtual Queuing

Julio Montecinos, Postdoctoral Researcher, École de Technologie Supérieure (ÉTS) - Numérix Lab., 1100, rue Notre-Dame Ouest, Montréal, QC, H3C 1K3, Canada, julio.montecinos@etsmtl.ca St-Amand Liliane, Mustapha Ouhimmou, Marc Paquet

Several walk-in clinics offer a paid service for patients to follow their turn in line and be notified when their consultation approaches. We developed a model based on Particle Filters joint with simulation to estimate the waiting time for a consultation. The model uses historical and new incoming data and considers two types of patients namely regular and private. Our method gives a more accurate estimate of the waiting time for service.

4 - Optimal Resource Allocation Strategy for Public Health Systems without Idle Time

Michael Zhang, Saint Mary's University, 903 Robie Street, Halifax, NS, B3H 3C3, Canada, michael.zhang@smu.ca

In this study we model the public health care service system as a queuing system without any idle time, and the expected waiting time is the performance measurement of the system. We consider two approaches to shorten the expected waiting time in a public health care service system. The two approaches are compared for the expected waiting time in real life situations.

■ WB19

19-Grand Ballroom West

Tutorial: Vector Space Decomposition for Linear Programming

Cluster: Tutorials

Invited Session

Chair: Jacques Desrosiers, Professor, HEC Montréal & GERAD, 3000, Ch Cote-Sainte-Catherine, Montréal, QC, H3T 2A7, Canada, jacques.desrosiers@gerad.ca

1 - Vector Space Decomposition for Linear Programming

Jacques Desrosiers, Professor, HEC Montréal & GERAD, 3000, Ch Cote-Sainte-Catherine, Montréal, Qc, H3T 2A7, Canada, jacques.desrosiers@gerad.ca, Jean Bertrand Gauthier, Marco L¸bbecke

VSD is a generic primal algorithm. It moves from a solution to the next according to a direction and a step size. The core component is obtained via the smallest reduced cost upon dividing the set of dual variables: one is fixed whiles the other is optimized. Special cases are the Primal Simplex, the Minimum Mean Cycle-Canceling algorithm for networks, and the Improved Primal Simplex. Properties of VSD allow identifying cases that avoid degenerate pivots and find interior directions.

Wednesday, 1:30pm - 3:00pm

■ WC01

01-Level 4, Salon 8

Marketing

Cluster: Contributed Sessions

Invited Session

Chair: Fouad El Ouardighi, ESSEC Business School, 30 Rue des Fauvettes, Fontenay Aux Roses, 92260, France, elouardighi@essec.fr

1 - Supervised Clustering Based Under Sampling Technique to Deal with Balanced and Unbalanced Datasets

Sankara Prasad Kondareddy, Senior Analyst, Fidelity Investments India, Fidelity, Embassy Golf Links, Business Park,Off Intermediate Ring Road, Bangalore, 560 071, India, sankaraprasad.kondareddy@fmr.com

Logistic regression is usually used in financial industry for customer scoring. Learning from completely balanced or completely unbalanced data sets using logistic regression is difficult. We propose a supervised clustering-based under sampling technique to select data which is more adept to train logistic regression. Our experiments based on real time data sets showed that our algorithm produce better results and is highly recommended as an alternative to random under sampling approach.

2 - An Empirical Study of Customers' Responses to the Volkswagen Recall Crisis in China

Ming Zhao, University of Science and Technology of China, Jinzhai Road, Hefei, China, zhao816@mail.ustc.edu.cn

Product-harm crises usually cause product recalls but it is not yet clear how product recalls influence customers' risk perceptions and behavior responses. We investigated the Volkswagen recall in China in 2013 and systematically examine customers' immediate responses to the Volkswagen product recall crisis, with focus on the difference between those customers whose cars were recalled and customers whose cars were not recalled.

3 - Spatial Modeling of Consumer Perceptions Based on Proximity Among Brands

Ajay Manrai, University of Delaware, 217 Alfred Lerner Hall, Department of Business Administration, Newark, De, 19716, United States of America, manraia@gmail.com, Lalita Manrai

Marketing researchers often focus on the concept of "proximity" (that is, similarity or dissimilarity) among brands to understand processes involved in brand switching, competition, brand loyalty, product design and positioning, and market structure analysis. This paper presents a new quantitative model of proximity, which serves as the basis for developing a novel algorithm that employs "proximity" type of marketing data to construct perceptual maps.

4 - Autonomous and Advertising-Dependent Word of Mouth under Costly Dynamic Pricing

Fouad El Ouardighi, ESSEC Business School, 30 Rue Des Fauvettes, Fontenay Aux Roses, 92260, France, elouardighi@essec.fr, Peter Kort, Gustav Feichtinger, Dieter Grass, Richard Hartl

This paper considers dynamic pricing and advertising in a sales model where word of mouth (WOM) both depends on a firm's advertising effort (advertising-dependent WOM) and develops beyond the firm's control (autonomous WOM). Both forms of WOM affect the sales proportionally to the price advantage, defined as the difference between the sales price and a reservation price based on the current customers' willingness to pay to repurchase the product.

■ WC02

02-Level 3, Drummond West

Staffing and Scheduling Models in a Dynamic Environment

Cluster: Healthcare

Invited Session

Chair: Jonathan Patrick, Telfer School of Management, University of Ottawa, 55 Laurier Avenue East, Ottawa, ON, K1N 6N5, Canada, patrick@telfer.uottawa.ca

1 - Supporting Staffing Decisions in a Department of Pathology: A Case Study of The Ottawa Hospital

Amine Montazeri, University of Ottawa, 324 Cambridge st north, ottawa, On, K1R7B5, Canada, montazeri.amine@gmail.com

In the Pathology Department, each month clinical managers must assign expected daily demand to available pathologists. Since the size of the pathologists' assignment problem is large, finding a feasible assignment policy manually is time-consuming. The manager must take into account availability, expertise and consistency within t the schedule. In this research we develop an optimization model embedded in a decision support tool that helps determine the optimal monthly staffing decisions.

2 - Combined Advanced and Appointment Scheduling

Mehmet Begen, Ivey Business School - Western University, 1255 Western Road, London, ON, N6G 0N1, Canada, mbegen@ivey.uwo.ca, Antoine Sauré, Jonathan Patrick

Appointment scheduling and advanced scheduling have generally been addressed as two separate problems despite being highly dependent on each other. We attempt to develop a framework that combines the two problems and present our findings.

3 - Dynamic New Patient Consult Scheduling for Medical Oncology

Antoine Sauré, Sauder School of Business, University of British Columbia, 2053 Main Mall, Vancouver, BC, V6T 1Z2, Canada, antoine.saure@sauder.ubc.ca, Claire Ma, Jonathan Patrick, Martin Puterman

Motivated by an increasing demand for cancer care and long waits for new patient consults, we undertook a study of medical oncology scheduling practices at a regional cancer center. As a result, we formulated and approximately solved a discounted infinite-horizon MDP model that seeks to identify policies for allocating oncologist consultation time to incoming new patients, while reducing waits in a cost-effective manner. The benefits from the proposed method are evaluated using simulation.

■ WC03

03-Level 3, Drummond Centre

Strategic Planning in the Forest Sector

Cluster: Applications of OR in Forestry

Invited Session

Chair: David Martell, Professor, University of Toronto, 33 Willcocks Street, Toronto, ON, M5S 3B3, Canada, david.martell@utoronto.ca

1 - Approaches to Strategic Planning in the Forest Sector

Eldon Gunn, Professor Emeritus in Industrial Engineering, Dalhousie University, Industrial Engineering, P.O. Box 15000, Halifax, NS, B3H 4R2, Canada, Eldon.Gunn@dal.ca

The forest sector includes the forests and the communities that depend on them, the industry that uses the forest to create traditional and novel products, and the logistics system that enables the value creation. This talk discusses how realistic strategy needs these to be accounted for in a consistent manner over a consistent time frame. The key requirement is engaging the sector in meaningful conversation as to what is possible and what is practical. Decision support tools can be helpful.

■ WC04

04-Level 3, Drummond East

Decision Analysis in Healthcare

Cluster: Contributed Sessions

Invited Session

Chair: Avenida Antonio Carlos Magalhães, nº. 51, Juazeiro, Brazil, thiago2magalhaes@hotmail.com

1 - A Hierarchical Decision Making Approach for the Operating Room Scheduling Problem

Fazle Baki, University of Windsor, 401 Sunset Avenue, Windsor, Canada, fbaki@uwindsor.ca, Ben Chaouch, Xiangyong Li

We discuss a hierarchical decision making approach for a multi-objective operating room scheduling problem. We decompose the problem into several levels. The problem at each level is solved using an integer program or, in some cases integer goal program. We discuss some preliminary results.

2 - Cost-Effectiveness of Genetic Diagnostic and Treatment Co-Dependent Technologies Under Uncertainty

Reza Mahjoub, University of Alberta, 790 University Terrace Building, 8303 - 112 Street, Edmonton AB T6G 2T4, Canada, reza.mahjoub@ualberta.ca, Philip Akude, Paul Baxter, Peter Hall, Roberta Longo, Christopher McCabe, Mike Paulden

We propose a framework for optimizing test and treatment decisions; characterizing uncertainty under a scenario consisting of two tests, genetic mutation and clinical expression, and a treatment. The first test identifies existence of health condition, the second the scope for benefit from treatment given clinical expression. Treatment effectiveness is a function of the ability to benefit. By an example we show relationship between test and treatment decisions and cost-effectiveness of therapy.

3 - Robust Medication Inventory Management under Demand Uncertainty and Drug Perishability

Sung Hoon Chung, Binghamton University, PO Box 6000, Binghamton NY 13850, United State of America, schung@binghamton.edu, Yinglei Li

LATE CANCELLATION

We examine the capacity of robust optimization applied to medication inventory management to effectively reduce the impact of drug perishability and uncertainty in operations, thereby providing a means to resolve critical issues pertaining to human health. For successful implementation of the proposed robust model, we apply machine learning, heuristics, and statistical methods to identify uncertain parameter ranges, which will be the key component for robust optimization.

4 - ELECTRE II and PROMETHEE II Methods as a Support to Decision Making in Hospital Administration

Thiago Amaral, Doctor, Federal University of San Francisco Valley, Avenida Antonio Carlos Magalhães, nº. 51, Juazeiro, Brazil, prof.thiago.magalhaes@gmail.com

This article aims to compare two outranking methods: the Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE II) and the Elimination Et Choix Traduisant de la Realité (ELECTRE II) applied in an Emergency Hospital in order to show the advantages and disadvantages of each method. The results showed that PROMETHEE II algorithm avoided the tie among alternatives. Future work can compare other methods of MCDA, such as AHP and MAUT to those described in this work.

■ WC05

05-Level 2, Salon 1

Transportation - Planning

Cluster: Contributed Sessions

Invited Session

Chair: Haihong Xiao, Ph.D Student, HEC, Paris, 1, Rue de la Libération, Jouy-en-Josas, France, xiaohh77@hotmail.com

1 - Truckload Dispatching Flexibility in Presence of Advance Load Information

Hossein Zolfagharinia, PhD candidate, Wilfrid Laurier University, 75 University Avenue West, Waterloo, ON, N2L 3C5, Canada, hzolfagharinia@wlu.ca, Michael Haughton

In this work, we statistically examined the benefit of operational flexibility in local truckload operations. The main approach is to design a mixed integer programming model and implement it in the dynamic context using a rolling horizon approach. The obtained results show that diversion capability does not significantly impact a carrier's profit. Moreover, we found that the re-optimization frequency is beneficial, but its benefit is moderated by the level of advance load information.

2 - Primal Box-Step Algorithm for Solving the Shortest Path Problem with Resource Constraints

Ilyas Himmich, PhD Student, École Polytechnique de Montréal & GERAD, Rue Querbes, Montréal, H3N2B6, Canada, ilyashimmich@gmail.com, Hatem Ben Amor, Issmail El Hallaoui

We propose a primal box-step algorithm for the constrained shortest path problem. This problem is used as a column generation subproblem when solving vehicle and crew scheduling problems. At each iteration, we perform a re-optimization in a current solution neighbourhood. Numerical results on real-life airline applications will be presented.

3 - Synchronized Worker and Vehicle Routing for Ground Handling at Airports

Martin Fink, Technical University of Munich, Boschetsrieder Strafle 61, Munich, 81379, Germany, martin.fink@wi.tum.de
Markus Frey, Ferdinand Kiermaier, Rainer Kolisch

Ground handling planning deals with routing workers to jobs while meeting each job's timeliness, qualification requirement and workforce demand. Workers with hierarchical skills use vehicles to travel to another job, which calls for movement synchronization. We introduce a new problem, the vehicle routing problem with worker and vehicle synchronization (VRPWVS), propose a mathematical model and a hybrid metaheuristic with tabu search, guided local search and large neighborhood search.

4 - Track Fleet Routing Problem in Fuel Distribution

Haihong Xiao, Ph.D Student, HEC, Paris, 1, Rue de la Libération, Jouy-en-Josas, France, xiaohh77@hotmail.com
Michel Minoux, Laoucine Kerbache

This presentation considers long-term vehicle purchase decisions, medium-term vehicle assignment decision and short term vehicle routing problem, A mixed-integer programming model is developed to minimize total distribution and fleet composition costs over multi-periods.

■ WC06

06-Level 2, Salon 2

Sustainable Operations Planning

Cluster: Contributed Sessions

Invited Session

Chair: Suresh Jakhar, Dr., Indian Institute of Management Rohtak, 105, Assistant Professor, Rohtak, 124001, India, suresh.jakhar@iimrohtak.ac.in

1 - Toward a Stochastic Model for End of Life Aircraft Recovery Network Design

Samira Keivanpour, PhD Student, Laval University, Laval University, Quebec, Canada, samira.keivanpour.1@ulaval.ca
Daoud Ait Kadi

This study aims to analyze the value recovery of aircraft at the end of life and examine its impacts on logistics network decisions. The Potential markets for retransformed products and materials are identified. Uncertainties related to these markets are considered and addressed. A framework for stochastic model is proposed in order to design a sustainable value chain.

2 - The Effect of Inventory Control on the Design of a Sustainable Supply Chain

Marthy Garcia-Alvarado, École de technologie supérieure, 1100, rue Notre-Dame Ouest, Montréal, QC, H3C 1K3, Canada, marthy-stivaliz.garcia-alvarado.1@ens.etsmtl.ca, Marc Paquet, Amin Chaabane

We explore the effect of a cap-and-trade scheme in strategic and tactical decisions. We consider a supply chain system with random demand and returns. Demand may be met by two production processes: green and conventional. The former uses returns and is considered greener but expensive. Formulating the problem as a MILP, we derive the optimal production, carbon management and investment strategies. Through numerical examples, we characterize the effect of underlying parameters on decision-making.

3 - Performance Evaluation and a Flow Allocation Decision Model for a Sustainable Supply Chain

Suresh Jakhar, Dr., Indian Institute of Management Rohtak, 105, Assistant Professor, Rohtak, 124001, India, suresh.jakhar@iimrohtak.ac.in

This paper aims to help decision makers by developing sustainable supply chain performance measures and proposes a partner selection and flow allocation decision-making model. Survey data from the Indian apparel industry supply chain network were used, and an integrated method of structural equation modeling, fuzzy analytical hierarchy process, and fuzzy multi-objective linear programming was applied to the proposed model.

■ WC07

07-Level 2, Salon 3

Strategic Planning and Management

Cluster: Contributed Sessions

Invited Session

Chair: Gunjan Malhotra, Assistant Professor, Institute of Management Technology, Ghaziabad, Raj Nagar, Hapur Road,, Ghaziabad, Se, 201001, India, mailforgunjan@gmail.com

1 - Implementing an Analytics Curriculum: Perils, Pitfalls, Opportunities, and Strategies

Alan Brandyberry, Kent State University, Management & Information Systems Dept., Kent, Oh, 44242, United States of America, abrandyb@kent.edu

New analytics degree programs are springing up throughout academia. This new degree domain is naturally multidisciplinary and requires a variety of technological capabilities be in place thus making implementing analytics programs significantly more challenging than most traditional, well-defined domains. Best practices and strategies are developed from a case study and a survey.

2 - Does Size Matter? The Mediating Effect of Alliances between CEO Compensation and Firm Performance

Marcel Lehmann, Technical University Dortmund, Martin-Schmeifler-Weg 12,, Dortmund, 44227, Germany, marcel.lehmann@rwth-aachen.de

This study exposes CEO long-term compensation as an antecedent for firm¥s to enter strategic alliances and includes the analysis of the indirect effect of CEO long-term compensation on firm performance. Our research model is tested regarding secondary data for S&P 500 firms from 2006 to 2012. The findings indicate that CEO contract designs are influential contributions to increase firm performances. The indirect effect is weakened in industries with high levels of market concentration.

3 - Patterns of Change in Supply Chain Strategies in the Indian Retail Sector

Gunjan Malhotra, Assistant Professor, Institute of Management Technology, Ghaziabad, Raj Nagar, Hapur Road, Ghaziabad, Se, 201001, India, mailforgunjan@gmail.com

The small Kirana stores in India are facing the fear and the challenge of sustaining their supply chain practices. Indian consumer prefer low price product when they are buying grocery product. The paper focuses on the difference between small kirana enterprise and medium organized supermarkets. The paper finds that there is a need to motivate small retailers to participate in supply chain startegies and the reasons that prevent to adopt supply chain management strategies.

4 - How Different Collaboration Strategies between Competitors have Effect on Green Product Development

Maryam Hafezi, Phd Candidate, Wilfrid Laurier University, 75 University Avenue West, waterloo, ON, N2J2N9, Canada, hafe1390@mylaurier.ca, Xuan Zhao

In this study, we use game-theoretic approach to see how collaboration of competitors affects the price, and environmental quality of green products. By considering three collaboration strategiesñIndependent Development, Investment Sharing, and Innovation Sharing (IN)ñwe give competing firms managerial insights about the pros and cons of the collaboration strategies. We find that IN strategy provides the best environmental quality for green products but the most expensive product in market.

■ WC08

08-Level A, Hémon

Combinatorial Optimization

Cluster: Contributed Sessions

Invited Session

Chair: Monique Guignard, Professor, University of Pennsylvania, UPenn Wharton OPIM 5th fl JMHH, 3730 Walnut Street, Philadelphia, PA, 19104-6340, United States of America, guignard_monique@yahoo.fr

1 - Non-Linear Model for Two-Dimensional Irregular Shapes Grouping in Cutting Stock Problem (CSP)

Aliya Awais, Research Associate, SEECS-NUST, Sector H-12, Islamabad, Pakistan, Islamabad, 44000, Pakistan, aliya.awais@gmail.com

CSP is the problem of mapping a set of shapes on 1,2,3 dimensional stock sheets, for cutting at a later stage, with the objective of maximizing the stock utilization. This paper investigates CSP with weakly heterogeneous irregular shapes and heterogeneous stock sheets having fixed width and variable length with focus on its application in apparel industry. It is hypothesized that creating groups of shapes and mapping the generated groups on heterogeneous stock sheets leads to improved utilization

2 - A Multistage Mixed-integer Stochastic Model for Perishable Capacity Expansion

Bahareh Eghtesadi, University of Waterloo, 178-350 Columbia St. W., Waterloo, ON, N2L6P1, Canada, b.eghtesadi@gmail.com Fatih Safa Erenay, Osman Yalin Ozaltin

This research proposes a multistage stochastic mixed-integer programming approach for the optimal vaccine vial opening problem. We formulate the problem as a multistage perishable capacity expansion problem under demand uncertainty. We use scenario tree approach to represent the uncertainty and propose a tailored branch and price algorithm based on a nodal decomposition approach.

3 - Optimal Scoring and Ranking of Promotional Offers in Retail

Kannan Balaji, Senior Operations Research Specialist, SAS Research and Development, Tower 5, Level 3, Magarpatta City, Hadapsar, Pune, India, kbala70@gmail.com

Big data and advanced analytical solutions are increasingly getting used by decision makers to improve effectiveness of marketing campaigns and increase profitability. In certain retail applications, optimal scoring and ranking of promotional offers based on customer profiles involve searching over a range of values for optimal score computation and then rank the offers based on the computed scores. This work addresses efficient computation of optimal scores using LP decomposition.

4 - Impact of Different Convex Reformulations for Quadratic Knapsack Problems with Cardinality Constraint

Monique Guignard, Professor, University of Pennsylvania, UPenn Wharton OPIM 5th fl JMHH, 3730 Walnut Street, Philadelphia, PA, 19104-6340, United States of America, guignard_monique@yahoo.fr, Michael Bussieck, Lucas Letocart

We review the convexification approaches of Hammer and Rubin, White, Billionnet, Elloumi and later, Plateau, Ji, Zheng and Sun, and our modification of this latter method, for quadratic knapsack problem with a cardinality constraint (E-kQKP). We report on extensive computational experiments with up to 200 0-1 variables. In particular we compare the behavior of cplex 12.6 with the various convexified models.

■ WC09

09-Level A, Jarry

Military Applications

Cluster: Contributed Sessions

Invited Session

Chair: Mingyu Kim, SUNY(University at Buffalo), 790 Maple Rd., Apt. 28A, Williamsville, NY, 14221, United States of America, mingyuki@buffalo.edu

1 - Air Defense Facility Launch Protocol Modeling and Simulation

Chad Long, CDR, USCG, 110 Iona Ave, Linwood, NJ, 08221, United States of America, chad.a.long@uscg.mil

The United States Coast Guard operates an Air Defense Facility protecting the Washington DC area. This facility is staffed with American pilots and an exchange pilot from the Royal Canadian Air Force. A study was conducted to determine the amount of time it would take to launch a static secondary alert helicopter if the primary aircraft failed using just one flight crew. This study created a robust model of failure options, gathered time study data and simulated the probabilities using Arena.

2 - Applying for Operations Research in Unstable Process

Omer Volkan Oteles, Industrial Engineering Student, Turkish Air Force Academy, Yesilyurt, Istanbul, Turkey, 1917oteles@harbiyeli.hho.edu.tr, Fatih Fent

Unstable systems as airstrikes that include dynamic restrictions as fuel level, altitude, priority of targets etc. Offering the optimal decision to these cases is very challenging in terms of time limitation and reliability. To overcome these kinds of problems; updated restrictions and situations will be assembled in a created program which solves dynamic model on behalf of the pilot. Hence, optimal solution prevents loss of time and wasting ammunition that increases cost and effectiveness.

3 - Complexity and Combat Models

Jeffrey Appleget, Senior Lecturer, Naval Postgraduate School/Operations Research Department, 1411 Cunningham Road GL-239, Monterey, CA, 93943, United States of America, jaappleg@nps.edu, Frederick Cameron

Moore's Law and computer games such as "Call of Duty" have seduced senior defense leaders into believing that computer-based combat models should be able to incorporate an excruciating amount of detail without any loss in the analyst's ability to explain the model's results. This paper details the trade space between complexity and results fidelity and makes the case for applying Einstein's quote "Everything should be as simple as it can be, but not simpler" to combat models.

4 - Optimal Routing of Infiltration Operations

Mingyu Kim, SUNY(University at Buffalo), 790 Maple Rd., Apt. 28A, Williamsville, NY, 14221, United States of America, mingyuki@buffalo.edu, Rajan Batta, Qing He

This research suggests the method for routing military ground operations, focused on circumstances that conduct infiltration. To define area of operations, first, we make possible scenarios depending on enemy's locations. Second, with the scenarios, analyze operations area as a shortest-path model that constructed by each link's costs consist of two factors combination, distance and risk. Finally, calculate optimal routes by robust optimization process.

■ WC10

10-Level A, Joyce

Tabu Search

Cluster: Contributed Sessions

Invited Session

Chair: Yasser Valcarcel Miro, PhD student, HEC Montreal, 308-6280 Sherbrooke Est, Montreal, QC, H1N1C1, Canada, yasserv@gmail.com

1 - Solving Sudoku Problem Based on Tabu Search Algorithm

Eyüp Yildirim, Turkish Air Force Academy, Yesilköy, Istanbul, 34100, Turkey, eyupselahattin16@gmail.com

Sudoku is a popular puzzle game and a combinatorial Math problem.Existing literature indicates that search processes and algorithms utilizing metaheuristic techniques in solving Sudoku is complex and time-consuming. Considering these characteristics of metaheuristic approach, this study aims not only to solve a puzzle but also to compare the performance of different algorithms. The author puts particular emphasis on types of Tabu Search algorithms.

2 - A Cooperation Scheme on a Smart-Grid

Yasser Valcarcel Miro, PhD Student, HEC Montréal, 308-6280 Sherbrooke Est, Montréal, Qc, H1N1C1, Canada, yasserv@gmail.com Boris Beausoleil

The present article introduces a cooperation scheme in a smart-grid. households store, consume and/or share the power generated with solar panels. The LP model proposed, minimizes the energy costs of the coalition and is solved using Tabu Search. In randomly generated instances electric bill is reduced, in average, 49%, with respect to a user entirely relying on the main grid in only 1.5 ms per iteration.

■ WC11

11-Level A, Kafka

Robust Optimization

LATE CANCELLATION

Cluster: Contributed Sessions

Invited Session

Chair: Miguel Goberna, University of Alicante, Ctra. San Vicente s/n, San Vicente, Spain, mgoberna@ua.es

1 - Formulations and Exact Algorithms for Robust Uncapacitated Hub Location

Carlos Zetina, PhD Student, Concordia University, 1455 De Maisonneuve Blvd. W., Montréal, QC, Montréal, QC, H3G 1M8, Canada, c_zetina@encs.concordia.ca, Ivan Contreras, Jean-François Cordeau

In this talk we present mathematical programming formulations for robust uncapacitated hub location problems with multiple assignments. We present exact methods for solving these problems and show that in some cases, the problem can be solved by decomposing into a finite number of deterministic uncapacitated hub location problems.

PAPER Moved to TD10

■ WC12

12-Level A, Lamartine

Production and Scheduling

Cluster: Contributed Sessions

Invited Session

Chair: Yongzhen Li, The University of Hong Kong, Room 823, Haking Wong Building, The University of Hong Kong, Pokfulam, Hong Kong, Hong Kong - PRC, yongzhen@hku.hk

1 - Integrated Production and Distribution for Distributed Manufacturing Systems

Yongzhen Li, The University of Hong Kong, Room 823, Haking Wong Building, The University of Hong Kong, Pokfulam, Hong Kong, Hong Kong - PRC, yongzhen@hku.hk, Miao Song

This paper studies an integrated production and distribution problem in a distributed manufacturing system, which incorporates production scheduling to explicitly model the production time and capacity. Based on a time-expanded network, the problem is formulated as a mixed integer program. The coefficient matrix is proved to be totally unimodular for a special case. Extensive numerical results are presented to reveal various insights.

■ WC13

13-Level A, Musset

Inventory Management

Cluster: Contributed Sessions

Invited Session

Chair: Peter Berling, Lund University/Linnaeus University, Box 118, Lund, 22100, Sweden, peter.berling@iml.lth.se

1 - Closed-Form Approximations for Optimal (r,q) and (S,T) Policies in a Parallel Processing Environment

Jing-Sheng Song, Professor, Duke University, 100 Fuqua Drive, Durham, 27708, United States of America, jssong@duke.edu Karl Sigman, Hanqin Zhang, Marcus Ang

We consider an (r, q) system with i.i.d. stochastic leadtimes and establish closed-form expressions for the optimal policy and cost in heavy traffic limit. In this limit, the well-known square root relationship between the optimal order quantity and demand rate is replaced by the power of 1/3.

2 - New and Improved Heuristics for the Lost Sales Inventory Problem

Peter Berling, Lund University/Linnaeus University, Box 118, Lund, 22100, Sweden, peter.berling@iml.lth.se

The optimal solution to the lost sales inventory problem is typically not known and as one must track the location of each unit to evaluate any policy the computational complexity is growing exponentially. In this work we provide a new heuristic based on the idea of the single unit tracking model pioneered by Axsäter (1990). I.e., an efficient heuristic based on minimizing the expected cost per demanded unit linked to the next unit to be ordered that performs well compared to existing policies.

■ WC14

14-Level B, Salon A

Environment, Energy, and Natural Resources

Cluster: Contributed Sessions

Invited Session

Chair: Juddha Bahadur Gurung, Conservation Development Foundation, Koteswor 35, Kathmandu, Nepal, juddhagurung@hotmail.com

1 - Tuning of Particle Swarm Optimization Algorithm to Optimal Design of Hybrid Renewable Energy Systems

Masoud Sharafi, University of Manitoba, Department of Mechanical Engineering, Winnipeg, Canada, sharafim@myumanitoba.ca, Tarek El Mekkawy

The design of experiments (DOE) techniques can be applied to optimization algorithms, considering the run of an algorithm as an experiment. In this study, a constraint method has been applied to minimize simultaneously the total cost, unmet load, and fuel emission of a hybrid renewable energy system (HRES). A simulation- base particle swarm optimization (PSO) approach has been used to optimal design of HRES problem. The parameters tuning of the PSO is investigated using DOE techniques.

2 - Modernization Impact on Cultural Conservation in Upper Mustang Annapurna Conservation Area, Nepal

Juddha Bahadur Gurung, Conservation Development Foundation, Koteswor 35, Kathmandu, Nepal, juddhagurung@hotmail.com

In Nepal Mustang has cultural diversity. Polyandry culture is practiced by the Loba communities since long time. After introduction of controlled tourism since 1992, democracy in country, road access and media plays vital role to change internal structure of society and direct impact observed in culture and natural resources.

3 - Food, Energy and Environment Trilemma: Land Use Configuration for Biofuel Industry Development

Michael Lim, University of Illinois, 1206 S. 6th Street, Champaign, IL, United States of America, mlim@illinois.edu Yanfeng Ouyang, Xin Wang

We address the negative side effects of the rapid development of the biofuel industry, which has caused extensive competition among food, energy, and the environment in agricultural land use. Taking into account interactions among multiple stake-holders (e.g., farmers, bioenergy firms, food industry, government), we develop policy guidelines for coordinating subsidy and mandates to better achieve sustainable development of this emerging bio-economy.

4 - Flexible Lease Contracts in Sustainable Fleet Replacement Model: A Real Options Approach

Amir Hossein Ansaripoor, Lecturer, Curtin Business School, Ground Floor, Building 407, Kent Street, Bentley WA 6102, Perth, WA, 6102, Australia, amirhossein.ansaripoor@essec.edu Fernando Oliveira

We study a fleet portfolio management problem faced by a firm with different available technologies deciding which technology to replace to its fleet for minimization of cost and risk simultaneously in a stochastic multi-period setting. A model by using real options, multi-stage stochastic programming, and conditional value at risk (CVaR) has been suggested to account for uncertainty in the decision process. We validate the results by a real world case study.

■ WC15

15-Level B, Salon B

Forecasting and Business Applications

Cluster: Contributed Sessions

Invited Session

Chair: Stanley Sclove, Professor, University of Illinois at Chicago, IDS Dept (MC 294), 601 S Morgan St, Chicago, IL, 606077124, United States of America, slsclove@uic.edu

1 - DEA-Based Estimation of Target Stock Prices

Bum-Seok Kim, Sogang Business School, Sogang University, 35 Baekbeom-ro, Mapo-gu, Seoul, 121-742, Korea, Republic of, bs4eva0615@gmail.com, Jae H. Min

This study suggests a data envelopment analysis (DEA) model of estimating proper target prices of stocks. We integrate a variety of stock related indices in output-oriented DEA context to identify undervalued and less risky stocks. With restructuring solution to transform inefficient unit into efficient one, we estimate the proper target prices, and verify the effectiveness of the suggested method using market data.

2 - Applying Dynamic Linear Model To Forecast Real-time Demand For Trucks In Logistics Center
Hsiu-chen Yang, Student, National Chung Hsing University, No. 7, Aly. 32, Ln. 200, Furen St., Taichung, 40141, Taiwan - ROC, verycute712@yahoo.com.tw, Huang-son Shiu, Mei-Ting Tsai

Applying big data analysis in logistics industry becomes critical. This study intends to extract effective information to create valuable components for logistics service providers by developing a truck prediction model. Specifically, the model helps the logistics provider making real-time truck demand forecasting using its customer's POS data. We verify model accuracy by comparing actual and forecast demands. The results can be used to enhance logistics service provider's performance.

3 - Measuring the Impact of Promotions on Store Traffic
Ignacio Inostroza-Quezada, Lecturer, School of Business, Universidad de los Andes, San Carlos de Apoquindo Avenue 2200, Las Condes, Santiago, 7620001, Chile, iinostroza@uandes.cl
Leonardo Epstein

To assess promotion effects on store traffic, we develop an approach that uses times between consecutive arrivals. Our approach builds a baseline by predicting time between arrivals during the promotion interval as if the promotion had not taken place and comparing those predictions with the actual observed times between arrivals during the promotion. We illustrate our approach with data obtained from video images captured at a store's entrance.

4 - ANOVA-Based Tests for Stable Seasonal Pattern with Application to Analysis of Business and Economic Data
Stanley Sclove, Professor, University of Illinois at Chicago, IDS Dept (MC 294), 601 S Morgan St, Chicago, IL, 606077124, United States of America, slsclove@uic.edu, Fangfang Wang

For quarterly data, the pattern is stable if the percentages attributable to the different quarters remain relatively constant over the years. A two-way Analysis of Variance (ANOVA) approach is applied to logged data, with annual and quarterly effects. Tukey's one degree of freedom for interaction is used to test for stability.

■ WC16

16-Level B, Salon C

Nonlinear Programming

Cluster: Contributed Sessions

Invited Session

Chair: Kenza Oufaska, Université Internationale de Rabat / Moulay Ismail University Meknes, Póle ELIT - UIR, Technopolis Rabat-Shore, Sala el Jadida, 11 100, Morocco, Kenza.Oufaska@gmail.com

1 - An Optimal Motion Profile for a Capsule Robot using Non-Linear Optimization
Sina Mahmoudzadeh, University of Guilan, Rasht, Rasht, Iran, mahmoudzadeh@msc.guilan.ac.ir, Hamed Mojallali

We propose a motion profile for the dynamic behavior of a capsule robot used in endoscopy. A multi-objective nonlinear optimization model is developed to maximize the distance traversed and the smoothness of the motion subject to constraints on the available battery power. The optimal solution showed 89% increase in the distance traversed with the same battery consumption compared to other work in the literature while maintaining other criteria.

2 - Reduced-Order Modeling using Wavelets to Solve Large-Scale Nonlinear Problems
Miguel Argaez, Associate Professor, University of Texas at El Paso, 500 West University Avenue, El Paso, TX, 79968, United States of America, margaez@utep.edu, Leobardo Valera, Reinaldo Sanchez-Arias, Martine Ceberio

Reduced-order modeling seeks to reduce large nonlinear models to obtain solutions in computational real time. A well-known method based on POD involves solving the original problem on selected inputs, selecting snapshots, and getting a reduced base using SVD. Although successful, a good understanding of the problem at hand is required to select inputs yielding relevant snapshots. In this work we propose to use wavelets as they are problem independent. We present promising preliminary results.

3 - Subdifferential Regularities of Perturbed Distance Functions on the Target Set in Banach Spaces
Messaoud Bounkhel, Professor, College of Science, Department of Maths, King Saud University, P.O. Box 2455, Riyadh 11451., Riyadh, Saudi Arabia, bounkhel@ksu.edu.sa

In this work I will present new results on the study of both concepts of regularity (Fréchet and proximal regularities) at points outside the target set of perturbed distance functions image determined by a closed subset image and a Lipschitz function image. Also, I will provide some important results on the Fréchet, proximal, and Clarke subdifferentials of image at those points in Banach spaces.

4 - Mixed Penalty Method for a Multi-Objective Problem
Kenza Oufaska, Université Internationale de Rabat / Moulay Ismail University Meknes, Póle ELIT - UIR, Technopolis Rabat-Shore, Sala el Jadida, 11 100, Morocco, Kenza.Oufaska@gmail.com, Khalid El Yassini

Optimization problems often have several conflicting objectives to be improved simultaneously. It is important to turn to a multi-purpose type of optimization to overcome the disadvantages of the approaches based on successive single-objective optimization. MO optimization offers all compromise solutions. We use the mixed penalty approach to resolve MO problems using a new Newton direction. Optimality conditions are given and a new gap is proposed to measure the solutions quality over iterations.

■ WC17

17-Level 7, Room 701

Behavioral Operations

Cluster: Contributed Sessions

Invited Session

Chair: Karthik Sankaranarayanan, Assistant Professor, University of Ontario Institute of Technology, 2000 Simcoe Street North, Oshawa, ON, L1H 7K4, Canada, karthik.sankaranarayanan@uoit.ca

1 - An Experimental Analysis of the Lead Time Syndrome
Anita Klotz, Research Assistant, University of Innsbruck, Universitaetsstrasse 15, Innsbruck, 6020, Austria, anita.klotz@uibk.ac.at, Stefan Haeussler, Hubert Missbauer

By influencing the order release decisions planned lead time plays a crucial role for production planning and control. When planned lead time is assumed to be a exogenous variable this may cause the lead time syndrome. The lead time syndrome is a vicious cycle between lead time update and order release decisions. Using a laboratory experiment, we provide empirical insights into the lead time syndrome. We investigate planers' order release decisions in a single-stage, single-item, MTO production.

2 - Agents, Queues, and Decision Making: A Framework
Karthik Sankaranarayanan, Assistant Professor, University of Ontario Institute of Technology, 2000 Simcoe Street North, Oshawa, ON, L1H 7K4, Canada, karthik.sankaranarayanan@uoit.ca

This work looks at how an agent based framework could be implemented to study decision making in a queuing system. We also show how a gamified experimental set-up of a queuing system can be used as a teaching tool.

■ WC18

18-Level 7, Room 722

Economic Modelling

Cluster: Contributed Sessions

Invited Session

Chair: Anton Badev, Economist, Federal Reserve Board, 1801 K street, Mailstop K1 188, Washington, DC, 20006, United States of America, anton.badev@gmail.com

1 - A Theoretical Framework for Determining the Subsidy in an Economy
Augustine Osagiede, Professor, University of Benin, Ugbowo Campus, Benin City, Nigeria, augustine.osagiede@uniben.edu
Virtue Ekhosuehi

This paper develops a framework for the subsidy that serves to equalize the per capita income shares across income classes. The framework characterizes the income dynamics by a Markov process and uses the principle of maximum entropy. The study serves as a tool to decide on the allocation to subsidy.

2 - Impact of Trade Liberalization on Deindustrialization
Muzzammil Wasim Syed, Student, University of Electronic Science and Technology China, Shahe Campus:No.4, Section 2, North Jian, Shahe Campus:No.4, Section 2, North Jian, Chengdu, 610054, China, aimsyed@hotmail.com, Hanif Muhammad Imran

This paper first deals with the different debates for and against free-trade. Secondly, it analyses the impact of policy liberalization (especially trade policy) on the industrial sector of an economy. And lastly, we analyze the impact of free-trade policy on Pakistan's manufacturing concern and we empirically show that there is a negative correlation between Trade openness and manufacturing output of Pakistan.

3 - Asymmetric Trade Liberalization, Comparative Advantage and Heterogeneous Firms

Yingzhe Gu, Tongji University, 1239 Siping Road, Shanghai, P.R. China, Shanghai, China, cheng-mo@hotmail.com
WenXing Nie

Asymmetric trade liberalization occurs when one country suddenly slashes its trade barriers. When this happens, the country which takes the initiative in reducing trade barriers would suffer from net job destruction but enjoy better welfare and have higher factor rewards in each sector. The relative factor rewards would increase more in comparative advantage industries and job destruction is relative higher in comparative advantage industries than in comparative disadvantage industries.

4 - Discrete Games in Endogenous Networks: Theory and Policy

Anton Badev, Economist, Federal Reserve Board, 1801 K street, Mailstop K1 188, Washington, DC, 20006, United States of America, anton.badev@gmail.com

This paper develops a framework for analyzing individuals' choices in the presence of endogenous social networks. The analysis first, focuses on a one-shot network formation game, where individuals choose both their friendships and their actions. The equilibrium play of the one-shot game is then embedded in an evolutionary model of network formation. The latter overcomes the multiplicity present in the static model and is computationally convenient for estimation and policy simulations.

■ WC19

19-Grand Ballroom West

Tutorial: Recent Advances in Mixed Integer Nonlinear Optimization

Cluster: Tutorials

Invited Session

Chair: Pierre Bonami, IBM, Calle Hortensia 26, Madrid, 28002, Spain, pierre.bonami@es.ibm.com

1 - Recent Advances in Mixed Integer Nonlinear Optimization

Pierre Bonami, IBM, Calle Hortensia 26, Madrid, 28002, Spain, pierre.bonami@es.ibm.com

Mixed Integer Nonlinear Optimization is the optimization of a nonlinear function over a feasible set described by nonlinear functions and integrality constraints. In this tutorial, we will review the main properties, basic algorithmic techniques and more recent advances to solve these problems. We will focus in particular on techniques implemented in current solvers with examples from the open source solver Bonmin and the solver CPLEX.

Session Chair Index

T

U

V

W

X

Y

Z

Author Index

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z

Session Index

Sunday, 1:30pm - 3:00pm

SC01 NSERC Discovery Grant Program Workshop
SC02 Dynamic Problems in Healthcare I
SC03 Forest Value Chain Management
SC04 Applications in Data Mining
SC05 Transportation - Freight
SC06 Manufacturing Applications of Simulation
SC07 Marketing Interface
SC08 Applications of DFO at Hydro-Québec
SC09 Stochastic Models in Aviation
SC10 Data-Driven Robust Optimization
SC11 COMEX: Combinatorial Optimization: Metaheuristics and EXact Methods I
SC12 Combinatorial Optimization in Constraint Programming
SC13 Pricing and Revenue Management
SC14 Electrical Markets
SC15 Maintenance Optimization
SC16 Environment
SC17 Quantitative Finance
SC18 Decision Analysis
SC19 Tutorial - Green Vehicle Routing

Sunday, 3:30pm - 5:00pm

SD02 Dynamic Problems in Healthcare II
SC03 Finalists of the 2015 David Martell Student Paper Prize in Forestry
SD04 OR in Mine Planning I
SD05 Transportation and Routing
SD06 Optimization via Simulation: Ranking and Selection, and Multiple Comparisons
SD07 Operations/ Marketing Interface
SD08 Parallel Methods for DFO
SD09 Assigning and Predicting Aviation Network Delays
SD10 From American Put Options to Wartime Portfolios
SD11 COMEX: Combinatorial Optimization: Metaheuristics and EXact Methods II
SD12 Constraint Programming I
SD13 Revenue/ Yield Management
SD14 Electrical Markets - Renewable Energy
SD15 Multicriteria Analysis and Applications
SD16 Game Theory
SD17 Financial Engineering
SD18 Decision Making
SD19 Tutorial- Clearing the Jungle of Stochastic Optimization

Monday, 9:00am - 10:30am

MA01 Practice Award
MA02 Health Services Outside the Hospital
MA03 Forest Management Planning
MA04 OR in Mine Planning II
MA05 Logistics, Transportation and Distribution I
MA06 Quasi-Monte Carlo Methods for Simulation
MA07 Inventory Routing
MA08 Recent Research in DFO
MA09 Flight Plan Optimization
MA10 Recent Developments in Stochastic Programming Algorithmics
MA11 Models and Methods for Network Design
MA12 Constraint Programming II
MA13 Competitive Pricing
MA14 Energy Systems I
MA15 Applications in Scheduling
MA16 Tutorial - Planning and Control of Container Terminals Operations
MA17 Real Options
MA18 Decision Making and Manufacturing
MA19 Tutorial - Deep Learning

Monday, 11:00am - 12:00pm

MB20 Plenary:IFORS Distinguished Lecture – Practical Optimization – Certainly Uncertain

Monday, 1:30pm - 3:00pm

MC01 Student Paper Prize
MC02 Hospital Operations
MC03 Big Data in Forest Decision Support Systems
MC04 OR in Mine Planning III
MC05 Logistics, Transportation, and Distribution II
MC06 Stochastic Modeling and Optimization in Call Centers and Service Systems
MC07 Pickup and Delivery
MC08 Dynamic Scaling, Evolution Strategies and Application of DFO
MC09 Optimization in Air Traffic Control I
MC10 Stochastic Mixed-Integer and Nonlinear Programming for Power Systems Applications
MC11 Telecommunications Network Design
MC12 Constraint-Based Scheduling
MC13 Marketing-Operations Interface
MC14 Energy Systems II
MC15 Science at JDA Innovation Labs
MC16 Tutorial – Administration and Grading of Online Exams for Analytics Courses
MC17 Recent Advances in Financial Engineering and Insurance
MC18 Queueing and Stochastic Models
MC19 Tutorial- Airline Schedule Development

Monday, 3:30pm - 5:00pm

MD01 Student Paper Prize Final 2
MD02 Improving Delays
MD03 Value Chain Optimization Research Network: Moving Forward
MD04 OR in Mine Planning IV
MD05 Logistics and Supply Chain Optimization
MD06 Simulation
MD07 Heuristics for Delivery Problems
MD08 Algorithm Designs and Selection Methods for Grey-Box DFO
MD09 Optimization in Air Traffic Control II
MD10 Stochastic Optimization, Innovations, and Applications
MD11 Hub and Facility Location
MD12 Integer Programming
MD13 Pricing Impacts and Algorithms for Dynamic and Uncertain Demand
MD14 OR Applications in Energy and Routing
MD15 Practical OR Models used in the Context of Crew Scheduling
MD16 Tutorial- Introduction to Optimization in Radiation Therapy
MD17 Heuristics
MD18 Control and Analysis of Queueing Systems
MD19 Tutorial - Models for Passenger Railway Planning and Disruption Management

Tuesday, 9:00am - 10:30am

TA01 Online Information Search
TA02 Large-scale Optimization and Computing for Operating Room Planning and Scheduling
TA03 OR in the Forest Products Sector
TA04 Transportation and Wood Handling
TA05 Strategic and Tactical Issues in Transportation Systems
TA06 Accounting for Choice Behavior in Revenue Management
TA07 Vehicule Routing Problem
TA08 DFO Methods for Multiobjective and Constrained Problems
TA09 Airline Transportation
TA10 Theory and Applications of Robust Optimization
TA11 Facility Location - Network Design
TA12 Dynamic Programming
TA13 Pricing & Revenue Management I
TA14 Energy Systems III
TA15 Practical Revenue Management
TA16 Algorithms for Nonconvex Optimization Problems
TA17 Innovative Analytics Solutions
TA18 Recent Advances in Accumulating Priority Queues
TA19 Tutorial - Dynamic Games Played over Even Trees

Tuesday, 11:00am - 12:00pm

TB20 Plenary – Simpler the Better: Thinning out MIP's by Occam's Razor

Tuesday, 1:30pm - 3:00pm

TC01 Learning by Working in Online Business Environment
TC02 Optimization Methods for Cancer Therapy
TC03 Operations Management in the Forest Sector
TC04 OR Applications in Forestry
TC05 Supply Chain Management and Sustainability
TC06 Choice Based Revenue Management Systems in Transportation
TC07 Supply Chain Management
TC08 Applications of DFO
TC09 Applications of Column Generation
TC10 Stochastic Programming Applications from Industry
TC11 Facility Location
TC12 Machine Learning
TC13 Innovations in Revenue Management
TC14 OR Methods in Hydroelectricity Generation Planning
TC15 Operations Research Applications in Home Delivery
TC16 Conic Optimization: Algorithms and Applications
TC17 Industrial Analytics Applications TC17.1
TC18 Queueing Systems - Solutions and Approximattions
TC19 Tutorial – Humanitarian Logistics

Tuesday, 3:30pm - 5:00pm

TD01 Social Media and Marketing
TD02 Optimization Methods for Radiation Therapy Treatment Planning
TD03 Management of Forest Bioenergy Value Chains
TD04 Forest Management Planning under Uncertainty
TD05 Vehicle Routing
TD06 Demand Modelling
TD07 Management and Optimization
TD08 DFO using Models
TD09 Primal Algorithms and Integral Simplex
TD10 Networks and Stochastic Optimization
TD11 Risk Analysis
TD12 Network Optimization
TD13 Reverse Logistics/ Remanufacturing
TD14 Electricity Market/Optimization of Energy Systems
TD15 Applications of Operations Research in the Transport Industry
TD16 Global Optimization and Mixed-Integer Nonlinear Optimization
TD17 Analytics Around the World and Future of Analytics
TD18 Queueing and Inventory Models
TD19 Tutorial- Robust Optimization in Healthcare Systems Engineering

Wednesday, 9:00am - 10:30am

WA01 Disaster and Disruption Management
WA02 Queueing and Other Models of Healthcare Systems
WA03 Wood Supply Challenges
WA04 Sawmill Planning
WA05 Rail Transportation
WA06 Lot Sizing Problems
WA07 Supply Chain Optimization
WA08 Applications and Robust Optimization in DFO
WA09 Military Applications I
WA10 Forecasting and Stochastic Optimization
WA11 Enterprise Risk Management
WA12 Scheduling
WA13 Reverse Supply Chains
WA14 Energy Policy and Planning
WA15 Airline Operations, Value of Integrated Solutions
WA16 Mixed Integer Conic Optimization
WA17 Developing Analytics Talent I
WA18 Healthcare Systems
WA19 Tutorial – Value Chain Planning for Natural Resources

Wednesday, 11:00am - 12:30pm

WB01 Commerce
WB02 Simulation Modelling in Healthcare 1
WB03 Forest Fire Management
WB04 Educational Tools in OR/MS Applied to the Forest Sector
WB05 Transportation - Operations
WB06 Project Management
WB07 Stochastic Operations Management
WB08 Recent Developments in and New Uses of DFO
WB09 Military Applications II
WB10 Metaheuristics for Combinatorial Problems
WB11 Finance - Risk Management
WB12 Task Scheduling
WB13 Operations Management
WB14 Environment and Energy
WB15 Operations Research in the Natural Resource Industry
WB16 Optimization Methods and Applications in Control
WB17 Developing Analytics Talent II
WB18 Capacity Allocation in Healthcare
WB19 Tutorial- Vector Space Decomposition for Linear Programming

Wednesday, 1:30pm - 3:00pm

WC01 Marketing
WC02 Staffing and Scheduling Models in a Dynamic Environment
WC03 Strategic Planning in the Forest Sector
WC04 Decision Analysis in Healthcare
WC05 Transportation - Planning
WC06 Sustainable Operations Planning
WC07 Strategic Planning and Management
WC08 Combinatorial Optimization
WC09 Military Applications
WC10 Tabu Search
WC11 Robust Optimization
WC12 Production and Scheduling
WC13 Inventory Management
WC14 Environment, Energy, and Natural Resources
WC15 Forecasting and Business Applications
WC16 Nonlinear Programming
WC17 Behavioral Operations
WC18 Economic Modelling
WC19 Tutorial – Recent Advances in Mixed Integer Nonlinear Optimization