Journées de l'optimisation
5-7 mai 2014

Optimization Days
May 5-7, 2014

Journée industrielle de l'optimisation

Les premières éditions de la Journée industrielle de l'optimisation, organisées pendant les JOPT 2010 et 2012, connurent un franc succès. Une dizaine d'entreprises ou d'organisations ayant des activités en recherche opérationnelle ont eu l'occasion de rencontrer et d'échanger avec des dizaines d'étudiants aux cycles supérieurs.

Comme vous le savez, la communauté de recherche opérationnelle à Montréal et au Québec est extrêmement dynamique, plusieurs centres de recherche sont fort actifs et de nombreux évènements scientifiques d'envergure sont organisés chaque année. Au fil des 30 dernières années, de nombreuses entreprises se sont aussi développées autour de cette communauté ; certaines sont devenues des chefs de file mondiaux alors que d'autres, qui n'en sont qu'à leurs premiers pas, connaissent déjà d'importants succès.

La création de l'Institut de la Recherche Opérationnelle de Montréal et l'avènement d'une Chaire d'Excellence de Recherche du Canada en Science des Données permettront de créer de nouvelles collaborations entre le milieu universitaire et ses différents partenaires industriels ainsi que d'intensifier les collaborations existantes. Lors des Journées de l'Optimisation 2014, nous désirons une fois de plus réunir la communauté « industrielle » de recherche opérationnelle ; nous organisons donc la troisième édition de la «Journée industrielle de l'optimisation» le 6 mai prochain.

Dans le cadre de cette journée, plusieurs entreprises œuvrant en RO ont accepté de présenter leurs activités, les travaux qu'ils mènent en optimisation, les collaborations possibles ou souhaitables avec la communauté scientifique, ainsi que les possibilités de carrières pour les étudiants diplômés en recherche opérationnelle. Leurs présentations rempliront la journée du mardi qui se terminera par un cocktail de réseautage (offert par le CIRRELT) avec des étudiants aux cycles supérieurs qui gradueront cette année.

Les compagnies suivantes ont confirmé leur présence: Artelys Canada Inc., Clear Destination, ExPretio, FPInnovations, GIRO, JDA Software et Kronos.

Instructions aux participants
et aux présidents de séances

La durée de chaque présentation est fixée à 25 minutes. Nous vous demandons de prévoir un exposé d'environ 20 minutes pour permettre les questions des participants.

Si vous présidez une séance, assurez-vous de faire respecter l'horaire en indiquant périodiquement aux auteurs le temps qui leur est encore alloué pour compléter leur exposé. De plus, si un auteur n'est pas présent, nous vous demandons de laisser passer les 25 minutes normalement prévues. Ces mesures permettront aux participants de se déplacer d'une salle à l'autre, s'ils le désirent, pour assister à des exposés dans des séances différentes.

Instructions to Participants and Session Chairs

Each talk should last 25 minutes. We ask you to prepare for about 20 minutes to allow questions from the audience.

If you act as chairperson, we ask you to adhere to the schedule:
-periodically inform each author of the time remaining to complete his (her) talk;
-in case of no show, take a 25 minute-break before moving to the next talk.

These measures will allow people to move freely between sessions.

Résumé du programme / Program Outline

Lundi 5 mai / Monday, May 5

Heure / Hour	Séance / Session	Salle / Room
08h00 - 08h45	Inscriptions et courrier électronique / Registration and e-mail facilities	Tata Communications
	Petit déjeuner / Breakfast	Investissement Québec
08h45 - 09h00	Séance d'ouverture / Opening Session	Amphi. Banque Nationale
09h00 - 10h00	Séance plénière / Plenary Session - Andrès Medaglia	Amphi. Banque Nationale
10h00 - 10h30	Pause-café / Coffee Break	Investissement Québec
10h30 - 12h10	Exposé magistral / Tutorial – Jonathan Patrick	TAL Gest. globale d'actifs
	Séances en parallèle / Parallel Sessions	1er étage
12h10 - 14h00	Pause / Break	
14h00 - 15h00	Séance plénière / Plenary Session - Mikael Rönnqvist	Amphi. Banque Nationale
15h00 - 15h30	Pause-café / Coffee Break	Investissement Québec
15h30 - 17h10	Exposé magistral / Tutorial - Walter Rei	TAL Gest. globale d'actifs
	Séances en parallèle / Parallel Sessions	1er étage
17h15 - 21h30	Réception vins et fromages / Wine and Cheese Party	Salon l'Oréal

Mardi 6 mai / Tuesday, May 6

Heure / Hour	Séance / Session	Salle / Room
08h00 - 09h00	Inscriptions et courrier électronique / Registration and e-mail facilities	Tata Communications
	Petit déjeuner / Breakfast	Investissement Québec
09h00 - 10h00	Séance plénière / Plenary Session - Christian Prins	Amphi. Banque Nationale
10h00 - 10h30	Pause-café / Coffee Break	Investissement Québec
10h30 - 12h10	Exposé magistral / Tutorial - Cristián E. Cortés	TAL Gest. globale d'actifs
	Journée industrielle de l'optimisation 1 / Industrial Optimization Day 1	Banque CIBC
	Séances en parallèle / Parallel Sessions	1er étage
12h10 - 14h00	Pause / Break	
14h00 - 15h00	Séance plénière / Plenary Session - Bernard Gendron	Amphi. Banque Nationale
15h00 - 15h30	Pause-café / Coffee Break	Investissement Québec
15h30 - 17h10	Exposé magistral / Tutorial - Willem-Jan van Hoeve	TAL Gest. globale d'actifs
	Journée industrielle de l'optimisation 2 / Industrial Optimization Day 2	Banque CIBC
	Séances en parallèle / Parallel Sessions	1er étage
17h15 - 19h30	Cocktail de réseautage (sur invitation seulement) / Networking cocktail (by invitation only)	Salon Deloitte – 4e étage

Mercredi 7 mai / Wednesday, May 7

Heure / Hour	Séance / Session	Salle / Room
08h00 - 09h00	Inscriptions et courrier électronique / Registration and e-mail facilities	Tata Communications
	Petit déjeuner / Breakfast	Investissement Québec
09h00 - 10h40	Exposé magistral / Tutorial - Jacques Carlier	TAL Gest. globale d'actifs
	Séances en parallèle / Parallel Sessions	1er étage
10h40 - 11h00	Pause-café / Coffee Break	Investissement Québec
11h00 - 12h40	Séances en parallèle / Parallel Sessions	1er étage

Emplacement des activités

➢ Toutes les activités se dérouleront à HEC Montréal, 3000 chemin de la Côte-Sainte-Catherine

➢ L'entrée Louis-Colin est accessible à partir de la station de métro Université-de-Montréal

Inscriptions et courriels	Salle Tata Communications, en face de l'amphithéâtre Banque Nationale (rez-de jardin)
Petits déjeuners et pauses-café	Salle Investissement Québec, adjacente à l'amphithéâtre Banque Nationale (rez-de-jardin)
Réception vins et fromages	Salon l'Oréal (rez-de-jardin)
Cocktail de réseautage	Salon Deloitte (4e étage, section bleue)
Séances plénières	Amphithéâtre Banque Nationale (rez-de-jardin)
Exposés magistraux	Salle TAL Gestion globale d'actifs (1er étage, section verte)
Journée industrielle de l'optimisation	Salle Banque CIBC (1er étage, section verte)
Toutes les autres séances	1er étage (section verte)

Location of Activities

➢ All activities take place at HEC Montréal, 3000 chemin de la Côte-Sainte-Catherine

➢ The Louis-Colin entrance can be reached from the Université-de-Montréal metro station

Registration & e-mail facilities	Tata Communications Room, across from Banque Nationale Lecture Hall (Garden level)
Breakfasts and coffee breaks	Investissement Québec Room, beside Banque Nationale Lecture Hall (Garden level)
Wine and Cheese Party	L'Oréal Room (Garden level)
Networking cocktail	Deloitte Room (4th floor, blue section)
Plenary sessions	Banque Nationale Lecture Hall (Garden level)
Tutorials	TAL Gestion globale d'actifs Room (1st floor, green section)
Industrial Optimization Day	Banque CIBC Room (1st floor, green section)
All other sessions	1st floor (green section)

Plan du quartier / Area Map

Plan d'accès

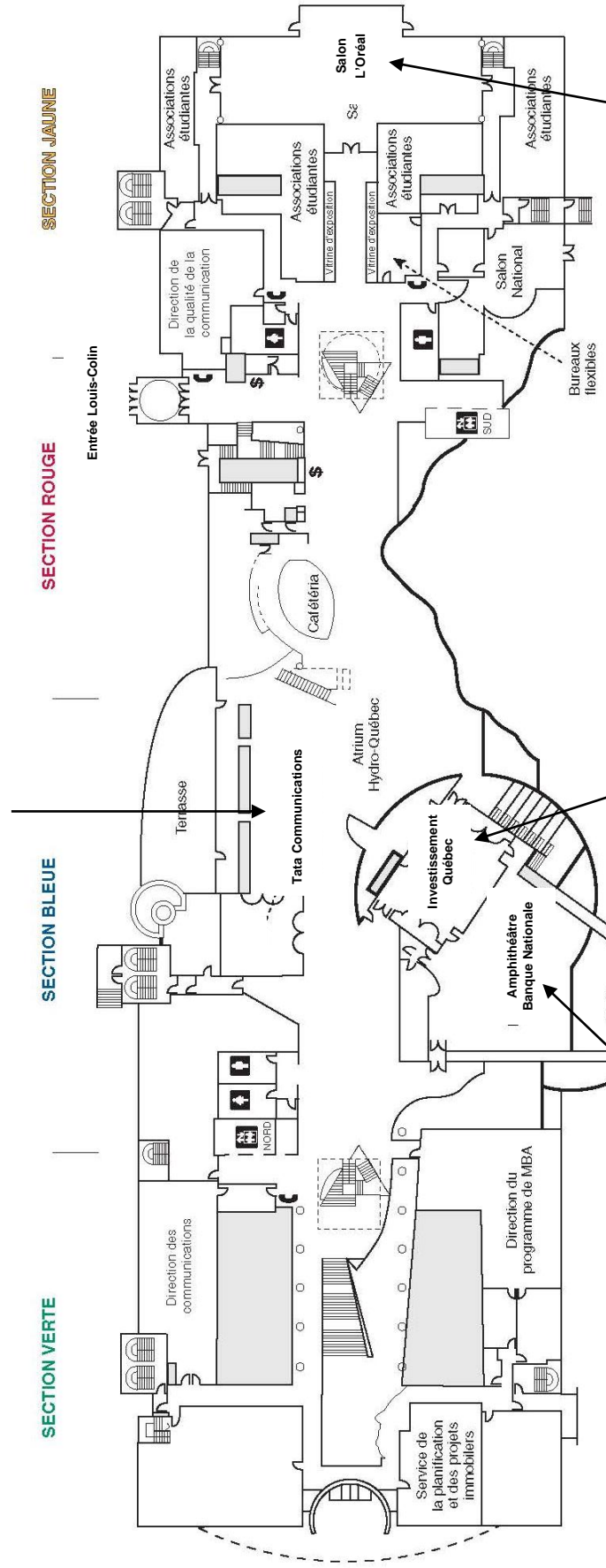Édifice principal
3000, chemin de la Côte-Sainte-Catherine
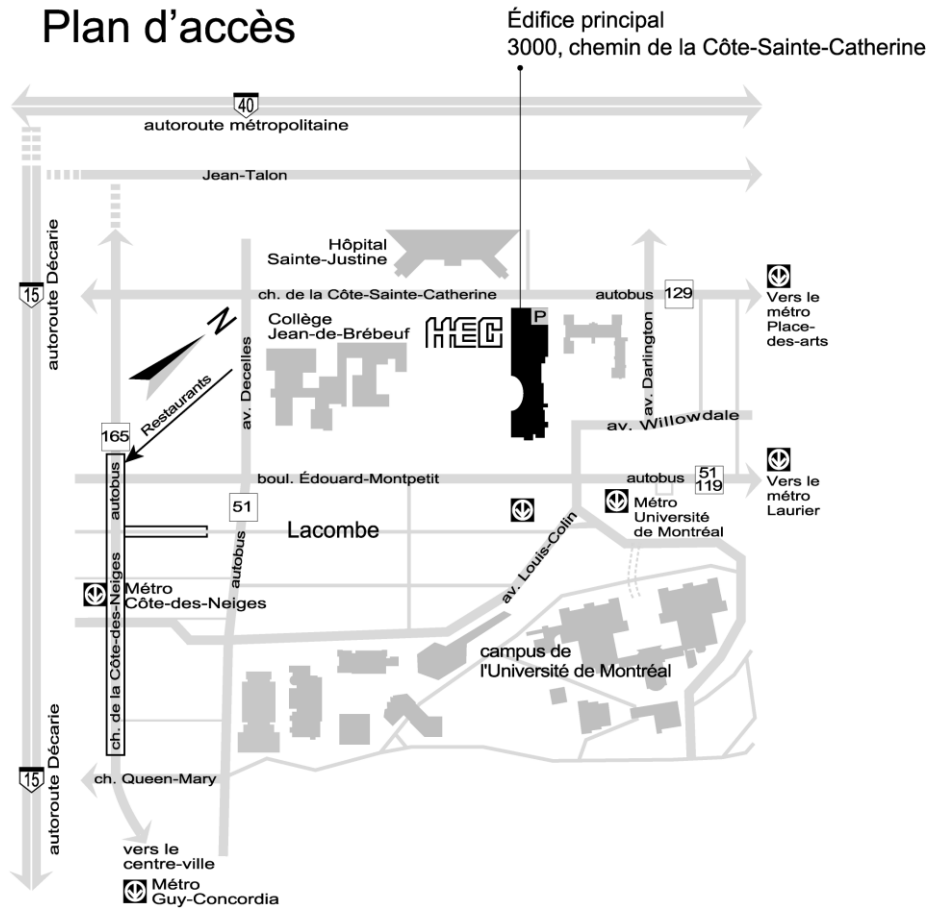
On peut trouver des restaurants sur la rue Lacombe (entre Decelles et Côte-des-Neiges) et sur le chemin Côte-des-Neiges. On peut également déjeuner au Cercle HEC (club facultaire, avec réservation seulement) au 6e étage ou à la cafétéria de HEC Montréal (rez-de-jardin).

Restaurants can be found on Lacombe Street (between Decelles and Côte-des-Neiges) and on Côte-des-Neiges Road. Lunch can also be obtained at the Cercle HEC (Faculty Club, with reservation only) on the 6th floor or in HEC Montréal cafeteria (garden level).

HEC Montréal
3000, chemin de la Côte-Saint-Catherine
Montréal QC H3T 2A7

REZ-DE JARDIN / GARDEN LEVEL

SECTION JAUNE

Associations étudiantes

Salon L'Oréal

Sé

Associations étudiantes

Associations étudiantes

Associations étudiantes

Associations étudiantes

Vitrine d'exposition

Vitrine d'exposition

Direction de la qualité de la communication

Salon National

Vins & fromages
Wine & cheese Party

Bureaux flexibles

SUD

Entrée Louis-Colin

SECTION ROUGE

Cafétéria

Atrium
Hydro-Québec

Inscriptions/Courriels
Registration/E-mail facilities

Terrasse

Tata Communications

SECTION BLEUE

Investissement Québec

Amphithéâtre Banque Nationale

Petits déjeuners et pauses-café
Breakfasts and breaks

Séances plénières /
Plenary sessions

NORD

SECTION VERTE

Direction des communications

Direction du programme de MBA

Service de la planification et des projets immobiliers

chemin de la Côte-Sainte-Catherine:

HEC Montréal
3000, chemin de la Côte-Saint-Catherine
Montréal QC H3T 2A7

1er ÉTAGE / 1st FLOOR

Séances en parallèle/
Parallel Sessions
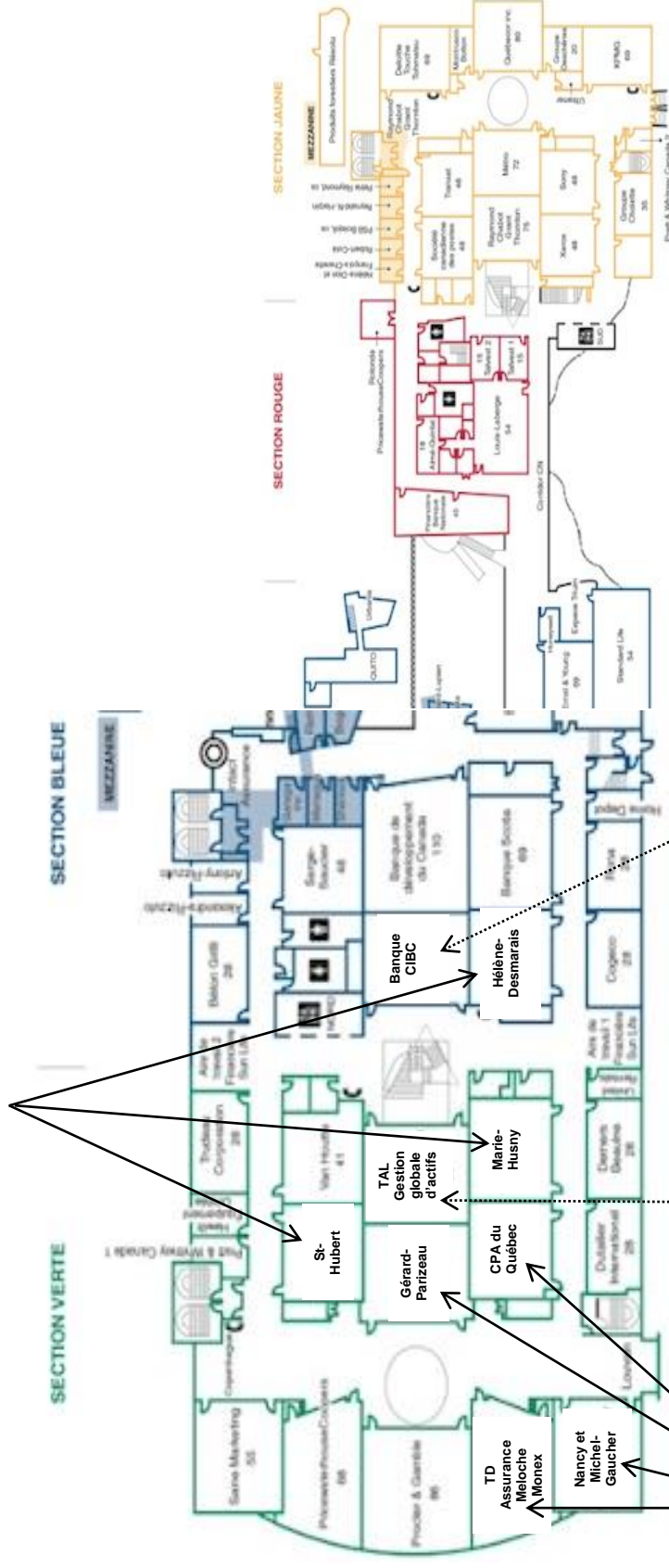
Séances en parallèle/
Parallel Sessions

Journée industrielle de
l'optimisation / Industrial
Optimization Day

Exposés magistraux /
Tutorials

Chemin de la Côte-Sainte-Catherine

Programme / Program

Lundi 5 mai 2014 / Monday, May 5, 2014

08h45   **Amphithéâtre Banque Nationale : Séance d'ouverture**

MA1   Séance plénière 1 / Plenary Session 1

Salle: Amphithéâtre Banque Nationale
Président: Rousseau, Louis-Martin, *Polytechnique Montréal*

09h00   **The Pulse Algorithm: A Modular Framework for Hard Shortest Path Variants**

Medaglia, Andrès, Universidad de los Andes, amedagli@uniandes.edu.co

Solving practical applications arising on transportation and logistics often involves the solution of underlying large-scale network problems with shortest path structures. Initially, we proposed the pulse algorithm as an exact method for solving shortest paths with side constraints. Later on, we identified other shortest path variants where the same principle behind the pulse algorithm applied. In this talk, we present the pulse algorithm as a framework based on the idea of performing an implicit enumeration of the entire solution space supported by pruning strategies that efficiently discard a vast number of suboptimal solutions. The framework relies on general components that can be easily extended to different routing problems and problem-specific components that can be used as modules. We show our experience on several shortest path variants such as the constrained shortest path, the biobjective shortest path, the elementary shortest path with resource constraints, the orienteering problem with time windows, and the weight-constrained shortest path with replenishment.

MB1   Exposé magistral 1 / Tutorial 1

Salle: TAL Gestion globale d'actifs
Président: Ruiz, Angel, *Université Laval*

10h30   **The Multiple Challenges Within Advanced and Appointment Scheduling**

Patrick, Jonathan, Telfer School of Management, University of Ottawa, Patrick@telfer.uottawa.ca

Advanced and appointment scheduling problems have largely been treated in the literature as two distinct problems. Advanced scheduling refers to the process of determining the day of service while appointment scheduling refers to determining the sequence and time of service of patients of the day of service. Treating them separately has been accomplished in the advanced scheduling stream by assuming such things as deterministic service times or using crude estimates of overtime costs on the day of service. Within the appointment scheduling literature the number of patients scheduled on a given day (the outcome of the advanced schedule) has largely been assumed to be given. Within these two camps multiple complications (prioritization of patients, cancellations and no-shows, stochastic service times, walk-ins…) have been addressed in an effort to improve the realism of the models. We look at the successes and remaining challenges of both camps and point to the limitations of treating these two problems separately.

MB2   Optimisation dans le commerce au détail / Optimization in Retail

Salle: CPA du Québec
Président: Côté, Marie-Claude, *JDA Software*

10h30   **The Prepacking Problem**

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Gauthier Melançon, Gabrielle, JDA Software, gabrielle.gauthiermelancon@jda.com
Hoskins, Maxim, Polytechnique Montréal, maxim.hoskins@gmail.com
Masson, Renaud, Polytechnique Montréal, renaud.masson@cirrelt.ca
E. Mendoza, Jorge, Université Catholique de l'Ouest, jorge.mendoza@uqo.fr
Meyer, Christophe, Université du Québec à Montréal, christop8m@hotmail.com

The prepacking problem consists in putting a product of different sizes, for instance T-Shirts, into packs sent to stores to satisfy demand. However, to reduce costs, the number of different pack configurations is limited. Different approaches were tried such as a MIP, constraint programming and a heuristic.

10h55   **Dynamic Task Assignment in a Warehouse**

Prescott Gagnon, Éric, JDA Software, Eric.PrescottGagnon@jda.com
Legrain, Antoine, Polytechnique Montréal, antoine.legrain@polymtl.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@cirrelt.net

A warehouse is a highly dynamic environment where tasks are created, modified and canceled as trucks come and go and things are moved around. The dynamic task assignment problem consists in assigning a new task to an employee based on productivity criteria.

11h20   **Optimization in Fashion Assortment Planning**

Prescott Gagnon, Éric, JDA Software, Eric.PrescottGagnon@jda.com
Raymond, Vincent, JDA Software, Vincent.Raymond@jda.com
Brisson, Marc, JDA Software, Marc.Brisson@jda.com
Côté, Marie-Claude, JDA Software, Marie-Claude.Cote@jda.com
Gauthier Melançon, Gabrielle, JDA Software, gabrielle.gauthiermelancon@jda.com

Planning an assortment in fashion consists in selecting the best set of items to be carried in each store of a chain for a future season based on user-defined constraints. To solve this problem, a genetic algorithm, a MIP model and new approaches to create new items have been developed. The slides are in English but will be presented in French.

MB3   Tournées de véhicules 1 / Vehicle Routing 1

Salle: Gérard-Parizeau
Président: Gouveia, Luis , *University of Lisbon*

10h30   **Resource-Based Cycle Elimination Applied to the Vehicle Routing Problem**

Contardo, Claudio, Université du Québec à Montréal, claudio.contardo@gerad.ca
Martinelli, Rafael, Universidade Federal de Ouro Preto, rafael.martinelli@iceb.ufop.br
Desaulniers, Guy, Polytechnique Montréal, Guy.Desaulniers@gerad.ca

In this talk we present a novel route relaxation for vehicle routing problems. It relies on the monotone consumption of a given resource along the edges used by a route, so as to forbid all cycles that are short according to the consumption of this resource. Preliminary computational experiments are presented to assess the performance of the new relaxation.

10h55	**A Branch-and-Cut Algorithm for the Capacitated Single Allocation Hub Location-Routing Problem**

Minh Hoang, Ha, Polytechnique Montreal, minhhoang.ha@cirrelt.net
Zhang, Mi, École Centrale de Nantes,
Bostel, Nathalie, Université de Nantes, nathalie.bostel@univ-nantes.fr
Dejax, Pierre, École des Mines de Nantes, pierre.dejax@mines-nantes.fr

The hub location-routing problem (HLRP) with less-than-truckload (LTL) shipments considers the location of hub facilities concentrating flows and through which flows are routed from origins to destinations, together with the design of both collection and delivery routes associated to each hub.The state of the art includes only very few works directly addressing the HLRP, and they mainly focus on particular cases as postal services. In this research, we address the HLRP with distinct collections and deliveries tours, as it is practiced by general goods freight carriers. We propose a new mathematical model for the capacitated single allocation hub location-routing problem (CASHLRP) and a branch-and-cut algorithm to solve exactly the problem.

11h20	**Classification, Models and Exact Algorithms for Multi-Compartment Delivery Problems**

C. Coelho, Leandro, Université Laval, leandro.coelho@cirrelt.ca
Laporte, Gilbert, HEC Montréal, gilbert.laporte@cirrelt.ca

The distribution of products using compartmentalized vehicles involves many decisions such as the allocation of products to vehicle compartments, vehicle routing and inventory control. These decisions often span several periods, yielding a difficult optimization problem. In this paper we define and compare four main categories of the Multi-Compartment Delivery Problem (MCDP). We propose two mixed-integer linear programming formulations for each case, as well as specialized models for particular versions of the problem. Known and new valid inequalities are introduced in all models.

11h45	**Modeling and Solving the One-to-One Multi-Commodity Pickup and Delivery Traveling Salesman Problem**

Gouveia, Luis, University of Lisbon, legouveia@fc.ul.pt
Ruthmair, Mario, Vienna University of Technology, ruthmair@ads.tuwien.ac.at

We address a traveling salesman problem variant with pickup and delivery aspects and propose several mixed integer programming models based on another equivalent problem formulation. Our branch-and-cut algorithms perform well on tightly constrained instances and solve several open TSPLIB instances for the sequential ordering problem.

## MB4	Chaine d'approvisionnement / Supply Chain

Salle: Hélène-Desmarais
Président: El Ouardighi, Fouad, *ESSEC Business School*

10h30	**Analysis of Interaction between Barriers of Supplier's Quality Management**

Mukhtar, Hassan, Université Concordia, h_mukh@encs.concordia.ca
Awasthi, Anjali, Université Concordia, awasthi@ciise.concordia.ca
Schiffauerova, Andrea, Université Concordia, andrea@ciise.concordia.ca

The study has been done to find out the important barrier to supplier's quality management. We identified seven important barriers to quality management performance and used the ISM approach to find out their contextual relationship. SSIM was developed and then reach ability matrix was made to find binary relationship among barriers. Graph was constructed to find the classification of these barriers.

10h55   **A Two-Phase Approach Based on Floyd's Algorithm for the Transshipment Problem**

Almaatani, Dalia, Laurentian University, dalmaatani@laurentian.ca
Diagne, Salimata G., Université Cheikh Anta Diop, gueyesalli@yahoo.com
Diop, El Moctar, École Superieure de Commerce,
Gningue, Youssou, Laurentian University, ygningue@cs.laurentian.ca
Takouda, Matthias P., Laurentian University, mtakouda@laurentian.ca

Transshipment Problems can be modeled as Network problems resulting in problems that are large in size and more complex when compared to the original one. We propose a two-phase approach combining Floyd's algorithm to reduce the problem to a small Transportation Problem whose initial solution is obtained via the Modified Vogel Method.

11h20   **Design Quality Versus Cost-Reducing R&D and the Double Marginalization Problem**

El Ouardighi, Fouad, ESSEC Business School, elouardighi@essec.fr
Denoyel, Victoire, ESSEC Business School,
Espinoza, Juan-Carlos, ESSEC Business School

We develop a dynamic game of collaboration between a manufacturer and its supplier, where the fundamental issue is, for each player, how to allocate own resources between improving the design quality of a finished product and reducing its production cost. The supplier has the option either to update its transfer price throughout the game or to set a constant transfer price from the outset of the game. In dynamic games, the players' strategy depends on whether they commit to a predetermined plan of actions during the whole game so that their decisions can only be based on time (open-loop strategy), or they make contingent decisions based on the information on the rival's reaction to a change in the current state of the game, which allows for strategic interaction to take place throughout the game (closed-loop strategy). In order to distinguish between dynamic and strategic effects, we derive the open loop and closed-loop Nash equilibria, with the cooperative solution as a benchmark.

MB5   Localisation et design de réseaux 1 / Location and Network Design 1

Salle: Marie-Husny
Président: Gendron, Bernard, *Université de Montréal*

10h30   **Lagrangian Heuristics for Large-Scale Dynamic Facility Location with Generalized Modular Capacities**

Jena, Sanjay Dominik, Université de Montréal, sanjay.jena@cirrelt.ca
Cordeau, Jean-François, HEC Montréal, jean-francois.cordeau@hec.ca
Gendron, Bernard, Université de Montréal, bernard.gendron@cirrelt.ca

We consider a facility location problem with multiple time periods, modular capacities and multiple commodities that generalizes several existing location problems due to its general cost structure. We propose Lagrangian heuristics that provide stable results even for large-scale instances, for which general-purpose MIP solvers do not find feasible solutions.

10h55   **Exact Solution Methodologies for the Capacitated p-Center Problem**

Calik, Hatice, HEC Montreal, hatice.calik@gmail.com
Karasan, Oya, Bilkent University, karasan@bilkent.edu.tr
Tansel, Barbaros, Bilkent University

The capacitated p-center problem requires locating p facilities with capacity restrictions on a given network so that the maximum distance between demand nodes and the facilities they are assigned to is minimized. We propose new mathematical formulations and exact algorithms based on these formulations for solving the problem.

11h20   **Integrated Location – Service Network Design**

Duc Minh, Vu, Université de Montréal, vdmedragon@gmail.com
Crainic, Teodor Gabriel, Université du Québec à Montréal, TeodorGabriel.Crainic@cirrelt.ca
Hewitt, Mike, Loyola University Chicago, mhewitt3@luc.edu
Toulouse, Michel, Oklahoma State University, michel.toulouse@okstate.edu

We address the problem setting wherein a single unit of resource is required to operate a service, resources are assigned to terminals to which they must ultimately return, there are a finite number of resources assigned to each terminal, and the length of resource circuits is restricted. Moreover, a number of fleet utilization issues must be addressed at the beginning of the season: 1) repositioning resources among terminals to account for shifts in demand patterns; 2) acquire (buy or long-term rent) new resources and assign them to terminals; 3) outsource particular services. We present an integrated formulation combining these selection-location and scheduled service design decisions. The mixed-integer formulation is defined over a time-space network, the initial period modelling the location decisions on resource acquisition and positioning, while the decisions on service selection and scheduling, resource assignment and cycling routing, and demand satisfaction being modelled on the rest of the network. We also present a matheuristic solution method combining slope scaling and column generation, discuss its algorithmic performance, and explore the impact of combining the location and design decisions in the context of consolidation carrier service design.

11h45   **Affinely Adjustable Robust Location Transportation Problem**

Ardestani-Jaafari, Amir, HEC Montreal, amir.ardestani-jaafari@hec.ca
Delage, Erick, HEC Montreal, Erick.delage@hec.ca

We study the application of adjustable robust optimization to a location transportation problem with uncertain demand. Unlike previous approximations for this problem, the method we employ allow us to exploit the fact that while strategic decisions need to be immediately implemented, operational decisions can be delayed until the actual demand is observed.

MB6   Planification de la production d'électricité 1 / Electricity Production Planning 1

Salle: Nancy et Michel-Gaucher
Président: Gendreau, Michel, *Polytechnique Montréal*

10h30   **Short-Term Unit Commitment and Loading Problem for a Hydroelectric Production System**

Séguin, Sara, Polytechnique Montréal, seguin_sara@hotmail.com
Côté, Pascal, Rio Tinto Alcan, pascal.cote@riotinto.com
Audet, Charles, Polytechnique Montréal, charles.audet@polymtl.ca
Presentation of a method for solving the short-term unit commitment and loading problem of a hydropower system. Dynamic programming is used to compute maximum power output generated by a power plant. This information is then used as an input of a two-phase optimization process. The first phase consists of solving the relaxation of a nonlinear mixed-integer program in order to obtain the water discharge, reservoir volume and optimal number of units working at each period in the planning horizon. The second stage solves a linear integer problem to determine which combination of turbines to use at each period. The goal is to maximize total power produced over all periods of the planning horizon which consists of a week divided in hourly periods. Start-up of turbines are penalized. Two

power plants with five turbines each are used to test the approach on thirty different test cases.

10h55   **Adaptive Discretization Method of the State Space for Stochastic Dynamic Programming Applied to Multi-Reservoir System**

Krau, Stéphane, Ouranos, Krau.Stephane@ouranos.ca
Émiel, Grégory, Hydro-Québec, emiel.gregory@hydro.qc.ca
Merleau, James, Institut de recherche d'Hydro-Québec, merleau.james@ireq.ca

For most real-size problems, the SDP algorithm applied to multi-reservoir systems suffers from the curse of dimensionality. A priori discretization of both control and state space should be avoided to apply SDP in higher dimensions: with more reservoirs or/and hydrological variables. The proposed method starts from an initial grid of the state space and refines it by using a splitting process, until some desired approximation of the Bellman function is achieved. Discretization of the state space is done online and our strategy yields a non-uniform and adaptive discretization grid. Numerical results on real hydropower systems are presented.

11h20   **A Robust Optimization Model for the Short Term Reservoir Management Problem with Stochastic Inflows**

Gauvin, Charles, Polytechnique Montréal, charles.gauvin@polymtl.ca
Delage, Érick, HEC Montréal, erick.delage@hec.ca
Gendreau, Michel, Polytechnique Montréal, michel.gendreau@cirrelt.ca

This talk presents a robust optimization model for the short-term reservoir management problem with stochastic inflows. Existing models include stochastic dynamic programming and 2-stage stochastic programs. The former presents significant computational limitations while the latter cannot take into account the full dynamic nature of the problem. Robust optimization offers a third tractable alternative that remedies most of these shortcomings. Our model specifically incorporates water delays, correlations across time and reservoirs, variable water head as well as other complex physical constraints. We evaluate the use of simplifying assumptions which allow us to formulate the affinely adjustable robust counterpart (AARC) as a conic program. We discuss various ways to represent the underlying stochastic process and their repercussions on the feasibility of the program. Preliminary results are presented.

11h45   **Optimal Scenario Set Partitioning for Multistage Stochastic Programming Using the Progressive Hedging Algorithm**

Carpentier, Pierre-Luc, Polytechnique Montréal, pierre-luc.carpentier@polymtl.ca
Gendreau, Michel, Polytechnique Montréal, Michel.Gendreau@cirrelt.ca
Bastin, Fabian, Université de Montréal, bastin@iro.umontreal.ca

In this presentation, we propose a new approach to speed up the progressive hedging algorithm (PHA) for solving large-scale multistage 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. We demonstrate the efficiency of our method on an hydroelectricity generation scheduling problem with stochastic inflows.

MB7   Optimisation de boites noires / Black Box Optimization

Salle: St-Hubert
Président: Audet, Charles, *Polytechnique Montréal*

10h30   **Formulations for Surrogate-Based Constrained Blackbox Optimization**

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This presentation introduces different ways of using statistical surrogate tools within the Mesh Adaptive Direct Search (MADS) framework for constrained blackbox optimization. The surrogates that we consider are global models, providing capabilities for diversification in order to escape local optima. In addition, we focus on different formulations of the subproblem that is considered at each search step of MADS, and in practice, the dynaTree package is used. The formulations exploit different tools such as interpolation, classification, expected improvement and feasible expected improvement. Numerical examples are presented both on academic problems and on realistic applications.

10h55   **The Mesh Adaptive Direct Search Algorithm for Blackbox Optimization with Linear Equalities**

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The Mesh Adaptive Direct Search (MADS) algorithm is designed to solve blackbox optimization problems under general inequality constraints. Currently, MADS does not support equality constraints, both in theory and practice. The present work proposes extensions to solve problems with linear equality constraints. The main idea consists in reformulating the optimization problem into an equivalent one without equality constraints, with possibly fewer optimization variables. Our reformulations involve orthogonal projections, QR and SVD decompositions as well as Simplex decompositions into basic and nonbasic variables. All of our proposed strategies are studied in a unified convergence analysis, guaranteeing Clarke stationarity under mild conditions. Numerical results on a subset of CUTEr collection are reported.

11h20   **Robust Optimization of Noisy Blackbox Problems using the Mesh Adaptive Direct Search Algorithm**

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Mesh adaptive direct search (MADS) is an algorithm designed to solve blackbox optimization problems where the objective function typically corresponds to a computer simulation. In this talk, we are interested in problems contaminated with stochastic noise, as often observed in practice. We propose a smoothing technique for the elimination of noise, directly incorporated within the MADS framework. The objective of this new method is to obtain a solution that is stable relative to small perturbations in the solution space, as commonly desired by engineers. Numerical results illustrate the efficiency of this approach.

MB8   Programmation par contraintes 1 / Constraint Programming 1

Salle: TD Assurance Meloche Monnex
Président: Pesant, Gilles, *Polytechnique Montréal*

10h30   **Counting Spanning Trees to Guide Search in Constrained Spanning Tree Problems**

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Pesant, Gilles, Polytechnique Montréal, Gilles.Pesant@polymtl.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca

Counting-based branching heuristics such as maxSD were shown to be effective on a variety of constraint satisfaction problems. These heuristics require that we equip each family of constraints with a dedicated algorithm to compute the local solution density of variable assignments, much as what has been done with filtering algorithms to apply local inference. This paper derives an exact polytime algorithm to compute solution densities for a spanning tree constraint, starting from a known result about the number of spanning trees in a graph. We then empirically compare branching heuristics based on that result with other generic heuristics.

10h55   **Solution-Density Branching for Precedence Constrained Disjunctive Scheduling Problems**

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Pesant, Gilles, Polytechnique Montréal, Gilles.Pesant@polymtl.ca

Designing robust generic branching heuristics is an important step in making constraint programming competitive with other approaches to combinatorial problem solving. Among such heuristics those based on counting solutions, such as maxSD, exploit the structure of a model by querying each constraint about how frequently a given variable-value assignment appears in solutions. They require that we equip each family of constraints with a dedicated algorithm to compute the local solution density of variable assignments, much as what has been done with filtering algorithms to apply local inference. The area of scheduling has been an excellent proving ground for constraint programming. In this talk we propose exact and heuristic algorithms that compute solution densities for a disjunctive resource constraint with some precedences between tasks. We then show how branching heuristics derived from such information can be effective on scheduling problems such as the Jump Number Problem.

11h20   **Constraint Propagation for Constrained CP-Nets**

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Managing both constraints and preferences is often required when tackling a wide variety of real world applications such as scheduling, planning and configuration. The goal here is to satisfy all the constraints while maximizing a given utility function. We model these types of problems using the Constrained Conditional Preference Network (Constrained CP-Net) where preferences and constraints are represented through CP-Nets and Constraint Satisfaction Problems (CSPs) respectively. A CP-Net is a graphical model for managing qualitative preference statements including conditional preferences of the form: "If A is true then I prefer X over Y". A CSP involves a list of variables, each defined on a set of discrete values, and a list of constraints restricting the values that each variable can take. The aim here is to find a complete assignment of values to variables such that all the constraints are satisfied. Solving a constrained CP-Net consists then in finding a scenario satisfying all the constraints of the related CSP while maximizing all the CP-Net preferences. Constrained CP-Nets have gained a considerable attention recently and have been tackled using backtrack search. However, a little study has been dedicated to the effect of variable ordering heuristics as well as constraint propagation techniques on the performance of the backtrack search. We experimentally investigate several constraint propagation strategies while adopting well known variable ordering heuristics. This is done by conducting an experimental study on several constrained CP-Net instances randomly generated using the RB model.

11h45   **Achieving Domain Consistency and Counting Solutions for Balance Constraints**

Pesant, Gilles, Polytechnique Montréal, Gilles.Pesant@polymtl.ca

Many combinatorial problems require of their solutions that they achieve a certain balance of given features. For this important aspect of modeling, the spread and deviation constraints have been proposed in Constraint Programming to 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. In this presentation 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, a generic and effective family of branching heuristics that free the user from having to write problem-specific search heuristics. We provide a time complexity analysis of our contributions and also evaluate them empirically on the Balanced Academic Curriculum Problem and the Nurse to Patient Assignment Problem.

MC1   Séance plénière 2 / Plenary Session 2

Salle: Amphithéâtre Banque Nationale
Président: Ruiz, Angel, *Université Laval*

14h00   Robust Planning for Transportation and Routing

Rönnqvist, Mikael, Université Laval, mikael.ronnqvist@gmc.ulaval.ca

Transport and route planning in practice involve some level of robustness. One reason is to ensure that some suitable level of uncertainty in, for example, demand or transport needs are included in the planning process. Another is to make sure that the overall plan is efficient also for operations before and after the transportation, for example, production and distribution. A third reason is to make sure that the plan sustainable and avoids or limits so-called creaming or cherry picking. In this presentation, we focus on some transportation and route planning applications in natural resources to illustrate some of the above issues and describe how robust planning can be achieved (or at least improved). In particular, we will look at generation of suitable data, integrative and anticipative planning, and direct use of robust optimization.

MD1   Exposé magistral 2 / Tutorial 2

Salle: TAL Gestion globale d'actifs
Président: Errico, Fausto, *École de technologie supérieure*

15h30   Partial Decomposition Strategies for Two-Stage Stochastic Integer Programs

Rei, Walter, Université du Québec à Montréal, walter.rei@cirrelt.ca

In this talk we present the concept of partial Benders decomposition for two-stage stochastic integer programs. This decomposition strategy is based on the idea of retaining a subset of scenario subproblems in the master formulation such as to strengthen it throughout the solution process. We have developed a theory to support this strategy and illustrate how it may be applied to any stochastic integer program with continuous recourse. Such programs are used to model many practical applications such as the one considered in this talk, network design. They are also useful for solving problems with integer recourse as many solution methods for such problems also solve one of its linear relaxations. We will present an extensive computational study that shows the significant advantages of using a partial decomposition. Specifically, we show that this approach greatly reduces the number of optimality and feasibility cuts generated when solving a stochastic program with a Benders-based algorithm. Furthermore, we also show that the manner in which partial decomposition is performed has a significant impact on the results and we point to the most performant strategy.

MD2   Logistique en santé / Healthcare Logistics

Salle: CPA du Québec
Président: Ruiz, Angel, *Université Laval*

15h30   **Dynamic Vehicle Dispatching Problem for Emergency Vehicles Based on Information Dissemination**

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Benyahia, Ilham , Université du Québec en Outaouais, benyahia@uqo.ca
Potvin, Jean-Yves, Université de Montréal, potvin@iro.umontreal.ca

Despite sophisticated optimization contributions in dynamic emergency vehicle dispatching problem, few of them have considered their integration in Intelligent Transportation Systems architectures. In this context, dynamic and unforeseen environment changes might be better addressed. We propose for our study a reactive approach for vehicle dispatching based on a context aware and reconfigurable architecture. Several simulation experiments are performed considering realistic scenarios. The numerical results underline the effectiveness and benefits of the new approach to solve the new stated problem.

15h55   **Choix de l'ordonnancement optimal pour la séquence de rendez-vous en radiothérapie**

Beauchamp, Etienne, Polytechnique Montréal, etienne.beauchamp@me.com

Les patients attendant un traitement pour le cancer doivent passer par une série de rendez-vous de préparation. Les patients actuels obtiennent leur date de rendez-vous lorsque la phase précédente est terminée. Afin de permettre à un plus grand nombre de patients d'être traité dans les délais prescrits, nous avons étudié l'impact de choisir au préalable une date de traitement et de fixer les rendez-vous de préparation par la suite. Ceci permettra de trouver la date d'entrée optimale afin que la préparation soit la plus rapprochée de la date du premier traitement.

16h20   **Optimization Model for the Biomedical Sample Transportation Problem: A Case Study**

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Ruiz, Angel, Université Laval, Angel.Ruiz@osd.ulaval.ca

This talk presents a rich VRP in the challenging context of biomedical sample transportation, where different specimen's collection centers are visited, many times on the same day, with specifics time windows, in order to pick-up the samples that will be analyzed by a laboratory. We propose an optimization model to find a plan that minimizes the total transportation costs. The performance of our model is tested with a case study taken from the network of laboratories in the Quebec province.

16h45   **Modeling the Logistics Response to a Bioterrorist Anthrax Attack**

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We propose a model which links the disease progression, the related medical intervention actions and the logistics development to provide strategic level standpoint for extracting crucial insights on emergency logistics management. The new model provide significant contributions on the related area yet to be well studied

MD3	**Tournées de véhicules 2 / Vehicle Routing 2**

Salle: Gérard-Parizeau
Président: Langevin, André, *Polytechnique Montréal*

15h30 **Evolutionary Approaches to a Pickup and Delivery Problem with Incompatible Loads**

Schönberger, Jörn, University of Bremen, jsb@uni-bremen.de

A customer orders several goods that are delivered by two vehicles from different depots. The time span between the starting times of the two deliveries at a customer location must not be longer than a threshold value. We present evolutionary algorithm approaches that handle these inter-routes constraints in a pickup-and-delivery problem.

15h55 **A Hybrid Metaheuristic for the Pickup and Delivery Problem with Time Windows and LIFO Loading**

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We consider the pickup and delivery problem with time windows and last-in-first-out loading. This policy ensures that no handling is required while unloading objects from the vehicle. We propose a population-based metaheuristic and adapt the order crossover based on a giant tour representation. Computational results on medium-size instances are presented.

16h20 **A Hybrid Evolutionary Algorithm for Heterogeneous Fleet Vehicle Routing Problems with Time Windows**

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This paper presents a hybrid evolutionary algorithm (HEA) to solve heterogeneous fleet vehicle routing problems with time windows. The HEA successfully combines several metaheuristics and offers a number of new advanced efficient procedures. Extensive computational experiments on benchmark instances have shown that the HEA is highly effective on the problems.

16h45 **Solving the Rural Postman Problem with Time Windows**

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Langevin, André, Polytechnique Montréal, andre.langevin@polymtl.ca

We present a branch and cut algorithm to solve the Rural Postman Problem with Time Windows. For the largest instances a competitive Adaptive Large Neighbourhood Search is proposed. We tested the algorithms in a set of instances adapted from the literature and in a set of instances based on a real network.

MD4	**Chaine d'approvisionnement durable / Sustainable Supply Chain**

Salle: Hélène-Desmarais
Président: El Ouardighi, Fouad, *ESSEC Business School*

15h30 **Supply Chain Coordination to Enhance Environmental Sustainability**

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El Ouardighi, Fouad, ESSEC Business School
Sim, Jeong Eun, KAIST Business School

Environmental sustainability is essential to the sustainable economic development. In a bid to curb pollution, governments impose penalties on the firms to emit pollutants. But such policy's effectiveness is not strongly verified, in particular, in the real business world. We suggest a more market-driven approach, requiring coordination among the economic entities sharing the same supply chain. Consider a supply chain consisting of one manufacturer, one retailer, and consumers. We develop a differential game model, where the manufacturer emits CO_2 while producing the products. Using the model, we compare cases such as when the consumers are sensitive to the pollution by incorporating it into their demand function and when the retailer synchronizes its demand for the manufacturer with the consumers' demand for itself. We discuss managerial as well as economic implications of the analysis results.

15h55 **Prise en compte du développement durable dans les modèles et méthodes de conception des réseaux logistiques : un état de l'art**

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Cet état de l'art porte sur 65 articles intégrant des facteurs environnementaux ou sociétaux dans les modèles de conception de réseau logistiques. Nous classifions ces articles selon les modèles mathématiques, les approches de résolution et les domaines d'application. Nous concluons par l'exposé de pistes de recherches prometteuses.

16h20 **Implications of Environmental Mechanisms in a Closed-Loop Inventory Model**

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We study a recovery inventory problem subject to a cap-and-trade scheme. The problem is formulated as a stochastic dynamic model, and is solved by a genetic algorithm. Through numerical examples, we characterize the potential impact of the environmental strategy and parameter values on replenishment decisions, environmental performance and operational costs.

16h45 **The Impact of Double Marginalization on the Evolution of Pollution in a Simple Supply Chain**

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Sim, Jeong Eun, KAIST Business School, aian0307@business.kaist.ac.kr
Kim, Bowon, KAIST Business School, BowonKim@business.kaist.ac.kr

This paper seeks to assess the impact of decentralized decision-making in a simple supply chain composed of one manufacturer and one retailer on the evolution of pollution. This vertical impact, which is yet uncovered in the literature on pollution control, should differ both in nature and magnitude from the horizontal impact of decentralized decision-making, which consists in an improper internalization of the social costs of pollution.

MD5 — Localisation et design de réseaux 2 / Location and Network Design 2

Salle: Marie-Husny
Président: Paquet, Marc, *École de technologie supérieure*

15h30   **Multi-Layer Network Design**

Akhavan Kazemzadeh, Mohammad Rahim, Université de Montréal,
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Multi-Layer Network Design Problem represents a generalized case of network design problem, that recently has had the interesting applications in telecommunication and transportation. we first present a detailed review and analysis of existing literature, and we propose a multi-layer network design model including L arbitrary layers. Such model and its solution methods enable the researchers to apply them in any applications of telecommunication and transportation.

15h55   **Solving a Multi-tier Cloud Service Deployment Problem Using Branch-and-Price**

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Nygreen, Bjørn, Norwegian University of Science and Technology,
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We present a branch-and-price approach for solving a deployment problem faced by a provider of multi-tier services. The problem consists of finding a cost-efficient mapping between the service components and the infrastructure while providing a satisfactory service quality. Our results show that branch-and-price performs better than a direct MIP formulation.

16h20   **A Branch-and-Cut Algorithm for the Cycle Hub Location Problem**

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Contreras, Ivan, Université Concordia, icontrer@encs.concordia.ca
Vidyarthi, Navneet, Université Concordia, navneetv@jmsb.concordia.ca

In this talk we present the cycle hub location problem, in which a set of hubs have to be located and connected by means of a cycle. We present a new family of generalized mixed-dicut inequalities which are embedded into a branch-and-cut algorithm to optimally solve the problem. Computational results are reported.

16h45   **Localisation et dimensionnement des centres de données pour un service Internet dans la province du Québec**

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Nous présenterons une formulation mathématique pour le problème de localisation et dimensionnement des centres de données. Le problème est modélisé à l'aide d'un modèle de programmation en nombres entiers et résolu avec le solveur : LINGO. Également, nous présenterons des résultats préliminaires pour la résolution du modèle.

MD6 — Planification de la production d'électricité 2 / Electricity Production Planning 2

Salle: Nancy et Michel-Gaucher
Président: Côté, Pascal, *Rio Tinto Alcan*

15h30   **Short-Term Hedging for an Electricity Retailer**

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Gauthier, Geneviève, HEC Montreal, genevieve.gauthier@hec.ca

A dynamic global hedging procedure making use of futures contracts is developed for retailers of the Nord Pool electricity market. Statistical models are developed for the electricity load, the day-ahead spot price and futures prices. Backtests show that the proposed procedure provides considerable risk reduction when compared to hedging benchmarks.

15h55   **The Impact of Complexity in Stochastic Dynamic Programming Model for Hydropower Optimization**

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Robert, Leconte, Université de Sherbrooke, Robert.Leconte@USherbrooke.ca

In the field of reservoirs management, a very popular way to solve the optimisation problem is to use stochastic dynamic programming with a lag-one model to represent the inflows. We show in a case study on Kemano system, managed by Rio Tinto Alcan and located in B.C., how increasing modelisation complexity of inflows and constraints can lead to dramatic performance gains.

16h20   **Two Approaches to Aggregate Smart Grid's Energy Systems' Production Plan**

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Barty, Kengy, Électricité de France, kengy.barty@edf.fr

In this paper, we propose a mathematical programming formulation and a Markov chain Monte Carlo approach in order to compute the production plan of a smart grid by aggregating its energy systems' production plans and considering the physical constraints of the grid.

16h45   **Analyse du comportement de méthodes d'optimisation pour le calage efficace de modèles hydrologiques coûteux en temps de calcul**

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Alarie, Stéphane, Institut de recherche d'Hydro-Québec, alarie.stephane@ireq.ca

La recherche porte sur l'analyse du comportement de trois algorithmes d'optimisation (SCE-UA, DDS et MADS) lorsqu'employés pour le calage d'HYDROTEL, un modèle hydrologique distribué et à base physique coûteux en temps de calcul. L'étude présentera également la configuration adéquate de MADS quant au calage d'HYDROTEL et l'impact du type de modèle hydrologique sur le comportement des méthodes d'optimisation sélectionnées. Les résultats et conclusions de l'étude seront présentés.

MD7   Optimisation conique / Conic Optimization

Salle: St-Hubert
Président: Adams, Elspeth, *Polytechnique Montréal*

15h30   **Unsatisfiability and Semidefinite Certificates of Infeasibility**

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Vieira, Manuel V.C., Universidade Nova de Lisboa, mvcv@fct.unl.pt

The satisfiability problem can be formulated using semidefinite programming. If the semidefinite problem is infeasible, then the satisfiability instance is unsatisfiable, and a proof of unsatisfiability follows from the dual certificate of infeasibility. We show that this certificate can provide information about minimal unsatisfiable subformulas.

15h55 **Finding Better Solutions to Nonconvex Quadratic Equilibrium Problems Using Semidefinite Programming**

Gillett, Patricia, Polytechnique Montréal, patricia-lynn.gillett@polymtl.ca
Anjos, Miguel F., Stanford University, anjos@stanfordalumni.org

For nonconvex problems, many nonlinear solvers can return suboptimal solutions. We solve SDP relaxations to bound QPECs and also derive warmstarting points for use with a nonlinear solver. In many cases, the solutions found using warmstarting can be confirmed to be at least near-optimal by comparison with the SDP bounds.

16h20 **Disjunctive-Conic-Cuts and Mixed Integer Second Order Cone Pptimization**

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Belotti, Pietro, FICO
Pólik, Imre, SAS Institute
Ralphs, Ted, Lehigh University, ted@lehigh.edu
Terlaky, Tamás, Lehigh University

Mixed integer second order cone optimization (MISOCO) problems have a increasing number of engineering applications including supply chain, finance, and networks design. In this talk we analyze the derivation of Disjunctive-Conic-Cuts (DCCs) for MISOCO problems. We present a full characterization of the DCCs when the disjunctive set considered is defined by parallel hyperplanes.

16h45 **Separating Hierarchical Cuts to Strengthen Semidefinite Relaxations of Max-Cut Problems**

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The max-cut problem can be closely approximated using the basic semidefinite relaxation and iteratively refined by adding valid inequalities. We propose a projection polytope as a new way to improve the relaxations and a separation algorithm to identify which of these are valid cuts. Theoretical and computational results will be presented.

MD8   Programmation par contraintes 2 / Constraint Programming 2

Salle: TD Assurance Meloche Monnex
Président: Rousseau, Louis-Martin, *Polytechnique Montréal*

15h30 **Constraint Programming for LNG Ship Scheduling and Inventory Management**

Goel, Vikas, ExxonMobil
Slusky, Marla, Carnegie Mellon University
van Hoeve, Willem-Jan, Carnegie Mellon University, vanhoeve@andrew.cmu.edu
Furman, Kevin, ExxonMobil
Shao, Yufen, ExxonMobil

We propose a constraint programming approach for the optimization of inventory routing in the liquefied natural gas industry. We present two constraint programming models that rely

on a disjunctive scheduling representation of the problem. We also propose an iterative search heuristic to generate good feasible solutions for these models. Computational results on a set of large scale test instances demonstrate that our approach can find better solutions than existing approaches based on mixed integer programming, while being 4 to 10 times faster on average.

15h55 **A Hybrid Constraint Programming Approach to a Wood Procurement Problem with Bucking Decision**

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Frayret, Jean-Marc, Polytechnique Montréal, jean-marc.frayret@polymtl.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca

We present a wood procurement problem that arises in the Eastern Canadian context. We will solve a multi-period wood supply planning problem, while taking into account bucking decisions. Furthermore, we present a form of flexibility which allows changing the harvesting capacity from time period to another. We study its impact upon the harvesting capacity used and the harvesting cost. We assessed its performance by comparing it to a variant where the harvesting capacity is kept unchanged. To address this problem, we develop a hybrid approach based on both Constraint and Mathematical Programming. In the first phase, we propose a constraint programming model dealing with forest sites harvesting and bucking problem. The result of this model will be used as an initial partial solution for the whole problem formulated as a mixed integer model. We tested the two versions of the problem on a set of different demand instances and we compared their results.

16h20 **A General Model for Operating Room Planning and Scheduling Problems; a Constraint Programming-Based Branch-and-Price-and-Cut Approach**

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Pesant, Gilles, Polytechnique Montréal, gilles.pesant@polymtl.ca

The goal of this paper is to present an efficient algorithm capable of solving a wide range of integrated operating room planning and scheduling problems which combine the assignment of surgeries to operating rooms and their scheduling over a short-term planning horizon. There are many details such as maximum daily working hours of surgeons, prevention from overlapping of surgeries corresponding to the same surgeon, obligatory cleanings due to switching from infectious to non-infectious surgeries and due dates of surgeries which must be respected. The problem is formulated as a mathematical programming model and a branch-and-price-and-cut algorithm is developed based on a constraint programming model to solve the subproblem. Some dominance rules and a fast infeasibility checking criterion based on a multidimensional knapsack problem are also developed which effectively improve the efficiency of the constraint programming model. Extensive computational results demonstrate the superiority of the proposed method to a compact mathematical formulation in the literature.

17h15 **Salon l'Oréal : Réception vins et fromages**

Mardi 6 mai 2014 / Tuesday, May 6, 2014

TA1   Séance plénière 3 / Plenary Session 3

Salle: Amphithéâtre Banque Nationale
Président: Ruiz, Angel, *Université Laval*

09h00   Order-First Route-Second Methods in Vehicle Routing

Prins, Christian, Université de Technologie de Troyes, christian.prins@utt.fr

Cluster-first route-second methods like the sweep heuristic (Gillett and Miller, 1974) are well known in vehicle routing. They determine clusters of customers compatible with vehicle capacity and solve a traveling salesman problem for each cluster. The opposite approach, called route-first cluster-second, builds a TSP tour (also called giant tour) covering all customers and splits it into feasible trips. Cited as a curiosity for a long time but lacking numerical evaluation, this technique has led to successful solution methods for various vehicle routing problems in the last decade. As most implementations order the visits to customers instead of building a giant tour, such algorithms are better called order-first split-second methods. The talk will present the principles of these approaches and examples of applications, from simple cases to less obvious contexts.

TB1   Exposé magistral 3 / Tutorial 3

Salle: TAL Gestion globale d'actifs
Président: Gendreau, Michel, *Polytechnique Montréal*

10h30   A Column Generation with Constraint Programming Scheme that Considers Robust Optimization, Simulation, and Local Search Heuristics to Solve Several Versions of a Real Technician-Dispatching Problem

Cortés, Cristián E., Universidad de Chile, ccortes@ing.uchile.cl

In this tutorial, I will show a family of models and solution methods we have been working on the last years, to solve a real application of a technician dispatching problem from one year data of a large company providing repair service of office machines in Santiago-Chile. Crucial in the problem is to incorporate clients with different priorities, phenomenon that is modeled with the soft time windows. It is worth to mention that different conditions generate different solution schemes. We started with the static deterministic routing of technicians for daily planning, in which we assume that service requests are well known in advance; for this case, we propose a branch and price scheme to solve a vehicle routing problem with soft time windows, in which the subproblems are efficiently solved by means of a constraint programming model, which allows the implementation of a generic branching scheme to explore efficiently the different nodes in the tree. We then decide to add uncertainty in service times formulating a robust counterpart of the previous problem, ending up with a similar formulation and solution method, but now providing safer solutions in the sense of avoiding unnecessary delays due to stochasticity in service times. The third step was the development of an annual planning scheme, in which we combine simulation with the optimization scheme for the daily operation, to design the fleet requirements over a whole year of operation. Finally, we show the formulation of the dynamic version of the problem, in which decisions are made in real-time while clients appear dynamically into the system; the model is based on dynamic column generation, including idle points together with covering rules to ensure adequate level of service to clients, and efficient local search heuristics to dynamically generate new columns to be added to the model. All versions (deterministic routing, robust counterpart, dynamic routing and fleet design) are tested with real data, showing interesting and intuitive results for various scenarios of high, medium

and low demand levels under various configurations and uncertainty in demand and service times. Coauthors: Paulina Briceño, Michel Gendreau, Daniel Leng, Fernando Ordoñez, José Rojas, Louis Martin Rousseau, Sebastián Souyris, Andrés Weintraub.

TB2   Transport aérien et par rail / Airline and Rail Transportation

Salle: CPA du Québec
Président: Atoosa, Kasirzadeh, *Polytechnique Montréal*

10h30   Optimization of Train Timetables Adapted to Dynamic Demand Based on Riemann's Sums

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We study the non-cyclic railway timetabling problem adapted to dynamic demand, thus focusing on passenger welfare. We analyze its similarities with Riemann's Sums and make use of the results of the latter in order to propose a metaheuristic which solves large instances of the problem within short computation times.

10h55   Improving Branching in the Crew Pairing Problem with Credit Constrains

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Desaulniers, Guy, Polytechnique Montréal, guy.desaulniers@gerad.ca

The airline crew scheduling problem is studied by many researchers. Usually, the problem is divided in two steps : the crew pairing and the crew rostering problems. This paper focuses on the former. We first show data relative to the airline crew scheduling problem, which will be published on the Internet. These are designed to be used as standard instances by other researchers, both on the crew pairing and the crew scheduling problem. We then present an original version of the pairing problem that includes constraints limiting the credit allowed for each base during the whole period. In some cases, these constraints increase difficulty to reach integer solutions. We present a systematic analysis of the behaviour of the branching phase according to the tighness of the constraints.

11h20   A Heuristic Algorithm for Personalized Crew Scheduling Problem

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Soumis, François, Polytechnique Montréal, francois.soumis@gerad.ca

We present a set-covering formulation and an iterative heuristic algorithm for personalized integrated cockpit pairing and assignment problems. The objective is having as much as possible similar pairings between pilots and co-pilots to increase the schedules robustness, even if pilots and co-pilots schedules are different to satisfy their preferences. We use a solution approach based on column generation for this problem. The computational results are provided based on a major US carrier data set.

11h45   Interactions Between Operations and Planning in Air Traffic Control

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Air traffic in Europe is predicted to largely increase over the next decades. In such a context, we present a study of the interactions between costs due to ground holding regulation and costs due to en-route air traffic control. With that in mind, a traffic simulator including the computations of regulation delays, aircraft trajectories and air conflict resolution is described. Through intensive simulations based on traffic forecasts extrapolated from 2012 historical French traffic data, regulation delays and avoidance maneuvers are computed assuming the current regulation or no regulation at all. The resulting costs analysis highlights the exponential growth of regulation costs that should be expected if the airspace capacity and the involved procedure do not change. Compared to this, the costs of air traffic control remain negligible whether regulation is performed or not. The analysis of controllers' workloads however emphasizes the future need to combine automated tools assisting controllers with a regulation better adapted to bigger traffic volumes.

TB3   Tournées de véhicules 3 / Vehicle Routing 3

Salle: Gérard-Parizeau
Président: Côté, Jean-François, *Université Laval*

10h30   **Limited Memory Subset Row Cuts (lm-SRC) for Routing Problems**

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Pessoa, Artur, Universidade Federal Fluminense, artur@producao.uff.br

Subset Row Cuts are frequently used to improve linear relaxation bounds for routing problems and often significantly impact the pricing efficiency. We propose the lm-SRC a weakening of the SRCs. They are decisive in the optimal resolution of CVRP instances with 300 or more clients. Extensive experiments are reported.

10h55   **Global Optimization of the Vehicle Routing and Scheduling Problem with Delivery and Installation**

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Guo, Lei, Shanghai Jiao Tong University, guolayne@sjtu.edu.cn

In the context of household appliance distribution, the delivery and installation activities are usually separated and synchronized, which imposes great difficulty on vehicle routing and scheduling. In this paper, a mixed integer program is proposed to model the synchronized vehicle routing and scheduling problem of delivery and installation (VRPDI) of these products. We develop a two-step exact algorithm to solve the problem. The first step includes a two-stage hybrid heuristics based on Clarke and Wright Savings algorithm, and the second step is based on Augmented Lagrangian method. The effectiveness and efficiency of this algorithm are tested and verified by several numerical tests.

11h20   **A Priori Optimization with Recourse for the Vehicle Routing Problem with Hard Time Windows and Stochastic Service Times**

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Rei, Walter, Université du Québec à Montréal, walter.rei@cirrelt.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca

The VRPTW-ST differs from other routing problems with stochastic times for the presence of hard time windows. We model the VRPTW-ST as a two-stage stochastic program and define two recourse policies to recover first stage infeasibility. We solve the VRPTW-ST by exact branch-cut-and-price algorithms. Our development included finding tight bounds on partial route reduced costs to efficiently prune dominated labels in the column generation subproblem. Results on benchmark data show that our methods are able to solve instances with up to 50 customers for both recourse policies.

11h45 **The Vehicle Routing Problem with Stochastic Two-Dimensional Items**

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Potvin, Jean-Yves, Université de Montréal, potvin@iro.umontreal.ca

We consider a stochastic vehicle routing problem where a discrete probability distribution characterizes the two-dimensional size of a subset of the items to be delivered to customers. Although some item sizes are not known with certainty when the routes are planned, they become known when it is time to load the vehicles.

TB4   Localisation de plaques tournantes / Hub Location

Salle: Marie-Husny
Président: Contreras, Ivan, *Université Concordia*

10h30 **Lagrangean Relaxation for p-Hub Arc Location Problems with Isolated Hubs**

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In this talk we present p-Hub Arc Location Problems with Isolated Hub nodes. We develop a Lagrangean relaxation algorithm that exploits the structure of a path-based formulation to efficiently obtain lower and upper bounds on the optimal solution value. Computational results on instances with up to 100 nodes are reported.

10h55 **Exact and Heuristic Algorithms for the Multiple Hub Line Location Problem**

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Martins de Sa, Elisangela, Federal University of Minas Gerais,
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We present solution algorithms for a hub location problem in which one must locate hub nodes and arcs so that the resulting network forms a set of lines. The problem arises, e.g., in the design of rapid transit systems comprising several intersecting lines. We introduce a Benders decomposition to compute lower bounds on the optimal solution value as well as meta-heuristics to obtain good feasible solutions. Computational results are reported on instances with up to 70 nodes and three lines.

11h20 **Hub Network Design Problems with Profits**

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Fernandez, Elena, Universitat Politècnica de Catalunya, e.fernandez@upc.edu

In this talk we present Hub location Problems with Profits, where it is not necessary to provide service to all demand nodes. A profit is associated with each flow between pair of nodes. The goal is the simultaneous optimization of the collected profit, the set-up cost of the hub network and the routing cost for routing the flow. Potential applications appear in

the design of airline and ground transportation networks. Mathematical models and a unifying Lagrangean relaxation approach are presented to solve this class of problems. Numerical results on a set of benchmark instances are reported.

11h45   **Robust Uncapacitated Hub Location**

Contreras, Ivan, Université Concordia, ivan.contreras@cirrelt.ca
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Nikbakhsh, Ehsan, Tarbiat Modares University, ehsan.nikbakhsh@cirrelt.ca

In this talk we present robust uncapacitated hub location problems in which uncertainty is associated with demands and transportation costs and modeled with a budget of uncertainty set. We study three robust counterparts of the well-known uncapacitated hub location problem with multiple assignments. The first focuses on demand uncertainty, the second one deals with transportation cost uncertainty and the third one considers both demand and transportation cost uncertainty. Computational experiments are reported.

TB5   RO dans l'industrie minière / OR in the Mining Industry

Salle: Nancy et Michel-Gaucher
Président: Gamache, Michel, *Polytechnique Montréal*

10h30   **Underground Stope Optimization with Maximum Flow Method**

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A novel stope optimizer for underground mining is presented. The optimizer is based on maximum flow method, and is analogous to the ultimate pit optimization in surface mining. It seeks to maximize the profit of stopes that respect the geometrical constraints. It can produce heuristic solutions for various deposit shapes mined with sublevel stoping method.

10h55   **Optimize a Mineral Supply Chain with Uncertainties Integrating Long-term Contracts**

Ray, Jian Zang, Université McGill, neu.zhang@gmail.com
Roussos, Dimitrakopoulos, Université McGill, roussos.dimitrakopoulos@mcgill.ca

A mining complex's strategic and tactical plans for production and transportation are optimized in consideration of both contracted customers and the spot market. The proposed mixed-integer stochastic program model can be employed before signing a long-period sale contract to reduce risk due to the resource and market uncertainties.

11h20   **A Multi-Neighborhood Tabu Search Metaheuristic for Stochastic Production Scheduling**

Senécal, Renaud, Université McGill, renaud.senecal2@mail.mcgill.ca
Dimitrakopoulos, Roussos, Université McGill, roussos.dimitrakopoulos@mcgill.ca

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 robust destination for materials mined from the deposit. A case study shows the computational advantages of the methods.

11h45   **Progressive Hedging Applied as a Metaheuristic to Schedule Production in Open-pit Mines Accounting for Metal Uncertainty**

Lamghari, Amina, Université McGill, amina.lamghari@mail.mcgill.ca

We consider a stochastic version of the open-pit mine production scheduling problem, where the uncertainty stems from the orebody metal content. We propose a solution approach based on Rockafellar and Wets' progressive hedging algorithm. Computational experiments indicate the efficiency of the proposed approach in generating near-optimal solutions.

TB6   Programmation linéaire / Linear Programming

Salle: St-Hubert
Président: Partovi Nia, Vahid , *Polytechnique Montreal*

10h30   **Deploying Concavity Cuts in BILD Problems**

Geagea, Maikel, Polytechnique Montréal, maikel.geagea@polymtl.ca

In the context of concave minimization, we propose two ways to extend the standard concavity cuts algorithm. First, we devise a strategy to dynamically update the cuts. Second, we allow cuts to be rooted at pseudo-vertices. This strategies can overcome some literature results. Numerical experiments are presented.

10h55   **Dual-Guided Pivot Rules for Linear Programming**

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We describe a generic primal algorithm guided by dual feasibility considerations. Special cases are the Primal Simplex, the strongly polynomial Minimum Mean Cycle-Canceling algorithm for network flow problems, and the Improved Primal Simplex. Properties of this generic algorithm allow identifying subsets of fixed dual variables that totally avoid degenerate pivots.

11h20   **Improving the Quality of Dual Solutions in Column Generation**

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A degenerate master problem(MP) produces poor quality dual solutions increasing drastically the number of column generation(CG) iterations. We propose a new CG algorithm where, at each iteration, the dual solution is partially given by an aggregated MP and completed by an auxiliary problem. This approach produces more central dual solutions and the iterations number is considerably reduced. We report numerical results on instances of the Vehicle and Crew Scheduling Problem.

11h45   **Uncertain Relative Efficiency Computation through Linear Programming**

Partovi Nia, Vahid , Polytechnique Montréal, vahid.partovinia@polymtl.ca

Computing or predicting the relative efficiency of decision making units is one of the most important issues in management and resource allocation. Relative efficiency is easy to compute if there is just one output variable and one input variable. The ratio of the output divided by the input is the efficiency, and the computed efficiencies are scaled to have maximum unit value to produce the relative efficiency. While there are several output and input variables, the relative efficiency computation is generalized by means of linear programming, also called Data Envelopment Analysis. However, often input and output measurements include uncertain measurements, and this complicates the analysis further.

I will talk about the proper handling of this uncertainty in computation of the relative efficiency.

TB7   Programmation par contraintes 3 / Constraint Programming 3

Salle: TD Assurance Meloche Monnex
Président: Chinneck, John, *Carleton University*

10h30   **A Variable Ordering Heuristic within a Parallel GA Approach for Constraint Satisfaction Problems**

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A Constraint Satisfaction Problem (CSP) corresponds to a finite set of variables with finite domains, and a finite set of constraints restricting the possible values that each variable can take. Solving a CSP consists in finding a complete assignment of values to all the CSP variables such that all the constraints are satisfied. Many real life applications under constraints, such as scheduling and planning, can be efficiently solved with CSPs using a backtrack search algorithm where constraint propagation is performed to reduce the size of the search space. While some attempts have been made to tackling CSPs using Genetic Algorithms (GAs), this latter approach suffers from the poor crossover operator. In order to overcome this limitation, we propose a variable ordering heuristic with a novel crossover and their integration into a parallel architecture. This new system enables the solving of hard problem instances as validated by the experimental tests conducted on CSPs randomly generated using the RB model, as well as those instances taken from Lecoutre's CSP library. We will indeed demonstrate, through these tests, that our proposed method is superior to the known GA based techniques for CSPs. In addition, we will show that we are able to compete with the efficient MAC-based Abscon 109 solver. Finally, we will demonstrate through additional experiments that our parallel architecture has an anytime property and is capable of solving CSPs in real time by returning a solution with a quality (number of solved constraints) depending on the time allocated for computation.

10h55   **Parallel Depth-bounded Discrepancy Search**

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Search strategies such as Limited Discrepancy Search (LDS) and Depth-bounded Discrepancy Search (DDS) find solutions faster than a standard Depth-First Search (DFS) when provided with good value- selection heuristics. We propose a parallelization of DDS: Parallel Depth- bounded Discrepancy Search (PDDS). This parallel search strategy has the property to visit the nodes of the search tree in the same order as the centralized version of the algorithm. The algorithm creates an intrinsic load-balancing: pruning a branch of the search tree equally affects each worker's workload. This algorithm is based on the implicit assignment of leaves to workers which allows the workers to operate without communi- cation during the search. We present a theoretical analysis of DDS and PDDS. We show that PDDS scales to multiple thousands of workers. We experiment on a massively parallel supercomputer to solve an industrial problem and improve over the best known solution.

11h20   **A Constraint Programming Approach to the Minimum Connected Dominating Set Problem**

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A dominating set of an undirected graph is a subset S of its vertices such that every vertex of that graph is either in S or adjacent to a vertex in S. Finding a minimum size connected dominating set is NP-hard but has important applications in communication and computer networks, especially as a virtual backbone in wireless networks. An iterative probing strategy solving the problem by integer programming was recently proposed. We present an alternative of this approach using Constraint Programming. We propose a global constraint for handling connectivity and a propagator using a lower bound on the Steiner number obtained by performing a breadth-first-search on each connected component of the dominating set under construction. We provide comparative empirical results.

11h45   **Experiments in Using Google's Go Language for Optimization Research**

Chinneck, John, Carleton University, chinneck@sce.carleton.ca

New optimization algorithms that do not take into account parallel execution are handicapped since multi-core machines are now everywhere, including on desktop PCs. For a recent project I searched for a programming language that has three characteristics: (i) easy to program, (ii) simple facilities for dealing with parallelism, and (iii) fast compilation and execution. Google's free Go language (see golang.org) seemed to fill the bill. I report on experiments in using Go to program an experimental optimization heuristic.

TB8   Journée industrielle de l'optimisation 1 / Industrial Optimization Day 1

Salle: Banque CIBC
Président: Rousseau, Louis-Martin, *Polytechnique Montréal*

10h30   **Présentation de Clear Destination**

Tagmouti, Mariam, Université de Montréal, Maria.Tagmouti@cirrelt.ca

Clear Destination provides an unmatched route optimization software solution in the Home Delivery of Large Items (furnitures, appliances, electronics...). The company was created 6 years ago because people experienced wasted time, inconsistent services, unpredictable delivery time windows. At Clear Destination, we were convinced that home delivery could be done with greater efficiency at a reduced cost. It had to be made more predictable, more transparent, more concise and more monitorable all translating into greater satisfaction and meaningful savings. We will share real world home delivery problems related to appointment scheduling, automating delivery service time and service task per product or service, planning deliveries and taking account of trafic.

10h55   **Présentation de GIRO**

Fleurent, Charles, GIRO Inc., charles.fleurent@giro.ca

Fondée en 1979, GIRO fournit des solutions logicielles et des services reliés pour des applications spécialisées du transport, notamment pour les domaines du transport public et des opérations postales. La présentation porte sur différents problèmes d'optimisation qui sont rencontrés dans ces secteurs, de même que sur les techniques de résolution qui sont utilisées en pratique.

11h20   **Présentation de ExPretio**

Boivin, Simon, Technologies Expretio, simon.boivin@expretio.com

ExPretio is a Montreal-based company that has developed a choice-based Revenue Optimization technology for transportation industries such as airlines and railways. We use discrete choice models to understand passenger behaviour and maximize resource

utilization by allocating limited resource units to the sale of products that contribute the most to revenue.

11h45   **Présentation Artelys**

Tarel, Guillaume, Artelys Canada, guillaume.tarel@artelys.com

Artelys est une entreprise spécialisée en optimisation, aide à la décision et modélisation. Grâce à une expertise de haut niveau dans les techniques quantitatives, ses consultants conçoivent et mettent en œuvre les solutions les mieux adaptées aux besoins de leurs clients. Ils interviennent dans des secteurs d'activité diversifiés : énergie, logistique & transport, télécommunications, finance et défense.

TC1   Séance plénière 4 / Plenary Session 4

Salle: Amphithéâtre Banque Nationale
Président: Gouveia, Luis , *University of Lisbon*

14h00   **Decomposition Methods for Network Design**

Gendron, Bernard, Université de Montréal, bernard.gendron@cirrelt.ca

Network design applications are prevalent in transportation and logistics. We consider the multicommodity capacitated fixed-charge network design problem (MCND), a generic model that captures three important features of network design applications: the interplay between investment and operational costs, the multicommodity aspect and the presence of capacity constraints. We focus on mathematical programming approaches for the MCND and present four classes of methods that have been used to solve large-scale instances of the MCND: cutting-plane, column generation, Benders decomposition and Lagrangian relaxation.

TD1   Exposé magistral 4 / Tutorial 4

Salle: TAL Gestion globale d'actifs
Président: Pesant, Gilles, *Polytechnique Montréal*

15h30   **Decision Diagrams for Discrete Optimization**

van Hoeve, Willem-Jan, Carnegie Mellon University, vanhoeve@andrew.cmu.edu

This tutorial provides an overview of the recent successful application of multivalued decision diagrams (MDDs) to represent and solve discrete optimization problems. The first part of the tutorial introduces limited-size MDDs to obtain upper and lower bounds for integer optimization problems. The resulting discrete bounds can be much stronger than continuous bounds based on linear programming, while being faster to compute. We present computational results on classical optimization problems including maximum independent set, maximum cut, and set covering problems. In the second part we discuss the use of MDDs in the context of constraint-based scheduling. In particular, we show how MDDs can be effectively applied to solve complex disjunctive scheduling problems. The resulting technology can outperform state-of-the-art industrial CP solvers by orders of magnitude in certain cases.

TD2   Ressources naturelles et environnement / Natural Resources and Environment

Salle: CPA du Québec
Président: Ruiz, Angel, *Université Laval*

15h30   **Modelling Geoengineering: the Ada-BaHaMa Approach**

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Chesney, Marc, Université de Zurich
Gheyssens, Jonathan, Université de Zurich
Knutti, Reto, ETH Zurich
Pana, Ana, Université de Zurich

We investigate geoengineering as a possible substitute for adaptation and mitigation to address climate change. With the help of Ada-BaHaMa, an integrated assessment model, we distinguish between the effects of solar radiation management (SRM) on atmospheric temperature levels and its side effects on ecosystems. To address the uncertainty regarding the magnitude of side effects, we rely on a distributional analysis. Our results indicate that mitigation is the preferred strategy, with adaptation acting as an effective complement. As SRM brings significant side effects, it is used in only a few of the analyzed scenarios. We then discuss additional concerns with SRM that further reduce its feasibility.

15h55   **Forest Resource Value Maximization through a Sustainable Allocation to Forest Companies**

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Given that forests are public owned in the province of Quebec; companies exploiting the forest resource are expected to process it in such a way that all economic, ecological, and social benefits are maximized. In this sense, a new forest policy law came into force in 2013 changing considerably how cutting rights are attributed to forest companies. Our research addresses the problem of allocating forests to companies in order to maximize the sustainable value. To this end, we propose a methodology that combines two decision-making techniques: AHP (Analytical Hierarchy Process) and linear programming (LP). AHP allows evaluating the performance of the candidate mills according to a set of economic, environmental, and social criteria. The scores obtained for each candidate are then used as inputs of the LP that maximizes the overall sustainability value of the allocated forest resource while the maximum allowable cut and the minimum guaranteed volumes are satisfied.

16h20   **Location of Water Depots in Open-Pit Mine Networks**

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Langevin, André, Polytechnique Montréal, andre.langevin@polymtl.ca

In open-pit mines, water is periodically sprayed over hauling roads by means of a set of trucks with limited capacity in order to suppress dust. The trucks refill at a water depot. We present a L-A-R (location, allocation, and routing) approach for locating water depots so that penalty costs for the lack of humidity in roads and routing costs are minimized.

16h45   **Underground Mine Planning Considering Geological Uncertainty**

Carpentier, Sabrina, Polytechnique Montréal, sabrina.carpentier@polymtl.ca
Dimitrakopoulos, Roussos, Université McGill, roussos.dimitrakopoulos@mcgill.ca

A mathematical model to optimize underground mine long term scheduling is presented. It corresponds to a second phase of a deterministic planning: a stochastic aspect is added in order to integrate geological uncertainty. The mining project corresponds to five potential mines, each being composed of several mineralized zones shaped as lenses. The mathematical model aims to maximize net present value while reducing geological risks.

The parameters are related to ore tonnage and average grade. In this stochastic approach, we used a grade tonnage curves for every simulation used. As outputs, we obtain the lenses to be mined, their cut-off grade, the starting time of their extraction and their production rate.

TD3   Tournées de véhicules 4 / Vehicle Routing 4

Salle: Gérard-Parizeau
Président: Erdogan, Gunes, *University of Southampton*

15h30   A Tabu Search Algorithm for the Fleet Size and Mix Inventory Routing problem

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A heuristic algorithm based on tabu search has been proposed to solve the fleet size and mix IRP, consisting of define the frequency and quantity of delivery to each customer, the number of vehicles, and the routing of each vehicle. Satisfactory results have been produced for a set of test problems used in the literature

15h55   A Heuristic for the Cyclic Inventory Routing Problem

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The Cyclic Inventory Routing Problem (CIRP) is concerned with finding a cyclic schedule for the distribution of a single product to a number of sales-points. The problem involves multiple vehicles that can be dispatched several times during their shift. Each sales-point has a local inventory capacity, a constant consumption rate and stock-outs are not allowed. The goal is to compose multiple trips which serve all sales-points and minimize the combination of transportation, inventory and vehicle costs, in a cyclic distribution pattern. Each trip can have a different frequency in the vehicle schedule. This is an important aspect that makes this so called Cyclic Inventory Routing Problem (CIRP) more complex than other Inventory Routing Problems. Our solution approach decomposes the problem into two different but related sub-problems. For each sub-problem, we propose a new heuristic. Our first heuristic composes trips based on cost estimations for node transfers between trips. The second algorithm tries to combine these trips in an acceptable cyclic schedule. In order to search the feasible area efficiently, three diversification moves are designed. Also a new type of "hash function" is used to prevent searching the same part of the solution space repeatedly. The proposed algorithm is capable of finding high quality solutions in a reasonable time, especially for large instances. Applying the algorithm on 320 available benchmark instances, for more than half of them, the best known solution is improved. The results show, on average, a 2.5% improvement in the objective function value compare to the best known results in the literature.

16h20   An Adaptive Large Neighborhood Search for a Two Echelon Vehicle Routing Problem Arising in City Logistics

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Lehuédé, Fabien, École des Mines de Nantes, fabien.lehuede@emn.fr

We consider a Two Echelon Vehicle Routing Problem (2E-VRP) which integrates constraints arising in City Logistics such as: time windows, synchronization, and multiple

trips for some vehicles. We have developed an ALNS that benefits both from custom ruin and recreate heuristics and an efficient feasibility check.

16h45   **An Exact Algorithm for the One Commodity Pickup and Delivery Traveling Salesman Problem with Multiple Visits**

Erdogan, Gunes, University of Southampton, G.Erdogan@soton.ac.uk
Battarra, Maria, University of Southampton, M.Battarra@soton.ac.uk
Wolfler Calvo, Roberto, Université Paris 13, roberto.wolfler@lipn.univ-paris13.fr

Shared Bicycle Systems are becoming increasingly popular. The problem of rebalancing stations is of particular interest. Although the Static Rebalancing Problem with Multiple Visits has been studied (Chemla, Meunier, Wolfler Calvo 2013), no exact solution algorithms have been proposed. This paper provides the first exact solution algorithm for the Static Bicycle Rebalancing Problem with Multiple Visits. The algorithm is based on solving a relaxed formulation of the problem, checking for feasibility of incumbents through an implicit enumeration scheme, and adding combinatorial Benders cuts to rule out infeasible solutions. Computational results for benchmark instances are provided.

TD4   Logistique de transbordements / Cross Docking Logistics

Salle: Marie-Husny
Président: Contardo, Claudio, *Université du Québec à Montréal*

15h30   **Lagrangean Relaxation for the Cross-Dock Door Assignment Problem**

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As'ad, Rami A. M., American University of Sharjah, rafif@aus.edu

In this talk, we study a Cross-dock door assignment problem. We present a mixed integer programming formulation that is embedded into a Lagrangean relaxation to obtain bounds on the optimal solution value. A heuristic is used to obtain high quality feasible solutions. Numerical results are reported.

15h55   **Heuristics for Truck Scheduling in Cross-Docking Terminals**

Yan , Wenying, Université Concordia, ywysteve@gmail.com
Contreras, Ivan, Université Concordia, icontrer@encs.concordia.ca

In this talk we study a truck scheduling problem arising in cross-docking terminals. It consists of sequencing a set of inbound and outbound trucks to a single strip and stack door to minimize the makespan. We present four different heuristic algorithms: a local search, a simulated annealing, a large neighborhood search, and a beam search. Computational experiments are reported.

16h20   **A Two Stage Optimization Approach to Schedule Material Handling at Cross-Cock**

Maknoon, Mohammad Yousef, Polytechnique Montréal, mohammad-yousef.maknoon@polymtl.ca
Baptiste, Pierre, Polytechnique Montréal, pbaptiste@polymtl.ca
Anjos, Miguel, Polytechnique Montréal, miguel-f.anjos@polymtl.ca

The operational cost at the cross-dock relates to the manner of processing freight that includes unloading, transferring, consolidating and loading products. In this talk, we represent a two stage optimization approach to synchronize the internal process that minimizes the operational cost.

| 16h45 | **Column Generation for the Cross-Dock Assignment and Vehicle Routing Problem** |

Enderer, Furkan, Université Concordia, frknndrr@gmail.com
Contreras, Ivan, Université Concordia, icontrer@encs.concordia.ca
Contardo, Claudio, Université du Québec à Montréal, claudio.contardo@cirrelt.ca

In this talk we study an integrated cross-dock assignment and vehicle routing problem. An MIP formulation based on a set partitioning reformulation is presented and a column generation is used to obtain lower bounds. A heuristic algorithm is also developed to efficiently obtain upper bounds. Computational results are reported.

TD5   Optimisation maritime / Maritim Optimization

Salle: Nancy et Michel-Gaucher
Président: Rakke, Jørgen G., *Norwegian University of Science and Technology*

| 15h30 | **Dynamic Positioning of Tugboats** |

Oppen, Johan, Molde University College, johan.oppen@hiMolde.no
Assimizele, Brice, Aalesund University College, bras@hials.no
Royset, Johannes O, Naval Postgraduate School, joroyset@nps.edu

The Norwegian Coastal Administration monitors vessel traffic along the Norwegian coastline and uses tugboats to prevent drifting vessels from running ashore. We present a model and a solution approach for dynamic tugboat positioning aimed at minimizing the expected costs of grounding accidents.

| 15h55 | **Speed Optimization in Supply Vessel Planning under Weather Uncertainty** |

Norlund, Ellen Karoline, Molde University College, ellenkaroline@gmail.com
Gribkovskaia, Irina, Molde University College, irina.gribkovskaia@himolde.no

The oil and gas industry relies on careful planning of supply vessel operations for delivery of cargo to offshore installations. We present speed optimization strategies for the generation of environmental friendly supply vessel weekly schedules and evaluate the performance of the strategies with discrete-event simulation taking weather uncertainty into account.

| 16h20 | **An Exact Method for Routing and Scheduling of Roll-On Roll-Off Vessels** |

Rakke, Jørgen G., Norwegian University of Science and Technology, jorgen.rakke@iot.ntnu.no
Desaulniers, Guy, Polytechnique Montréal, guy.desaulniers@gerad.ca
Stålhane, Magnus, Norwegian University of Science and Technology, magnus.staalhane@iot.ntnu.no

We present a branch-and-price method for routing and scheduling of Roll-on Roll-off vessels used to transport multiple commodities. The method is based on a hybrid nested column generation approach where we pre-generate paths and dynamically generate the schedules and pickup quantities for each vessel-path combination.

TD6   Optimisation stochastique / Stochastic Optimization

Salle: St-Hubert
Président: Poggi, Marcus, *Pontifícia Universidade Católica do Rio de Janeiro*

| 15h30 | **Random-Valued Scenario Trees Based on an Objective-Aware Criterion** |

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Saucier, Antoine, Polytechnique Montréal, antoine.saucier@polymtl.ca

The stability and accuracy of the solution of a multistage stochastic program approximated on a scenario tree is highly dependent on the quality of the sampling provided by the tree. In order to conduct an educated search for "good" scenario trees, we propose to rank trees using a rigorous criterion based on a node-by-node decomposition of the error on the optimal objective. This criterion is parameterized to reflect various sensitivities in the objective. We also propose a method for populating the tree with structured random values in a way to produce a random estimator for the optimal objective value, so that one can assess its stability through, for example, its variance. We illustrate actual tree construction using simple search methods.

15h55   **A New Progressive Hedging Algorithm for Linear Stochastic Optimization Problems**

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Progressive Hedging Algorithm remains a popular method to deal with multistage stochastic problems. The performance can be poor due to the quadratic penalty terms associated with nonanticipativity constraints. In this work, we investigate its connection with the developments in augmented Lagrangian methods. To preserve linearity, we consider linear penalty terms and evaluate the numerical performance on various test problems.

16h20   **Stochastic Dynamic Dual Programming for Asset Allocation Problem**

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Poggi, Marcus, Pontifical Catholic University of Rio de Janeiro , poggi@inf.puc-rio.br
Valladão, Davi, Pontifical Catholic University of Rio de Janeiro, davimv@puc-rio.br

Some attempts have been made to model the asset allocation problem as a multistage stochastic problem. The propose approach uses Stochastic Dynamic Dual Programming to solve the asset allocation problem for multiple periods with Conditional Value at Risk. To analyze the risk averse approach behavior we present a test case.

16h45   **A Policy-Based Recourse for the Vehicle Routing Problem with Stochastic Demands**

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Rei, Walter, Université du Québec à Montréal, walter.rei@cirrelt.ca

Consider a transportation company that targets some operational conventions to selectively perform the predefined recourse actions. These rules are typically based on fixed policies, risk-based policies, and mixed policies. Regarding what policy is selected, a set of thresholds is generated associated with an a priori route. An integer L-shaped algorithm is implemented to solve the problem exactly.

TD7   Choix discrets / Discrete Choices

Salle: TD Assurance Meloche Monnex
Président: Bastin, Fabian, *Université de Montréal*

15h30   **Capturing Endogneity of Bicycle Sharing System Infrastructure on Usage: Evidence from BIXI Montreal**

Eluru, Naveen, Université McGill, naveen.eluru@mcgill.ca
Faghih-Imani, Ahmadreza, Université McGill, seyed.faghihimani@mail.mcgill.ca

With the growing installation of bicycle sharing systems across the world there is substantial interest on examining the influence of bicycle infrastructure (number of station and station capacity), land-use and built environment on bicycle usage. A majority of these

studies consider bicycle infrastructure as exogenous to modeling demand. However, the decision process of bicycle infrastructure installation considers the influence of land-use and built environment. In cases where the bicycle infrastructure is closely related to the land-use and urban form it is important to recognize that developing models treating the bicycle infrastructure as exogenous to the dependent variable (bicycle demand) might lead to incorrect and biased model estimations. In this study, we address this challenge by proposing a joint decision process composed of three choice processes. The first process considers the bicycle infrastructure installation process while the second and third processes consider bicycle usage characterized as arrivals and departures respectively. In this modeling framework we allow for potential correlations across the three choice systems. We consider an ordered representation for all the variables yielding a three dimensional panel ordered formulation. In addition, in our approach, we recognize that hourly arrivals and departures at the same station are likely to be influenced by common unobserved factors. To accommodate this, we adopt a repeated observation based panel ordered logit model. At the same time, the framework developed recognizes that BSS infrastructure model is a one-time decision variable (unlike repeated observations of usage). The proposed model is estimated using data compiled from the Montreal BIXI system from April to August 2012.

15h55 **Comparison of Route Choice Models' Predictive Performance**

Raymond, Jean-Philippe, Université de Montréal, raymonjp@iro.umontreal.ca
Frejinger, Emma, Université de Montréal, frejinge@iro.umontreal.ca

Route choice models are used to predict the path an individual will choose to travel on a network conditional on his origin and destination. These models are important to many transport related applications and models that are often used in practice, such as path size logit (PSL), are based on choice sets of paths. Recently, a link-based recursive logit model (RL) was proposed where route choice is modeled as a sequence of link choices without any restrictions to the network. In this talk we discuss issues related to comparing the prediction performance of PSL and RL. Moreover we present an empirical comparison using cross validation.

16h20 **Network Capacity Control under a Non-Parametric Choice Model of Demand**

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Savard, Gilles, Polytechnique Montréal, gilles.savard@polymtl.ca

One of the most powerful and simple approaches to model a customer's choice behavior, with the aim to predict his choice decision facing different options, is non-parametric choice modeling of demand. In this approach, each arriving customer chooses from available alternatives according to an ordered preference list of products. If the customer's most preferred product is not available, he substitutes it with the next lower rank product in his ordered preference list. In this research, we propose a new mathematical programming approach to compute optimal allocation of resources under a non-parametric choice model of demand. We develop a modified column generation algorithm to efficiently solve large scale, real world practical problems. The computational results show that the approach outperforms alternative models.

16h45 **Decomposition Method and a Recursive Mixture Logit for Route Choice Analysis**

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The multinomial logit (MNL) model is in general used for analyzing route choices in real networks. Recently, Fosgerau et al. (2013) proposed the link based recursive multinomial

logit (RL) which is based on the underlying assumption that any path in the network is feasible and belongs to the universal choice set. The RL model is theoretically superior to the well-known sampling approach because it can be consistently estimated and efficiently used for prediction. However, the estimation requires solving a system of linear equation per observation whch raises computational concerns. We therefore propose the decomposition approach that significantly speeds up the estimation and a mixed recursive logit model which is based on the mixed logit idea. Our numerical results are based on the Borlange network in Sweden. This network is composed of 3077 nodes and 7459 links and it is uncongested so travel times are assumed static and deterministic. The sample of real path observations consists of 1832 with 466 destinations, 1420 different origin-destination (OD) pairs and more than 37,000 link choices.

TD8   Journée industrielle de l'optimisation 2 / Industrial Optimization Day 2

Salle: Banque CIBC
Président: Rousseau, Louis-Martin, *Polytechnique Montréal*

15h30   Présentation de JDA Software

Côté, Marie-Claude, JDA Software, Marie-Claude.Cote@jda.com

Les solutions de JDA permettent de transformer l'ensemble de la chaîne logistique des entreprises. Elles apportent aux entreprises toute la souplesse nécessaire pour une réactivité optimale. JDA compte plus de 3 000 employés et est présent dans plus de 20 pays. Nos connaissances, nos compétences et nos solutions sont le fruit de plus de 25 années d'expérience, complétées par l'acquisition de sociétés de premier plan, comme i2, Manugistics, E3, Intactix et Arthur. La présentation porte sur les activités du groupe de technologies partagées en optimisation, basé à Montréal.

15h55   Présentation de Kronos

Lingaya, Norbert, Kronos, nlingaya@Kronos.com

AD OPT est une division de développement logiciel dont la raison d'être est fortement liée à la recherche opérationnelle. A travers un survol de l'histoire de la compagnie et de la place de la RO dans son quotidien, nous verrons comment des liens peuvent se tisser entre le milieu académique de la RO et l'industrie du développement logiciel.

16h20   Présentation de FPInnovations

Favreau, Jean, FPInnovations, jean.favreau@fpinnovations.ca

FPInnovations est parmi les plus grands centres de recherche privés à but non lucratif au monde en matière de recherche sur la forêt. Son programme de recherche en opérations forestières aide à accroître l'efficacité et à développer des pratiques rentables, de l'utilisation optimale de la fibre forestière à l'efficacité de la livraison à l'utilisateur final.

Mercredi 07 mai 2014 / Wednesday, May 7, 2014

WA1   Exposé magistral 5 / Tutorial 5

Salle: TAL Gestion globale d'actifs
Président: Baptiste, Pierre, *École Polytechnique de Montréal*

09h00   **Nouvelles bornes pour un problème d'ordonnancement avec production et consommation de ressources**

Carlier, Jacques , Université de Technologie de Compiègne, carlier@utc.fr
Moukrim, Aziz , Université de Technologie de Compiègne, aziz.moukrim@hds.utc.fr
Salhi, Abderrahim , Université de Technologie de Compiègne

Le GRSPSP (Generalized Resource Constrained Project Scheduling Problem) est la généralisation du RCPSP (Resource Constrained Project Scheduling Problem) où les activités sont remplacées par des événements. La fonction économique reste la durée totale à minimiser. La ressource est renouvelable et un événement peut produire ou consommer de la ressource. Le but de cet exposé est de décrire des bornes inférieures pour le GRCPSP. Nous rapporterons des cas polynomiaux et les bornes de la littérature. Puis nous montrerons les relations entre Le RCPSP et le GRCPSP qui conduisent à de nouvelles bornes.

WA2   Modélisation de centres d'appels / Modeling of Call Centers

Salle: CPA du Québec
Président: Regnard, Nazim, *Université de Montréal*

09h00   **Prediction Waiting Time in Multi-Skill Call Centres with Callback Option**

Thiongane, Mamadou, Université de Montreal, mamadou.thiongane@umontreal.ca
L'Ecuyer, Pierre, Université de Montréal, lecuyer@iro.umontreal.ca

We present methods to estimate the waiting time of a client when he arrives to the multi-skills call center with the goal to announce this estimated delay time to the client and possibly to offer a callback option to the client. The customer can thus make a more informed choice to either wait, give up, or ask to be called back. We built predictor by regression with the method of splines, neural networks and kriging method.

09h25   **Modélisation d'arrivées d'appels à un centre d'appel par un modèle de Poisson à taux d'arrivées lognormales// Lognormal Based Rate Model for Modeling of Call Center Arrivals**

Regnard, Nazim, Université de Montréal, nazim.regnard@gmail.com

Nous introduisons un modèle de Poisson constant par morceaux, dont le taux d'arrivée stochastique et lognormal est spécifié sous une forme souple et adaptée à la modélisation des temps d'arrivées d'appels à un centre d'appel. Une application sur données réelles sera présentée // We introduce a piecewise constant Poisson model, with a lognormal stochastic rate specified in a very flexible way, especially designed for the modeling of arrival times of calls to a call center. A application on real data will be presented.

09h50   **Hierarchical Bayesian State-Space Model for Call Center Arrival Rate Forecasting**

Chapados, Nicolas, ApSTAT Technologies, chapados@apstat.com
L'Ecuyer, Pierre, Université de Montréal, lecuyer@iro.umontreal.ca

We address the problem of forecasting call center arrival rates with a two-level hierarchical state-space model, which can account for both inter-day and intra-day persistence

patterns. The model is capable of accommodating seasonalities at monthly, weekly and daily horizons, and deal with special events through the use of explanatory variables. A Bayesian framework is retained throughout, allowing short histories and rare events to be considered.

WA3   Problèmes du voyageur de commerce / Traveling Salesman Problems

Salle: Gérard-Parizeau
Président: Ouenniche, Jamal, *University of Edinburgh*

09h00   The Selective Traveling Salesman Problem with Incompatibility Constraints

Salazar-Aguilar, M. Angélica, Universidad Autónoma de Nuevo León, angysalag@gmail.com
Palomo-Martínez, Pamela Jocelyn, Universidad Autónoma de Nuevo León, pamela.palomomrt@gmail.com

The problem addressed in this work consists of finding a path whose duration does not exceed a given time limit, includes all mandatory vertices, and a subset of optional vertices such that the total collected profit is maximized. Additionally, some incompatibility constraints between vertices is taken into account.

09h25   Comparative Analysis of Construction Methods for Probabilistic TSPs

Ouenniche, Jamal, University of Edinburgh, jamal.ouenniche@ed.ac.uk
Wissink, Pascal, University of Edinburgh, s1269935@sms.ed.ac.uk

The first attempts to address the stochastic versions of the well-known and challenging traveling salesman problem (TSP) have led to a variety of heuristics – both construction methods and improvement methods. In this research, we classify the construction heuristics proposed so far for the probabilistic TSP and provide a conceptual comparative analysis along with an empirical one with the aim of shedding light on the similarities and differences in design and their implications on empirical performance.

09h50   The Traveling Salesman Problem with Time-Dependent Service Times

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The Traveling Salesman Problem (TSP) with time-dependent service times is a generalization of the classical TSP where the duration required to serve any customer is defined as a function of the moment to begin service at that location. We describe analytical insights derived from properties of service time, and present experimental results.

WA4   Prise de décision / Decision Making

Salle: Marie-Husny
Président: Delage, Erick, *HEC Montréal*

09h00   Design of DSSs for PPP Projects

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Boukouras, Aristotelis, University of Edinburgh, aris.boukouras@ed.ac.uk

In this research, we survey and classify the literature on public-private-partnership (PPP) projects. Based on our critical analysis of the literature, we propose a generic methodological framework for PPPs & discuss how to operationalize it.

09h25 **A More Human-like Portfolio Optimization Approach**

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Poggi, Marcus, Pontifical Catholic University of Rio de Janeiro, poggi@inf.puc-rio.br
Pinheiro, Plácido, University of Fortaleza , placido@unifor.br

The construction of views in the Black-Litterman model can be confusing and depends largely on the investor ability in quantifying something extremely subjective. We propose a new way to evaluate these views using Verbal Decision Analysis. Discussions are elaborated over two cases.

09h50 **Analyzing Technology Acceptance Model in Higher Education to Understand Student Behavior Intention for the Use of e-Learning System: A Study Case of Students in Saudi Arabia**

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Understanding student behavior in this digital age has became one of the major challenges for the successful implementation of e-learning system in higher education. The purpose of this on-going study is to analyze the willingness and ability of students to accept e-learning system as new learning technology. We propose to build a model that anticipates the level of technology acceptance among students at Umm Al-Qura University in Saudi Arabia. Therefore, there is a need to assess the acceptance of such technology by examining relationship amongst the factors that have influence on it. A survey questionnaire was conducted to collect data from 500 participants from ten faculties. Confirmatory Factor Analysis (CFA) will be deployed to analyze the data and Structural Equation Modeling (SEM) will be used to validate the research model.

10h15 **Decision Making under Uncertainty with Imperfect Preference Information**

Delage, Erick, HEC Montréal, erick.delage@hec.ca

We consider the problem of optimal decision making under uncertainty but assume that the decision maker's utility function is not perfectly known. Instead, we consider all the utilities that meet some criteria, such as preferring certain lotteries over certain other lotteries and being risk averse, s-shaped, or prudent. We give tractable formulations for such decision making problems that can account both for incomplete and noisy information about the risk attitude. A live demonstration will illustrate how this modelling framework can be used to identify a customized portfolio that reflects more accurately an investors risk attitude.

WA5   Transport et gestion du bois / Transportation and Wood Handling

Salle: Nancy et Michel-Gaucher
Président: Gendron, Bernard, *Université de Montréal*

09h00 **Models and Mathematical Decomposition for Large-Scale Location Problems in the Forestry Sector**

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Gendron, Bernard, Université de Montréal, bernard.gendron@cirrelt.ca
Cordeau, Jean-François, HEC Montréal, jean-francois.cordeau@hec.ca

We present mathematical models and algorithms for a complex location problem which is found in the forestry sector. Based on logging demands for the next five years, this problem investigates the optimal number, locations and sizes for new camps in order to host workers involved within logging activities and balance transportation, camp construction and camp relocation costs. The problem includes a very detailed cost structure. We compare different models and present heuristics based on two different Lagrangian decomposition approaches, capable to solve even very large instances. Case studies are provided based on data from a Canadian logging company. Given the generality of the problem, the presented models and algorithms may also be applied to other location problems typically found in the forestry sector.

09h25   **Dock and Driver Scheduling in a Timber Transport Supply Chain**

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Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca
Pesant, Gilles, Polytechnique Montréal, Gilles.Pesant@polymtl.ca

We present an inventory-routing problem with pickups and deliveries that arises in the forest products industry. A heterogeneous vehicle fleet must be scheduled to meet driver constraints, and also synchronized with loading equipment at supply and demand points. A branch-and-price based heuristic is developed to to generate near-optimal solutions under a practical time limit.

09h50   **A Heuristic Approach for a Tactical Harvest Planning Problem under Market Price Uncertainty**

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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 are under uncertainty. This uncertainty is modeled by a scenario tree. Each realization of scenario has an associated probability. The problem is then to find solution for each scenario that maximizes the expected value of the NPV of each scenario and respect the non anticipativity principle. This principle ensures that decision are only taken considering parameters available at the moment. Those constraints increase the difficulty to solve the formulated stochastic mixed integer programming problem. We use a heuristic solution process based on a decomposition method by scenarios (progressive hedging). Preliminary results in Chilean case study will be presented.

10h15   **Real-Time Transportation and Logistics Systems Planning and Control**

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Gendron, Bernard, Université de Montréal, bernard.gendron@cirrelt.ca

Once a transportation plan is derived for one day at the operational planning level and the wood transportation from forest areas to mills starts, several unforeseen events may occur, events that perturb planned trips (e.g., because of weather conditions, forest fires, or the occurrence of new loads). When such events take place and the demand at mills can no more be satisfied if the daily plan is still followed, the latter must be reoptimized taking into account the new changes. The time available for computing a good choice is limited. Hence, there is a need to develop systems that are capable of supporting the dispatcher in real-time. We present the first steps towards developing a tool that will allow forest companies to quickly redraw their truck schedule to respond to any event that has perturbed the original operational truck schedule.

WA6   Méthodes d'optimisation / Optimization Methods

Salle: St-Hubert
Président: Orban, Dominique, *Polytechnique Montréal*

09h00   A Regularized SQP Method for Degenerate Equality-Constrained Optimization

Arreckx, Sylvain, Polytechnique Montréal, sylvain.arreckx@polymtl.ca
Orban, Dominique, Polytechnique Montréal, dominique.orban@gerad.ca

In nonlinear optimization, numerous computational difficulties arise when a constraint qualification fails to hold. Indeed the linear systems typically used to compute search directions become singular. We propose an SQP method for equality-constrained optimization based on a problem in which all constraints are systematically regularized. This regularization can be interpreted as applying an augmented Lagrangian method to previous optimization problem, only in a non-standard way. We will also show how the linear systems generated by this method can be efficiently solved using appropriate iterative methods.

09h25   Mixed-Integer Optimization Using a Genetic Algorithm Hybridized With Implicit Filtering

Ritz, Benjamin, Clarkson University, ritzbd@clarkson.edu

Mixed-integer optimization problems occur frequently in science and engineering. Implicit filtering is a powerful local search tool designed for noisy systems, but it cannot perform mixed-integer optimization. By hybridizing with a genetic algorithm, we expand the breadth of problems to which implicit filtering may be applied.

09h50   Algorithmes d'Optimisation par Colonie de Fourmis Pareto pour l'optimisation multi-objectifs : Comparaison Uni/Multi colonie.

LeBel, Annie, Université du Québec à Chicoutimi, annielbl@gmail.com
Gagné, Caroline, Université du Québec à Chicoutimi, Caroline_Gagne@uqac.ca

Cette recherche propose une comparaison de méthodes uni-colonie et multi-colonie en Optimisation par Colonie de Fourmis Pareto (OCFP) pour traiter des problèmes multi-objectifs. Le problème à l'étude consiste à l'ordonnancement de travaux avec réglages et fenêtre d'échéance sur une machine unique. Ce travail démontre, entre autres, que la transposition de certains principes empruntés aux algorithmes évolutionnaires multi-objectifs et adaptés à l'OCFP améliore la qualité des résultats.

WA7   Confection de quarts de travail / Shift Scheduling

Salle: TD Assurance Meloche Monnex
Président: Rousseau, Louis-Martin, *Polytechnique Montréal*

09h00   Une approche à deux phases pour la résolution du problème de confection d'horaires multi-départements.

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Contardo, Claudio, Université du Québec à Montréal, claudio.contardo@gerad.ca

Nous proposons une approche à deux phases pour résoudre le problème de confection d'horaires avec transferts d'employés entre les départements. Un modèle séquentiel département par département est utilisé dans la première phase sans permettre les transferts. La solution obtenue est alors ré-optimisée dans la seconde phase en permettant les transferts entre les départements. Différentes approches de résolution sont proposées

pour la seconde phase. Des résultats numériques seront présentées pour comparer chaque approche.

09h25   **Shift Scheduling with Employees' Preferences**

Hoang, Lê Nguyên, Polytechnique Montréal, le.nguyen.hoang@gerad.ca

We present a shift scheduling program over a 1-week horizon for 29 employees, which includes employees' preferences. We use the MACBETH software to help employees enter their preferences, hence defining linear multi-attribute utility functions. These are inputs of a integer linear program in two phases. The first phase computes the optimal costs without preferences. Then, the second phase maximizes employees' utilities while guaranteeing a small gap from optimal costs. Crucially though, for this maximization to make sense, employees' utilities must be normalized. We discuss how to do so in a meaningful way.

09h50   **A Decomposition Scheme to Solve Multi-Department Shift Scheduling Problems**

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Soumis, François, Polytechnique Montréal, francois.soumis@gerad.ca

We present a decomposition scheme to construct multi-department personalized schedules given some prior transfer decisions. We identify specific acyclic transfer graphs to decompose the NP-hard problem into a set of tractable sub-problems. These sub-problems are solved sequentially and framed within a rolling horizon procedure.

10h15   **Grammar and Network based Column Generation for Multi-activity Tour Scheduling problems**

Restrepo-Ruiz , Maria-Isabel , Polytechnique Montréal, maria-isabel.restrepo-ruiz@polymtl.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca
Gendron, Bernard, Université de Montréal, bernard.gendron@cirrelt.ca

We present a grammar and network based column generation approach to solve tour scheduling problems in a multi-activity context. In order to reach integrality, the column generation procedure is embedded into a branch-and-price method. Computational results show that our approach is able find high-quality solutions for all the instances tested.

WB1   Planification de la production / Lot Sizing and Production

Salle: TAL Gestion globale d'actifs
Président: Jans, Raf, *HEC Montréal*

11h00   **Lagrangian Heuristic Applied to Lot Sizing on Parallel Machines**

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de Araujo, Silvio, Universidad Estadual Paulista, saraujo@ibilce.unesp.br
Jans, Raf, HEC Montréal, raf.jans@hec.ca

This work addresses the problem that involves the production planning of multiple items in a single stage composed of distinct parallel machines and each item can be produced on any machine. We apply a Lagrangian heuristic to obtain upper and lower bounds of good quality for this problem.

11h25	**A Constructive Heuristic for the U-Shaped Assembly Line Problem with Heterogeneous Workers**

de Oliveira Moreira, Mayron César, University of São Paulo , mayroncesar@gmail.com
Machado Costa, Alysson, University of Melbourne, acosta@unimelb.edu.au
Miralles, Cristóbal, Universidad Politécnica de Valencia, cmiralles@omp.upv.es

We investigate an U-shaped assembly line balancing problem which deals with an insertion of a set of heterogeneous workers (in terms of task execution times). This problem appears in just-in-time manufacturing systems where disabled workers must be integrated. We propose a mixed-integer model and a fast constructive heuristic. Computational experiments show the efficiency of the proposed approach.

11h50	**Production Planning with Perishable Raw Material Considerations**

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Contreras, Ivan, Université Concordia, ivan.contreras@cirrelt.ca
Chen, Mingyuan, Concordia University, mychen@encs.concordia.ca

In many types of industries, it is common to face significant rates of product or raw material perishability. We discuss about various ways in which perishability can occur in production processes and how this aspect enforces specific constraints on a set of different decisions. We propose new modeling approaches to manage raw material perishability in production planning.

12h15	**Lot-Sizing in a Two-Level Supply Chain with Carbon Emission Constraints**

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Jabali, Ola, HEC Montréal, Ola.Jabali@hec.ca

We present a lot-sizing problem in a two-level supply chain with carbon emission constraints. These emission constraints are distinct from regular capacity constraints because carbon is emitted throughout the chain from production, transportation to inventory keeping. We examine how different Mixed Integer Programming formulations and heuristics perform.

WB2	**Optimisation des centres d'appels / Call Center Optimization**

Salle: CPA du Québec
Président: Chan, Wyean, *Université de Montréal*

11h00	**Staffing Optimization with Chance Constraints in Call Centers**

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Bastin, Fabian, Université de Montréal, bastin@iro.umontreal.ca

We consider a problem of staffing call centers with respect to chance constraints. We introduce chance-constrained formulations of the scheduling problem which requires that the quality of service (QoS) constraints are met with high probability. We define a sample average approximation of this problem in a multi skill setting. We prove the convergence of the optimal solution of the sample-average problem to that of the original problem when the sample size increases. For the special case where we consider the staffing problem and all agents have all skills (a single group of agents), we design three simulation-based optimization methods for the sample problem. For the call center models in our numerical experiment, these algorithms give good solutions, i.e., most constraints are satisfied, and we cannot decrease any agent in any period to obtain better results. One advantage of these algorithms, compared with other methods, that they are very easy to implement.

11h25   **Dynamic Call Routing Policies Using Call Waiting Times and Agent Idle Times**

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L'Ecuyer, Pierre, Université de Montréal, lecuyer@iro.umontreal.ca

We propose new routing policies for multi-skill call centers where the matching priorities between calls and agents are defined as affine combinations of the customer waiting times and agent idle times. The quality of service constraints are formulated as penalty cost functions. Our policies are more flexible than traditional ones found in practice, and numerical examples show they also perform better in many situations.

11h50   **Scheduling of Agents from Forecasted Future Call Arrivals at Hydro-Quebec's Call Centers**

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L'Ecuyer, Pierre, Université de Montréal, lecuyer@iro.umontreal.ca
Delorme, Louis, Institut de recherche d'Hydro-Québec, delorme.louis@ireq.ca

In this project, we want to help the call center managers at Hydro-Québec (HQ) achieve a high quality service at low operating costs. Their current techniques of determining the schedules of their large-size workforce (1000+ employees) can be optimized. Our method will use mathematical model and simulation to consider complex union regulations and to reproduce the various activities that occur in a call center. We will test our algorithms based on real-life data provided by HQ.

12h15   **Staffing Hydro-Québec Call Center: Modeling and Experiments**

Zegal, Walid, Institut de recherche d'Hydro-Québec, walid.zegal@gmail.com
Delorme, Louis, Institut de recherche d'Hydro-Québec, delorme.louis@ireq.ca

The presentation addresses the staffing problem of a multi-skills call center, taking into account the available resources. There is a lack of staff allocation methods designed to treat transient call-center simulation. That's why we have developed two approaches denoted CCHQ and NomadCC in order to determine the required staffing per time step as small as 15 minutes throughout the day. CCHQ is based on a new original heuristic, while NomadCC is based on black-box optimization algorithm (Nomad). The two proposed approaches were tested on a set of data provided by the Hydro-Québec call center. CCHQ is the approach that gives the best results, it allows a significant reduction of required personnel while improving quality of service and in all cases we have experienced.

WB3   Problèmes de tournées multi-attributs / Multi-Attribute Routing Problems

Salle: Gérard-Parizeau
Président: Dayarian, Iman, *Université de Montréal*

11h00   **Multi-Period Collection of Recyclable Materials**

Elbek, Maria, Aarhus University, meandersen@econ.au.dk
Wøhlk, Sanne, Aarhus University, sanw@asb.dk

We consider an approach for scheduling the multi-period collection of recyclable materials. To establish a high service level for the citizens, cubes for collection may not be overfilled. Inspired by theory on the IRP, we present a deterministic solution method for scheduling the collection in order to minimize the operation cost.

11h25 **A Stochastic Solution Approach for Multi-Period Collection of Recyclable Materials**

Elbek, Maria, Aarhus University, meandersen@econ.au.dk
Crainic, Teodor, Université de Montréal, TeodorGabriel.Crainic@cirrelt.ca
Rei, Walter, Université de Montréal, rei.walter@uqam.ca

We consider an approach for scheduling the multi-period collection of recyclable materials. To establish a high service level for the citizens, cubes for collection may not be overfilled. Inspired by theory on the IRP, we present a two-stage stochastic model and solution method for scheduling the collection in order to minimize the cost.

11h50 **A Tabu Search for the Multi-zone Multi-trip Pickup and Delivery Problem with Time Window and Synchronization**

Nguyen Khanh, Phuong, Université de Montréal, phuong@crt.umontreal.ca
Crainic, Teodor Gabriel, Université du Québec à Montréal, TeodorGabriel.Crainic@cirrelt.ca
Toulouse, Michel, Oklahoma State University, michel.toulouse@okstate.edu

The Multi-zone Multi-trip Pickup and Delivery Problem with Time Window and Synchronization has two sets of intertwined decisions: the routing decisions which determine the sequence of customers visited by each vehicle route, the scheduling decisions which plan movements of vehicles between facilities within time synchronization restrictions. We propose a tabu search algorithm integrating multiple neighborhoods targeted to the decision sets of the problem. To assess the proposed algorithm, test have been conducted on the first benchmark instances of the problem which have up to 72 facilities and 7200 customer demands.

12h15 **An Adaptive Large-Neighborhood Search Heuristic for a Multi-Period Vehicle Routing Problem**

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Crainic, Teodor Gabriel, Université du Québec à Montréal, TeodorGabriel.Crainic@cirrelt.ca
Gendreau, Michel, Polytechnique Montréal, Michel.Gendreau@cirrelt.ca
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We consider tactical planning for a particular class of multi-period vehicle routing problems (MPVRP). This problem involves optimizing product collection and distribution from several production locations to a set of processing plants over a planning horizon. Each horizon consists of several days, and the collection-distribution are performed on a repeating daily basis. In this context, a single routing plan must be prepared for the whole horizon, taking into account the seasonal variations in the supply. We model the problem using a sequence of periods, each corresponding to a season, and intra-season variations are neglected. We propose an adaptive large-neighborhood search with several special operators and features. To evaluate the performance of the algorithm we performed an extensive series of numerical tests. The results show the excellent performance of the algorithm in terms of solution quality and computational efficiency.

WB4 Gestion du revenu et finance / Finance and Revenue Management

Salle: Marie-Husny
Président: Ouenniche, Jamal, *University of Edinburgh*

11h00 **Stochastic Bilevel Models for Revenue Management**

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Savard, Gilles, Polytechnique Montréal, gilles.savard@polymtl.ca

During the last 30 years, Hotel Revenue Management research has not proposed and solved models that simultaneously consider inventory assignment, price, length of stay and uncertainty. The purpose of this paper is to develop a new model inspired in both Bilevel Pricing and Two-stage Stochastic models to allow managers to account with useful data for pricing decisions based on a better understanding of consumer's behaviour and market uncertainty. The main contributions of this study are the following. First, we develop a mathematical model that addresses several elements, such as uncertainty, length of stay, quality of service, capacity, and groups' preferences, among others. Second, we propose a data generation process to overcome atypical and/or irrelevant cases. Finally, we develop exact and heuristic resolution methods, which allow us to provide useful results for decision making in the Hotel Industry.

11h25 **American-Style Options in Gaussian Jump-Diffusion Models: Estimation and Evaluation**

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Rémillard, Bruno, HEC Montréal, bruno.remillard@hec.ca

We propose a quasi-analytical approach for valuing American-style options in Gaussian jump-diffusion models that extend Merton's (1976) setting. Our approach is based on dynamic programming coupled with finite elements. We perform a numerical investigation that shows convergence and efficiency. We also address the model estimation and report an empirical investigation based on Apple.

11h50 **Market Deployment Planning Optimization for Born Global Firms**

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In today's fast global economy, entrepreneurs have a tendency to ever more to holistically design their born global business ventures in early stages of foundation. Embedded in the business design process is market deployment roadmap planning which is formulated as a vehicle for analyzing the timing of entry into markets along the planning horizon. We introduce an approach for market deployment roadmap planning, based on self-organizing maps for clustering markets and an optimization model that considers multi period strategic revenue and cost effects of market deployment decisions. We provide empirical results for a case study.

12h15 **Do Some Modelling Frameworks Perform Better than Others by Design? A Case of Bankruptcy Prediction Models Investigated**

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In this research, we address two important questions; namely, do some modelling frameworks perform better than others by design? and to what extent the choice and/or the design of explanatory variables and their nature affect the performance of modelling frameworks? Answers to these generic research questions are devised for classification problems applied to corporate failure prediction. Six statistical and stochastic modelling frameworks are investigated along with several potential performance improvement mechanisms. The performance of these modelling frameworks and improvement mechanisms is tested within a multi-criteria framework. Our findings reveal that, although conceptually some modelling frameworks are supposed to perform better than others by

design, from an application perspective, both the nature of information these framework are fed with and the packaging of such information make a difference in performance.

WB5 Transport et logistique / Transportation and Logistics

Salle: Nancy et Michel-Gaucher
Président: Rekik, Monia, *Université Laval*

11h00 **The Modified Vogel Method applied to Unbalanced Transportation Problem**

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Unbalanced Transportation Problems are balanced by adding of dummy sources or destinations with big-M as related unit transportation costs. This makes it difficult to use a classic Vogel Approximation Method to obtain initial solution for the problem. We show the Modified Vogel Method overcomes these difficulties.

11h25 **Reliability Model for Transportation Procurement Auctions**

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We consider a transportation procurement auction where winning bids are selected based on ask-prices and carriers reliability. The proposed model estimates reliability by combining internal (direct reliability and difference in beliefs) and external (indirect reliability) factors. Difference in beliefs represents the difference that exists between carrier bid-price and shipper beliefs.

11h50 **Reputation-Based Winner Determination Problem in Centralized Transportation Procurement Auctions**

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We consider a centralized procurement auction in which a set of shippers run together a unique auction. The objective is to determine winning bids knowing that: (1) a bid may include shipping contracts requested by different shippers and (2) a carrier reputation may differ from one shipper to another.

12h15 **Investigating the Different Aspects of Information Sharing and Network Barrier on Disaster Relief Operations using ArcGIS and AIMMS**

Ahmed, Ali, Concordia University, ali.ahmed.hd@gmail.com

Purpose - explore the pros and cons of using modern GIS technology with over the top logistical optimization model and solution heuristics. Design/methodology/approach - Based on network design problems literature the adopted model is made of three steps: 1) Demand forecasting based on three scenarios (high, medium, and low impact probabilities). 2) locating warehouses and allocating impacted population 3) finding the best routes from the located warehouses to the impacted populations of each district. The case study is solved using exact and heuristics algorithms using AIMMS and arcGIS (respectively). Findings - Optimization heuristics used by the GIS software tested, arcGIS, are close to the optimal solutions provided by exact solution algorithms. Time and learning curve concerns have been raised. Practical implications - When choosing the right

software to solve a network design problem, logisticians should take into consideration the use of GIS over the counter network design problem solvers, which provide satisfactory optimum solutions. As well as it has other benefits which are elaborated on in this research.Originality/value - The models are solved using two solution methods: exact algorithms (AIMMS software) and heuristics algorithms (arcGIS software). This adds to the credibility of using over the counter solutions pre-packed with multi-disciplinary GIS solutions. The power of GIS and open source data (network details, population, and geographic details) makes the model recreatable anywhere in the world.

WB6   Optimisation combinatoire / Combinatorial Optimization

Salle: St-Hubert
Président: Potvin, Jean-Yves, *Université de Montréal*

11h00   Solving the Clique Partitioning Problem as a Maximally Diverse Grouping Problem

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We show that the Clique Partitioning Problem can be reformulated as the Maximally Diverse Grouping Problem (MDGP). We then modify a skewed general variable neighborhood search heuristic that was first developed to solve the MDGP. As with the MDGP, the new heuristic achieves a significant improvement over the state of the art.

11h25   A New Variant of the Assignment Problem: Application, NP-Hardness and Algorithms

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The paper proposes a new variant of the classical assignment problem which arises in important applications such as health care and inventory management. A proof of its NP-hardness is discussed. Furthermore, an emerging solution technique of Artificial Intelligence and Cohort Intelligence is applied to efficiently solve the problem. The results are compared to solutions obtained by CPLEX.

11h50   Finding Totally Independent Spanning Trees with Integer Programming

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Two spanning trees of an undirected graph are totally independent if they are edge disjoint and if the unique paths that connect any pair of vertices in these trees are also node disjoint. Accordingly, K spanning trees are totally independent if they are pairwise totally independent. The problem of finding K totally independent spanning trees (KTIST) or proving that no such trees do exist is NP-Complete. We investigate KTIST and two optimization problems derived from it. One of them consists in finding the maximum K such that G has K totally independent trees. The other consists of finding K totally independent spanning trees with the minimum possible number of central nodes. We discuss integer programming formulations, valid inequalities and and exact solution approaches, Branch-and-cut and Branch-and-price algorithms, to solve them.

12h15   A Multi-Coloring Problem with Constrained Color Class Sizes

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We consider an extension of the graph coloring problem with application in scheduling. Each vertex must be given multiple different colors, and bounds on the size of each color class must be respected. Two different tabu search approaches (relying on different search spaces) are proposed and compared.

WB7   Ordonnancement / Scheduling

Salle: TD Assurance Meloche Monnex
Président: Carlier, Jacques, *Laboratoire Heudiasyc, Université de Technologie de Compiègne*

11h00   On/Off Event Based Model for the Mutli-Objective RCPSP with Budget Optimization

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We consider Event-based MILP formulations of RCPSP in multi-objective programming frameworks. In particular, we extend this type of models to take into account financial criteria. References: O. Koné, C. Artigues, P. Lopez, M. Mongeau, Event-based MILP models for resource-constrained project scheduling problems, Computers & Operations Research, 38(1), p.3-13, 2011.

11h25   A Tabu Search/Path Relinking Algorithm to Solve the Job Shop Scheduling Problem

Lu, Zhipeng, Huazhong University of Science and Technology, zhipeng.lui@gmail.com

We present an algorithm that incorporates a tabu search procedure into the framework of path relinking to tackle the job shop scheduling problem (JSP). To test the performance of TS/PR, we apply it to tackle almost all of the benchmark JSP instances available in the literature. The test results show that TS/PR obtains competitive results compared with state-of-the-art algorithms in the literature. In particular, TS/PR is able to improve the upper bounds for 49 out of the 205 tested instances and it solves a challenging instance that has remained unsolved for over 20 years.

11h50   New Mathematical Programming Models for Scheduling Unrelated Parallel Machine with Heterogeneous Delays

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One of the main problems in implementing the maintenance actions is the scheduling of the related set of task. This problem could be modelled as an RCPSP, task mapping problem with side constraints or as a load balancing problem. In general it concerns the allocation of a set of task to a set of unrelated resources, that have different capabilities, and with some side constraints like a waiting time, setup time or transition time between tasks execution. Moreover, in real cases, this lag depends on the tasks and the resources. For example, let us consider a set of maintenance action to be conducted on different points on a rail network with limited and non-identical resources. The transition times or delays between the execution of two consecutively scheduled tasks will depend: (1) on the tasks themselves, the setup and the preparation of the resource depend on the executed

or to be executed task; (2) on the resources; the speed of the resource is one of the obvious parameter in this case. We investigate this scheduling problem to study how the exact methods perform. One of the difficulties, which limit the exact method performances for this combinatorial problem, is the disjunctive constraints – the non-overlapping constraints between tasks assigned to the same resource. We overcome this limit by some result from graph theory and propose a new mathematical model that contains less binary variables and outperforms the existing models. The size of the model is drastically reduced and the solution time is divided by 5 and even more for some cases. Our contributions are three fold: taking into account the heterogeneous delays in its general form; a slender linear mathematical formulation of the problem that uses a minimum number of variables and constraints; a heuristics integration which improves a solving time of the mathematical model by endowing good cuts and good bounds. To compare our model with the existing ones, we applied this approach to the case of task scheduling in heterogeneous processors with heterogeneous communication delay. We are able to solve a problem with up to 50 tasks on 8 computing units in few seconds. A benchmark set of data shows the superiority of our model comparing to the existing ones.