Journées de l'Optimisation 2018 *Optimization Days*

7-9 mai 2018
May 7,9 2018

Programme et résumés
Program and abstracts

Bonjour !

Bienvenue aux Journées de l'Optimisation 2018 !

C'est avec joie et honneur que nous vous accueillons à HEC Montréal pour cette conférence internationale. Nous vous proposons six séances plénières, cinq exposés magistraux, et près de deux cent cinquante présentations sur des sujets variés.

Nous espérons que vous trouverez votre participation des plus enrichissantes du point de vue scientifique. De plus, nous vous convions, lundi à 17 h 30, au traditionnel « Vins et fromages » où vous pourrez socialiser avec les autres participants. Nous vous y attendons en grand nombre.

Welcome !

Welcome to the 2018 Optimization Days !

It is with delight and honor that we welcome you at HEC Montréal for this international conference. We are offering six plenary sessions, five tutorials and nearly two hundred fifty presentations on various subjects.

We wish all participants a very fruitful conference. We also invite you to the traditional "Wine and Cheese" party on Monday at 5:30pm where you can socialize with other participants. See you there in large numbers. We hope you will all join us.

Les membres du comité organisateur
The members of the organizing committee

Emplacement des activités / *Activity locations*

HEC Montréal
3000, ch. de la Côte-Ste-Catherine
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◊ Inscriptions : salle Tata communications (rez-de-jardin)
◊ Pauses café : salle Investissement Québec (rez-de-jardin)
◊ Courrier électronique : salle Tata communications (rez-de-jardin)
◊ Séances plénières : Amphithéâtre Banque Nationale (rez-de-jardin)
◊ Autres séances : 1er étage
◊ Vins et fromages : Salon L'Oréal (rez-de-jardin)
◊ Cocktail : Atrium (rez-de-jardin)

◊ *Registration: room Tata communications (Garden Level)*
◊ *Coffee breaks: room Investissement Québec (Garden Level)*
◊ *Email facilities: room Tata communications (Garden Level)*
◊ *Plenary Sessions: Amphithéâtre Banque Nationale (Garden Level)*
◊ *Other Sessions: 1st floor*
◊ *Wine and Cheese Party: Salon L'Oréal (Garden Level)*
◊ *Cocktail: Atrium (Garden Level)*

Comité organisateur / *Organizing Committee*

Gilles Caporossi
GERAD - HEC Montréal

Fausto Errico
GERAD - École de technologie supérieure

Sébastien Le Digabel
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Karine Hébert
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GERAD

Commanditaires / *Sponsors*

Le programme en bref / *Overview of Events*

Lundi, 7 mai 2018 / *Monday, May 7, 2018*

08:00–08:45	Déjeuner / Breakfast (Investissement Québec)
08:45–09:00	Séance d'ouverture / *Opening Session*
	Guy Desaulniers, directeur du GERAD / *Director of GERAD*
09:00–10:00	Séance plénière MAP / *Plenary Session MAP*
	Gianpaolo Ghiani, Università del Salento
	Emanuela Guerriero, Università del Salento
10:00–10:30	Pause café / *Coffee Break*
10:30–12:10	Exposé magistral MA1 / *Tutorial MA1*
	Fernanda Del Castillo, McGill University
10:30–12:10	Séances en parallèle MA / *Parallel Sessions MA*
12:10–14:00	Dîner / *Lunch*
14:00–15:00	Séance plénière MBP / *Plenary Session MBP*
	Miguel F. Anjos, GERAD - Polytechnique Montréal
15:00–15:30	Pause café / *Coffee Break*
15:30–17:10	Exposé magistral MB1 / *Tutorial MB1*
	Charles Audet, GERAD - Polytechnique Montréal
15:30–17:10	Séances en parallèle MB / *Parallel Sessions MB*
17:30–21:00	Réception “Vins et fromages” / *Wine and Cheese Party*

Mardi, 8 mai 2018 / *Tuesday, May 8, 2018*

08:00–9:00	Déjeuner / Breakfast (Atrium)
09:00–10:00	Séance plénière TAP / *Plenary Session TAP*
	Martine Labbé, GOM, Université Libre de Bruxelles - INRIA
10:00–10:30	Pause café / *Coffee Break*
10:30–12:10	Exposé magistral TA1 / *Tutorial TA1*
	Nadia Lahrichi, Polytechnique Montréal
10:30–12:10	Séances en parallèle TA / *Parallel Sessions TA*
12:10–14:00	Dîner / *Lunch*
14:00–15:00	Séance plénière TBP/ *Plenary Session TBP*
	Stefan Wild, Argonne National Laboratory
15:00–15:30	Pause café / *Coffee Break*
15:30–17:10	Exposé magistral TB1 / *Tutorial TB1*
	Denis Larocque, GERAD - HEC Montréal
15:30–17:10	Séances en parallèle TB / *Parallel Sessions TB*

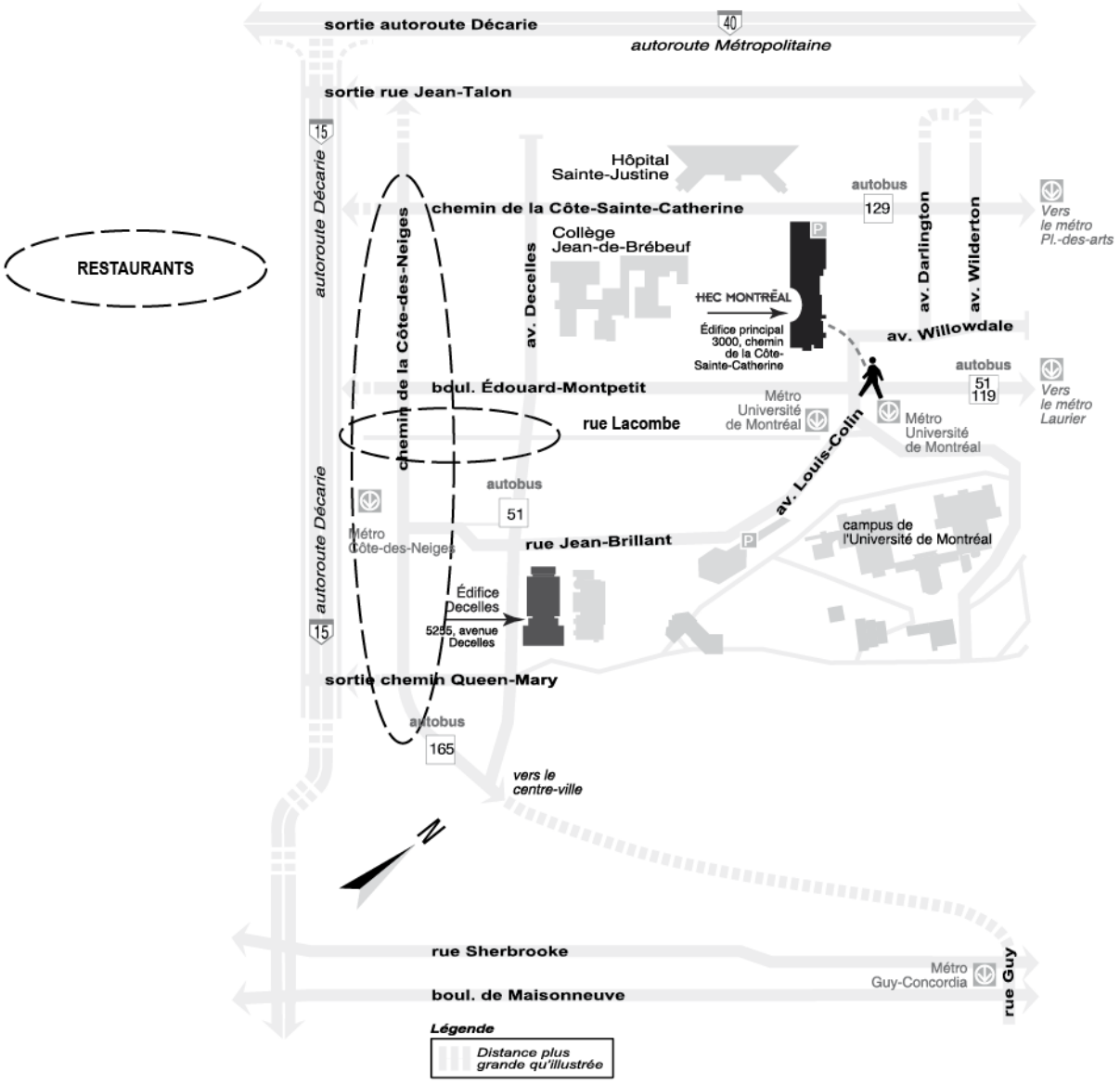
Mercredi, 9 mai 2018 / *Wednesday, May 9, 2018*

08:00–9:00	Déjeuner / Breakfast (Atrium)
09:00–10:00	Séance plénière WAP / *Plenary Session WAP*
	Nenad Mladenovic, Mathematical Institute SANU
10:00–10:30	Pause café / *Coffee Break*
10:30–12:10	Exposé magistral WA1 / *Tutorial WA1*
	Jacques Desrosiers, GERAD - HEC Montréal
10:30–12:10	Séances en parallèle WA / *Parallel Sessions WA*
12:10–14:00	Dîner / *Lunch*
14:00–15:00	Séance plénière WBP / *Plenary Session WBP*
	Laurence A. Wolsey, Université catholique de Louvain
15:00–15:10	Séance de fermeture / *Closing remarks* (Amphithéâtre Banque Nationale)
15:00–15:30	Pause café / *Coffee Break*
15:30–17:10	Séances en parallèle WB / *Parallel Sessions WB*
17:15–18:30	Cocktail / *Cocktail*

Restaurants

On peut trouver une variété de restaurants sur le chemin de la Côte-des-Neiges et sur la rue Lacombe (entre Decelles et Côte-des-Neiges). On peut également manger au Cercle HEC au 6e étage (réservation nécessaire 340-7170) ou à la cafétéria de HEC Montréal (rez-de-jardin).

Restaurants can be found on Côte-des-Neiges Road and on Lacombe Street (between Decelles and Côte-des-Neiges). Lunch can also be obtained at the Cercle HEC on the 6th floor (reservation required 340-7170) or in the HEC Montréal cafeteria (Garden level).



La langue dans laquelle apparaît le titre sera celle utilisée lors de la présentation.
Talks will be given in the language in which the title appears.
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Lundi, le 7 mai 2018 / *Monday, May 7, 2018*

MAP Séance plénière I / Plenary Session I

Salle/Room: Amphithéâtre Banque Nationale
Président/Chairman: Errico, Fausto, GERAD - École de technologie supérieure

09h00 **Recent algorithmic results for time-dependent routing problems**

Ghiani, Gianpaolo, Università del Salento, gianpaolo.ghiani@unisalento.it
Guerriero, Emanuela, Università del Salento, emanuela.guerriero@unisalento.it

In the last decade, a number of technological advances have stimulated an increased interest in time-dependent routing problems. In this talk we survey the research in this field and present a review of applications and solution methods.

MA1 Exposé magistral I / Tutorial I

Salle/Room: BDC
Président/Chairman: Gamache, Michel, GERAD - Polytechnique Montréal

10h30 **Developing simultaneous stochastic optimization of industrial mining complexes and responding to unveiling information**

Del Castillo, Fernanda, McGill University, maria.delcastillo@mail.mcgill.ca
Dimitrakopoulos, Roussos, McGill University, roussos.dimitrakopoulos@mcgill.ca

Over the last few years, new digital technologies have been developed based on the concept of optimizing industrial mining complexes. A mining complex or mineral value chain is an engineering system where raw materials are extracted from a group of mineral deposits, transformed into sellable products using different processing/treatment streams, transported and delivered to the spot-market and/or customers. However, the supply of materials extracted from the mines represents a major source of uncertainty and technical risk that needs to be managed. Stochastic integer programs extended to dynamic implementations and solved through newly developed metaheuristic algorithms allow for the simultaneous stochastic optimization of mineral value chains, consisting in tens of millions of binary variables, in one single optimization model. Additionally, new research has focused on developing adaptive models which can assimilate new information to maximize performance and project value at a short and long-term optimization level.

MA2 OR/MS scientific writing activity – Best presentation competition

Salle/Room: Banque Scotia
Président/Chairman: Cherkesly, Marilène, GERAD -ESG UQÀM

10h30 **A model strengthening for solving an off-road transportation problem under steep-slope terrains**

Ezzati, Sattar, Postdoctoral, sattar.ezzati.1@ulaval.ca
Eriksson, Ljusk Ola, SLU, Sweden

The planning of off-road transportation network to allow logging systems to harvested sites is a challenging task. To address this problem, a mixed-integer programming model is developed to handle these decisions at the operational level. The model solved by introduced a set of valid inequalities in to the original model.

10h55 **A mathematical model for mobile clinic site evaluation in war zones**

Santa González, Rosemarie, UQÀM, rosemarie.santa@gmail.com

When the United States withdraw its troops from Iraq, the Islamic State in Iraq and Levant, also known as ISIS or IS, took advantage of the debilitated position of Iraq's government to seize and control civilians and territory (BBC News Website) turning Iraq into a war zone. One of the side effects of this is that citizens have limited access to healthcare; thus, various non-governmental organizations (NGOs) are providing humanitarian relief to the population affected by the war. Currently, the Première Urgence Internationale (PUI), an international French NGO foresees mobile clinics operations in Iraq. Mobile clinics are employed to serve as a temporary solution. These are vehicles in which healthcare practitioners and equipment travel to populations in need. These vehicles are often modified to provide health services from within them. Yet, before deploying a mobile clinic to a war zone, the potential locations must be evaluated to ensure that there is a need for the allocation of a mobile clinic and most importantly that the medical personnel and equipment are not exposed to extreme conditions that would hinder the services. This study seeks to provide a mathematical model to aid in the evaluation of potential sites for mobile clinics in Iraq. To identify common practices and guidelines of mobile clinic operations, official documentation from the International Federation of the Red Cross and Red Crescent Societies (IFRC) and World Health Organization (WHO) were studied. Additionally, a literature review is conducted to identify relevant studies that employed tools from operations management and operations research that could be applied to the problem at hand. In this study, mathematical model will be proposed to provide PUI a schedule of the visits to potential sites. The model will consider the estimated population in need, the war status of the zone, and the authorization to access the zones. The main objective of the mathematical model is to minimize the costs incurred during the visits of potential sites. As part of the collaboration between the researchers and PUI this model will be implemented and further improved for mobile clinic operations in Iraq. Furthermore, the researchers will continue to work with PUI to develop decision making tools for humanitarian operations in war zones.

11h20 **A robust optimization model for tactical capacity planning in an outpatient setting**

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Tactical capacity planning (TCP) is essential for addressing physician scarcity and long access times. TCP provides decisions for allocation of clinic's resources to schedule appointments. We propose an optimal robust TCP based on cardinality constrained method which deals with demand uncertainty, multiple appointment types and access time targets.

11h45 **Optimization of railway transportation: Hazmat and regular commodities**

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Transportation of dangerous goods (TDG) has been receiving more attention in the realm of academic and scientific research during the last few decades as countries have been increasingly becoming industrialized throughout the world, thereby making Hazmats an integral part of our life style. Considering the low-probability-and-high-consequence (LPHC) essence of transportation of Hazmats, on the one hand, and immense volume of shipments accounting for more than hundred tons in North America and Europe, on the other, we can safely state that the number of scholarly articles and dissertations have not been proportional to the significance of the subject of interest. In consonance with the abovementioned motivation, we are focusing on railway transportation of both Hazmats and regular commodities. Yards and tracks are the constituents of our network. Orders are made at various nodes and shipped towards their destination yards. The interests of both carrier companies and authorities, which is the minimization of cost and risk, respectively, have been considered; hence, both transportation cost and population exposure terms have been incorporated into the objective function. We made use of a mathematical air dispersion model, vis à vis Gaussian Plume Model (GPM), to compute the radius of evacuation distance from potential incident spots, either on rail segments or yards of the underlying network. Since the incorporated risk evaluation measure which minimizes the population exposure, was a nonlinear concave down function, then the link-based multicommodity, multiorder multiobjective MINLP model was piecewise linearized, thereby reducing to a MILP model, variants of which are also

included with bifurcated and nonbifurcated flows. Moreover, under various scenarios w.r.t. the risk adversity/proneness of decision maker, a set of nondominated Pareto-optimal paths for each traffic class have been found while experimenting on a network from literature.

MA3 Air crew scheduling

Salle/Room: EY
Président/Chairman: Quesnel, Frédéric, GERAD

10h30 Combining Benders decomposition and column generation for integrated crew pairing and personalized crew assignment problems

Zeighami, Vahid, Polytechnique Montréal, vahid.zeighami@polymtl.ca

The airline crew scheduling problem, because of its size and complexity, is usually solved in two phases: the crew pairing problem and the crew assignment problem. A pairing is a sequence of flights, connections, and rests starting and ending at the same crew base. The crew pairing problem consists of determining a minimum-cost set of feasible pairings such that each flight is covered exactly once. In the crew assignment problem, the goal is to construct monthly schedules from these pairings for a given set of pilots and copilots independently, while respecting all the safety and collective agreement rules. However, this sequential approach may lead to significantly suboptimal solutions since it does not take into account the crew assignment constraints and objective during the building of the pairings. In this paper, first, we propose an extension of the crew pairing problem that incorporates pilot and copilot vacation requests at the crew pairing stage. Second, we introduce a model that completely integrates the crew pairing and crew assignment problems simultaneously for pilots and copilots. To solve this integrated problem, we develop a method that combines Benders decomposition and column generation. We conduct computational experiments with real-world data from a major US carrier.

10h55 Alternate Lagrangian decomposition for solving integrated crew pairing and crew assignment problems

Soumis, François, GERAD -Polytechnique Montréal, francois.soumis@gerad.ca
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We propose an integrated crew scheduling model to generate personalized monthly schedules for pilots and copilots simultaneously in a single optimization step where we keep the pairings in the two problems as similar as possible. We develop a method that combines Lagrangian relaxation, column generation, and dynamic constraint aggregation.

11h20 Airline crew assignment problem solved by branch and price using neighborhood

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The crew assignment problem aims to cover, by crew members monthly covering blocks, every task of the pairings generated in a previous phase. A task represents a crew position on a pairing needing many crew members. We should also respect others constraints like government regulations and collective agreements. The crew assignment problem is a large scale problem solved by branch and price. Its solution is a very time consuming because of many reasons. The dual variable values have strong variation from iteration to iteration, thus, a large diversity of columns and a tailing-off effect. This produces a very fractional LP solution yielding a difficult branch and bound. To shorten the time solution process of a crew assignment software of a specific airline, we propose to use the solution of the cabin manager category (CM) (a small size problem) as set of reference paths (columns) to stabilize the solution of the largest category(FA). We will try to generate, as much as possible, columns in the neighbourhood of these paths. This will reduce the diversity of columns and the number of column generation iterations. It will also produce less fractional solutions and permit to converge rapidly to an integer solution. We experiment our work on instances with up to twenty five thousand pairing tasks and two thousand FA crew members.

11h45 **Considering crew preferences in the airline crew pairings to improve rostering**

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

Airline crew scheduling is usually divided in two steps : the crew pairing problem (CPP) and the crew rostering problems (CRP). While the goal of the CPP is to find feasible pairings at minimum cost, the CRP aims at finding a feasible schedule that satisfy as many employee preferences (preferred airlegs, vacations, etc.) as possible. The main challenge with this approach is that the pairings generated by the CPP may not be suitable for the objective of the CRP. In this talk, we propose a new variant of the CPP, called the CPP with complex features (CPPCF) that takes into account crew preferences in order to create pairings that are better suited for the CRP. Specifically, we identify six pairing features related to crew preferences that are beneficial for the CRP, and the objective function of the CPPCF rewards pairings that contain these features. The CPPCF is solved using a column generation algorithm in which new pairings are generated by solving subproblems consisting of constrained shortest path problems. For this purpose, we introduce a new type of path resources designed to handle complex features and we adapt the dominance rules accordingly. Finally, we present results showing the effectiveness of our method.

MA4 Blackbox and derivative-free optimization I

Salle/Room: Hélène Desmarais
Président/Chairman: Abramson, Mark, Utah Valley University

10h30 **Review of measures of the quality of approximated Pareto fronts in multiobjective optimization**

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Bigeon, Jean, Univ. Grenoble Alpes, CNRS, Grenoble INP, G-SCOP, jean.bigeon@grenoble-inp.fr
Cartier, Dominique, Polytechnique Montréal, dodo.cartier@videotron.ca
Le Digabel, Sebastien, GERAD - Polytechnique Montréal, sebastien.le.digabel@gerad.ca

In the recent years, the development of new algorithms for multiobjective optimization has considerably grown. To face the need to reassure the quality of approximated Pareto fronts, metrics used as performance indicators have been developed in the last two decades. They are notably used to compare multiobjective optimization algorithms. In this presentation, we propose a review of performance indicators. We first give a mathematical framework describing the indicators and classify them according to their properties. Some applications are presented as well as new opportunities for the future.

10h55 **Dynamic and static models in derivative-free optimization**

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Audet, Charles, GERAD - Polytechnique Montréal, charles.audet@gerad.ca

The Mesh Adaptive Direct Search algorithm (MADS) orders poll points using models. Two types of models can be used: a given static surrogate, or a dynamic model updated at each iteration. This work introduces a third type of models, which is a dynamic model that uses the static surrogate information. This new model aims at improving the efficiency of model ordering for the poll step when a static surrogate is given.

11h20 **Mesh adaptive direct search algorithms for multifidelity optimization**

Abramson, Mark, Utah Valley University, mark.abramson@uvu.edu

Multifidelity optimization occurs in engineering design when multiple engineering simulation codes are available at different levels of fidelity. An example of this might be in aerodynamic optimization of the shape of a wing, in which the computation of aerodynamic quantities, such as lift and drag, can be computed using a full Navier-Stokes solver, or an Euler solver, or a linearized potential code. High fidelity simulations are more accurate, but also more computationally expensive. The goal of this work is the design of algorithms that optimize with respect to the high-fidelity simulation, but exploit the use of lower

fidelity codes as much as possible. Two new surrogate-based mesh adaptive direct search (MADS) algorithms will be presented, in which interpolating surrogates are constructed and updated from previously evaluated iterates of the algorithm to speed convergence. The first algorithm employs a recursive Search step that optimizes a surrogate function constructed from the next lower fidelity level simulation augmented with an interpolating surrogate that accounts for the difference between adjacent levels of fidelity. The second approach is an augmentation of the optimization problem, in which the fidelity level is incorporated as a variable in the problem, and a relaxable constraint is added to force the solution to be at the highest level of fidelity. Some preliminary numerical results are presented.

MA5 Scheduling I

Salle/Room: Manuvie
Président/Chairman: Paik, Urbbi,

10h30 Flexible versus robust lot-scheduling subject to random production yield and deterministic dynamic demand

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We consider the problem of scheduling production lots for multiple products competing for a common production resource that processes the product units serially. The demand for each product and period is assumed to be known with certainty, but the yield per production lot is random as the production process can reach an out-of-control state while processing each single product unit of a lot. A service-level constraint is used to limit the backlog in the presence of this yield uncertainty. We address the question of how to determine static production lots and how to schedule these lots over the discrete periods of a finite planning horizon. The scheduling problem is characterized by a trade-off between the cost of holding inventory and the cost of overtime, whereas the production output is uncertain. For this purpose, we develop a rigid and robust planning approach and two flexible heuristic scheduling approaches. In an extensive numerical study, we compare the different approaches to assess the cost of operating according to a robust plan as opposed to a flexible policy.

10h55 Hospital maintenance scheduling and resource allocation applying multi-agent systems

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Moselhi, Osama, Professor, osama.moselhi@concordia.ca

Healthcare buildings and hospitals are included among vulnerable assets. Moreover, these assets have the budget constraints which makes them more vulnerable. According to Reviewing literature illuminates this fact that hospitals across Canada are engaged with deferred maintenance problems. Therefore, budgets constraints have to be managed by hospitals manager with very less impact on the primary expenditures. Solving the issue of deferred maintenance requires a high level of dedication and commitment of the maintenance human resource in hospital buildings. Resource allocation processes include several activities such as scheduling, allocation of personnel and coordination of facility manager's team. Facility managers are under increasing pressure to prioritize maintenance work orders due to declining human resources and limited budget. Furthermore, it is necessary to optimize the cost of human resource allocation in order to achieve the desired performance. On the other hand, the resource allocation is an interactive, dynamic and complex environment of diverse and independent of facility manager's team. In such a complex environment, each party's behavior may be simple, but the aggregate patterns of their interactions can be complex. Despite significant mathematical models contributions to optimize the cost of resource allocation, these approaches have some limitations such as ignorance of unforeseen events and financial losses while a facility waits for maintenance. Solving these kinds of problems is difficult for mathematical formulation. Multi-Agent System (MAS) has viable potential in modeling that complex environment. The purpose of this research is to propose a Multi-Agent Based System (MAS) to simulate and optimize the cost of human resource allocation. This research proposes a MAS to simulate the maintenance human resource allocation of hospitals. Furthermore, it analyzes some scenarios to achieve near optimum resource allocation cost and modify the probabilities

related to work defects and poor performance. This model studies the coordination of facility manager's team as agents to minimize out of service time and maximize utilization of maintenance human resources to increase patients 'satisfaction in healthcare and hospitals. The proposed MAS model provides an opportunity for facility managers to generate a near optimal schedule and test it under a variety of conditions. In this research, a MAS model is generated using AnyLogic software to re-engineer facility maintenance work order processes in a department of healthcare.

11h20 **Optimal scheduling of demand-driven cogeneration biogas plants using mixed integer linear programming**

Paik, Urbbi, McGill University, urbbi.paik@mail.mcgill.ca
Bouffard, François, McGill University, francois.bouffard@mcgill.ca

This work presents a mixed-integer linear programming formulation of demand-driven biogas combined heat and electricity generation units. It analyzes the economic benefits of having a flexible substrate management for biogas generation along with a variable heat-to-electricity conversion ratio for profit maximization of spot market electricity sales.

MA6 Simulation and manufacturing

Salle/Room: Serge-Saucier
Président/Chairman: Djeumou Fomeni, Franklin, Polytechnique Montréal

10h30 **Application of simulation and lean techniques for the improvement of glulam production: a case study**

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Cloutier, Caroline, Université Laval, caroline.cloutier@gmc.ulaval.ca

Modular construction manufacturing helps to improve standardization and increase productivity in the construction industry. Glued laminated timber (glulam) is a type of engineered wood which can be used in modular construction as an environment-friendly product. This article considers improvements in the production of curved glulam by investigating the sources of waste and non-value adding activities in the production processes. A simulation model is built for glulam production and validated by a case-study for a gridshell project. Sources of waste are identified, and lean methods are suggested for improvement. The lean solutions are tested in the simulation model and results demonstrate 27% improvement in cycle time and 77% improvement in wait time. Additionally, the impact of applying only 50% elimination of non-value adding activities is compared with 100% elimination.

10h55 **Predicting the behavior of dynamic systems using reduced-order modeling and interval computations**

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The ability to conduct fast and reliable simulations of dynamic systems is of special interest to many fields of operations. Such simulations can be very complex and, to be thorough, involve millions of variables, making it prohibitive in CPU time to run repeatedly for many different configurations. Reduced-Order Modeling (ROM) provides a concrete way to handle such complex simulations using a realistic amount of resources. However, uncertainty is hardly taken into account. Changes in the definition of a model, for instance, could have dramatic effects on the outcome of simulations. Therefore, neither reduced models nor initial conclusions could be 100% relied upon. In this research, Interval Constraint Solving Techniques (ICST) are employed to handle and quantify uncertainty. The goal is to identify key features of a given dynamical phenomenon in order to be able to propagate the characteristics of the model forward and predict its future behavior to obtain 100% guaranteed results. This is specifically important in applications, as a reliable understanding of a developing situation could allow for preventative or palliative measures before a situation aggravates.

11h20 **Pre-optimizing tools positions in a CNC machine when facing arbitrary sequences of production**

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Gaudreault, Jonathan, FORAC Research Consortium, Université Laval, jonathan.gaudreault@forac.ulaval.ca

The manufacturing sector uses numerically controlled machines that require a setup time to change tools to move from manufacturing one product to another. We use a MIP to position the tools in the machine while minimizing the average setup time on a random sequence of products.

11h45 **A multi-objective optimization approach for the blending problem in the tea industry**

Franklin, Djeumou Fomeni, Lancaster University, franklin@aims.ac.za

The blending problem is one of the oldest and well-known optimisation problems. It is generally formulated as a linear program and has been applied in many industries. However, the blending problem encountered in the tea industry requires a lot more than a straight forward linear programming formulation. Indeed, the classical blending model would almost always be infeasible for the blending problem in the tea industry. This is because it is often not possible to match the characteristics of the blends as desired, which prompts the decision makers to search for solutions that are the closest possible to the targeted ones. In this talk, I will present a multi-objective optimisation model for the tea blending problem that we developed and solved. The model minimises the total cost of the raw materials as well as the violations of the desired characteristic scores of the final blends. I will also present some computational results conducted with real data from a UK-based tea company who brought the problem to us. These results show that our model can provide useful decision support tools to select the best solution option from a set of acceptable ones.

MA7 Conic optimization and applications

Salle/Room: Groupe Cholette
Président/Chairman: Anjos, Miguel F., GERAD & Polytechnique Montréal

10h30 **Two stage architecture optimization for differentially private Kalman filtering**

Degue, Kwassi Holali, Ecole Polytechnique de Montreal, kwassi-holali.degue@polymtl.ca
Le Ny, Jérôme, GERAD - Polytechnique Montréal, jerome.le-ny@polymtl.ca

The problem of Kalman filtering under privacy constraints is addressed. This problem occurs in scenarios where a data aggregator aims at releasing publicly, in real-time, a combination of privacy-sensitive signals that originate from a linear Gaussian model. An optimum differentially private mechanism that is computed using semidefinite programming is proposed.

10h55 **Improving the linear relaxation of maximum k-cut with semidefinite-based constraints**

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We consider the maximum k-cut problem that consists in partitioning the vertex set of a graph into k subsets such that the sum of the weights of edges joining vertices in different subsets is maximized. The associated semidefinite programming (SDP) relaxation is known to give strong bounds but it suffers from high CPU times. We deploy a cutting plane algorithm that exploits the early termination of an interior-point method, and we study the performance of SDP and linear programming (LP) relaxations for a variety of values of k and of types of instances. The LP relaxation is strengthened using combinatorial facet-defining inequalities as well as SDP-based constraints. Our computational results suggest that the LP approach, especially with the addition of SDP-based constraints, outperforms the SDP relaxations for graphs with positive weights edges and k larger or equal to 7.

11h20 **Bounding procedure improvements for BiqCrunch, a semidefinite-based solver for binary quadratic optimization**

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BiqCrunch is a branch-and-bound solver using semidefinite optimization to compute high-quality bounds for combinatorial optimization problems that can be modeled as binary quadratic problems, such as MaxCut, Max-k-Cluster, Maximum-Independent-Set, Exact Quadratic Knapsack, and the Quadratic Assignment Problem. BiqCrunch does not use an interior-point method for computing its bounds. Instead, an eigenvalue solver and a gradient-based method are used to compute tight bounds. We will discuss new improvements to the bounding procedure of BiqCrunch.

MA8 Node and arc routing

Salle/Room: Metro inc.
Président/Chairman: Semet, Frédéric, École Centrale de Lille

10h30 **The clustered target-visitation arc-routing problem**

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Target Visitation problems combine Linear Ordering and Vehicle Routing. There exist profits (targets) associated with the order of demand service, as well as costs on routes. We study the case of demand located at some edges and it is imposed that all demand edges in a component are served consecutively.

10h55 **Clustering techniques for very-large scale arc routing problems in curbside waste collection**

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Wøhlk, Sanne, Cluster for Operations Research and logistics, Department of Economics and Business Economics, Aarhus University, sanw@econ.au.dk

We present novel clustering techniques for very-large scale real-life instances of multi-compartment capacitated arc routing problems in curbside waste collection. The aim of the clustering is to reduce the graph sizes considerably to sizes that are computationally tractable, and subsequently solve them using the Multi-Move Chain Descent algorithm.

11h20 **The open vehicle routing problem with decoupling points**

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This practical problem is faced by companies dealing with carriers to ship their goods over large territories. In this case it may be profitable to use more than one carrier to perform a specific expedition: the first one leaves the depot and performs part of the deliveries, drops off all remaining load, and the second carrier continues from that point onwards. We model this problem using a realistic multi-drop less-than-truckload cost function composed of a non-linear transportation cost, a detour cost and a drop cost. We have developed a tailored Iterated Local Search (ILS) algorithm which handles the special features of the problem. The efficiency of the ILS was demonstrated by obtaining all best known solutions on a set of classical OVRP instances and improving it for one instance. Then, using real orders and transportation costs obtained from industrial partners, we clearly show the benefit of using decoupling points to optimize transportation costs.

11h45 **An adaptive large neighborhood search for multicommodity VRP**

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In this work we study a vehicle routing problem where customers request multiple commodities. We allow to split the delivery to a customer but force each commodity to be delivered at once. We propose an adaptive large neighborhood search to solve this problem. Problem-defined local search operators based on the resolution of MIPs are developed. Results show that the method is able to obtain near optimal solutions for large instances.

MA9 Nonlinear optimization

Salle/Room: Quebecor
Président/Chairman: Andoglu, Ecem Muge, Bilecik Seyh Edebali University

10h30 **Computing steps with the conjugate residuals method in unconstrained optimization**

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Orban, Dominique, GERAD - Polytechnique Montréal, dominique.orban@gerad.ca

The method of conjugate residuals (CR) is similar to the method of conjugate gradients (CG) in several respects. We describe and analyze a truncated version of CR in the context of trust-region and line search methods for continuous unconstrained optimization. We present convergence results and report on numerical experience.

10h55 **"On the figure of columns" of Lagrange, revisited**

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The column's bucking load problem was formulated by Lagrange around 1770. This eigenvalue problem is well-known for being nondifferentiable. Since the problem is Hadamard semidifferentiable, a necessary optimality condition can be obtained. Numerical results will then give us an insight about propreties of the problem.

11h20 **Kinetic parameter estimation of Claus reaction**

Andoglu, Ecem Muge, Bilecik Seyh Edebali University, muge.andoglu@bilecik.edu.tr
Kaytakoglu, Suleyman, Anadolu University, skaytako@anadolu.edu.tr

The Claus process is the most significant gas desulfurization process, recovering elemental sulfur from acid gas with high hydrogen sulfide concentration. For the purpose of developing a representative and accured model of this process, estimation of the kinetic parameters is an important task. This study aims to estimate the optimal kinetic parameters of the Claus reaction by traditional and modern methods.

11h45 **A review on the optimization studies of sulfur recovery unit**

Andoglu, Ecem Muge, Bilecik Seyh Edebali University, muge.andoglu@bilecik.edu.tr
Kaytakoglu, Suleyman, Anadolu University, skaytako@anadolu.edu.tr

Acid gas obtained from oil refineries contains large amounts of hydrogen sulfide which are not allowed as the off gas or burned to the atmosphere. Claus process is the most famous method for sulfur recovery from hydrogen sulfide in oil and natural gas refinery units. In this talk, we will present the previous works on optimization of Claus unit and aim to open the mind to explore possible applications in this field.

MA10 Marketing and finance

Salle/Room: Sony
Président/Chairman: Akari, Mohamed Ali, HEC Montréal

10h30 Cheating or delighting customers on product quality?

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In this paper, we claim that, though based on different tradeoffs, cheating and delighting policies are the two faces of the same coin. Cheating relies on inflated goodwill and provides a cheating rent as long as the cheating is not disclosed, while delighting benefits from enhanced goodwill and yields a delighting rent as soon as the delighting is awarded. The conditions that allow for rent equalization between the two policy options are identified. We also characterize the conditions under which either cheating or delighting customers on quality is beneficial.

10h55 The impact of central clearing on the market of single-name credit default swaps

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In this paper, we examine the impact of the voluntary central clearing scheme on the CDS market of North American firms during the period spanning 2009 to 2015. In order to address the endogeneity problem arising from the fact that central clearing is not mandatory for CDS single names, we use a methodology that relies on propensity score matching combined with generalized difference-in-differences. Our empirical findings show that the initiation of central clearing results in an increase in CDS spreads while there is no evidence of an associated improvement in market liquidity or in trading activity. These results suggest that the increase in CDS spreads of centrally-cleared entities can be mainly attributed to the reduction in counterparty risk, and that the magnitude of this price increase could be used as an assessment of counterparty risk in the non-cleared CDS market.

11h20 L'optimisation du bien-être des touristes par la co-création

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La co-création a pour vocation majeure de générer des bénéfices pour l'ensemble des acteurs de l'écosystème de service. L'objectif de cette communication est d'analyser en profondeur les enjeux et les bénéfices de l'activité de co-création. Plus précisément, elle étudie le rôle de la co-création comme vecteur d'optimisation du bien-être des touristes.

MA11 Game theory

Salle/Room: Xerox Canada
Président/Chairman: Fortz, Bernard, Université Libre de Bruxelles

10h30 Hub interdiction problem: Alternate solution approaches

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We study the hub interdiction problem. The problem is modeled as a 2-stage sequential game, resulting in a bi-level mixed integer program. We present alternate approaches to reduce the model to single level, followed by efficient exact methods to solve the problem to optimality.

10h55 **Optimal policy for reforming energy subsidies in presence of heterogeneous consumers and suppliers**

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To raise the necessary public support for the energy consumption subsidies reform, a prevalent recommendation is to redistribute its revenue among the affected consumers. However, the main challenge to design a feasible and optimal policy is the scale and target of compensation payments, particularly in the presence of heterogeneous consumers and suppliers of non-energy goods. We study the problem of a social planner, which aims to maximize the national gain of reform while expecting a minimum purchasing power for the households. We analyze the impact of heterogeneity on the feasibility range of such a reform and compare the result of different compensation policies.

11h20 **Unit commitment under market equilibrium constraints**

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We consider an extension of the Unit Commitment problem with a second level of decisions ensuring that the produced quantities are cleared at market equilibrium. In their simplest form, market equilibrium constraints are equivalent to the first-order optimality conditions of a linear program. The UC in contrast is usually a mixed-integer nonlinear program (MINLP), that is linearized and solved with traditional Mixed Integer (linear) Programming (MIP) solvers. Taking a similar approach, we are faced to a bilevel optimization problem where the first level is a MIP and the second level linear.

MBP Séance plénière II / Plenary Session II

Salle/Room: Amphithéâtre Banque Nationale
Président/Chairman: Le Digabel, Sebastien, GERAD - Polytechnique Montréal

14h00 **Optimizing the future of smart grids**

Anjos, Miguel F., GERAD - Polytechnique Montréal, miguel-f.anjos@polymtl.ca

A smart grid is the combination of a traditional electrical power system with information and energy both flowing back and forth between suppliers and consumers. This new paradigm introduces major challenges such as the integration of decentralized energy generation, the increase of electric transportation, and the need for electricity consumers to play an active role in the operations of the grid. This presentation will summarize the opportunities for optimization to contribute to the success of smart grids and present some recent breakthroughs.

MB1 Exposé magistral II / Tutorial II

Salle/Room: BDC
Président/Chairman: Le Digabel, Sebastien, GERAD - Polytechnique Montréal

15h30 **Blackbox and derivative-free optimization**

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Hare, Warren, UBC, warren.hare@ubc.ca

Some problems do not possess the required structure to be addressed by traditional optimization methods. In this presentation, we focus on situations where the evaluation of the functions to be minimized and those delimiting the feasible region are assessed by running a computer simulation, expensive in terms of computational time, and for which derivatives are either inexistant or unavailable. These functions are usually nonsmooth, discontinuous, and may even be contaminated by numerical noise. The tutorial follows the structure of our recent textbook on the subject (Springer Series in Operations Research and Financial Engineering, 2017). We present a brief history of direct-search methods designed for these blackbox and derivative-free optimization problems, and their convergence

analysis using nonsmooth calculus. We also discuss the construction of linear and quadratic models, and how to integrate them into linesearch or trust-region methods. We will also discuss recent developments and extensions including including the use of surrogates and strategies to handle various types of constraints, as well as selected applications from engineering. This tutorial is intended for anyone interested in blackbox or derivative-free optimization. We do not present the absolute state-of-the-art in modern algorithms and theory, as we feel that it belongs to the specialized sessions of the conference.

MB2 Transportation

Salle/Room: Banque Scotia
Président/Chairman: Zimmermann, Maëlle, Université de Montréal

15h30 Optimizing the preventive-maintenance plan of a public transit bus fleet

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

We describe a system that was implemented in the city of Angers to optimize the maintenance plan of its public transport bus fleet. Important issues related to designing an effective maintenance plan are discussed, and an algorithm is presented to generate such a plan.

15h55 MIP formulations for the rapid transit line design problem for maximum demand capture

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The strategic problem of designing rapid transit lines for maximum demand capture consists of locating stations and segments between them to form lines, with the objective of maximizing O-D pairs coverage under topological and budget constraints. The commonly used subtour elimination constraints grow exponentially with the size of the problem, and play a key role in its complexity. The problem is consequently known to be NP-Hard. We propose therefore two alternative formulations using single commodity and multicommodity flow constraints which are of polynomial size. We provide the results of solving these formulations on artificial instances of different sizes (10 to 108 potential stations), randomly generated using real data from Concepcíon city in Chili.

16h20 Exact solution of the evasive flow capturing problem

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We present a bilevel program and a branch-and-cut solution technique for the 'evasive flow capturing problem' defined as locating a set of law enforcement facilities on a road network to intercept unlawful vehicle flows who deviate from their routes to avoid any encounter with such facilities.

16h45 A Markovian traffic equilibrium model for capacitated networks

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Frejinger, Emma, DIRO and CIRRELT, emma.frejinger@cirrelt.ca
Marcotte, Patrice, Université de Montréal, marcotte@iro.umontreal.ca

We propose a Markovian traffic equilibrium model which considers the case of networks with rigid arc capacities. This work endorses the concept of access probabilities to strictly enforce capacity constraints, playing the role of state transition probabilities in an absorbing Markov chain. We illustrate the approach on small networks.

MB3 Linear programming

Salle/Room: EY
Président/Chairman: Cire, Andre Augusto, University of Toronto

15h30 LP-based sparse solutions revisited

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

Finding sparse solutions for underdetermined linear systems is the key step in compressive sensing and a number of other important problems. One category of solutions uses linear programming, e.g. Basis Pursuit. However, there are other ways to formulate the LP which have not been explored and which lead to different algorithms with different characteristics. The talk presents a variety of new LP-based formulations and associated algorithms, along with numerical evaluation and comparisons.

15h55 On integrating mixed-integer programming and decision diagrams for optimization

Gonzalez, Jaime, Polytechnique Montréal, jaime.gonzalez@polymtl.ca
Cire, Andre Augusto, University of Toronto, acire@utsc.utoronto.ca
Lodi, Andrea, GERAD - Polytechnique Montréal, andrea.lodi@polymtl.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca

In this talk, we propose an optimization framework which combines mixed-integer linear programming and decision diagrams to solve combinatorial optimization problems. We address the classical maximum independent set problem where the proposed hybrid approach integrates complementary strengths to exploit a suitable structure and solve the problem.

16h20 A local search framework for compiling relaxed decision diagrams

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We present a local search framework for constructing and improving relaxed decision diagrams (DDs). The framework consists of a set of elementary DD manipulation operations including a redirect operation introduced in this paper and a general algorithmic scheme. We show that the framework can be used to reproduce several standard DD compilation schemes and to create new compilation and improvement strategies. In computational experiments for the 0-1 knapsack problem, the multidimensional knapsack problem and the set covering problem we compare different compilation methods. It turns out that a new strategy based on the local search framework consistently yields better bounds, in many cases far better bounds, for limited-width DDs than previously published heuristic strategies.

16h45 Network-based approximate linear programming for discrete optimization

Cire, Andre Augusto, University of Toronto, acire@utsc.utoronto.ca
Nadarajah, Selvaprabu, University of Illinois at Chicago, selvan@uic.edu

We present a new hierarchy of approximate linear programming methods for a general class of discrete optimization problems. In particular, our hierarchy considers network-based relaxations as basis functions. A numerical evaluation is discussed on challenging discrete optimization problems arising in practice.

MB4 Optimization in the railway industry

Salle/Room: Hélène Desmarais
Président/Chairman: Ortiz-Astorquiza, Camilo, Université de Montréal

15h30 An integrated approach for inbound train split and container loading in an intermodal railway terminal

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In the context of intermodal transportation of containers, we propose an integrated approach to a problem where one must decide how inbound trains are split into sequences of railcars, on which tracks those railcars are parked for loading and off-loading operations, and how to design proper load and block plans.

15h55 Collaborative optimization for train scheduling and maintenance time slots planning on conventional railway line in China

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Train services and maintenance activities of railway line are mutually exclusive, and they should be planned together in the ideal case. Nevertheless, most research has treated them as two separate planning problems. This paper proposes a collaborative optimization method for both train scheduling and maintenance time slots planning on the tactic level. Specially, through embedding the maintenance time slots planning constraints into train scheduling process, and allowing the maintenance time slots to move within pre-defined time windows. We particularly consider the minimization of the total impact of maintenance time slots planning on train scheduling. Then the problem is formally formulated as a mixed integer programming model, and a two-stage heuristic algorithm is designed to solve it. Finally, we consider Baoji-Chengdu railway line in China as a real-world application of the methodology. The results show that the CPLEX solver can efficiently obtain the approximate optimal solution within the acceptable computational time, demonstrating the effectiveness of the proposed approaches.

16h20 Reducing hazardous materials releases from railroad freights through hazardous materials trip plan policy

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This research explores the routing and scheduling of rail shipment of hazardous materials (hazmat) with blocking decisions. We consider a transportation system where different customers make their requests for railcar moves, i.e., both hazmat and non-hazmat freights, between different origins and destinations, with specific requirements on delivery times. we focus on minimizing total cost, i.e., the earliness, tardiness, classification and holding costs acquired to fulfill all the demands, and the risks associated with hazmat transportations. The problem is to determine for each demand (a) the itinerary that must follow from its origin yard to its destination yard (if not outsourced), (b) the sequence of trains that it must assign along the route so that the request time, and train capacities constraints are satisfied, and (c) the blocks used to transport it for each train leg along its route. A non-linear mixed-integer programming and two MIP heuristic-based solutions are proposed for generating the trip plans. Finally, we analyze a number of medium-size problem instances.

16h45 **The locomotive assignment problem with distributed power**

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We introduce a variant of the Locomotive Assignment Problem which consists on determining the optimal assignment of locomotive types to trains and the choice of operation mode while satisfying power requirements. Additional constraints are included to model the requirements of the railway company. We present an IP formulation and some preliminary computational results.

MB5 Scheduling II

Salle/Room: Manuvie
Président/Chairman: Kaur, Rupinder, concordia university

15h30 **Cross-dock scheduling with fixed outbound departures, multiple transshipment trips and known order of shipments**

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We study a cross-dock inbound scheduling problem with fixed outbound departure times to minimize the number of tardy products per shipment. We consider two extensions: multiple trips and known unloading order of shipments. A time-indexed formulation is introduced and compared with the state-of-the-art. Computational experiments on benchmark instances are reported.

15h55 **Tactical aerial search and rescue fleet optimization**

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When an accident occurs far in the ocean, an ad hoc fleet is usually formed for searching survivors and debris. However, it presents challenges to obtain a high search efficiency in combining a set of aircraft from different sources and varied performances, especially when it is not possible to forecast for how long the aerial operation will last. This research considers the problem for planning such fleet as a resource allocation problem and proposes a binary integer programming model to calculate the best combination of available aircraft for maximizing the area searched while minimizing costs and considering operational, time and crew constraints. Instances are used to demonstrate the potential of the model for planning the aerial fleet at the tactical level for solving real-world problems.

16h20 **Cross-disciplinary workforce planning for Industry 4.0**

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Since smart factories are capable of adopting changes, the staff should be trained and qualified on multiple skills. We propose a genetic algorithm based approach to address the multi skill workforce planning and scheduling problem for Industry 4.0. A case study is provided.

MB7 Graphs and networks

Salle/Room: Groupe Cholette
Président/Chairman: Camby, Eglantine, Université Libre de Bruxelles

15h30 Large-scale graph clustering using metaheuristic techniques

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We begin with the combinatorial optimization-based graph clustering problems formulated by Fan and Pardalos and Aloise et al. After modifying the model formulations presented in the literature, we compare the performance of metaheuristic techniques, paying particular attention to scalability. We use simulated data sets as benchmarks.

15h55 Graph theory as a tool to analyze the writing process

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Graph theory is useful to model a variety of situations from transportation (network flows) to biology, even when the data evolves with time. The process of writing a text is complicated to observe as the state of a text changes constantly. The goal of this research is to analyze the writing process, find insights on writing strategies and generate complex statistics using graph theory.

16h20 Optimizing a graph invariant based on a new distance

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In this talk, we propose a new distance, defined as the expected length of a walk between any pair of vertices, and the RW Index, which sums the expected walks lengths between pairs of vertices. According to the computer system AutoGraphiX III, we conjecture on graphs minimizing/maximizing the RW Index.

16h45 Maximal number of leaves in induced subtrees

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Subtrees of graphs, as well as their number of leaves, have been investigated by various communities: from discrete mathematics to data mining and information retrieval. We consider a variant where we require the subtrees to be induced and compute their maximal number of leaves. The problem, which is NP-complete in general, becomes polynomial in the case of trees. The leaf function associates to a number n the maximal number of leaves an induced subtree of size n can have. To compute the leaf function, we provide an efficient branch and bound algorithm. In the particular case of trees, we describe a polynomial algorithm using the dynamic programming paradigm. We conclude by exhibiting a link between the leaf functions of caterpillar graphs and a particular class of words called prefix normal.

MB8 Location and routing

Salle/Room: Metro inc.
Président/Chairman: Gouveia, Luis, University of Lisbon

15h30 Modeling a multi-attribute two-echelon location-routing problem with facility synchronization

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We study a multi-attribute two-echelon location-routing problem with synchronization constraints. Overall, the problem definition involves both strategic and tactical planning to minimize distribution-related costs in urban logistics. We propose a decomposition scheme to decouple echelons and discretize time constraints while maintaining the link of the demand flow between each echelon.

15h55 Flexible two-echelon location routing

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In this talk, we consider an integrated routing problem in which a supplier delivers a commodity to its customers through a two-echelon supply network. Before being sent to the final customers, the commodities are first to be sent to a set of available of distribution centers (DCs). We consider a limited planning horizon over which the total cost consisting of the sum of the shipping costs from the depot to the DCs, the traveling costs from DCs to customers, the location costs, and the penalty costs for any unmet demand, needs to be minimized. On top of this basic setting, we study two sources of flexibility: flexibility in due dates and flexibility in the network design. The former establishes an interval within which the customer requests can be satisfied while the latter is related to the possibility of deciding which DCs are convenient to be rented at each period of the planning horizon. We present a mathematical formulation of the problem together with different classes of valid inequalities. We solve the problem with both exact and approximate methods. Extensive computational tests are made on randomly generated instances to show the value of the two kinds of flexibility. We will also discuss computational and business insights.

16h20 Median and covering location problems with interconnected facilities

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We introduce two classes of location problems with interconnected facilities, i.e., facilities must be located within a prescribed distance of each other. The problems are modeled through several formulations. A greedy randomized adaptive search procedure (GRASP) is developed. Extensive tests are performed to assess the performance of the GRASP.

16h45 A new formulation for the Hamiltonian p-median problem

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Santos, Daniel, University of Lisboa, DEIO, CMAFCIO, d.r.santos@outlook.com

This talk concerns the Hamiltonian p-median problem defined on a directed graph, which consists of finding p mutually disjoint circuits of minimum total cost, such that each node of the graph is included in one of the circuits. Earlier formulations are based on viewing the problem as resulting from the intersection of two subproblems. The first subproblem states that at most p circuits are required, that are usually modeled by using subtour elimination constraints known from the traveling salesman problem. The second subproblem states that at least p circuits are required, for which this paper makes

an explicit connection to the so-called path elimination constraints that arise in multi-depot/location-routing problems. A new extended formulation is proposed that builds on this connection, that allows the derivation of a stronger set of subtour elimination constraints for the first subproblem, and implies a stronger set of path elimination constraints for the second subproblem. The paper describes separation routines for the two sets of constraints that are used in a branch-and-cut algorithm to solve asymmetric instances with up to 150 nodes and symmetric instances with up to 100 nodes using the new formulation.

MB9 Data mining I

Salle/Room: Quebecor
Président/Chairman: Chanca, Etienne, CIRRELT

15h30 Text analytics and topic extraction from employee feedbacks

Mesana, Patrick, HEC Montréal, patrick.mesana@gmail.com
Caporossi, Gilles, GERAD - HEC Montréal, gilles.caporossi@gerad.ca

In this talk, we present a methodology to extract the main topics in a corpus composed of over ten thousand textual employee feedbacks, from a single company. We developed an analytics tool and used DBSCAN to find semantic clusters of feedbacks automatically.

15h55 Predicting engagement and sentiment in commercial B2C Facebook pages using textual information

Jin, Yuan Ping, HEC, yuan-ping.jin@hec.ca
Caporossi, Gilles, GERAD - HEC Montréal, gilles.caporossi@gerad.ca

We propose an alternative to manual tagging of social media data by exploring the use of two training metrics. The first is derived from platform users feedback metrics unique to Facebook. The second is the aggregate emotional polarity expressed by platform users through their comments on a status. In both cases, a model using the company status is proposed that predicts the reaction of the users.

16h20 Railway demand forecasting using machine learning approaches

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In railway industries, demand forecasting is the estimation of the number of passengers aiming to travel by train with a specific itinerary. Railway uses this information to satisfy their demands and maximize the revenues. In this study, we present detailed analyses of applications of various machine learning algorithms and preprocessing techniques to predict the future bookings in railway industries in two different aggregation levels. As a result, stacked generalization method combined with proper preprocessing techniques outperformed other approaches at both levels. We successfully achieved 11% Mean Absolute Percentage Error for level-1 aggregation and 18% Weighted Absolute Percentage Error for level-2.

16h45 VRP routing with driver experience considerations: automating the process of driver to route assignment according to previous deliveries

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This study introduces a method for representing the spatial and the temporal knowledge of drivers. The objective is to take into account their knowledge for the planning of delivery routes in vehicle routing problems. Assigning drivers to routes in areas they are familiar with will potentially lead in improvements in terms of accuracy, execution speed and overall transportation costs. Computer experiments from real data show the soundness of our approach.

MB10 Optimization in radiotherapy centers

Salle/Room: Sony
Président/Chairman: Lahrichi, Nadia, Polytechnique Montréal

15h30 **Mixed electron-photon radiation therapy treatment plan optimization using the column generation method**

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Column generation is well suited for mixed-modality optimisation in radiation therapy as the aperture shaping and modality selection problem can be solved rapidly. We demonstrate that the column generation method applied to mixed photon-electron planning can efficiently generate treatment plans, and investigate its behaviour under different aperture addition schemes.

15h55 **Data-driven appointment scheduling using service time predictive model**

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Lahrichi, Nadia, Polytechnique Montréal, nadia.lahrichi@polymtl.ca

Our work concerns a data-driven approach based on the real data of the Centre Intégré de Cancérologie de Laval (CICL) to develop an efficient patient planning. The study is divided into two main stages. First, we elaborate a predictive model of patient treatment time using data mining and regression tools. Then, based on the predicted service times, new schedule grids are constructed and compared using different assignment rules. The proposed schedule in this study proves its performance with the reduction in waiting time and the augmentation of patients seen per day.

16h20 **A column generation-based heuristic optimizing dose-volume objectives for volumetric-modulated arc therapy**

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Volumetric-modulated arc therapy (VMAT) treatment planning is an efficient treatment technique with a high degree of flexibility in terms of dose rate, gantry speed, and aperture shapes during rotation around the patient. However, the dynamic nature of VMAT results in a large-scale nonconvex optimization problem. Determining the priority of the tissues, voxels, and objectives to obtain clinically acceptable treatment plans poses additional challenges for VMAT optimization. The main purpose of this work is to develop an automatic planning approach integrating direct aperture optimization and re-planning for VMAT, adjusting the model parameters during the algorithm and decreasing the use of trial-and-error in the search for clinically acceptable plans. The proposed algorithm is based on column generation technique which sequentially generates the apertures by solving subproblems and optimizes the corresponding intensities in the master model. In the present work, we modify the weight vector of the penalty function based on the dose-volume histogram (DVH) during the CG iterations. We evaluate the efficiency of the algorithm and the treatment quality using a clinical prostate case and a challenging head-and-neck case.

16h45 **An active-reactive methodology for an online multi-appointments chemotherapy scheduling problem**

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We study a real-world scheduling problem which accommodates requests of patients for chemotherapy treatments in a major metropolitan hospital in Montreal. To solve the problem, an effective and efficient online methodology is proposed which systematically combines two well-defined linear mixed integer programming formulations to handle occurring expected and unexpected events. Using the historical data provided by the oncology clinic, several computational experiments and sensitivity analyses are conducted to draw managerial insights.

MB11 Game theory and environment

Salle/Room: Xerox Canada
Président/Chairman: Garrab, Samar, Royal Military College of Canada

15h30 Equilibrium analysis for common-pool resources

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An aggregative game to describe investment decision making situations for a Common-Pool Resource is presented: we consider a noncooperative approach, searching a Nash equilibrium, and a cooperative one searching a fully cooperative equilibrium. Moreover, we introduce a threshold investment, that depends on the probability of destruction of the CPR, and we study the resulting stochastic aggregative game looking for a Nash equilibrium and a fully cooperative equilibrium.

15h55 Vehicle scrappage incentives to accelerate the replacement decision of heterogeneous consumers

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Vehicle scrappage subsidy programs have been widely applied by governments to replace old cars by newer, more fuel-efficient ones. While these programs have been implemented to motivate earlier replacement, they may not be as effective as expected. From a cost-benefit perspective, the consumers who would have replaced anyway, even without the program, need to be addressed when evaluating the net benefits of the program. This requires accounting for variations in consumers' willingness to replace. Considering consumer heterogeneity in net trade-in valuation, this study investigates a dynamic vehicle-replacement problem based on a life cycle optimization (LCO) approach. We theoretically demonstrate that although increasing the subsidy level motivates low-value consumers to replace earlier, it also induces consumers with a high net trade-in valuation to replace later to become eligible for the subsidy program. We have also developed a simulation program based on real data to show the application of our general model. According to the simulation results, ignoring consumer heterogeneity could result in an overestimation of the net benefits of the scrappage program.

16h20 Equilibria in a two species fishery: Dynamic, biological and ownership interactions

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In this paper we study an example of a two-species fishery dynamic game in which there are two types of agents strategically harvesting each species. The proposed model allows us to study the effect of three externalities, namely: Dynamic interactions, Ownership of the resource, and the Biological interaction between the species on the steady states and the outcomes.

16h45 Impact of leadership on the stability of international environmental agreements

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We consider international agreements for the protection of the environment where the signatories agree to cooperate to determine the level of their joint emissions. In a stylized model, we evaluate the impact of leadership on the stability of an International Environmental Agreement (IEA) over time. Players' welfare is constituted of two terms: revenue from production, which is assumed quadratic in a player's private emissions, and environmental damage cost, which is a non-linear function of the global stock of pollution. We consider a discrete-time, infinite horizon model where only one coalition forms with open membership. The coalition stability concept is based on the non-cooperative point of view, which assumes that agreements must be self-enforcing. To assess the impact of leadership on the stability of the agreement, we compute the steady-state equilibrium pollution stock and the corresponding size of the internally and externally stable coalition under two contrasting assumptions (Nash and Stackelberg).

TAP Séance plénière III / Plenary Session III

Salle/Room: Pléniers - Amphithéâtre Banque Nationale
Président/Chairman: Caporossi, Gilles, GERAD - HEC Montréal

09h00 **Stackelberg games and bilevel bilinear optimization problem**

Labbé, Martine, GOM, Université Libre de Bruxelles and INRIA, mlabbe@ulb.ac.be

Stackelberg Games confront contenders with opposed objectives, each wanting to optimize their rewards. Decision-making parties involve a party with the capacity of committing to a given action or strategy, referred to as the leader, and a party responding to the leader's action, called the follower. The objective of the game is for the leader to commit to a reward-maximizing strategy anticipating that the follower will best respond. Finding the optimal mixed strategy of the leader in a Stackelberg Game is NP-hard when the leader faces one out of several followers and polynomial when there exists a single follower. Additionally, games in which the strategies of the leader consist in covering a subset of at most K targets and the strategies of the followers consist in attacking some target are called Stackelberg Security Games and involve an exponential number of pure strategies for the leader. A Stackelberg game can be modeled as a bilevel bilinear optimization problem which can be reformulated as a single level mixed integer nonlinear program (MINLP). We present different reformulations of this MINLP and compare them from both theoretical and computational points of view.

TA1 Tutorial - N. Lahrichi

Salle/Room: BDC
Président/Chairman: Rousseau, Louis-Martin, Polytechnique Montréal

10h30 **Stochastic tabu search and application in healthcare**

Lahrichi, Nadia, Polytechnique Montréal, nadia.lahrichi@polymtl.ca

Many approaches are used to handle uncertainty in stochastic combinatorial optimization problems. In this talk, we are interested in metaheuristic methods. We describe a stochastic tabu search approach in detail and present a real application. We use the scheduling of physicians in a radiotherapy center during the pretreatment phase for cancer patients. This is defined as the period between the referral to a cancer center and the confirmation of the treatment plan. Physicians have been identified as bottlenecks in this process, and the goal is to determine a weekly cyclic schedule that improves the patient flow and shortens the pretreatment duration. High uncertainty is associated with the arrival day, profile and type of cancer of each patient.

TA2 Collaborative transport

Salle/Room: Banque Scotia
Président/Chairman: Rekik, Monia, GERAD - Université Laval

10h30 Auction-based centralized procurement of TL services

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Traditionally, a shipper, that needs to outsource its transport operations to external carriers, runs a transportation auction on its own. Carriers then submit bids in each auction separately, either sequentially or simultaneously, with no guarantee that all the submitted bids would win in all auctions. We propose a novel centralized transportation procurement auctions in which shippers collaborate by presenting their transportation requests to the same market. Carriers are thus offered the possibility to submit their bids to a unique auction and to combine shipping requests of different shippers. We investigate the benefits/drawbacks of such a mechanism from the carriers' perspective through an exhaustive experimental analysis. Different economic and environmental performance measures are evaluated.

10h55 A two-stage stochastic programming approach for the bid construction problem with stochastic contracts

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In combinatorial auctions for the procurement of transportation services, bid construction problems (BCPs) have been studied since the 1990s. A BCP must be solved by each carrier participating into a transportation procurement auction in order to choose the set of contracts that are the most profitable to bid on and the associate bid price. These decisions are generally made under uncertainty due to other competing carriers' offers. In this work, we propose a two-stage stochastic programming approach with recourse to handle uncertainty on the contracts winning probabilities. Preliminary results will be presented.

11h20 A robust optimization approach for the WDP with uncertainty on shipment volumes and carriers' capacity

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We address the winner determination problem (WDP) for TL transportation procurement auctions under uncertain shipment volumes and uncertain carriers' capacity. The proposed approach extends an existing two-stage robust formulation proposed for the WDP with uncertain shipment volumes. We identify and theoretically validate a number of accelerating strategies to speed up the convergence of a basic constraint generation algorithm proposed in the literature. Experimental results prove the high computational performance of the proposed new algorithm and the relevance of considering uncertainty on the carriers' capacity when solving the WDP.

TA3 Constraint programming I

Salle/Room: EY
Président/Chairman: Pesant, Gilles, Polytechnique Montréal

10h30 A comparison of optimization methods for multi-objective constrained bin packing problems

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In practice, bin packing problems often feature various considerations such as pairwise conflicts or profits between items, or aiming for balanced loads amongst the bins. We present a constraint programming model and two integer programming models of such problems and compare them empirically to a metaheuristic approach.

10h55 The WeightedCircuitsLmax constraint

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The travelling salesman problem is a well-known problem that can be generalized to the m-travelling salesmen where the objective is to minimize the longest circuit travelled. We generalize the Circuit and WeightedCircuit constraints and present a new constraint that encodes m cycles all starting from the same city and whose lengths are bounded by a variable Lmax.

11h20 Automatic melody generation using constraint programming

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

We are developing a hierarchical constraint system to generate a melody given an existing melody and a chord sequence. Using suffix trees, we extract structural characteristics from the given example. The user will then be able to decide which of the extracted patterns he wants to replicate in the output, how close to the original he wants them to sound and also add his own constraints.

11h45 Modelling disjunctive constraints using time interval variables

Cherkaoui, Rachid, Polytechnique Montréal, rachid.cherkaoui-el-azzouzi@polymtl.ca

We show that computing domain consistency for the disjunctive constraint is Fixed Parameter Tractable. This can be achieved by a dynamic programming algorithm that computes a set of time intervals for each task. These intervals can serve as variables for branching and filtering. We expect that hybridization with conventional branching techniques for disjunctive scheduling can improve the search.

TA4 Blackbox and derivative-free optimization II

Salle/Room: Hélène Desmarais
Président/Chairman: Audet, Charles, GERAD - Polytechnique Montréal

10h30 Opportunism and ordering strategies in derivative-free optimization

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We consider the opportunistic strategy present in some direct-search methods for derivative-free optimization, and more specifically blackbox optimization. This strategy interrupts the evaluations following the discovery of a successful point. And this without interfering with the convergence analysis of the method. This opportunistic strategy is computationally tested on a range of algorithms (including CS, GPS, GSS, MADS, IMFIL), with different strategies to order the candidates.

10h55 **Different ordering strategies in blackbox optimisation with no models**

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In blackbox optimisation algorithms, the opportunistic strategy has been used to preserve the budget of evaluations. With no models given, an algorithm like MADS orders its elements according to the direction of last success. Two other strategies will be considered here. The first will use regression methods from supervised classification to evaluate first the elements who have the most chances to be feasible. The second one will try to explore more unknown regions and evaluate first the elements the furthest from the elements already evaluated.

11h20 **The complex barycenter method for direct optimization**

Pait, Felipe, USP, pait@lac.usp.br

A randomized version of the recently developed barycenter method for derivative-free optimization has desirable properties of a gradient search. We develop a complex version to avoid evaluations at high-gradient points. The method is parallelizable in a natural way and robust under noisy measurements and has applications to control design.

11h45 **Mesh-based Nelder-Mead algorithm for inequality constrained optimization**

Audet, Charles, GERAD - Polytechnique Montréal, charles.audet@gerad.ca
Tribes, Christophe, Polytechnique Montréal, christophe.tribes@polymtl.ca

Despite the lack of theoretical and practical convergence support, the Nelder-Mead (NM) algorithm is widely used to solve unconstrained optimization problems. It is a derivative-free algorithm, that attempts iteratively to replace the worst point of a simplex by a better one. The present paper proposes a search step of the Mesh Adaptive Direct Search (MADS) algorithm for inequality constrained optimization, inspired by the NM algorithm. The proposed algorithm does not suffer from the NM lack of convergence, but instead inherits from the totality of the MADS convergence analysis. Numerical experiments show an important improvement in the quality of the solutions produced using this search step.

TA5 Applications of robust optimization

Salle/Room: Manuvie
Président/Chairman: Delage, Erick, GERAD - HEC Montréal

10h30 **Dynamic emergency medical services network design: A novel probabilistic envelope constrained stochastic model**

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Li, Jinlin, Beijing Institute of Technology, jinlinli@bit.edu.cn

This talk introduces a two-stage stochastic programming model for dynamic emergency medical services network design. This model enforces a minimum probabilistic coverage (either through chance constraints or probabilistic envelope constraints) of future emergency demand while minimizing total expected cost over a planning horizon. Numerical experiments involve data from Northern Ireland.

10h55 **Improving stroke routing protocol**

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Stroke is medical emergency and must be treated immediately. However, transporting patients to the closest stroke hospital may not be the best solution. This often causes congestion in some hospitals, while underutilization in others. We study patients routing protocol under congestion using robust queuing technique.

11h20 **Robust binary optimization with an application to talent analytics**

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Bjarnadottir, Margret, University of Maryland College Park, margret@rhsmith.umd.edu

We consider a binary linear programming problem in the presence of high uncertainty on the objective coefficients. We investigate theoretically four models based on an "estimate-then-optimize" paradigm and a robust optimization approach. We finally compare the results of those four methods using real-life data about baseball team player selection.

11h45 **Preference robust optimization for decision making under uncertainty**

Delage, Erick, GERAD - HEC Montréal, erick.delage@hec.ca
Li, Jonathan, Telfer School of Management, University of Ottawa, jonathan.li@telfer.uottawa.ca

While different risk measures can account for risk aversion, it is often unclear which one models best a decision maker's perception of risk. We introduce preference robust optimization as a way of accounting for ambiguity about the DM's preferences. We illustrate numerically our findings with a portfolio allocation problem and discuss possible extensions.

TA6 Smart and sustainable supply chain systems

Salle/Room: Serge-Saucier
Président/Chairman: Izadi-Najafabadi, Behnam, Mr.

10h30 **Fiber procurement planning under sourcing uncertainties**

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Fiber procurement in the pulp and paper companies is challenging due to various uncertainties affecting supply operations. These uncertainties may cause, for instance, delayed deliveries or changed order levels on supply. Such lack of supply may lead to changed production plan or expensive purchases to compensate the shortage. When external suppliers are involved, proper selection of sourcing strategy under these circumstances can counteract the deviations in the volume of deliveries as a sourcing uncertainty. In addition, companies need to manage level of inventory in response to risk of shortage and to avoid excessive inventory cost. We propose a new integer programming model, including purchasing from external suppliers through a set of available sourcing contracts and their transportation to woodyards and pulpmill, with consideration of uncertainty in quantity of deliveries. The objective of this model is to minimize the total procurement cost and evaluate the optimal plan by simulating in presence of risk. We apply three different strategies for the inventory control as well and compare their efficiency.

10h55 **Strategic evaluation of forest residues for biorefinery supply chain**

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Low-value logging residue has a potential to be considered as a valuable resource to produce bio-energy. The current research aims to analyze and propose innovative logistics solutions for the delivery of a large volume of biomass to a new biorefinery located in the territory of La Tuque (Québec, Canada). The fact is that the necessary biomass volumes are very large. However, their removal should not disturb existing forest industries. Finally, the consolidation of the wood fiber flows and the sharing of the available resources (e.g., equipment and transfer terminal) need to be optimized. To achieve this purpose, we developed a timber harvest optimization model (strategic model) to evaluate the different biomass scenarios that can be made available to satisfy demand of the biorefinery. The results of the strategic model provide availability of biomass 25% to 30% larger than those initially confirmed. This is a significant potential that can help the decision makers to design a cost-effective supply chain network for the implementation of a commercial biorefinery in the La Tuque region, Québec.

11h20 **Preliminary study on autonomous vehicle fleet size for carsharing under demand uncertainty**

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We model the carsharing fleet sizing problem for autonomous vehicles as a Markov decision problem. A sequence of stochastic shortest path Problems is solved and the revenue from satisfying new demands is the immediate reward. A discrete event simulation is presented to evaluate MDP solution in different scenarios.

11h45 **Benchmarking port sustainability performance using Data Envelopment Analysis**

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Awasthi, Anjali, Concordia University, anjali.awasthi@concordia.ca

Sustainable development agendas are challenging the world and ports in ways to become more efficient while meeting economic, social and environmental objectives. In comparison to Europe and America, there is limited synthesis about Canadian green ports practices. This research aims to benchmark Canadian sustainability ports performance to identify relevant improvement using Data Envelopment Analysis

TA7 Advances in solving ACOPF problems

Salle/Room: Groupe Cholette
Président/Chairman: Ruiz, Manuel, RTE

10h30 **New conic relaxation for optimal reactive power dispatch**

Bingane, Christian, Polytechnique Montréal, christian.bingane@polymtl.ca
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Le Digabel, Sebastien, GERAD - Polytechnique Montréal, Sebastien.le.digabel@gerad.ca

The optimal reactive power dispatch (ORPD) problem is an alternating current optimal power flow (ACOPF) problem where discrete control devices for regulating the reactive power, such as shunt devices and load tap changers, are considered. The ORPD problem is modeled as a mixed-integer nonlinear program and its complexity is increased compared to the ACOPF problem, which is highly nonconvex and generally hard to solve. Recently, conic relaxations of the ACOPF problem have attracted a significant interest since they lead to global optimality in many cases. We propose a conic relaxation of the ORPD problem whose accuracy is corroborated by computational results on selected MATPOWER test cases.

10h55 **Solving alternative current optimal power flow to global optimality with semi-definite programming and a branch-and-bound algorithm**

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Alternative Current Optimal Power Flow (ACOPF) is known as a non-convex problem. Solving ACOPF to global optimality remains a challenge when classic convex relaxations are not exact. We use Semi-Definite Programming to reformulate ACOPF and get some convexity properties. We solve the reformulation to global optimality with a branch-and-bound algorithm.

11h20 **Application of optimization problems in complex variable with a AC-OPF modeling tool**

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Thanks to extensive scientific research, newly developed methods are able to provide good solutions for the non-convex AC-OPF problems. Computational results can be easily reproduced on academic datasets and for some kinds of AC-OPF (minimizing losses, with or without thermal limit, unit commitment etc). In order to experiment on these methods in an industrial context, the time spent in implementing an AC-OPF needs to be reduced. The R&D department of RTE will present the key components of an AC-OPF modeler implemented in Julia, which stores the optimization problem with polynomials in complex variables while keeping information on the network structure. At the moment, the tool can build OPF problems from Matpower and the GridOptimizationCompetition input format. State-of-art relaxations (SDP, SOCP, …) or B&B methods can then be applied in a generic a way.

TA8 Facility location

Salle/Room: Metro inc.
Président/Chairman: Contardo, Claudio, GERAD - ESG UQAM

10h30 **A scalable exact algorithm for the vertex p-center problem**

Contardo, Claudio, GERAD - ESG UQÀM, claudio.contardo@gerad.ca
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We present a scalable relaxation algorithm for the vertex p-center problem. Our algorithm can handle to proven optimality problems derived from the TSP library containing up to 1 million nodes, this is roughly 200 times larger than the state-of-the-art solvers for this problem

10h55 **Revenue management in hub location problems**

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We consider one of the basic and classical revenue management model known as capacity-control discount fares within the hub location problem and develop a deterministic formulation of this problem. We further extend this model considering uncertainty associated with demand and revenues and develop a stochastic minmax regret formulation. Two exact algorithms based on a Benders reformulation are proposed to solve large-size instances of the problem.

11h20 **Hub location problem under the risk of interdiction**

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In this paper, we study hub location problem under the risk of interdiction (HLPI). We present several formulations of the problem and compare them theoretically and computationally. We further develop an efficient cutting plane algorithm to solve the problem.

11h45 **Dynamic facility location problems with stochastic demands and congestion**

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In this thesis, we study a multi-periodic facility location problem with stochastic demand to determine the optimal location, capacity selection and demands allocation of facilities within distinct time periods, while, each facility contains a server with a limited capacity. It causes facilities to experience a period of

congestion, when not all arriving demands can be served immediately. Customers that arrive in this period might await service in a queue. This thesis perspective incorporates customers waiting costs as part of the objective. In this case, facilities do not utilize whole of the established capacity to ensure a maximum waiting time of the allocated customers. Firstly, a mathematical model is presented for a dynamic facility location problem with stochastic demand and congestion. The problem is setup as a network of spatially distributed queues and formulated as a nonlinear mixed integer program (MINLP). To transform the nonlinear congestion function to a piecewise linear, a linearization method is adapted. This method adds a set of inequalities to the model. We show that lifting this set of inequalities, with keeping generality of the method, reduces CPU times up to 3.5 times, on average. Moreover, a decent heuristic is proposed to solve the problem. Computational experiments indicate that the heuristic results in less costly solutions than them obtained by CPLEX algorithms, in 58% of relatively-difficult test problems.

TA9 Data mining II

Salle/Room: Quebecor
Président/Chairman: Debia, Sébastien, GERAD - HEC Montréal

10h30 A computational study on imputation methods for environmental applications

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Recently, a considerable amount of research has been devoted to the issue of missing data. In this work we perform a computational comparison among three imputation methods based on a random forest, k-nearest neighbor and multivariate imputation by chained equations. In our study we consider nine data sets differing in terms of dimension, nature of variables, and data distribution structure. Preliminary results suggest that the Random forest based method outperforms the others. Our purpose is to give an insight into which imputation method to use, depending on the data types encountered in environmental issues.

10h55 Detecting and predicting the traffic condition by applying image processing methods on CCTV's all around the town

Amoei, Mohsen, Student, mohsenatcce@gmail.com

By utilizing two fields of computer science, computer vision, and data mining we come up with a way to not only reduce the traffic congestion but also to predict it in future. By using CCTV's all around the town and applying image processing methods to evaluate the traffic status of each road.

11h20 Corrosion failure prediction models for gas transmission pipelines

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Corrosion is considered as the most frequent failure in gas transmission pipelines. A literature review reveals that some contributing parameters are ignored in the developed corrosion prediction models. This research aims to develop a corrosion failure estimation model for gas pipelines by exploiting historical data using statistical methods.

11h45 Assessing Québec's hydropower value in a decarbonized future: how public data are sufficient?

Debia, Sébastien, GERAD, sebastien.debia@gerad.ca

Québec's hydropower is a key asset in the development of a decarbonized future in Northeastern America. However, hydropower is not a perfectly flexible resource, and one must take hydro management constraints into account if he does not want to overestimate its value. Taking these constraints into account for a long-term, multi-area problem is however a difficult task: hydro modelling

is dynamic--hence suffering from the curse of dimensions--, hydropower in Québec has typically supply-chain characteristics--several plants with different flexibility are placed at different point of the same river--, and only few technical data are public to calibrate such a model. The methodology to model and calibrate a linear model allowing for a plant-based representation of 71% of Hydro-Québec Production capacity is presented, namely the La Grande, Manicouagan and Aux Outardes valleys. Simplifying the model to an open-loop dynamic problem permits us to represent each valley with the main reservoirs and their underlying supply-chain-management.

TA10 Optimization in the mining industry

Salle/Room: Sony
Président/Chairman: Gamache, Michel, GERAD - Polytechnique Montréal

10h30 Multi-product mine scheduling optimization under multi-element geological uncertainty

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Dimitrakopoulos, Roussos, McGill University, roussos.dimitrakopoulos@mcgill.ca

A new method is proposed to address the multi-product open-pit mine production scheduling problem with multi-element uncertainty. The method is based on extending the Bienstock-Zuckerberg algorithm to the stochastic optimization. A rounding heuristic and a Tabu Search are then applied to obtain an integer solution within 1-2% of optimality in reasonable time.

10h55 Determining the feasibility of a medium term mine plan using a short term planning optimization model to an underground mine

Sanhueza Soto, Pedro, Delphos Mine Planning Laboratory - AMTC - Universidad de Chile, pedro-pablo.sanhueza-soto@polymtl.ca
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The feasibility of medium-term models may not allow realistic operation of the mine in practice due to their time scale and assumptions made to remove detail from the model. We propose a linear programming model to solve this problem and to study the feasibility of a medium-term model.

11h20 Simultaneous stochastic optimization of an open pit gold mining complex with supply and market uncertainty

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Dimitrakopoulos, Roussos, McGill University, roussos.dimitrakopoulos@mcgill.ca

This work presents an application of a stochastic framework that simultaneously optimizes mining, stockpiling and processing decisions for a gold mining complex. Supply and market uncertainties are accounted for through orebody and commodity price simulations. Solutions capitalize on synergies of components, manage and quantify risk in strategic plans, consequently recovering more metal and generating higher NPVs.

11h45 Integreted optimization of short- and medium-term planning in underground mine

Campeau, Louis-Pierre, GERAD, louis-pierre.campeau@gerad.ca

This presentation will present a model for integrated optimization of short- and medium-term underground mine scheduling with variable time discretizations. Different approaches to solve the problem will be discussed as well as results of its application to a Canadian mine data.

12h10 **Optimisation de la planification moyen terme des mines à ciel ouvert**

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Gamache, Michel, GERAD - Polytechnique Montréal, michel.gamache@polymtl.ca

Optimisation de la planification moyen terme des mines à ciel ouvert. La production est à planifier sur plusieurs périodes tout en créant des tournées pour les équipements qui réalisent les opérations de forage, de dynamitage et d'extraction. Cette planification doit respecter les cibles de production et les performances des équipements

TA11 Bilevel optimization

Salle/Room: Xerox Canada
Président/Chairman: Dan, Teodora, Université de Montréal

10h30 **Dynamic programming approach for bidding problems on day-ahead markets**

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In several markets, such as the electricity market, spot prices are determined via a bidding system involving an oligopoly of producers and a system operator. We consider a profit-maximizing producer, whose bids depend on the behaviour of the system operator, as well as the stochastic nature of final demand, and that can be cast within the framework of stochastic bilevel programming. A dynamic programming approach is applied to tackle this problem.

10h55 **Arc-based MILP reformulation of a traffic control bi-level program**

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We discuss a traffic control application where a transportation network manager allocates traffic flow controlling resources. Traffic flows can be antagonistic or cooperative. We present a bi-level programming formulation with an arc-based random utility model that we reformulate in a mixed integer linear program.

11h20 **A branch-and-bound algorithm for a bilevel location model involving competition and queueing**

Dan, Teodora, Université de Montréal, teodoradan85@gmail.com
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Marcotte, Patrice, Université de Montréal, marcotte@iro.umontreal.ca

We consider a competitive environment in which users patronize the facility minimizing the sum of travel time and queueing delay. This situation can be modeled as a bilevel program that involves discrete and continuous variables, as well as linear and nonlinear functions. We propose an exact branch-and-bound framework for determining the optimal locations and service levels associated with facilities. A valid upper bound for this maximization problem is obtained via linearization of the lower level nonlinear terms. Whenever an integer solution is achieved, a lower bound is computed by solving the follower's mathematical program. Numerical results will be presented and discussed.

11h45 **A transportation network pricing problem**

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

I will present a transportation network pricing problem where the leader wants to maximize its revenue by considering the network’s equilibrium. This profit depends on the tolls that we impose on a subset of roads. Thereafter, I will introduce different reformulations for this bilevel program and the methods that we used to solve them.

TBP Séance plénière IV / Plenary Session IV

Salle/Room: Amphithéâtre Banque Nationale
Président/Chairman: Le Digabel, Sebastien, GERAD - Polytechnique Montréal

14h00 **Derivative-free robust optimization by outer approximations**

Wild, Stefan, Argonne National Laboratory, wild@mcs.anl.gov
Menickelly, Matt, Argonne National Laboratory, mmenickelly@anl.gov

We present an algorithm for minimax problems that arise in robust optimization in the absence of objective function derivatives. This important class of problems includes design under uncertainty, for cases where some design evaluations are only available through experiment or simulation. The algorithm utilizes an extension of methods for inexact outer approximation in sampling a potentially infinite-cardinality uncertainty set. Clarke stationarity of the algorithm output is established alongside desirable features of the model-based trust-region subproblems encountered. We demonstrate the practical benefits of the algorithm on a new class of test problems.

TB1 Exposé magistral IV / Tutorial IV

Salle/Room: BDC
Président/Chairman: Caporossi, Gilles, GERAD - HEC Montréal

15h30 **Random forests**

Larocque, Denis, GERAD - HEC Montréal, denis.larocque@hec.ca

Random forests (Breiman, 2001), that are now part of the essential toolbox of any data analyst, is a very powerful non-parametric statistical learning method that can be used for classification, regression and many other problems including survival data. One of its main appeal is its ability to effectively capture nonlinear dependencies and interactions. We will discuss the basic properties of a random forest, review the useful implementations, some of the many extensions to more complex settings, and the available theoretical results. Random forests are still a very active area of research and we will provide an overview of current topics and recent developments.

TB2 Vehicle routing I

Salle/Room: Banque Scotia
Président/Chairman: Desaulniers, Guy, GERAD - Polytechnique Montréal

15h30 **A column-generation based model to pickup and delivery problem with transfers**

Gil, Cristiam, Universidad de Chile, cristiam.gil@gmail.com

Exact methods in the PDP-T literature were only employed for solving small instances with larges computational times: the best is no more than 75 requests and 4 transfer points running up to 1 CPU time hours (an imposed limit) with average gaps of 33.84% (Masson et al., 2014), showing an existing gap in real applications. Some recent promising works have improved gaps in reasonable computational times. Cortes et al. (2010) proved the computational benefits of implementing a branch-and-cut algorithm (based on Benders decomposition) to solve PDP-T problems. They reported savings of around 90% in CPU time when compared to standard MIP solvers. Ghilas et al. (2017) solves the PDPTW-T, through a Branch-and-Price methodology mainly consider for the PDPTW with scheduled lines, with up to 40 requests on the considered instances. Gschwind (2015) evidenced the effectiveness of column generation approaches for the PDP (with no transfer), solving 91% small and medium size instances and 66% of large size instances to optimality. It could be worth to explore this approach for the problem for the problem with transfers. Currently, we are developing of cutting-edge solution methods to Pickup and Delivery problem with transfers, specifically methodologies based in Column Generation. The purpose of this work is to show our ongoing progress in this problem: to propose a three and a two index formulations including precedence, route synchronization and capacity constraints, which present difficulties deal.

15h55 **Selection step impact on the genetic algorithm for the bi-objective vehicle routing problem with time windows**

Akli, Meriem, USTHB, makli@usthb.dz

This paper proposes a Genetic Algorithms for the Vehicle Routing Problem with Time Windows, where both total lengths traveled by the vehicles and the number of vehicles are minimized. The main topic of this work is to evaluate the selection step impact and to detect the appropriate procedure of selection to balance between intensification and diversification.

16h20 **Optimizing drone routing for rapid needs assessment in post sudden-onset disasters**

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Pellerin, Robert, Polytechnique Montréal, robert.pellerin@polymtl.ca
Gamache, Michel, GERAD - Polytechnique Montréal, michel.gamache@polymtl.ca

In the aftermath of a sudden-onset disaster (earthquakes, etc.), rescuers often are tasked in assessing the needs of an affected population and locating those in need of aid. Using drones equipped with wireless sensors, we use a self-organizing map and simulated annealing to optimize the flight operations of the drones.

16h45 **Two-arc sequence variable fixing in branch-price-and-cut algorithms for vehicle routing**

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Irnich, Stefan, Johannes Gutenberg Universität Mainz, irnich@uni-mainz.de
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In branch-price-and-cut algorithms for vehicle routing, variable fixing based on path reduced cost is a well-known speedup technique that allows to eliminate arcs after solving a linear relaxation. In this talk, we extend this technique to also eliminate sequences of two arcs. This requires modifying the labeling algorithm used to solve the pricing problem. Computational results on the vehicle routing problem with time windows will be reported.

TB3 Constraint programming II

Salle/Room: EY
Président/Chairman: Pesant, Gilles, Polytechnique Montréal

15h30 **A O(n log^2 n) checker and O(n^2 log n) filtering algorithm for the energetic reasoning**

Ouellet, Yanick, Université Laval, yanick.ouellet.2@ulaval.ca
Quimper, Claude-Guy, Université Laval, claude-guy.quimper@ift.ulaval.ca

Energetic reasoning is a strong filtering technique for the Cumulative constraint. However, the best algorithms process O(n^2) time intervals to perform the satisfiability check which makes it too costly to use in practice. We present how to apply the energetic reasoning by processing only O(n log n) intervals and propose improved checker and filtering algorithms.

15h55 **Solving systems of linear equalities in modular arithmetic with applications to model counting in CP**

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

Model counting and sampling are two important problems in artificial intelligence. A previously proposed approach for SAT models, inspired by universal hashing, adds randomly-generated XOR constraints to partition the solution space until each cell becomes tractable. We generalize this approach to CP models by considering randomly-generated linear constraints in modular arithmetic and investigate the opportunities to perform domain filtering and solution counting with such constraints using dynamic programming and Gaussian elimination.

16h20 **Accelerating counting-based search**

Gagnon, Samuel, École Polytechnique Montréal, samuel.gagnon92@gmail.com
Pesant, Gilles, Polytechnique Montréal, gilles.pesant@polymtl.ca

Counting-based search, a branching heuristic used in constraint programming, relies on computing the proportion of solutions to a constraint in which a given variable-value assignment appears in order to build an integrated variable- and value-selection heuristic to solve constraint satisfaction problems. The information it collects has led to very effective search guidance in many contexts. However, depending on the constraint, computing such information can carry a high computational cost. This paper presents several contributions to accelerate counting-based search, with supporting empirical evidence that solutions can thus be obtained orders of magnitude faster.

16h45 **Getting more out of the exposed structure in constraint programming models of combinatorial problems**

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

To solve combinatorial problems, Constraint Programming builds high-level models that expose much of the structure of the problem. The distinctive driving force of Constraint Programming has been this direct access to problem structure. This has been key to the design of powerful inference algorithms but we could do much more. Considering the set of solutions to each constraint as a multivariate discrete distribution opens the door to more structure-revealing computations that may significantly change this solving paradigm. As a result, we could improve our ability to solve combinatorial problems and our understanding of the structure of practical problems.

TB4 Blackbox and derivative-free optimization III

Salle/Room: Hélène Desmarais
Président/Chairman: Le Digabel, Sebastien, GERAD - Polytechnique Montréal

15h30 **A new strategy for selecting variables in the parallel space decomposition for the mesh adaptive direct search algorithm**

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The parallel space decomposition of the Mesh Adaptive Direct Search algorithm (PSD-MADS) is an asynchronous parallel technique for derivative-free optimization. PSD-MADS uses a simple generic strategy to select variables used to build subproblems from the original problem. The present work defines a new strategy for selecting variables combining between a statistical technique to quantify the influence of variables on the outputs and a classification technique to analyze the statistical results and provide clusters of influential variables. This new approach improves upon the random strategy used in PSD-MADS and treats larger problems up to 4000 variables.

15h55 **A taxonomy of constraints for blackbox-based optimization**

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The types of constraints encountered in black-box simulation-based optimization problems differ significantly from those treated in nonlinear programming. We introduce a characterization of constraints to address this situation. We provide formal definitions for several constraint classes and present illustrative examples in the context of the resulting taxonomy. We believe that this taxonomy is a critical step for modeling and problem formulation, as well as optimization software development and deployment. Such a taxonomy can also be used as the basis for a dialog with practitioners in moving problems to increasingly solvable branches of optimization as well as informing the development of new classes of mathematical optimization algorithms. Attendees are invited to provide constraint (counter)examples as part of this effort.

16h20 **The mesh adaptive direct search algorithm for granular and discrete variables**

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Tribes, Christophe, Polytechnique Montréal, christophe.tribes@polymtl.ca

The mesh adaptive direct search (MADS) algorithm is designed for blackbox optimization problems where the functions defining the objective and the constraints are typically the outputs of a simulation seen as a blackbox. It is a derivative-free optimization method designed for continuous variables and is supported by a convergence analysis based on the Clarke calculus. This work introduces a modification to the MADS algorithm so that it handles granular variables, i.e. variables with a controlled number of decimals. This modification involves a new way of updating the underlying mesh so that the precision is progressively increased. A corollary of this new approach is the ability to treat discrete variables. Computational results are presented using the NOMAD software, the free C++ distribution of the MADS algorithm.

TB5 Stochastic, robust, and noisy optimization

Salle/Room: Manuvie
Président/Chairman: Ninin, Jordan, GERAD

15h30 **Parameters estimation of 3D model for viscoelastic polymers: Bayesian approach**

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The parameters identification for viscoelastic materials is always open question as the result of ill-posedness. A Bayes' theorem based statistical method is introduced to select appropriate viscoelastic model and estimate parameters from mechanical test data. The experimental errors are also quantified. The results will be validated by a complex loading test on same sample.

15h55 **Coupling decomposition algorithm with dynamic programming for a stochastic spatial model for medium-term energy management problem**

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Mahey, Philippe, Institut Supérieur d'Informatique, Modélisation et de leurs Applications, mahey@isima.fr
Dussault, Jean-Pierre, Université de Sherbrooke, jean-pierre.dussault@usherbrooke.ca

This talk is on energy management from hydro and thermal sources on a medium time scale with multiple zones with stochastic demand and water inflow. We will discuss the use of decomposition to split the problem spatially, then use dynamic programming to solve the zonal problems. We will compare the results and computation times with the direct solving and will discuss about the complexity growth of the two methods.

16h20 **Solving an inverse integer optimization problem with noisy data using a cutting plane algorithm**

Moghaddass, Mahsa, mahsa.moghaddass@gmail.com
Terekhov, Daria, Concordia University, daria.terekhov@concordia.ca

This study develops a method for solving an inverse integer optimization problem when solutions are noisy. We propose a cutting plane algorithm to obtain a cost vector for the forward problem such that the given solution becomes optimal or approximately optimal with the minimum optimality gap.

16h45 **Global optimization with quantified constraints and integral objective function: An interval branch and bound approach**

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Clément, Benoit, ENSTA-Bretagne, benoit.clement@ensta-bretagne.fr

The main benefits of Interval-Analysis-based methods are to cope with non-convexity and heterogenous optimization problems. We illustrate these approachs by solving a structured robust control problems with H_2 and H_infinity constraint and model uncertainties. These problems can be formulated as an optimization problem with integral objective function and quantified constraints.

TB6 Supply chain I

Salle/Room: Serge-Saucier
Président/Chairman: Moisan, Thierry, JDA Software

15h30 **Formulations and branch-and-cut algorithms for multi-trip drone routing problem with time windows**

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This paper studies a multi-trip drone routing problem with time windows, where drones' energy consumption is influenced by payload and travel distance. To tackle the nonlinear energy function, we propose two types of cuts to calculate it exactly, instead of using linear approximation methods. Two formulations are presented, which are solved by branch-and-cut algorithms. Benchmark instances are first generated for this problem. Numerical tests evaluate the performance of the formulations and compare the solutions generated by exact and approximate methods.

15h55 **Order picking in e-commerce warehouses**

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We tackle a problem which is closely related to the Amazon's PrimeNow service that proposes its customers to deliver them in a competitive time-lag (1 H after the demand's release date). We focus on the order picking process. We aim to organize the order picker's routes to satisfy all the demands and minimize the order pickers number. We propose a MILP model and a two-stage heuristic to solve the problem.

16h20 **An online stochastic optimization approach for the management of "smart warehouses"**

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Robot managed 'smart warehouses' are winning popularity as with online retailers such as Amazon and Alibaba. We consider the joint problem of requests sequencing and storage allocation using a fleet of robots. To account for the dynamic nature of the problem, a subset of requests is revealed through the day. This study proposes an online stochastic optimization framework for this specific version of an Automated Storage and Retrieval System.

16h45 **Warehouse task prioritization**

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Warehouse management involves a set of diverse problems. One of them concerns the prioritization of picking tasks to employees to minimize global treatment time while taking into account the warehouse state. We show how task management is usually designed and different alternative approaches that we experimented at JDA labs.

TB7 Smart grids and demand response

Salle/Room: Groupe Cholette
Président/Chairman: Anjos, Miguel F., GERAD & Polytechnique Montréal

15h30 Demand response planner with scheduling for building districts

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We present a demand response planner for a district with heterogeneous buildings and scheduling decisions. We use a multi-objective optimization model to trade off the total cost of energy consumption and the user's dissatisfaction generated by load shifting. Computational experiments and simulations validate the performance of the proposed approach.

15h55 A bi-level approach for increase in power consumption predictability in smart grids

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The decentralization of energy generation has motivated the development of Demand Response programs. We investigate one of these as a bi-level problem for the utility. In this framework, the utility sets pricing parameters for users to book consumption capacity. They optimize both their financial involvement and guaranteed information on users' consumption.

16h20 An optimization model for real-world electricity scheduling usage in smart homes

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Smart homes have the potential to achieve optimal energy consumption so that households can profit from appropriately scheduling electricity consumption. Fully 35% of all households in North America and 20% in Europe are expected to become smart homes by 2020. However, integrated optimization models still have limitations in the number of specific models appliances considered and/or in their reliability. Our work presents a new appliance-oriented integrated linear optimization model to find an optimal trade-off between cost and comfort associated with the use of energy in residential equipment, appliances, and electric vehicles considering renewable local generation, batteries and demand response. We make use of selected models from the literature and analyze them in detail. The proposed model can be used in an energy management system to find an optimal consumption pattern and the corresponding trade-off between cost and comfort. Computational results validate the proposed model and demonstrate how it addresses the limitations of previous models in the literature.

16h45 A decomposition-based approach for the coordination of distributed energy resources

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We present a decentralized framework for coordinating numerous and heterogeneous Distributed Energy Resources. This approach allows to integrate any type of resource whose operation can be formulated within a mixed-integer linear program. The practical efficiency of the algorithm is demonstrated through extensive computational experiments, using data from Ontario energy markets.

TB8 Combinatorial optimization

Salle/Room: Metro inc.
Président/Chairman: Rostami, Borzou, Polytechnique Montréal

15h30 A novel Newton-min algorithm for linear complementarity problems (LCP)

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Despite its efficiency in many applications, there is yet no global convergence result for the semi-smooth Newton algorithm on the min function to solve an LCP involving a P-matrix. One reason is that the Newton-min direction is not always a descent direction at the kinks of the least-squares merit function. New variants ensuring both descent and finite local convergence are proposed. Empirical comparisons with other solvers will be presented.

15h55 A metaheuristic approach for the single-finger keyboard layout problem

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SK-QAP is the problem associated with designing a single-finger keyboard layout. This work approaches the SK-QAP by means of an Iterated Local Search (ILS) algorithm. It solves the 24 existing instances and 6 new developed ones with highly competitive results both in terms of solution quality and CPU time.

16h20 Mathematical programming formulations for the efficient solution of the k-sum approval voting problem

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In this work we model the approval voting problem as a mixed integer linear program. Different formulations for the Minisum, Minimax and k-centrum objective functions have been developed, which are experimentally compared in a data base from the literature.

16h45 A convex reformulation and an outer approximation for a class of binary quadratic program

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In this talk, we propose a general modeling framework for a large class of binary quadratic programs subject to variable partitioning constraints. This problem has a wide range of applications as many of the binary quadratic programs with linear constraints can be represented in this form. By exploiting the problems' structure, we propose mixed-integer nonlinear program (MINLP) and mixed-integer linear program (MILP) reformulations and show the relationship between the two models in terms of the relaxation strength. Our methodology relies on a convex reformulation of the proposed MINLP and a branch-and-cut algorithm based on outer approximation cuts where the cuts are generated on the fly by efficiently solving separation subproblems. Our experimental results on various quadratic combinatorial optimization problems show that our approach outperforms the state-of-the-art solver applied to different MILP reformulations of the corresponding problems.

TB9 On the integration of machine learning and mathematical optimization I

Salle/Room: Quebecor
Président/Chairman: Frejinger, Emma, Université de Montréal

15h30 A comparison of inverse optimization and machine learning for predicting behaviour of optimizers

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We consider the problem of imputing a customer's utility function. Both machine learning (ML) and inverse optimization (IO) methods can be used to impute utility functions. We experimentally compare the performance of these methods and identify their respective strengths and weaknesses when data is generated by an optimization process.

15h55 A trust-region method for minimizing regularized non-convex loss functions

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The training of deep neural networks is typically conducted via nonconvex optimization. Indeed, for nonlinear models, the nonlinear nature of the activation functions yields empirical loss functions that are nonconvex in the weight parameters. Even for linear models, i.e., when all activation functions are linear with respect to inputs and the output of the entire deep neural network is a chained product of weight matrices with the input vector, the (squared error) loss functions remain nonconvex. On the other hand, to circumvent the limits resulting from finding sharp minima (corresponding to weight parameters specified with high precision) of the empirical loss function, Hochreiter suggested in 1995 to find a large region in the weight parameter space with the property that each weight from that region can be given with low precision and lead to similar small error. In this paper, we propose to minimize the empirical loss (training error) together with weights precision (regularization error) by means of a Trust Region (TR)-based algorithm. When extended to nonconvex regularized objectives, this method contrasts to current techniques which either arbitrarily -sometimes strongly- convexify the empirical loss minimization problem or involve slowly converging Stochastic Gradient algorithms without guaranteeing the production of good predictors. TR methods instead provide i) better convergence guarantees compared to other second order methods by means of rich set of methods for step computation, e.g., dogleg, Steighaug; ii) advantageous computational complexity compared to Stochastic Gradient (SG) for nonconvex loss functions; and iii) fast escape from saddle points, e.g., by model reparametrization. In addition, they are combinable with techniques, e.g., tunneling, smoothing, etc., to avoid getting trapped into local minima and with randomized approximation (sub-sampling) that is effective in reducing computational cost associated to Hessian evaluation. The latter provides an essential property in solving high-dimensional instances. Performance bounds of the TR-based algorithm are characterized against gradient descent together with numerical experiments for evaluation and comparison purposes.

16h20 A machine learning approximation algorithm for fast prediction of solutions to discrete optimization problems

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We propose to predict descriptions of solutions to discrete stochastic optimization problems in very short computing time using machine learning. The labeled training dataset consists of a large number of deterministic problems that have been solved independently. Uncertainty regarding the inputs is addressed through sampling and aggregation methods.

16h45 **Deciding whether to linearize MIQPs: A learning approach**

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Within state-of-the-art solvers such as IBM-CPLEX the ability to solve both convex and nonconvex Mixed-Integer Quadratic Programming (MIQP) problems to proven optimality goes back few years, yet presents unclear aspects. We are interested in understanding whether for solving an MIQP it is favorable to linearize its quadratic part or not. Our approach exploits Machine Learning techniques to learn a classifier that predicts, for a given instance, the most suitable resolution method within CPLEX's framework. We aim as well at gaining methodological insights about the instances' features leading this discrimination. Together with a new generated dataset, we examine part of CPLEX internal testbed and discuss different scenarios to integrate learning and optimization processes. By defining novel measures, we interpret learning results and evaluate the quality of the tested classifiers from the optimization point of view.

TB10 Healthcare planning and logistics

Salle/Room: Sony
Président/Chairman: Anaya Arenas, Ana María, ESG-UQAM

15h30 **Modeling and comparison of alternative approaches for sector duration optimization in a dedicated radiosurgery system**

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Stereotactic radiosurgery (SRS) is an effective technique to treat brain metastasis for which several inverse planning methods may be appropriate. We compare three different optimization models, namely, a linear programming model, a piecewise quadratic penalty model, and an unconstrained convex moment-based penalty model for segment duration optimization in SRS.

15h55 **A cardinality-constrained robust approach for the biomedical samples laboratories network problem**

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We consider the Biomedical Samples Laboratories Network Problem, fundamental in modern healthcare systems, and propose a cardinality-constrained robust model for decision making under demand uncertainty. Robust solutions evaluation through real-life scenarios shows better feasibility performances than those of its deterministic counterpart. Solution cost increase is limited and affordable.

16h20 **Demand-driven districting to minimize response time in emergency medical services**

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Districts defined a priori are largely adopted to manage Emergency Medical Services. However, a priori districts do not consider the dynamics of service provisioning, triggering out-of-district ambulance services. To tackle this problem and to improve the solution quality, we propose a demand-driven districting to minimize response time and out-of-district assignments.

16h45 **A VNS for the biomedical sample transportation problem with interdependent pickups**

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In this talk we will present a vehicle routing problem with interdependent pickups based on the biomedical sample transportation problem from Quebec's Ministry of Health and Social Services. A MIP has been formulated and a matheuristic algorithm has been proposed to tackle the real-size instances furnished by our partner.

TB11 Multiobjective optimization

Salle/Room: Xerox Canada
Président/Chairman: Bodur, Merve, University of Toronto

15h30 **An algorithm to find the Pareto frontier for convex pure Integer bi-objective problems**

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De Santis, Marianna, Sapienza University of Rome, mdesantis@diag.uniroma1.it
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In this talk we tackle bi-objective convex nonlinear optimization problems with integer variables. The algorithm allows to construct the full Pareto frontier and is based on the definition of a finite number of subproblems each of them returning a Pareto optimal solution. The construction of the subproblems is done by adding cuts in the space of the objectives that define a partition of the original space. As a tool to find a Pareto solution of each subproblem we can use any method for multiobjective optimization (weights, goal programming etc). The approach works only for pure integer bi-objective convex nonlinear problems. We report preliminary numerical experiments of a benchmark of integer quadratic programming problems and compare with existing state-of-the-art methods.

15h55 **How information theory based mutual information metrics serve optimization in active Mapping?**

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Information theory is a very well known to be the basis of the communication systems developed during the last fifty years and more with Shannon theory (Entropy definition) and its continuous improvement and investigation in Telecommunication as well as in other disciplines, Machine learning, Data compressing, ICA, and recently introduced to the robotics community. Starting from the entropy definition and its direct connection with uncertainty, new information quantities such as relative entropy, mutual information and the latest quadratic mutual information metrics have been developed and the latest quadratic mutual information metrics used as a novel cost functions in many applications in robotics. The most famous challenging ones are active Mapping and active SLAM where the goal is to optimize the exploration by maximizing the mutual information between the state and the measurement. This presentation is dedicated to carrying out the information theory based optimization in robotics with a review and proposal of a new metrics recently investigated and proposed. New divergences and distances based mutual information will be discussed.

16h20 **Decomposition for loosely coupled mixed-integer programs: A multiobjective perspective**

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We consider loosely coupled mixed-integer programs (MIPs), that consist of (possibly a large number of) interrelated subsystems and a small number of constraints, which link blocks of variables that correspond to different subsystems. Motivated by recent developments in multiobjective programming (MOP), we

develop a MOP-based decomposition algorithm to solve loosely coupled MIPs. The proposed algorithm iteratively generates columns for the master problem. However, unlike traditional column generation methods, the master problem is an IP and considers a differently structured (and usually smaller) set of columns. We provide computational results on instances with knapsack structure in the subsystems, demonstrating the potential benefits of our approach.

16h45 **Optimisation des structures vectorielles floues pour les données cartographiques continues**

Grandchamp, Enguerran, LAMIA, enguerran.grandchamp@univ-antilles.fr

Cette présentation traite de la représentation des phénomènes continus au sein des Systèmes D'Information Géographiques (SIG). Nous introduisons une représentation vecteur basée sur les concepts flous. Cette nouvelle structure nécessite de spécifier différents anneaux géographiques. Leur nombre et leur position sont définis par l'optimisation d'un algorithme de classification par recouvrement. Nous donnons des exemples d'application sur la classification de forêts.

Mercredi, le 9 mai 2018 / *Wednesday, May 9, 2018*

WAP Séance plénière V / Plenary Session V

Salle/Room: Amphithéâtre Banque Nationale
Président/Chairman: Caporossi, Gilles, GERAD - HEC Montréal

09h00 **Less is more approach in optimization**

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Whichever creative work a man undertakes, if the inclination to improve it by adding more and more new elements prevails, there comes a moment when he/she reveals that the obtained result is far from the desired and expected. It is the case in almost all the scientific and art disciplines, in Architecture, Music, Physics, Medicine, Neurosciences, Teaching, Cuisine, etc. A respond to this "more and more" attitude is an approach usually called "Less is more". My collaborators and I have recently proposed "Less is more approach" (LIMA) in Optimization. Its main idea is to find the minimum number of search elements (ingredients) when solving an optimization problem that would make some optimization method more efficient and effective than the currently best. LIMA has appeared as a reaction to more and more complex hybrid heuristic methods that combine many different ideas yet giving no proper explanations for such combinations. Combining several heuristics to get a new hybrid method has a price of losing efficiency and user friendliness, the two very important and desired properties of any heuristic. Indeed, despite of the simplicity of LIMA, we got significantly better results than the more complex heuristics have got in solving several classical optimization problems. Such examples will be presented in my talk. Thus, including many ideas in the search does not necessarily lead to better computational results. On the contrary, sometimes less can yield more.

WA1 Exposé magistral V / Tutorial V

Salle/Room: BDC
Président/Chairman: Errico, Fausto, GERAD - École de technologie supérieure

10h30 Cycles, pricing, and pivots

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Within the realm of linear programming, iterative algorithms that maintain feasibility throughout the solution process all identify a direction and then move along the latter with some non-negative step-size. We call the oracle used to identify a direction the pricing problem. Since this oracle maintains its form across the various algorithms, it is a common denominator whose canonical form is first observed in the minimum mean cycle-cancelling algorithm, the average cost of a cycle being taken over the number of arcs. In this respect, the network flow nomenclature is heavily borrowed thus contributing to the intuitive understanding of the pricing problem. It is well known that all directed cycles necessary to reach an optimal minimum cost flow solution can be observed on the residual network. Furthermore, each of these can individually accommodate some strictly positive flow. In optimization terms, each of these directed cycles, or combination of, forms a direction. A degenerate pivot is therefore induced when the selected cycle does not actually exist on the residual network. The concepts of paths and cycles along with some network flow properties can be transferred to linear programs and alternative necessary and sufficient optimality conditions expressed on the so-called residual problem are obtained in the process. We propose a family of algorithms with non-degenerate pivots and also show that the local search heuristics for vehicle routing problems, such as 2-opt, 3-opt, swap, relocate, … are indeed directed cycles on the residual network.

WA2 Green routing

Salle/Room: Banque Scotia
Président/Chairman: Pelletier, Samuel, HEC Montréal

10h30 Leverage the long recharging times of electric vehicles in city logistics

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Electric Vehicle usage represents environmental and economic benefits. Here a variant of e-VRP is studied. We allow visiting a customer by walking while the vehicle is charged. A hybrid-ILS is tested on literature instances: the total recharging time is reduced up to 2.5% and the total distance up to 2.8%.

10h55 Measuring emissions in vehicle routing: new emission estimation models using supervised learning

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Based on real-world data of instantaneous fuel consumption, time-varying speeds observations, and traffic data related to a large set of shipping operations, we propose effective methods to estimate greenhouse gas (GHG) emissions. By carrying out nonlinear regression analysis using supervised learning methods, namely Neural Networks, Support Vector Machines, Conditional Inference Trees, and Gradient Boosting Machines, we develop new emission models that provide more prediction accuracy than classical models. Extensive computational experiments under real datasets show the effectiveness of the proposed machine learning emissions models, clearly outperforming the Comprehensive Modal Emissions Model (CMEM) and the Methodology for Estimating air pollutant Emissions from Transport (MEET) in the prediction of hot running traffic emissions according to root mean square error metrics. Based on performance indicators we show that MEET underestimates real-world GHG emissions by 24.94% and CMEM leads to an overestimation of emissions by 13.18% according to observed fuel consumption, while our best machine learning model (Gradient Boosting Machines) exhibited superior estimation accuracy and is off by only 1.70% considering real-world driving conditions.

11h20 **The electric vehicle routing problem with energy consumption uncertainty**

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In urban environments, freight electric vehicles (EVs) are often exclusively charged at a central depot. We therefore introduce the EV routing problem with energy consumption uncertainty, in which EVs must be routed so that no vehicle ends up stranded even in the worst-case energy consumption scenario. We solve small instances using robust optimization techniques, and we propose a metaheuristic to solve large instances.

WA3 Scheduling problems in healthcare

Salle/Room: EY
Président/Chairman: Lahrichi, Nadia, Polytechnique Montréal

10h30 **Home healthcare staffing and scheduling**

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We present a two-stage stochastic programming model for caregiver staffing and scheduling in home healthcare. Results on real-world instances show that when compared with a deterministic model, the two-stage model leads to significant cost savings, as staff dimensioning and staff scheduling decisions are more robust to accommodate changes in demand.

10h55 **Stochastic tabu search for scheduling**

Di Candido, Marco, Polytechnic University of Milan, marcodicandido@gmail.com

In stochastic combinatorial optimization problems, the time for computation often represents a constraint. The study addresses a scheduling problem from the healthcare sector with a Tabu Search algorithm. To reduce the simulation effort during the evaluation of the neighborhood, different procedures are applied with a focus on Ranking and Selection.

11h20 **Healthcare staff dimensioning and scheduling in a telemedicine context**

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This project aims to build a decision-support tool to staff dimensioning and scheduling in a telemedicine context. First, historical demand information and the interactions between the medical team and patients are analyzed to create a workload forecasting model. Then, a mathematical programming model is developed to decide the staffing level and to produce schedules for the healthcare team.

11h45 **Productivity-driven physician scheduling in emergency departments**

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Optimal scheduling of emergency physicians is key to respond to the problem of overcrowding of emergency departments. Despite most papers in the literature, we propose a mathematical model that considers each individual productivity to align offer (that depends on each physician) and demand (number of patients). First, historical data from patient demand is analyzed to create a productivity index. Then this index is incorporated into the mathematical model to show how to better organize physician scheduling to meet patient demand.

WA4 Blackbox and derivative-free optimization IV - Applications

Salle/Room: Hélène Desmarais
Président/Chairman: Gheribi, Aimen, Polytechnique Montréal

10h30 Surrogate-assisted optimization of model-designed cancer nanotherapy

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Optimization is applied to the design of drug-carrying nanoparticles targeting cancerous tumors. The required model for analysis is computationally expensive. Therefore, a surrogate-assisted approach and the MADS algorithm are used to obtain optimizers of nanoparticle-mediated treatment efficacy. This work provides a quantitative tool to support decisions relevant to precision medicine.

10h55 Extracting constitutive mechanical parameters in linear elasticity using the virtual fields method within the ordinary state-based peridynamics framework

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The extraction of material parameters from experimental data is important in experimental mechanics to characterize the material's properties. We briefly introduce the virtual fields method within the ordinary state-based peridynamics framework, which is utilized to define a minimization problem to identify the material parameters. The solution for the minimization problem is obtained by the NOMAD black-box solver. As an application the extraction of material parameters out of 3-point bending experiment is shown. The influence of the usage of experimental data, like noise in the measured data or missing data, on the minimization process is discussed.

11h20 Determination of optimal compositions and properties for phase change materials. Case study: Solar electric generating station IX

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Thermal energy storage (TES) is becoming a key technology for the implementation of renewable energies in buildings and in industry, and also in increasing energy efficiency of our systems. Moreover, TES will clearly contribute in the decrease of CO2 emissions and climate change mitigation. However, TES systems need a good material selection. Moreover, available materials for TES applications need to be improved and enhanced. Latent heat storage materials also known as phase change materials (PCMs), for which the basic principle is to store the energy through changes of states, is one of the most promising technique to store the solar energy. The design of a new PCM consists, above all, in finding, within a more or less broad range of temperature, the specific compositions of local minima on the liquidus surface, i.e. eutectic point or azeotrope-like extrema. Then performance properties are compared in order to select optimal, or at least satisfactory mixtures as possible PCM candidates. However, up to now, PCMs design is not really efficient due to the lack of available data for both phase equlibria data, in particular the composition of the singular points upon the liquidus surface (i.e eutectic point or simple minima), and thermophysical properties required to evaluate the materials performance. In this paper we present an efficient tool specifically developed for PCM design. This tool can identify the composition of singular points upon the liquidus surface and the material performance, at both the liquid and solid state.

WA5 Two-stage stochastic programming with chance constraints

Salle/Room: Manuvie
Président/Chairman: Bastin, Fabian, Université de Montréal

10h30 Stochastic lot-sizing problem with joint service level constraints

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In this research, the stochastic lot sizing problem for which the objective is to minimize the total cost whereas the decisions are subject to certain demand fulfillment criteria, is considered. These service levels are usually defined for each product. We investigate a joint service level which is defined jointly for multiple products in addition to individual service levels when uncertainty in the demand is present. Two different mathematical models are proposed to approximate this problem; the first one is based on probabilistic constraints and the second one is based on a scenario set.

10h55 On a two-stage stochastic optimization problem with stochastic constraints and nested sampling

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We consider a two-stage stochastic discrete program in which some of the second stage constraints have no closed form and need to be approximated by simulation (i.e., expected value constraints). We study the sample average approximation (SAA), which allows to approximate the solution to the two-stage problem. In particular, we study a nested sampling approach that includes the number of second stage scenarios and the number of replications per scenario to estimate the second stage constraint. We show that, in the second-stage problem, given a scenario, with probability one, optimal values and solutions to the SAA converge to those of the exact problem when the sample sizes go to infinity. However, in the two-stage problem, these convergence results of the second-stage problem do not hold uniformly for all scenarios. Despite of having this issue, we show that, with probability one, the optimal values and solutions given by the SAA approach converge to the true one with large enough sample sizes. We apply the SAA method to the staffing problem in call centers, i.e., the problem of how to optimize the numbers of multi-skill agents while satisfying some quality of service (QoS) constraints. The staffing allocation has to be decided under an uncertain arrival rate, but can be adjusted at some additional cost when the arrival rate is more precisely known. The results show the efficiency of the SAA approach with relatively large numbers of samples.

11h20 A learning-based approach for multi-skill staffing optimization in call centers

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We study a staffing problem in multi-skill call centers. The objective is to minimize the total cost of agents under some probability constraints defined over the randomness of the service level in a given time period. We formulate and solve a sample average approximation (SAA) version of the problem, where the probability functions in the constraints are expressed as functions of the staffing for a fixed sequence of random numbers driving the simulation. There are several challenges lying in solving this problem, namely, the non-linearity of the constraints, the noisiness of simulation, and the complication of large problem instances. We propose a nonlinear regression approach to approximate the probability functions, and design a learning-based algorithm to efficiently find staffing solutions. Our algorithm performs three steps in an iterative manner, namely, a simulation step to generate probability values given each staffing candidate, a learning step to learn the shape of the probability functions, and the third step concerns solving an integer linear program to obtain new staffing solutions. We test our algorithm with data sets collected from real-life call centers, and we show that our approach returns better solutions in shorter computational times, compared to existing approaches in the literature.

11h45 **A two-stage stochastic model for scheduling aircraft arrivals under uncertainty**

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Efficient sequencing and scheduling aircraft arrivals up to a few hours before landing is foreseen to be a key measure towards limiting delays and mitigate air traffic growth. This yields greater uncertainty on predicted arrival times to be dealt with. To address this problem, we propose a two-stage stochastic optimization model enriched by chance constraints.

WA6 Supply chain II

Salle/Room: Serge-Saucier
Président/Chairman: Jans, Raf, GERAD - HEC Montréal

10h30 **Stochastic optimization for material requirement planning (MRP) under demand uncertainty**

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We investigate multiple stochastic optimization formulations for Master Requirement Planning systems under stochastic demand. The execution of the resulting methods is simulated in three environments, which differ by the decisions updated at each period. Results show that these methods lead to significantly lower costs than classical approaches.

10h55 **A branch-and-cut algorithm for an assembly routing problem**

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We consider an integrated optimization problem including the production, inventory and inbound transportation decisions where several suppliers each provide a subset of components necessary for the production of a final product. We present several classes of valid inequalities for this problem. Computational experiments show the performance of our branch-and-cut algorithm.

11h20 **Two-level capacitated facility location with concave costs**

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We study a two-level capacitated facility location problem with concave costs for production, inventory and transportation. The concave costs assumption represents economies of scale, and hence the resulting problem is an integer concave minimization problem. We compute lower and upper bounds to this problem using Lagrangian relaxation and inner integer approximations.

11h45 **Lot-sizing models with simultaneous backlogging and lost sales**

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We study capacitated multi-item lot-sizing models which simultaneously consider the possibility of backlog and lost sales as a means of dealing with a stock-out. We propose new formulations considering several types of interactions between these two types of recourse and by allowing that customers have a different willingness to wait.

WA7 Economic aspects of energy systems

Salle/Room: Groupe Cholette
Président/Chairman: Anjos, Miguel F., GERAD - Polytechnique Montréal

10h30 Increasing electric vehicle adoption via strategic siting of charging stations

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Governments everywhere have started setting ambitious goals for electric vehicle (EV) adoption for the next few decades. Today's charging infrastructure is, however, insufficient to service all these new EVs. Moreover, private investment in charging stations is unlikely while the number of EVs is small, and potential customers will not purchase EVs while these infrastructures are not widespread. Governments must therefore drive this investment during a first stage, thus promoting a higher EV adoption. We present a holistic optimization framework for the strategic siting and sizing of EV charging stations, which takes into account how new infrastructure impacts future EV demand.

10h55 Complementarity modeling of renewable energy credit (REC) and electricity markets to inform effective renewable energy policy formation

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Across the United States (U.S.), at least 2,650 renewable energy incentives and regulations exist at the state level. The most common overarching policy instrument is the Renewable Portfolio Standard (RPS), also known as a Renewable Energy Target (RET), which mandates that a certain percentage of electricity be produced from renewable energy. The highest targets in the U.S. are currently 100% renewable energy production in Hawaii by 2045, and 50% in California, New York and Oregon. While the overarching goal of increasing renewable energy production is common among policies, the mechanisms for achieving a given RET vary widely. This study is one of the first to analyze whether an RET is best set as a single or multi-stage goal; at the state level (regionally), or at the firm-level; and whether the mechanism of trading the environmental benefits of renewable energy via Renewable Energy Credits (RECs) aids RET achievement. By modeling both the REC and electricity market, this study finds that an RET policy design of multi- stage targets at the firm-level, without an REC market, is optimal. It not only achieves the highest social surplus, but also the highest renewable investment, as well as the greatest reduction in greenhouse gas emissions.

11h20 A techno-economic optimisation model of the Greater Montreal Area transport sector

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The objective of this research is to build a techno-economic optimisation model of the Greater Montreal Area transport sector, taking into account energy flows and environmental constraints. Scenarios implementing Quebec policies regarding technologies, greenhouse gases emissions and petroleum limits are computed over the growing demand of the next fifty years.

11h45 Flexibility scheduling for microgrids

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A framework for flexibility management in microgrids is presented. This framework is based on robust optimization and the concept of the flexibility envelopes. It is formulated as a mixed-integer linear programming problem. Numerical experiments demonstrate that the proposed approach is capable of (a) reducing the operating cost of microgrids, (b) reaching high levels of reliability, and (c) maximizing the use of renewable generation.

WA8 Primal and dual methods for integer programming

Salle/Room: Metro inc.
Président/Chairman: El Hallaoui, Issmail, GERAD - Polytechnique Montréal

10h30 Primal integer optimization: A new paradigm

El Hallaoui, Issmail, GERAD - Polytechnique Montréal, issmail.elhallaoui@gerad.ca

After some very interesting progress in solving the set partitioning problems (clustering problems for example), we introduce in this presentation a new primal paradigm, called Primal Integer Optimization (PIO), for the exact solution of general ILP, thus opening up a huge field of applications. These primal methods make it possible to go from an integer solution to a better one until the optimality is proven. To do this, they use a new method of decomposition that benefits, rather than suffer, from the degeneracy inherent in these problems. This translates in practice by two great advantages: i) this paradigm makes it possible to generate quite quickly several high-quality solutions, contrary to the "dual" methods of the Branch & Cut type. The other major advantage of this paradigm is its great flexibility: we can easily integrate the metaheuristics, often used in practice, without sacrificing the exactness (optimality), which is the major drawback of the latter.

10h55 A multidirectional dynamic programming algorithm for the shortest path problem with resource constraints

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The shortest path problem with resource constraints finds the least cost path between two nodes in a network while respecting constraints on resource consumption. The problem is mainly used as a subproblem inside column generation for crew scheduling and vehicle routing problems. The standard approach for the subproblems is based on dynamic programming. This class of methods is generally effective in practice when there are only a few resources, but it seems to be time-consuming for huge instances with many resources. To handle this problem, we propose a new exact primal algorithm called the multidirectional dynamic programming algorithm (MDDPA). The proposed approach splits the state space into small disjoint subspaces. These subspaces are sequentially explored in several iterations, where each iteration builds on the previous ones, to reduce the dimension of the subspaces to explore and to quickly generate better paths. Computational experiments on vehicle and crew scheduling instances show the excellent performance of our approach compared to the standard dynamic programming method. In particular, MDDPA is able to generate feasible paths with up to 90% of the optimal cost in less than 10% of the time required by standard dynamic programming. This feature is useful in column generation and may greatly reduce the computational effort, because we can stop the MDDPA solution process once columns with sufficiently negative reduced costs are obtained.

11h20 The shortest path problem with congestion and waiting times

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We focus on a shortest path problem in a congested network where the driver can wait at vertices to avoid wasting time in traffic. The objective is to minimize the driving time. We study the time complexity of the problem. Then, we describe two approaches by integer programming and dynamic programming.

11h45 A new Lagrangian relaxation for multicommodity capacitated network design problem

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The usual Lagrangian relaxations for multicommodity capacitated network design are the so-called shortest path and knapsack relaxations, which are obtained, respectively, by relaxing linking constraints and flow conservation equations. We present a new reformulation and Lagrangian relaxation for the problem. We show that the Lagrangian dual bound improves upon the so-called strong LP bound (known to be equal to the Lagrangian dual bounds of the shortest path and knapsack relaxations).

WA9 On the integration of machine learning and mathematical optimization II

Salle/Room: Quebecor
Président/Chairman: Potvin, Jean-Yves, Université de Montréal

10h30 Accelerating the optimization of aircrew rotations with machine learning

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The optimization of crew rotations is a critical problem in air transport. So far, this problem has been handled by GENCOL: a solver that uses column generation to minimize costs while respecting collective agreements. We combine artificial intelligence and operational research to accelerate this optimization to achieve a better solution.

10h55 OR/ML for recommendation systems, retail assortments, and financial markets

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This presentation focuses on two independent projects. The first project proposes to explore the synergies between recommendation systems and assortment optimization. While both applications have similar objectives, they have been treated mainly by distinct research and practitioner communities. We propose to exploit the synergies on both the application and the methodological level. The second project aims at finding optimal real-time order strategies for large institutional orders in financial markets, based on historical data-sets that account for multiple terabytes.

11h20 A network design problem arising in the restoration of the water supply system in Nepal

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We propose an optimization approach for the community water network rehabilitation problem targeting remote populations affected by the 2015 Nepal earthquake. To this end, we describe the problem and a matheuristic developed to solve it. Data provided by the Red Cross and satellite imagery are used to generate solutions.

11h45 Nouvelles approches pour la modélisation et la résolution de problèmes de livraisons à domicile

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Ce projet s'intéresse à la génération de tournées de véhicules pour des problèmes de livraisons à domicile. Une partie des travaux portera sur la modélisation de ces problèmes, particulièrement les objectifs poursuivis par les expéditeurs. L'autre partie s'intéressera au développement de méta-heuristiques permettant de produire des tournées de bonne qualité.

WA10 Clustering

Salle/Room: Sony
Président/Chairman: Aloise, Daniel, Polytechnique Montréal

10h30 A typology of logistics service providers in Canada

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This work analyzes the content of 100 websites of Canadian logistics service providers (LSP) in order to identify a variety of value propositions defined as the services offered and the promised outcomes to the customers. Using clustering techniques on this data, it is possible to create a typology of LSPs.

10h55 Towards station-level demand prediction for effective rebalancing in bike-sharing systems

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Bike-sharing systems are today an efficient means of transportation. The proposed model uses temporal and weather features to model the network behavior. The model extracts main behaviors, characterizes them and rebuilds a prediction station-wise. This model is applied to the Montreal network and is able to loose 20% fewer trips than the operator.

11h20 Less is more: Basic variable neighborhood search heuristic for balanced minimum sum-of-squares clustering

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Balanced clustering addresses the problem of finding homogeneous and well-separated subsets of equal cardinality from a set of data points. We present a basic variable neighborhood search heuristic for balanced minimum sum-of-squares clustering. Computational experiments and statistical tests show that the proposed algorithm outperforms the current state-of-the-art algorithm.

11h45 A scalable algorithm for the solution of large clustering problems

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Clustering consists in finding homogeneous and well-separated subsets, called clusters, from a set of given objects. The literature presents numerous clustering criteria to be maximized for separation and minimized for homogeneity. In this paper, we propose a global optimization method for clustering problems with respect to clustering criteria that satisfy three simple properties. We exemplify the use of our method on the diameter minimization clustering problem, which is strongly NP-hard. Our algorithm can solve problems containing more than 500,000 objects while consuming only moderate amounts of time and memory. The size of the problems that can be solved using our algorithm is two orders of magnitude larger than the largest problems solved by the previous state-of-the-art exact methods.

WA11 Networks and logistics

Salle/Room: Xerox Canada
Président/Chairman: Dems, Amira, HEC Montréal

10h30 Modeling the hyperconnected urban freight transportation system (HCL)

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We introduce a new problem for selecting services in a tactical plan of an n-tier hyperconnected city logistics system. Compared to existing models, we consider a coalition of carriers and logisticians sharing their resources and residual transportation capacity. These actors share their equipment and their information in order to optimize economic costs and environmental impact.

10h55 **Multi-period prize collecting Steiner tree problem with budget constraints**

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In this work we consider the problem of finding an optimal expansion plan for gas pipeline networks. The model maximizes the potential increase to a company's profit on a specified horizon. It is defined as a Multi-period Prize Collecting Steiner Tree problem with budget constraints, since there are vertex profits, edge costs and budget limits per period.

11h20 **Relay network design under demand uncertainty**

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The placement problem of relays arises in telecommunications and distribution systems where the load must be regenerated or transferred at intermediate stations (relays) on the route from its origin to its destination. The optimal location of relay nodes depends on the traffic pattern on the network; however, this pattern might be uncertain or variable over time. We review various formulations and variations of the problem (mainly deterministic) from the literature. Then we explicitly incorporate demand uncertainty in the strategic design of the relay network and explore alternative formulations. Preliminary results are presented.

11h45 **Distribution network design and inventory planning under uncertainty**

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An integrated distribution network design-inventory control problem with service requirements in retailing is addressed. This problem is complex due to the general form of demand uncertainty and nonlinear customer service level constraints. To solve the problem, an algorithm based on branch-and-cut framework and a new family of valid cuts are presented. A heuristic approach is developed to tackle large scale problems.

WBP Séance plénière VI / Plenary Session VI

Salle/Room: Pléniers - Amphithéâtre Banque Nationale
Président/Chairman: Lodi, Andrea, GERAD - Polytechnique Montréal

14h00 **Cutting planes and simple MIPs**

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Motivated by the problem of finding strong cutting planes and tight descriptions of the convex hulls of certain simple MIPs, we discuss two approaches to the analysis and/or solution of LPs and MIPs in which extended formulations and their projection into the original space of variables play a crucial role. First we show how some recent work on "facet" separation by a single LP is potentially relevant to the solution of the linear programs arising in Benders' algorithm and also in Dantzig-Wolfe decomposition. Secondly we consider a family of simple mixed-sets generalizing single-node flow models with constant capacities and show how one can derive explicit descriptions of the convex hull of solutions by i) deriving an extended formulation for the convex hull, ii) showing that the formulation is tight and iii) projecting back into the original space of variables using Fourier-Motzkin and induction to eliminate the variables.

WB2 Vehicle routing II

Salle/Room: Banque Scotia
Président/Chairman: Côté, Jean-François, Université Laval

15h30 Improving Benders decomposition method for the traveling salesman problem with generalized latency

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The Traveling Salesman Problem with Generalized Latency finds application in the context of intelligent transportation systems and telecommunications, among others. We develop a solution method based on an improved Benders Decomposition (BD) scheme. Preliminary results show the effectiveness of the proposed method with respect to the classical BD.

15h55 Approximate solution methods for the vehicle routing problem with stochastic and correlated travel times

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In this talk, we propose approximation solution methods for the capacitated vehicle routing problem (CVRP) with uncertain and statistically correlated travel times (CVRP-SCT). The CVRP-SCT is a convex binary quadratic program with exponentially many variables and seeks vehicle routes that their observed travel times are not excessively dispersed with respect to their expected value. We provide new insights into the problem using the eigenvalue decomposition and approximate the problem based on the principal component analysis (PCA). We discuss the quality of the approximate solutions by analyzing the worst case optimality gap. Moreover, we also construct a linear approximation that exploits the convexity of the problem. To solve the approximate models to optimality, we develop exact branch-price-and-cut algorithms based on a labeling algorithm for generating feasible vehicle routes. Our experimental results on a rich collection of instances show the efficiently of the proposed approximate algorithms in finding good quality feasible solutions. In particular, the PCA-based algorithm provides solutions that are optimal for all instances with known optimal values.

16h20 Vehicle routing with arrival time diversification

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One way to generate unpredictable routes is to vary the arrival time of each customer over successive visits. Inspired by a real-life case in cash distribution, we present an efficient solution approach to generate sufficiently unpredictable routes by varying the arrival time at a customer, while minimizing transportation costs.

16h45 A computational study on methods to increase the offer of time windows in time window assignment problems

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This work addresses the challenge of establishing delivery schedules for consumers who buy goods online or who buy furniture and appliances in a store. Home delivery companies try to increase the satisfaction of their customers by offering them a delivery schedule that includes several choices of time windows while limiting transportation costs. This work presents several methods for building delivery schedules. Extensive computational experiments compare the methods in terms of transportation costs, number of served customers and number of offered time windows. Our results show that some methods used in the literature might be very costly and that there exists methods that increase the number of choices while limiting the transportation costs.

WB3 Scheduling and transportation problems in Healthcare

Salle/Room: EY
Président/Chairman: Grenouilleau, Florian, Polytechnique Montréal

15h30 Simultaneous operating room and staff scheduling considering residents' training

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Operating rooms (OR) belong to a hospital's most important and expensive resources. Thus hospitals strive to operate ORs at high utilization, however without jeopardizing patient service. In this context, one of the current challenges lies in an integrated OR- and staff scheduling especially if the staff's (e.g., residents') training has to be taken into account. In this talk we present first modeling approaches how to include residents' training into the integrated OR- and staff scheduling.

15h55 A flexible approach for solving patient transportation problems

Cappart, Quentin, CIRRELT, quentin.cappart@uclouvain.be

This talk presents a static optimization problem aiming to bring patients to health centers given a set of constraints. To do so, a heterogeneous fleet of vehicles is available. The main objective is to satisfy the most requests as possible. We propose to solve it using Constraint Programming.

16h20 A Benders decomposition method for the home health care routing and scheduling problem

Grenouilleau, Florian, CIRRELT, florian.grenouilleau@cirrelt.net
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Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca

In this project, we have developed a Benders decomposition method to solve a routing and scheduling problem in the home health care context. We present here different Benders formulations and some preliminary results.

16h45 Integrated consultation and chemotherapy scheduling in an oncology clinic

Haghi, Maryam, Concordia University, mhaghi.90@gmail.com
Contreras, Ivan, Concordia University, icontrer@encs.concordia.ca
Bhuiyan, Nadia, Concordia University, nadia.bhuiyan@concordia.ca

Oncology clinics often schedule high volume of patients for several types of appointments using limited resources. In most clinics, consultation and chemotherapy appointments should be scheduled on the same day or on two sequential days. Therefore, we propose a mathematical model to schedule both types of appointments simultaneously to obtain the most satisfying schedule for both patients and the clinic.

WB4 Optimization applications in hydropower and hydrology

Salle/Room: Hélène Desmarais
Président/Chairman: Séguin, Sara, Université du Québec à Chicoutimi

15h30 Short-term management of hydropower generation system by Q-learning

Zarghami, Mahdi, Ecole de Technologie supérieure, zarghami_mahdi@yahoo.com
Errico, Fausto, GERAD - École de technologie supérieure, fausto.errico@etsmtl.ca

Determining the optimal operating policy of multireservoir systems is an extremely challenging task, which has been studied for several decades. The most commonly adopted solution approach is based on Stochastic Dynamic Programming (SDP), which, however, suffers from the course of dimensionality and modeling. The Q-learning algorithm is known for his potential to overcome some of the downsides of SDP. In this study develop a Q-learning algorithm for the short-term management of a multireservoir hydropower system and provide extensive computational results. The Q-learning algorithm turns out to be efficient and able to provide solutions whose value is within 3% with respect to solutions obtained in presence of perfect information.

15h55 **A mixed integer nonlinear optimization approach for maintenance planning for hydropower plants**

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Anjos, Miguel F., GERAD - Polytechnique Montréal, miguel-f.anjos@polymtl.ca
Côté, Pascal, Rio Tinto, pascal.cote@riotinto.com

Maintenance planning for hydropower plants is a crucial problem. We propose a mixed integer nonlinear optimization approach that takes into account both the standard constraints in maintenance planning for hydropower plants and the nonlinear aspects of the power output function, often linearized in the literature.

16h20 **Une approche d'optimisation hybride pour le calage efficace de modèles hydrologiques coûteux en temps de calcul**

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Poulin, Annie, École de technologie supérieure, annie.poulin@etsmtl.ca
Alarie, Stéphane, GERAD - Institut de recherche d'Hydro-Québec, alarie.stephane@ireq.ca

La présentation porte sur la proposition d'une nouvelle approche d'optimisation qui combine les stratégies efficaces de deux méthodes existantes : (1)"Dynamically Dimensioned Search" (DDS) et (2)"Mesh Adaptive Direct Search" (MADS). Lorsqu'employés à la calibration d'HYDROTEL, un modèle hydrologique distribué, à base physique et coûteux en temps de calcul, cette nouvelle approche hybride DDS-MADS permet d'encaisser des gains significatifs en temps de calcul (plus de 40%). Je présenterai à la fois la configuration adéquate de l'approche hybride ainsi que les résultats concrets comparativement aux méthodes existantes.

16h45 **Exploitation de modèles substituts représentatifs au sein d'un processus d'optimisation efficace pour les modèles hydrologiques coûteux en temps de calcul**

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

La présentation porte sur l'exploitation de modèles à fidélité réduite représentatifs (surrogates) au sein d'un processus de calibration du modèle HYDROTEL, un modèle hydrologique coûteux en temps de calcul. Par diverses avenues de simplification du modèle de simulation HYDROTEL, la présentation a pour objectif de démontrer les gains possibles en temps de calcul lorsque qu'une méthode d'optimisation efficace exploite ces modèles substituts moins coûteux et représentatifs. Les résultats et conclusions de l'étude seront présentés.

WB5 Advances in scheduling

Salle/Room: Manuvie
Président/Chairman: Bürgy, Reinhard, GERAD - Polytechnique Montréal

15h30 A cutting plane algorithm for resource constrained project scheduling problems without preemption

Soares Araujo, Janniele Aparecida, CIRRELT - Federal University of Ouro Preto (UFOP), jannysdp@hotmail.com
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Jena, Sanjay Dominik, ESG UQAM, sanjay.jena@cirrelt.ca

Resource Constrained Project Scheduling Problems without preemption are NP-hard combinatorial optimization problems. A solution consists in a schedule of jobs with specific execution modes respecting precedence constraints and resource usage limits. In this work we propose a cutting plane algorithm to generate strong bounds and improve the linear programming relaxations.

15h55 Optimization of employee shift schedules with inter-department transfers

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Employee scheduling integer program is intractable for large real-life instances. We propose a three-phase heuristic, solving small integer sub-programs. The first phase identifies probable transfers needs. The second creates for each department, employee schedules using previously gathered information. The third globally fulfills remaining demand. Results and comparison with other similar work are presented. The results show that the heuristic scale very well for very large instances.

16h20 Integrated bus driver rostering and days off scheduling

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El Hallaoui, Issmail, GERAD - Polytechnique Montréal, issmail.elhallaoui@gerad.ca

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

16h45 Employee scheduling with short demand perturbations and extensible shifts

Bürgy, Reinhard, GERAD - Polytechnique Montréal, reinhard.burgy@gerad.ca
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Desaulniers, Guy, GERAD - Polytechnique Montréal, guy.desaulniers@gerad.ca

We consider a practice-inspired employee scheduling problem under demand uncertainty arising in retail stores. In particular, the scheduling problem includes short demand perturbations, potentially leading to an increase of the demand in some given time intervals, and the possibility of assigning overtime work by extending shifts to cope with a lack of employees in real-time. The goal is to find a schedule minimizing the sum of demand fulfillment and employee preference-related costs, where each cost term is expressed as a convex function of an appropriate variable. The cost of a schedule is evaluated using a simulation-based approach that reproduces the materialization of demand perturbations and shift extensions. In order to find high-quality robust employee schedules, we propose two integer programming models taking into account the demand uncertainty and shift extension possibilities in different ways. Extensive computational results on retail store instances reveal that the two proposed models improve the schedule quality significantly when compared with a basic non-robust model.

WB6 Supply chain III

Salle/Room: Serge-Saucier
Président/Chairman: Zetina, Carlos, CIRRELT

15h30 Inventory routing problem with perishable products: Formulations and branch-and-cut algorithms

Alvarez, Aldair, Federal University of São Carlos; HEC Montréal; CIRRELT, aldair.alvarez@outlook.com
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Jans, Raf, GERAD - HEC Montréal, raf.jans@hec.ca

In this talk, we propose different MIP formulations for an inventory routing problem with perishable products. The perishability is modeled by considering a predefined fixed shelf-life for the product. We present branch-and-cut algorithms to solve the problem and report computational experiments with the algorithms using problem instances from the literature.

15h55 A branch-and-price algorithm to solve a three-level lot sizing problem with a distribution structure

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Jans, Raf, GERAD - HEC Montréal, raf.jans@hec.ca

We address a three-level lot sizing problem where a central plant produces items that are sent to warehouses and then to retailers facing a deterministic demand over a finite time horizon. The supply chain considered has a distribution structure and we develop a branch-and-price algorithm to efficiently solve the problem. We also add several improvements and test it on numerous instances.

16h20 Principal role of agent-based approach in further advancements of bioenergy supply chain management

Esmaeilzadeh, Sahar, Concordia University, esmaelzadeh.sahar@gmail.com
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Renewable energies play a pivotal role in social, political and environmental affairs of every country. Numerous reports states that among all the renewable options, biomass is one of the most sustainable alternatives. Yet the heterogeneous nature of biomass along with the complexities risen from seasonality and scattered geographical distribution of biomass sources turns biomass supply chain management into one of the most complex management problems. Dealing with these challenges requires an extensive and intelligent decision-making support tool. Vast majority of studies adopt system dynamics as their approach and because of the complexities, they end up over-simplifying the problem or limiting themselves to a fraction of biomass supply chain. Integration of different tools and approaches is crucial in order to gain a wholesome understanding of this system's behavior. We discuss the importance of Agent-Based modeling and how it can be efficiently combined with SD, allowing us an in-depth analysis of the problem.

16h45 Benders cut-and-solve: A new versatile tool for mixed integer programming problems

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Cordeau, Jean-François, GERAD - HEC Montréal, jean-francois.cordeau@hec.ca

Introduced by Climer and Zhang (2006), cut-and-solve has been used to solve well-known optimization problems such as the TSP and facility location to optimality. The cut-and-solve framework can be thought of as a generalized local branching in which at each level of the enumeration tree only two child nodes exist, one corresponding to a smaller "sparse" problem and the other as its complement known as the "dense" problem. In this study, we propose the use of Benders-based branch-and-cut as the black box MIP solver for "sparse" problems within the cut-and-solve algorithm. Two important advantages of this are the reduced problem size and the re-usability of the Benders cuts generated in previous sparse problems. We present promising computational results for a naive implementation used to solve the fixed-charge multicommodity network design problem.

WB7 Humanitarian logistics applications

Salle/Room: Groupe Cholette
Président/Chairman: Balcik, Burcu,

15h30 A collaborative prepositioning model for strengthening local disaster response capacity

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We present a prepositioning strategy and a stochastic optimization model to strengthen disaster preparedness of a region, which involves multiple countries prone to disaster risk, such as the Caribbean. We consider the uncertainties related to the location and impact of disasters, and present a collaborative approach based on risk-pooling.

15h55 Food aid modality selection problem

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Verter, Vedat, McGill University, vedat.verter@mcgill.ca

There is a vast empirical literature suggesting that providing food aid in cash or vouchers is significantly more effective compared to in-kind. Yet, ours is the first study that mathematically models the aid modality selection and provides a methodology that can respond the dynamics of the environments requiring food assistance.

16h20 A robust optimization approach for humanitarian needs assessment planning under travel time uncertainty

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In this study, we focus on rapid needs assessment operations conducted immediately after a disaster to investigate the conditions of different affected community groups, and address the problem of selecting the sites to be visited by the assessment teams during a fixed assessment period and constructing assessment routes. We represent uncertain travel times by specifying a range of values, and propose a robust optimization approach to support site selection and routing decisions. We present tractable formulations that are robust with respect to different uncertainty sets and propose using the robust formulation with a co-axial box uncertainty set for rapid assessment planning. We develop an efficient tabu search heuristic to solve the proposed model. We present computational results to test our solution method and illustrate our approach on a case study, which is based on data from Van (a southeastern province of Turkey) earthquake in October 2011.

16h45 Risk evaluations of transportation corridors for humanitarian aid: The case of the World Food Programme based in Niger

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Rancourt, Marie-Eve, HEC Montréal, marie-eve.rancourt@hec.ca

We evaluate the risks affecting the World Food Programme's logistic supply chain, upstream of its food distribution to the beneficiaries in Niger. We are developing a descriptive and predictive model able to evaluate the decision taken under uncertainty. It is driven by the intent of generating valid scenarios that quantifies the stochastic parameters of the case studied: the delays, the cost and the losses.

WB8 Optimization software

Salle/Room: Metro inc.
Président/Chairman: Rochon Montplaisir, Viviane, GERAD

15h30 A formal modeling and optimization software

Bigeon, Emmanuel, École de Technologie Supérieure, emmanuel.bigeon.1@ens.etsmtl.ca
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We present VDesign, a preliminary design environment based on the separation of concern concept providing each different user with an adapted interface. For the physicist, a formal language to describe systems in mathematical equations. For the engineer, a constraint description interface that adapts to the models and their modifications. It additionally provides a public API to extend the environment with new optimization methods and variants.

15h55 Nonlinear optimization with Artelys Knitro

Berge, Violette, Artelys Canada, violette.berge@artelys.com

Nonlinear optimization is used in many applications in a broad range of industries such as economy, finance, energy, health, 3D modeling, and marketing. With four algorithms and great configuration capabilities, Artelys Knitro is the leading solver for nonlinear optimization and demonstrates high performance for large scale problems. This session will introduce you to Artelys Knitro, its algorithms (interior points and active sets methods for continuous problems and MIP Branch and Bounds), key features and modeling capabilities.

16h20 Nonlinear optimization with Artelys Knitro II: Latest improvements and modeling tips

Berge, Violette, Artelys Canada, violette.berge@artelys.com

This second session on nonlinear optimization with Artelys Knitro will introduce the features of the latest release Knitro 11.0, including a new algorithm designed for second order cone constraints, and a new API to build-up models piece-by-piece with structural information. Finally, this presentation will end with an insightful session on nonlinear modeling tips and tricks!

16h45 NOMAD, a blackbox optimization software

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Tribes, Christophe, Polytechnique Montréal, christophe.tribes@polymtl.ca

A blackbox is a system which can be viewed in terms of its inputs and outputs, without any knowledge of its internal workings. NOMAD is a software for the optimization of such problems. It implements the Mesh Adaptive Direct Search (MADS) algorithm of 2006 and many of its recent extensions. This talk briefly introduces the MADS algorithm and then details the NOMAD software usage, tuning, and results. NOMAD is intended to be easy to use. It is designed and used to solve real-world optimization problems from the industry. It works out of the box, as long as the objective and constraints are provided. It can be executed as a batch command or as a callable library. NOMAD's parameters are configurable. Useful parameters for superior performance will be discussed. Real-world optimization problems and results will be presented.

WB9 On the integration of machine learning and mathematical optimization III

Salle/Room: Quebecor
Président/Chairman: Rousseau, Louis-Martin, Polytechnique Montréal

15h30 Data-driven transplantation science

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There is a rising incidence of patients suffering from renal failure. The life quality of these patients would be significantly improved through a kidney transplant from a compatible donor. Thus, it is of crucial importance to properly plan the system that allocates donated organs to patients. In this project, we use machine learning models to predict graft survival and analyze how to introduce this qualitative information on the allocation systems.

15h55 Learning representations of uncertainty for decision making processes

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Decision support and optimization-based software are being deployed and used in a constantly growing number of areas affecting our lives. Most of the existing software/programs are today based on data which are approximated using a set of a priori models. In most cases, such software take important decisions based on a weak representation of the uncertainty of the underlying data. Fundamental questions such as “what is the evolution of a tumor during treatment?”, “which market conditions have an impact on a given stock?”, or “how does the demand for a new product fluctuates over time?” are often answered by point forecasts, which means ignoring variance and adverse scenarios. In some other cases, one makes use of probabilistic forecasts based on choices made by human modelers. However, as our economic and social environment is constantly and rapidly evolving, we believe that it is crucial to base decisions on data-driven representations of uncertainty rather than relying on a priori beliefs. We propose to address this challenge using probabilistic deep neural network (DNN), which can learn complex hierarchical representation based on historical and current data to generate possible scenarios of future outcomes. Such scenarios can then be used by optimization methods under uncertainty such as multistage stochastic programming, robust optimization, and chance constrained programming. The challenge will consist of understanding the tradeoff between the quantity and diversity of such scenarios and the complexity of the decision model. We aim to use this new approach to address key paradigms in the decision making processes and methods in several domains, i.e., health care, logistics, and finance, which will overcome the limitations of the tradition methods in their respective applications. This proposal is thus at the core of the research program of IVADO’s apogee grant, both from methodological and application standpoints. This research aims to bridge the gap between the field of ML and OR in a practical yet fundamental way. We first describe the methodology and then present some areas in which we will apply the proposed techniques.

16h20 Optimization of hydropower: Dynamic programming techniques, present and future

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Simonato, Jean-Guy, HEC Montréal

We will present our current results based on simulation-and-regression dynamic programming techniques, as well as our projects for the future, which are based on reinforcement learning and Q-learning approaches. Our reference application is hydropower optimization, but we may also discuss portfolio optimization issues.

WB10 Exact methods for combinatorial optimization

Salle/Room: Sony
Président/Chairman: Contardo, Claudio, ESG UQAM

15h30 Benders decomposition for tree-of-hubs location problems

Enderer, Furkan, Université Concordia, frknndrr@gmail.com
Contardo, Claudio, GERAD - ESG UQÀM, claudio.contardo@gerad.ca
Gendron, Bernard, Université de Montréal, bernard.gendron@cirrelt.ca

In this talk, we study the Tree-of-Hub Location Problems. First, we present relevant literature review and motivation for the problem. We present a mathematical formulation and a Benders Decomposition to solve the problem. In the second part of the talk we study the hop-constrained THLP. We reformulate the problem and present a Benders decomposition to solve the hop-constrained version of the problem. We discuss optimality-feasibility cuts and their relation to other valid inequalities for both variations of THLP. We present experimental results assessing the performance of the proposed solution methodologies. Finally, we draw conclusions and talk about possible future research.

15h55 Binary search for partitioning graphs using k-connected subgraphs

Contardo, Claudio, GERAD - ESG UQÀM, claudio.contardo@gerad.ca

We study the problem of partitioning a weighted graph G = (V, E, w) into p subgraphs, each of which must be k-connected. The weight of a cluster is the minimum weight of a k-connected subgraph, and the objective is to find the partition that minimizes the maximum such weight. We solve this problem using a binary search algorithm, for which the subproblems are solved by means of branch-and-price. Preliminary results will be provided

16h20 A new branch-price-and-cut algorithm for the pickup and delivery problem with time windows

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The pickup and delivery problem with time windows aims at finding routes to satisfy a set of requests. We investigate the impact of disregarding precedence and paring relations within the routes to obtain less restrictive dominance rules in column generation algorithms. Multi-commodity paths are then generated to reinforce route feasibility.

16h45 Solving the optimum communication spanning tree problem

Contreras, Ivan, Concordia University, icontrer@encs.concordia.ca
Zetina, Carlos, CIRRELT, czet_88@hotmail.com
Fernandez, Elena, Universitat Politècnica de Catalunya, e.fernandez@upc.edu

This talk presents an exact algorithm based on Benders decomposition to solve the optimum communication spanning tree problem. It integrates a strong reformulation, combinatorial bounds, in-tree heuristics, fast separation algorithms, and a tailored branching rule. Computational experiments show solution time savings of up to two orders of magnitude compared to state-of-the-art exact algorithms.

WB11 Data mining III

Salle/Room: Xerox Canada
Président/Chairman: Main, Antoine, HEC Montréal /Centre de recherche du CHU sainte-Justine

15h30 **Modèle à base d'agents du comportement des consommateurs pour l'analyse de flux de produits en fin de vie**

Labelle, Alexandre, Polytechnique Montréal, alexandre.labelle@polymtl.ca

Un modèle de simulation du comportement des consommateurs, permettant l'analyse de flux de produits en fin de vie, est présenté à l'aide d'une étude de cas sur l'implantation d'une consigne sur les bouteilles de vin au Québec. Le modèle est calibré et validé avec des données empiriques québécoises.

15h55 **Pronostic du risque de défaillance de systèmes hautement fiables**

Ouali, Mohamed-Salah, Polytechnique Montréal, msouali@polymtl.ca
Berrais, Amira, Polytechnique Montréal, msouali@polymtl.ca
Meango, Jean-Marc, Polytechnique Montréal, marc.meango@polymtl.ca

La communication analyse la contribution de trois scénarios de modélisation des avis des experts en fiabilité dans le pronostic du risque de défaillance de systèmes hautement fiables. Le risque est actualisé tout au long de la durée de vie du système à l'aide de l'inférence bayésienne.

16h20 **Guider les opérations manufacturières avec prise en compte de la variabilité en contexte 4.0**

Lajoie, Patrice, Université Laval, patrice.lajoie.1@ulaval.ca

À la veille d'une transformation numérique, beaucoup d'entreprises manufacturières ne possèdent pas les outils nécessaires pour effectuer ce virage. Cette présentation portera sur le développement d'un cadre méthodologique qui permettra de mieux guider les procédés manufacturiers en forte variabilité en permettant la mise en place de solutions technologiques adaptées.

16h45 **Mesure de l'importance de variable à partir de forêt aléatoire : Application à la génétique des fonctions cognitives**

Main, Antoine, HEC Montréal, antoine.main@hec.ca
Huguet, Guillaume, Centre de recherche du CHU Sainte-Justine

Récemment, des modèles linéaires ont permis d'estimer et de prédire l'impact de l'information génétique sur les fonctions cognitives. Cependant l'utilisation de forets aléatoires pourrait mettre en évidence des associations non linéaires de nouvelles variables et leurs interactions.
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Index des auteurs

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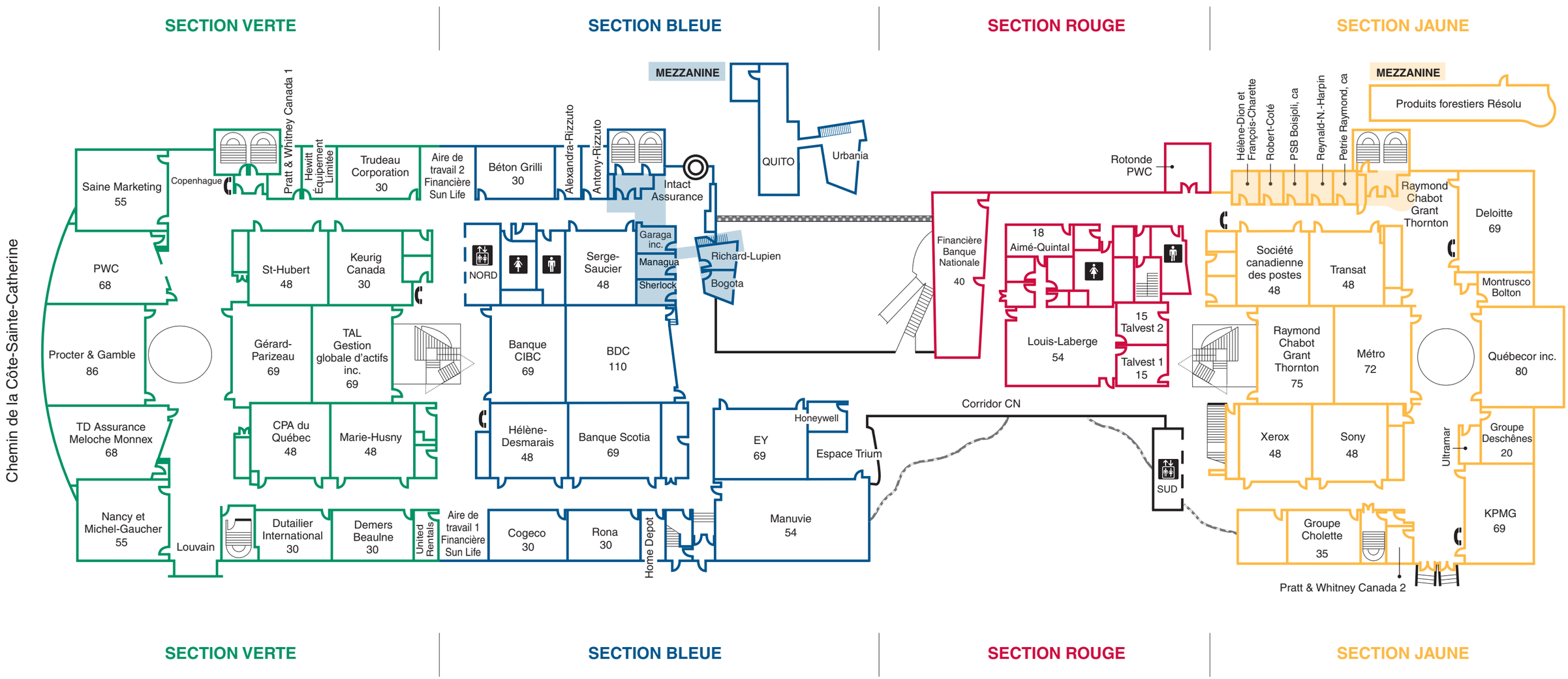
PLAN DES SALLES DE COURS ET SALLES D'ÉTUDE

1ER ÉTAGE



Le chiffre inscrit en dessous du nom de la salle indique le nombre de places disponibles.

SDG-11603 Novembre 2017

Journées de l'optimisation 2018

2018 Optimization Days

Salle / Room	Amphithéâtre Banque Nationale	BDC (Magistraux / *Tutorials*)	Banque Scotia	EY	Hélène Desmarais	Manuvie	Serge-Saucier	Groupe Cholette	Metro inc.	Quebecor	Sony	Xerox Canada
Lundi/*Monday* 08:45–09:00	Amphithéâtre Banque Nationale Séance d'ouverture / *Opening Session*											
Lundi/*Monday* 09:00–10:00	**MAP** Séance plénière / *Plenary Session* **G. Ghiani & E. Guerriero**											
Lundi/Monday 10:30–12:10		**MA1** Exposé magistral *Tutorial* **F. Del Castillo**	**MA2** OR/MS scientific writing activity – Best presentation competition	**MA3** Air crew scheduling	**MA4** Blackbox and derivative-free optimization I	**MA5** Scheduling I	**MA6** Simulation and manufacturing	**MA7** Conic optimization and applications	**MA8** Node and arc routing	**MA9** Nonlinear optimization	**MA10** Marketing and finance	**MA11** Game theory
Lundi/*Monday* 14:00–15:00	**MBP** Séance plénière / Plenary *Session* **M. F. Anjos**											
Lundi/Monday 15:30–17:10		**MB1** Exposé magistral *Tutorial* **C. Audet**	**MB2** Transportation	**MB3** Linear programming	**MB4** Optimization in the railway industry	**MB5** Scheduling II		**MB7** Graphs and networks	**MB8** Location and routing	**MB9** Data mining I	**MB10** Optimization in radiotherapy centers	**MB11** Game theory and environment
Lundi/*Monday* 17:30–20:00	Salon L'Oréal Vins et fromages / *Wine and Cheese Party*											
Mardi/*Tuesday* 09:00–10:00	**TAP** Séance plénière / *Plenary Session* **M. Labbé**											
Mardi/Tuesday 10:30–12:10		**TA1** Exposé magistral *Tutorial* **N. Lahrichi**	**TA2** Collaborative transport	**TA3** Constraint programming I	**TA4** Blackbox and derivative-free optimization II	**TA5** Applications of robust optimization	**TA6** Smart and sustainable supply chain systems	**TA7** Advances in solving ACOPF problems	**TA8** Facility location	**TA9** Data mining II	**TA10** Optimization in the mining industry	**TA11** Bilevel optimization
Mardi/*Tuesday* 14:00–15:00	**TBP** Séance plénière / *Plenary Session* **S. Wild**											
Mardi/Tuesday 15:30–17:10		**TB1** Exposé magistral *Tutorial* **D. Larocque**	**TB2** Vehicle routing I	**TB3** Constraint programming II	**TB4** Blackbox and derivative-free optimization III	**TB5** Stochastic, robust, and noisy optimization	**TB6** Supply chain I	**TB7** Smart grids and demand response	**TB8** Combinatorial optimization	**TB9** On the integration of machine learning and mathematical optimization I	**TB10** Healthcare planning and logistics	**TB11** Multiobjective optimization
Mercredi *Wednesday* 09:00–10:00	**WAP** Séance plénière / *Plenary Session* **N. Mladenovic**											
Mercredi Wednesday 10:30–12:10		**WA1** Exposé magistral *Tutorial* **J. Desrosiers**	**WA2** Green routing	**WA3** Scheduling problems in healthcare	**WA4** Blackbox and derivative-free optimization IV - Applications	**WA5** Two-stage stochastic programming with chance constraints	**WA6** Supply chain II	**WA7** Economic aspects of energy systems	**WA8** Primal and dual methods for integer programming	**WA9** On the integration of machine learning and mathematical optimization II	**WA10** Clustering	**WA11** Networks and logistics
Mercredi *Wednesday* 14:00–15:00	**WBP** Séance plénière / *Plenary Session* **L.A. Wolsey**											
Mercredi *Wednesday* 15:00–15:10	Amphithéâtre Banque Nationale Séance de fermeture / *Closing Remarks*											
Mercredi Wednesday 15:30–17:10			**WB2** Vehicle routing II	**WB3** Scheduling and transportation problems in Healthcare	**WB4** Optimization applications in hydropower and hydrology	**WB5** Advances in scheduling	**WB6** Supply chain III	**WB7** Humanitarian logistics applications	**WB8** Optimization software	**WB9** On the integration of machine learning and mathematical optimization III	**WB10** Exact methods for combinatorial optimization	**WB11** Data mining III