CIRRELT

Centre interuniversitaire de recherche
sur les réseaux d'entreprise, la logistique et le transport

Interuniversity Research Centre
on Enterprise Networks, Logistics and Transportation

Bureaux de Montréal :
Université de Montréal
Pavillon André-Aisenstadt
C.P. 6128, succursale Centre-ville
Montréal (Québec)
Canada H3C 3J7
Téléphone : 514 343-7575
Télécopie : 514 343-7121

Bureaux de Québec :
Université Laval
Pavillon Palasis-Prince
2325, de la Terrasse, bureau 2642
Québec (Québec)
Canada G1V 0A6
Téléphone : 418 656-2073
Télécopie : 418 656-2624

www.cirrelt.ca

Journées de l'optimisation
13-15 mai 2019

Optimization Days
May 13-15, 2019

Instructions aux participants et aux présidents de séances

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

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

Instructions to Participants and Session Chairs

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

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

These measures will allow people to move freely between sessions.

Résumé du programme / Program Outline

Lundi 13 mai / Monday, May 13

Heure / Hour	Séance / Session	Salle / Room
08h00 – 08h45	Inscriptions / Registration and e-mail facilities	Tata Communications
	Petit déjeuner / Breakfast	Investissement Québec
08h45 - 09h00	Séance d'ouverture / Opening Session	Amphi. Banque Nationale
09h00 - 10h00	Séance plénière / Plenary Session – Jean-François Cordeau	Amphi. Banque Nationale
10h00 - 10h30	Pause-café / Coffee Break	Investissement Québec
10h30 - 12h10	Exposé magistral / Tutorial – Alain Hertz	CPA du Québec
	Séances en parallèle / Parallel Sessions	1er étage
12h10 - 14h00	Pause / Break	
14h00 – 15h00	Séance plénière / Plenary Session – Hani Mahmassani	Amphi. Banque Nationale
15h00 - 15h30	Pause-café / Coffee Break	Investissement Québec
15h30 - 17h10	Séances en parallèle / Parallel Sessions	1er étage
17h30	Réception vins et fromages / Wine and Cheese Party	Salon l'Oréal

Mardi 14 mai / Tuesday, May 14

08h00 – 09h00	Inscriptions / Registration	Tata Communications
	Petit déjeuner / Breakfast	Investissement Québec
09h00 – 10h00	Séance plénière / Plenary Session – Sally Brailsford	Amphi. Banque Nationale
10h00 – 10h30	Pause-café / Coffee Break	Investissement Québec
10h30 – 12h10	Exposé magistral / Tutorial – Jean-Marc Frayret	CPA du Québec
	Séances en parallèle / Parallel Sessions	1er étage
12h10 – 14h00	Pause / Break	
14h00 – 15h00	Séance plénière / Plenary Session – Manuel López-Ibáñez	Amphi. Banque Nationale
15h00 – 15h30	Pause-café / Coffee Break	Investissement Québec
15h30 – 17h10	Exposé magistral / Tutorial – Mikael Rönnqvist	CPA du Québec
	Séances en parallèle / Parallel Sessions	1er étage

Mercredi 15 mai / Wednesday, May 15

08h00 – 09h00	Petit déjeuner / Breakfast	Investissement Québec
09h00 - 12h25	Séances en parallèle / Parallel Sessions	1er étage
10h45 – 12h35	MORSC 3rd anniversary	CPA du Québec

Emplacement des activités

- Toutes les activités se dérouleront à HEC Montréal, 3000 chemin de la Côte-Sainte-Catherine
- L'entrée Louis-Colin est accessible à partir de la station de métro Université-de-Montréal

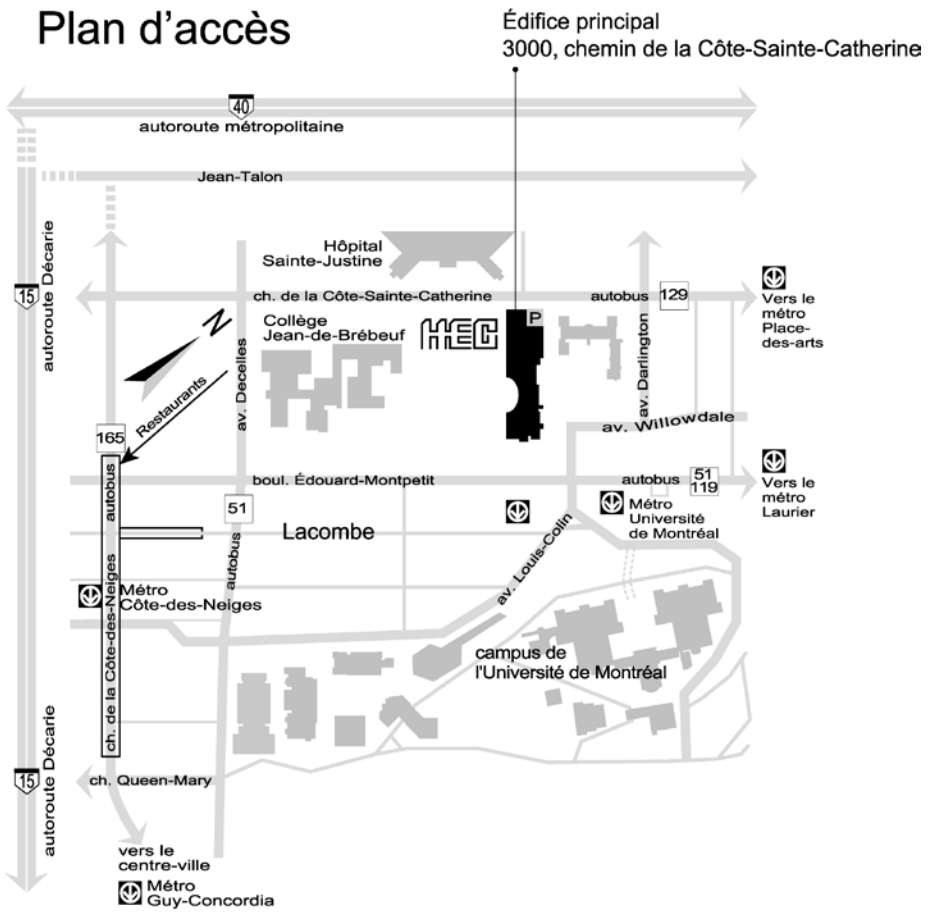
Inscriptions	Salle Tata Communications, en face de l'amphithéâtre Banque Nationale (rez-de jardin)
Petits déjeuners et pauses-café	Salle Investissement Québec, adjacente à l'amphithéâtre Banque Nationale (rez-de-jardin)
Réception vins et fromages	Salon l'Oréal (rez-de-jardin)
Séances plénières	Amphithéâtre Banque Nationale (rez-de-jardin)
Exposés magistraux	CPA du Québec (1er étage / section verte)
Toutes les autres séances	1er étage (section verte)

Location of Activities

- All activities take place at HEC Montréal, 3000 chemin de la Côte-Sainte-Catherine
- The Louis-Colin entrance can be reached from the Université-de-Montréal metro station

Registration	Tata Communications Room, across from Banque Nationale Lecture Hall (Garden level)
Breakfasts and coffee breaks	Investissement Québec Room, beside Banque Nationale Lecture Hall (Garden level)
Wine and Cheese Party	L'Oréal Room (Garden level)
Plenary sessions	Banque Nationale Lecture Hall (Garden level)
Tutorials	CPA du Québec (First Floor / green section)
All other sessions	1st floor (green section)

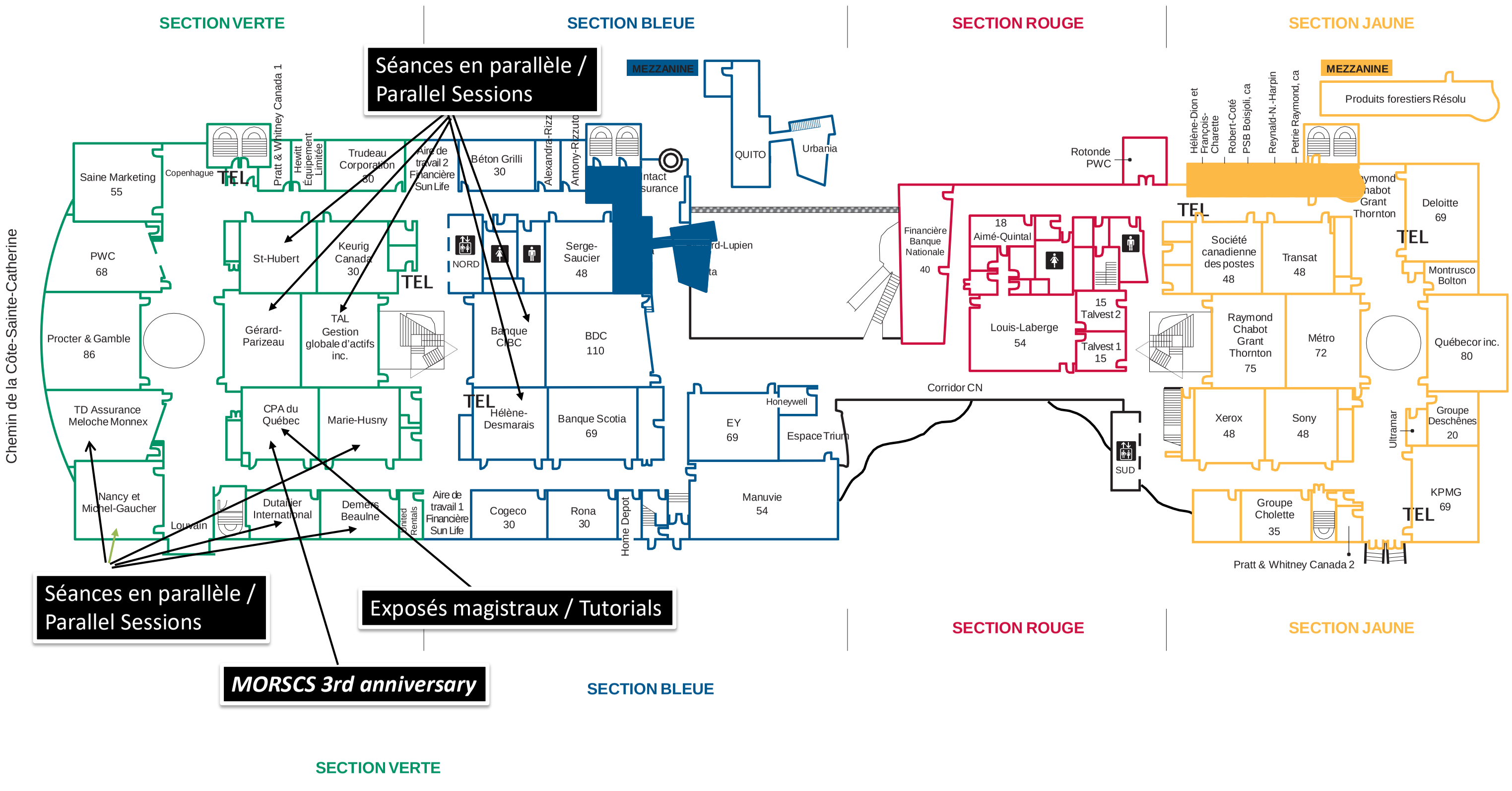
Plan du quartier / Area Map



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

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

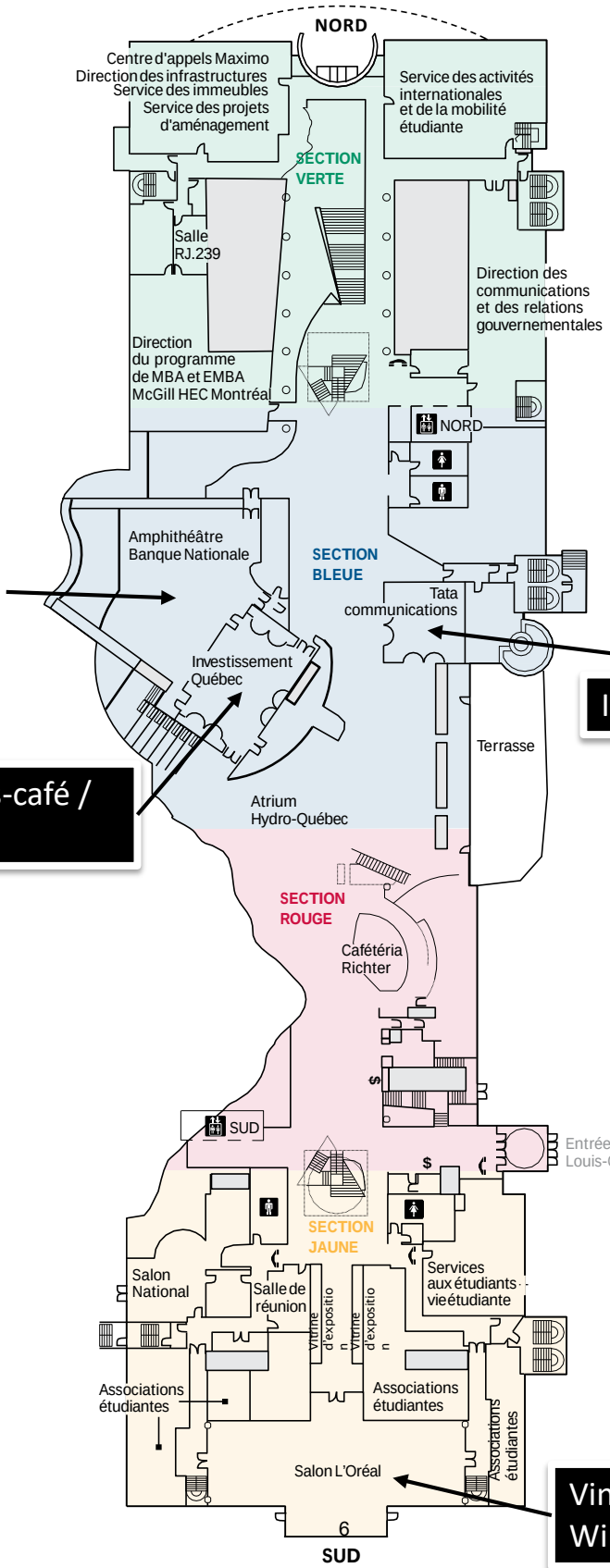
1ER ÉTAGE


SECTION VERTE
SECTION BLEUE
SECTION ROUGE
SECTION JAUNE
Séances en parallèle / Parallel Sessions
MEZZANINE
Produits forestiers Résolu
Chemin de la Côte-Sainte-Catherine
Saine Marketing 55
Copenhague
TEL
Pratt & Whitney Canada 1
Hewitt Équipement Limitée
Trudeau Corporation 30
Aire de travail 2 Financière Sun Life
Béton Grilli 30
Alexandra-Rizz
Antony-Rizzuto
QUITO
Urbania
PWC 68
St-Hubert
Keurig Canada 30
NORD
Serge-Saucier 48
Procter & Gamble 86
Gérard-Parizeau
TAL Gestion globale d'actifs inc.
Banque CIBC
BDC 110
TD Assurance Meloche Monnex
CPA du Québec
Marie-Husny
Hélène-Desmarais
Banque Scotia 69
Honeywell
EY 69
Espace Trium
Nancy et Michel-Gaucher
Louvain
Dutrisac International
Demers Beaulne
United Rentals
Aire de travail 1 Financière Sun Life
Cogeco 30
Rona 30
Home Depot
Manuvie 54
Corridor CN
SUD
Rotonde PWC
Financière Banque Nationale 40
18 Aimé-Quintal
Louis-Laberge 54
15 Talvest 2
Talvest 1 15
Hélène-Dion et François-Charette
Robert-Coté
PSB Boisjoli, ca
Reynald-N.-Harpin
Petrie Raymond, ca
Raymond Chabot Grant Thornton
Deloitte 69
Société canadienne des postes 48
Transat 48
Montrusco Bolton
Raymond Chabot Grant Thornton 75
Métro 72
Québecor inc. 80
Xerox 48
Sony 48
Ultramar
Groupe Deschênes 20
Groupe Cholette 35
KPMG 69
Pratt & Whitney Canada 2
Séances en parallèle / Parallel Sessions
Exposés magistraux / Tutorials
MORSCS 3rd anniversary

PLAN

Édifice Côte-Sainte-Catherine - RJ

3000, chemin de la Côte-Sainte-Catherine, Montréal (Québec) Canada H3T 2A7



Séances plénières / Plenary sessions

Inscriptions / Registration

Petits déjeuners et pauses-café / Breakfasts and breaks

Vins & fromages / Wine & cheese party

OPT2019

Programme / Program

Lundi 13 mai / Monday, May 13, 2019

08h45 Opening Session - Amphithéâtre Banque Nationale

MA1 Plenaries - Integrated Production and Transportation Planning

Salle: Amphithéâtre Banque Nationale
Président: Lahrichi, Nadia, Polytechnique Montréal

09h00 **Integrated Production and Transportation Planning**

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

Production planning, inventory management and vehicle routing are three cornerstones of supply chain management. In both the scientific literature and the industry, there is a growing interest in models and algorithms that integrate these three components with the aim of reducing overall logistics costs. This leads to challenging combinatorial optimization problems that combine classical lot sizing and vehicle routing structures. We present a simple and flexible heuristic framework that yields high quality solutions to some of the most important variants, such as the inventory-routing problem and the production-routing problem. We also explain how Benders decomposition can successfully solve the production-routing problem under demand uncertainty. Finally, we describe some recent industrial applications.

MB1 Tutorial - Variations and Extensions of the Standard Vertex Coloring Problem

Salle: CPA du Québec
Président: Lahrichi, Nadia, Polytechnique Montréal

10h30 **Variations and Extensions of the Standard Vertex Coloring Problem**

Hertz, Alain, Polytechnique Montréal and GERAD, alain.hertz@gerad.ca

Given a graph G = (V;E) with vertex set V and edge set E, and given an integer k, a k-coloring of G is a function c : V -> {1, ... k} that assigns a color c(v) to every vertex v so that no edge has both endpoints with the same color. The vertex coloring problem is to determine the smallest integer k, called chromatic number, for which G admits a k-coloring. Variations and extensions of this famous combinatorial optimization problem have been developed to deal with increasingly complex scheduling problems. We present some of them and illustrate them in specific applications. We first consider the selective graph coloring problem which can be defined as follows. Let V = {V1, ..., Vp} be a partition of the vertex set V. We define a selection as a subset of vertices V' (in V) such that the intersection of V' and Vi is exactly of size 1 for all i. A selective k-coloring of G with respect to the partition V is defined by (V',c), where V' is a selection and c is a k-coloring of the subgraph induced by the selection V'. The smallest integer k for which G admits a selective k-coloring with respect to V is called the selective chromatic number. The standard vertex coloring problem is often used to solve scheduling problems involving incompatibility constraints. For more general scheduling problems with precedence constraints, the second considered generalisation, called mixed graph coloring problem, is a more appropriate model. The minimum number of colors needed to color the vertices of a mixed graph is called the mixed chromatic number. In practical applications, it may happen that the graph to be colored is not known from the beginning. The input graph is then only partially available because some relevant input arrives only in the future. This is the case, for example, in dynamic storage allocation, or when assigning channels (colors) to users (vertices) in a telecommunication network. In such situations, the vertices arrive one by one together with the edges linking them to previously revealed vertices. An online algorithm must color the vertices as they arrive, and no color can be changed later. The online chromatic number of G is then defined as the smallest number k such

that there exists a online algorithm which is able to color G using k colors for any incoming order of the vertices.

MB2 Vehicle Routing I

Salle: Banque CIBC
Président: Semet, Frédéric, École Centrale de Lille

10h30 Vehicle routing with due dates and stochastic release dates

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

In most variants of the VRP, static and deterministic situations are considered, whereas, in many real-life applications, information is not available in advance, but it is revealed at the time of planning. In this talk, we discuss a variant of the vehicle routing problem (VRP) in which the delivery may occur between a release and a due date. However, the delivery is conditioned on the availability of the product at the supplier. The due dates are pre-specified by the customers but the availability of the product at the supplier, which we consider to be stochastic, determines when, and if, a product could be delivered to the customers. The objective is to satisfy the demand of customers before a pre-specified due date with the least routing and penalty costs. We propose and compare several policies for this problem and solve instances of the problem under the presence of each policy.

10h55 A branch-and-price algorithm for the vehicle routing problem with stochastic demands and probabilistic duration constraints

Florio, Alexandre, University of Vienna, alexandre.de.macedo.florio@univie.ac.at
Hartl, Richard, University of Vienna, richard.hartl@univie.ac.at
Minner, Stefan, TU Munich, stefan.minner@tum.de
Salazar Gonzalez, Juan Jose, Universidad de La Laguna, jjsalaza@ull.es

In many routing applications, it is necessary to place limits on the duration of the individual routes. When demands are stochastic and restocking during route execution is allowed, the durations of the resulting routes are also stochastic. In this paper, we consider the vehicle routing problem with stochastic demands and (probabilistic) duration constraints (VRPSD-DC). We assume optimal restocking, which means that, during the route execution, replenishment trips to the depot are performed in an optimal way. The resulting optimization problem calls for a set of routes with minimal total expected cost for visiting all customers, such that the duration of each route, with a given probability, does not exceed a prescribed limit. We solve the VRPSD-DC with a novel branch-and-price algorithm. An orienteering-based completion bound is proposed to control the growth of labels in the pricing algorithm. Feasibility of a priori routes is verified by applying Chebyshev's bounds, by Monte Carlo simulation and statistical inference, or by analytically deriving the distribution of the route duration. Consistency checks are incorporated into the branch-and-price framework to detect statistical errors. Computational experiments are performed with demands following binomial, Poisson, or negative binomial probability distributions, and with duration constraints enforced at the levels of 90%, 95% and 98%. Optimal solutions to the VRPSD-DC may contain routes that serve an expected demand that is larger than the capacity of the vehicle. These solutions actively employ optimal restocking to reduce travelling costs and the number of required vehicles. Sensitivity analyses indicate that high demand variability negatively impacts the solution, both in terms of total expected cost and the number of routes employed.

11h20 A branch-and-cut algorithm for the multi-pickup and delivery problem with time windows

Aziez, Imadeddine, Université Laval, imadeddine.aziez@cirrelt.ca
Côté, Jean-François, Université Laval, jean-francois.cote@cirrelt.ca
Coelho, Leandro C., Université Laval, leandro.coelho@cirrelt.ca

We solve the multi-pickup and delivery problem with time windows (MPDPTW), in which a set of requests is satisfied by a fleet of vehicles. Three mathematical formulations are proposed for the problem and a state-of-the-art branch-and-cut algorithm is designed to solve them. Several families of cuts are also used to help tackle this difficult problem.

11h45 A column generation based heuristic for the generalized vehicle routing problem with time windows

Semet, Frederic, Univ. Lille, CNRS, Centrale Lille, Inria, CRIStAL, frederic.semet@centralelille.fr
Yuan, Yuan, Univ. Lille, CNRS, Centrale Lille, Inria, CRIStAL, yuan.yuan@inria.fr
Cattaruzza, Diego, Univ. Lille, CNRS, Centrale Lille, Inria, CRIStAL, diego.cattaruzza@centralelille.fr
Ogier, Maxime, Univ. Lille, CNRS, Centrale Lille, Inria, CRIStAL, maxime.ogier@centralelille.fr
Vigo, Daniele, Universita di Bologna, daniele.vigo@unibo.it

The generalized vehicle routing problem with time-windows (GVRPTW) is a generalization of the vehicle routing problem with time-windows in which, for each customer, one location must be selected in an associated cluster. The GVRPTW has applications in e-commerce to design last-mile delivery systems. We present a heuristic based on column generation which produced high-quality solutions.

MB3 Stochastic Optimization I

Salle: Demers Beaulne
Président: Jans, Raf, HEC Montréal

10h30 A multi-stage stochastic programming approach for an integrated maintenance and production planning with demand uncertainty

Zarei, Hamid Reza, , h.r.zarei@ut.ac.ir
Kazemi, Masoumeh, Concordia University, kazemi@encs.concordia.ca
Nourelfath, Mustapha, Université Laval, Mustapha.Nourelfath@cirrelt.ca

In this paper, we developed an integrated multi-stage stochastic programming model for production and maintenance planning problems for a multi-state system with random time to failure under uncertain demand for products in each stage. The proposed model is solved for small-sized problems and the results are compared with mean-value deterministic model.

10h55 Lagrangian dual decision rules for multi-stage stochastic integer programming

Daryalal, Maryam, University of Toronto, m.daryalal@mail.utoronto.ca
Bodur, Merve, University of Toronto, bodur@mie.utoronto.ca
Luedtke, Jim, University of Wisconsin at Madison,

Multi-stage stochastic programs can be approximated by restricting policies to follow decision rules. This talk introduces Lagrangian dual decision rules (LDDRs) for multi-stage stochastic integer programs. We investigate techniques for using LDDRs to obtain bounds on the optimal value, and compare the strength of the relaxation from these different techniques.

11h20 Solving stochastic large-scale mixed integer linear problems for industrial production scheduling

Brika, Zayneb, École Polytechnique de Montréal, zayneb.brika@polymtl.ca
Gamache, Michel, Polytechnique Montréal, michel.gamache@polymtl.ca
Dimitrakopoulos, Roussos, COSMO Stochastic Mine Planning Laboratory, Université McGill, roussos.dimitrakopoulos@mcgill.ca

A new linear model is presented to address the topic of an open-pit mine production scheduling accounting for stockpiles and investment decisions in a stochastic context. The solution approach

consists in first solving the linear relaxation using an extension of the Bienstock-Zuckerberg algorithm to the stochastic optimization. Then, a rounding heuristic based on the topological sorting is applied followed by a Tabu search with multiple neighbourhoods. A parallelization strategy is used to reduce the time spent creating the neighbourhoods. Real-sized instances are used to test the proposed method.

11h45 Investigating aggregate γ service level constraint in the stochastic lot sizing problem

Sereshti, Narges, HEC Montréal, narges.sereshti@hec.ca
Adulyasak, Yossiri, HEC Montréal, yossiri.adulyasak@hec.ca
Jans, Raf, HEC Montréal, Raf.jans@hec.ca

In this research, we extend the stochastic programming model of the multi-item lot-sizing with γ service level for each individual product to a more practical setting where multiple service levels can be used in conjunction across multiple products to ensure that the business requirements are satisfied on an aggregate level. Stochastic Lot-Sizing, Aggregate Service Level

MB4 Game Theory

Salle: Gérard-Parizeau
Président: Carvalho, Margarida, Université Montréal

10h30 A game theoretic analysis for community microgrid network

Dagdougui, Hanane, Assistant Professor, Department of Mathematical and Industrial Engineering, Polytechnique Montreal, hanane.dagdougui@polymtl.ca
Elhallaoui, Issmail, Associate Professor, Department of Mathematical and Industrial Engineering, Polytechnique Montreal, issmail.elhallaoui@polymtl.ca
Aziz, Mohamad, PhD Candidate, Department of Mathematical and Industrial Engineering, Polytechnique Montreal, mohamad.aziz@polymtl.ca

Current electricity markets may be better described in terms of an oligopoly than of perfect competition from which they may be rather far. Microgrid, a promising component of the smart grid, will potentially yield a free electricity market. This paper proposes a novel construction for a community microgrid (MG) by deploying a virtual power bank which consists of household storage batteries and mediates the communications between the MG and the macro-grid (MA). Households, representing the distributed energy resources (DER) and the demand side, are considered the MG prosumers (i.e. they are the consumers and the potential energy producers). In this paper, Nash Equilibrium strategies which minimize a linear combination of the households' energy generation cost, energy consumption cost and revenue of sold energy are found via an application of mean field control theory (MFG). The decentralized community microgrid optimization (MGO) problem via mean field control is configured using a flat rate macrogrid pricing mechanisms. Computational investigations of the decentralized MGO problem via MFG are presented for a constructed community MG in Quebec, Canada.
.

10h55 Impact of a leader-follower equilibrium concept on the stability of environmental agreement

Garrab, Samar, Royal Military college of Canada , Samar.garrab@rmc.ca

We study in this paper the impact of the leader-follower equilibrium concept on the stability of international environmental agreements. In an infinite-horizon dynamic game, we assume that signatories hold the leader role and decide first about their emission strategies while non-signatories are followers.

11h20 Is it time to intervene? An impulse control approach to dynamic games

Sadana, Utsav, GERAD, HEC Montreal, utsav.sadana@hec.ca
Reddy, Puduru Vishwa, Indian Institute of Technology Madras, India, vishwa@ee.iitm.ac.in

Zaccour, Georges, GERAD, HEC Montreal, georges.zaccour@gerad.ca

In this paper, we introduce a class of two player non-zero-sum dynamic games (DG) where one player uses continuous control while the other player uses impulse control. We determine the necessary and sufficient conditions for the existence of open loop Nash equilibrium. For linear state DG, we obtain analytical solutions.

11h45 When Nash meets Stackelberg

Sankaranarayanan, Sriram, Polytechnique Montreal, s.sri.ram1992@gmail.com
Feijoo, Felipe, PUCV, Chile, felipe.feijoo@pucv.cl
Lodi, Andrea, Polytechnique Montreal, andrea.lodi@polymtl.ca

We provide an algorithm to compute a mixed-strategy Nash equilibria of a Nash game where each player's (or leader's) pay off is given as a bilevel linear program. This leads to a situation where the leaders not only play a Nash game with other leaders but also a Stackelberg game with their own follower(s). The algorithm exploits the polyhedral structure in the game and our ability to solve mixed-integer linear program fast. We then use this model to solve for equilibrium in a Nash game among countries (leaders) where each country also plays a Stackelberg game with their indigenous industries (followers).

MB5 Healthcare Optimization I

Salle: Hélène-Desmarais
Président: Lahrichi, Nadia, Polytechnique Montréal

10h30 Time-space network formulation for biomedical samples transportation problem

Ocampo-Giraldo, Daniel M., Univerisdad Nacional de Colombia - Sede Medellin, dmocampog@unal.edu.co
Anaya Arenas, Ana María, ESG - UQAM, AnaMaria.AnayaArenas@cirrelt.ca
Contardo, Claudio, ESG UQÀM / GERAD, claudio.contardo@gerad.ca

We introduce a novel formulation over a time-expanded network for a vehicle routing problem arising in the collection and transportation of biomedical samples. The new model has better numerical properties than a classical three-index model from the literature. We provide computational evidence of the efficiency of the formulation to generate high quality bounds. We also depict a promising dynamic refinement algorithm to exploit the model properties.

10h55 Integration of user preferences for the home health care routing and scheduling multi-objective problem

Musaraganyi, Laura, , laura.musaraganyi@polymtl.ca
Germain, Simon , , simon.germain@alayacare.com
Lahrichi, Nadia, Polytechnique Montréal, nadia.lahrichi@polymtl.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca

Home Health Care Services provide medical and paramedical services at the patients' home rather than in a facility (such as a hospital). This means these HHCS need to optimize the schedule of the caregivers to visit all their assigned patients in the most efficient way possible. Each agency employ a number of schedulers whose task is to manually schedule the visits, taking into account multiple criteria. In this paper, we present a heuristic method aimed at finding the best solution according to the user preferences or priorities. Using a hierarchical ordering of the criteria our algorithm returns the best solution found regarding the strict order. In addition, it also suggests a list of near-equivalent solutions based on user tolerance levels. These solutions, Pareto-optimal alternatives to the best hierarchical solution, offer more decision-making power to the user. Finally, the performances of the proposed method are compared to those of the classic weighted sum approach.

11h20 **A decomposition method for the dynamic home health care routing and scheduling**

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

Due to the aging of the population, the demand in home health care services have greatly increased during the past decade. In order to manage this demand, an improvement of the resources utilization is necessary. In this work, we are interested in the dynamic home health care routing and scheduling problem. The objective here is to develop a decomposition method based on scenarios in order to dynamically accept and schedule new patients in the system while conserving a high quality of service for existing patients.

MB6 OR/MS Scientific Writing Activity - Methods and Applications in Logistics

Salle: Marie-Husny
Président: Cherkesly, Marilène, ESG UQÀM

10h30 **The multi-objective multi-period location routing problem: A mobile clinic application**

Santa González, Rosemarie, UQÀM, rosemarie.santa@gmail.com
Rancourt, Marie-Eve, HEC Montréal, marie-eve.rancourt@hec.ca
Crainic, Teodor Gabriel, CIRRELT - École des sciences de la gestion - UQÀM, marcotte.suzanne@uqam.ca
Cherkesly, Marilène, GERAD - Polytechnique Montréal, marilene.cherkesly@gerad.ca

In this study we present the Multi Period Location Routing Problem (MLRP) formulation and illustrate it with a mobile clinic application. Mobile clinics give healthcare practitioners the ability to provide medical attention to populations that have limited access to healthcare. When conducting mobile clinic operations practitioners have to locate the depots, select the locations at which services will be offer, and design the schedule for the visits. There is more than one objective when planning a mobile clinic operation, therefore the problem is multi objective in nature. Due to the fact that medical treatments depend on the order and frequency in which they are administered this renders the problem as a multi period problem. The model proposed is tested on real life instances generated with the input of the Premier Urgence Internationale (PUI). Location Routing Problem, Healthcare, Humanitarian Logistics, Multiperiod, Multicriteria

10h55 **Logic-based Benders reformulations for integrated process configuration and production planning problems.**

Perez Martinez, Karim, HEC Montreal, karim.perez-martinez@hec.ca
Raf, Jans, HEC Montréal, Raf.jans@hec.ca
Adulyasak, Yossiri, HEC Montréal, yossiri.adulyasak@hec.ca

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

11h20 **An experimental study on learning convex parametric optimization programs via inverse optimization and machine learning**

Iraj, Elaheh, , elly.iraj@gmail.com
Daria, Terekhov, Concordia University, daria.terekhov@concordia.ca

We study the problem of learning from data that is generated by a parametric optimization process using inverse optimization. We reinterpret the applicability of inverse optimization for the purpose of learning and experimentally compare its predictive performance with machine learning algorithms: Random Forest, Support Vector Regression and Gaussian Process.

11h45 Routing hub location problem

Bernardes Real, Luiza, IFMG, luizabernardesreal@gmail.com
Contreras, Ivan, Concordia University, icontrer@encs.concordia.ca
Cordeau, Jean-François, HEC Montreal, jean-francois.cordeau@hec
Saraiva de Camargo, Ricardo, Federal University of Minas Gerais, rcamargo@dep.ufmg.br
de Miranda, Gilberto, Federal University of Espírito Santo, gilberto.miranda@ufes.br

We introduce a variant for the routing hub location problem. We assume that each route may contain a mix of non-hub and hub nodes, commodity transfers can only be done at hubs and transportation costs are flow-dependent. A mathematical formulation is proposed and computational experiments are presented.

MB7 Optimization applied to the Energy Sector

Salle: Nancy et Michel-Gaucher
Président: Séguin, Sara, Université du Québec à Chicoutimi

10h30 Net power maximization in a beam-down solar concentrator

Diago, Miguel, GERAD, miguel.diago@gerad.ca
Calvet, Nicolas, Khalifa University, nicolas.calvet@ku.ac.ae
Armstrong, Peter R., Khalifa University, peter.armstrong@ku.ac.ae

The reflectors of a beam-down solar concentrator are adjusted to maximize the net power collected at the receiver. The performance of the solar plant is predicted with a Monte Carlo ray-tracing model as a function of a feasible reflector geometry. Optimization is carried out with NOMAD, an instance of the mesh-adaptive direct search (MADS) blackbox algorithm. Challenges include reducing the number of optimization variables, dealing with the stochastic aspect of the blackbox, and the selection of effective MADS optimization parameters.

10h55 Long-term planning of a flexible generation portfolio

Dhaliwal, Navdeep, McGill University , navdeep.dhaliwal@mail.mcgill.ca
Bouffard, François, McGill University, francois.bouffard@mcgill.ca
O'Malley, Mark, University College Dublin, mark.omalley@ucd.ie

To bridge the gap between long-term capacity planning and short-term intra-hour flexibility, our approach exploits the linear time-invariant feature of variable generation using historical phase planes of capacity (in MW) and ramp(in MW/min). Compared to other proposals, it is much more computationally tractable while adequately capturing the short-term operational features.

11h20 Hydropower control with a reinforcement learning approach

Veron, Maël, HEC, mael.veron@hec.ca
Denault, Michel, GERAD - HEC Montréal, michel.denault@hec.ca
Côté, Pascal, Rio Tinto, pascal.cote@riotinto.com

We apply a reinforcement learning technique to optimize hydropower at a site in British Columbia. The policies are generated by a neural network which is tuned to maximize power while satisfying a set of environmental constraints.

11h45 A linear mixed-integer formulation of the short-term hydropower problem

Daadaa, Maissa, Université du Québec à Chicoutimi, maissa.daadaa1@uqac.ca
Séguin, Sara, UQAC, GERAD, sara.seguin@uqac.ca
Demeester, Kenjy, Rio Tinto, kenjy.demeester@riotinto.com

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

We present a mixed integer model to solve the short-term hydropower problem. It determines the volumes for given pairs of maximum efficiency discharges and power production. The objective function is calculated using energy losses from maximum storage and penalizes unit startups. Constraints on the maximum number of turbine changes are imposed to find a viable solution in practice. Computational results are presented.

MB8 Demand Response

Salle: St-Hubert
Président: Kuznetsova, Elizaveta, Polytechnique Montréal

10h30 Optimization of phase unbalance on a distribution network with demand response

Pedroli, Florian, , florian.pedroli@polymtl.ca
Anjos, Miguel F., GERAD, Polytechnique Montréal, miguel-f.anjos@polymtl.ca
Gendreau, Michel, Polytechnique Montréal, Michel.Gendreau@cirrelt.ca

Phase unbalance is a problem for electricity grids that exists because of the transformation from three-phase to mono-phase current that leads to losses and to faster deterioration of devices. As electricity grids change, demand response via control of consumption, becomes possible. We propose a method based on black-box optimization that uses demand response to minimize phase unbalance.

10h55 Optimal energy management in a multi-unit residential building integrating microgrid and demand response

Rezaei, Ehsan, , ehsan.rezaei@polymtl.com
Dagdougui, Hanane, Mathematics and Industrial Eng. Polytechnique Montreal, hanane.dagdougui@polymtl.ca

This paper presents a high-level centralized optimal power control management mechanism based on model predictive control for grid-connected building integrated microgrid. The thermal load of a large residential building has been modeled according to resistance-capacitance networks model. Besides by participating in demand response program, for thermostatically controlled loads and electric vehicles, operation cost can be reduced.

11h20 A framework for peak shaving through the coordination of smart homes

De Souza Dutra, Michael David, Polytechnique Montréal, michaeldavidsd@gmail.com
Le Digabel, Sebastien, Polytechnique Montréal, Sebastien.Le.Digabel@gerad.ca
Anjos, Miguel F., GERAD, Polytechnique Montréal, miguel-f.anjos@polymtl.ca

In demand--response programs, aggregators balance the needs of generation companies and end-users. This work proposes a two-phase framework that shaves the aggregated peak loads while maintaining the desired comfort level for users. In the first phase, the users determine their planned consumption. For the second phase, we develop a bilevel model with mixed-integer variables and reformulate it as a single-level model. We propose an exact centralized algorithm and a decentralized heuristic. Our computational results show that the heuristic gives small optimality gaps and is much faster than the centralized approach. mots-clés: demand response, aggregator, bilevel optimization

11h45 Demand response field tests on smart homes using reinforcement learning

Proulx, Louis-Philippe, RNCAN, louis-philippe.proulx@canada.ca
Salimi, Armin, NRCAN, armin.salimi@canada.ca

This presentation discusses the control strategy for heating smart homes without prior knowledge of their designs and characteristics (model agnostic). Using reinforcement learning, intelligent agents are trained with data coming from those homes, which are equipped with multiple thermostats controlling electric baseboards. Demand response field tests on smart homes are currently in progress.

MB9 Applications I

Salle: Dutailier International
Président: Bastin, Fabian, Université de Montréal

10h30 Le rôle de la démarche de la - Space syntax - dans la caractérisation de la relation entre la forme urbaine et marchabilité et l'optimisation de l'espace urbain. Cas de la ville Ali Mendjeli, Constantine, Algérie.

Boukelouha, Radhwane, Université Concordia, radhwane.boukelouha@mail.com

La démarche de la syntaxe spatiale englobe un ensemble de théories et de techniques pour l'analyse et la quantification de la configuration spatiale à partir des variables dérivées de la théorie des graphes et de rechercher les relations entre la structure et les fonctions urbaines pour optimiser le ressources et potentialités de l'espace urbain.

10h55 Portrait des Municipalités Régionales de Compté du Québec en utilisant l'approche EABD (Ensembles approximatifs basés sur la dominance) comme outil d'aide à la décision pour l'identification de stratégies de développement socio-économique.

Boudreau-Trudel, Bryan, Université du Québec en Abitibi-Témiscamingue, boudreab@uqat.ca
Zaras, Kazimierz, Université du Québec en Abitibi-Témiscamingue, kazimierz.zaras@uqat.ca
Marin, Jean-Charles, Université du Québec en Abitibi-Témiscamingue, jean-charles@uqat.ca

L'objectif de cet article est d'exposer les résultats de recherche de l'application de l'approche des ensembles approximatifs basés sur la dominance (EABD) pour la sélection des objectifs stratégiques du développement économique et sociologique des Municipalités Régionales de Compté (MRC) du Québec. Les décideurs, leaders et politiciens pourront, selon cette recherche, prioriser les MRC selon leurs besoins réels sur le plan social et économique. Plus précisément, nous croyons que les gestionnaires pourront prendre différents indicateurs sociaux-économiques et classifier différentes MRC (objets) selon des critères choisis à l'une des trois catégories suivantes: [A] - Les MRC qui sont les meilleures en termes de critère(s) considéré(s); [B] - Les MRC qui ont besoin de soutien pour passer dans la classe A; [C] - Les MRC qui ont les moins bonnes performances et nécessitent une assistance particulière sur le(s) critère(s) considéré(s). Ces trois catégories sont délimitées par rapport au rang moyen des MRC selon les critères considérés. Les critères sont alors mesurés pour offrir des règles de décision basées sur cette classification. Ces règles de décision ciblent donc les besoins des MRCs sur le plan social et économique afin de s'améliorer et de monter de classification. Dominance-Based Rough Set; analyse multicritère, Classification, MRC du Québec, économie du Québec.

11h20 Multi-objective project scheduling for multi-project engineer-to-order systems

Lehoux, Nadia, Associate Professor Laval University, Nadia.Lehoux@gmc.ulaval.ca
Ménard, Sylvain, Professor University of Quebec, Chicoutimi, sylvain_menard@uqac.ca
Cloutier, Caroline, Research professional Laval University, Caroline.Cloutier@gmc.ulaval.ca
Ghiyasinasab, Marzieh, PhD student Laval University, marzieh.ghiyasinasab.1@ulaval.ca

Small companies that produce prefabricated parts for the construction industry often encounter planning issues as they usually do not systematically plan their production. In this paper, an integrated production planning method for a multi-project engineered-to-order (ETO) system is proposed. An optimization model with the main objective of cost reduction is first developed and then a second objective minimizing the projects' finish time is added to develop a second model. A third objective of set-up reduction is added to each of these models to optimize the use of a

bottleneck station. The models are applied in a case study with an engineered wood production firm considering fifteen construction projects over a period of forty weeks. The results provide integrated project-oriented capacity planning and scheduling considering set-up reduction. Moreover, three scenarios for adding complex, medium and easy projects are tested to provide a decision-support tool for strategic decisions in the project acceptance phase. This article provides four production scheduling models for the prefabrication of ETO parts in construction, which has not been considered previously in the literature. It also applies the models to a real case, detailing the small ETO factory's complexities, which had not been addressed in academic literature.

11h45 High frequency market making

Bastin, Fabian, Université de Montréal, bastin@iro.umontreal.ca
Huot-Chantal, Francis, Université de Montréal, francis.huot-chantal@umontreal.ca

We are going to describe a quoting policy for market makers trying provide liquidity in a stock market. Working in a high frequency framework, we will focus on a threshold policy which is simple but will help us understand how to approach the problem in an event driven perspective.

MB10 Coupling Operations Research and Machine Learning I - Columm Generation

Salle: TD Assurance Meloche Monnex
Président: Desaulniers, Guy, Polytechnique Montréal/GERAD

10h30 Accelerating the optimization of aircrew rostering with machine learning

Wu, Alice, , alice.wu.2014@polytechnique.org

A classical approach to optimize the crews' rosterings is column generation. With the pairings as input, the optimizer solves for each employee a shortest path problem in a graph with all the possible pairings to generate rosters. The purpose of this project is to predict with machine learning the probability of a pairing being in an employee's monthly block. We aim to solve this in sequential phases, with the most probable pairings first, and then gradually adding the rest of the pairings. This is how we can significantly reduce the size of the graphs and therefore the computational time.

10h55 Evolution strategies for the crew rostering problem

Racette, Philippe, Polytechnique Montréal, philippe.racette@gerad.ca

The crew rostering problem is solved using dynamic constraint aggregation (DCA), but schedules must sometimes be rearranged at greater speed than available. This talk explores how artificial intelligence can guide the DCA algorithm with a focus on evolution strategies and neural networks. Preliminary results are presented and next steps discussed.

11h20 Machine learning in airline crew pairing to construct initial clusters for dynamic constraint aggregation

Yaakoubi, Yassine, Gerad, yassine.yaakoubi@gerad.ca
Soumis, François, Polytechnique Montréal, francois.soumis@gerad.ca
Lacoste-Julien, Simon, MILA, Université de Montréal, slacoste@iro.umontreal.ca

In this talk, we introduce a new paradigm for solving the crew pairing problem, modeled as a set partitioning problem: "Start with Machine Learning – Finish with Mathematical Programming." Machine Learning produces predictions on some parts of the solution of the new instance based on solutions of similar instances. This information feeds the Column Generation optimizer to finish the work taking account of the exact cost function and the complex constraints. This approach reduces the solution time significantly without losing on the quality of the solution.

11h45 Accelerating column generation using machine learning

Morabit, Mouad, Polytechnique Montréal, mouad.morabit@gerad.ca
Desaulniers, Guy, GERAD and Polytechnique Montreal, guy.desaulniers@gerad.ca
Andrea, Lodi, Polytechnique Montreal, andrea.lodi@polymtl.ca

Column generation (CG) is a well-known method for solving large-scale linear problems. In this presentation, we propose to integrate a machine learning technique in the context of CG to reduce computation time. More precisely, a classification algorithm is proposed to select promising columns at each CG iteration when solving a problem that is subject to degeneracy in the master problem. An application to the vehicle and crew scheduling problem in urban transport will be presented

MB11 Decomposition Methods in Facility Location and Network Design

Salle: TAL Gestion globale d'actifs inc.
Président: Contreras, Ivan, Université Concordia

10h30 Combining Lagrangean relaxation and Benders decomposition to solve a tight linearization of binary quadratic programs

Zetina, Carlos, CIRRELT, czet_88@hotmail.com
Andrea, Lodi, Polytechnique Montreal, andrea.lodi@polymtl.ca
Rostami, Borzou, École de technologie supérieure, bo.rostami@gmail.com

We present an algorithm that combines Lagrangean relaxation and Benders decomposition to solve a tight linearization of general binary quadratic programs. For the case of single allocation hub location, we derive a closed form to calculate optimal Lagrangean multipliers of a set of coupling constraints which we relax. This allows for the decomposition of the Benders subproblem and the use of a multi-cut Benders decomposition without compromising the strength of the obtained Benders cuts. Computational experiments show this to be a promising method.

10h55 A Benders decomposition based algorithm for the quadratic capacitated hub location problem

Gündoğdu, Emine, CIRRELT and UdeM, gemine@metu.edu.tr
Gürel, Sinan, Middle East Technical University, Ankara, Turkey, gsinan@metu.edu.tr

We consider a hub location problem where both the objective function and capacity constraints have nonlinear terms consisting of multiplication of binary variables. We propose an exact branch-and-check algorithm. In the algorithm, we generate feasibility and optimality cuts and compare the performance of this algorithm with two different optimality cuts.

11h20 Exact algorithms for multilevel capacitated facility location problems with concave costs

Contreras, Ivan, Université Concordia, ivan.contreras@cirrelt.ca
Malik, Aditya, John Molson School of Business, aditya9vt@gmail.com
Vidyarthi, Navneet, Concordia University, N.Vidyarthi@concordia.ca

We study multi-level capacitated facility location problems with concave costs in which production, warehousing, and distribution costs are considered to be concave functions of the quantities produced, stored and distributed. We present and compare two exact branch-and-bound algorithms based on a mixed-integer nonlinear program and on a pure nonlinear continuous program.

11h45 Benders decomposition for large-scale quadratic capacitated facility location

Contreras, Ivan, Université Concordia, ivan.contreras@cirrelt.ca
Zetina, Carlos, CIRRELT, czet_88@hotmail.com
Jayaswal, Sachin, Indian Institute of Management Ahmedabad, sachin@iima.ac.in
Vidyarthi, Navneet, Concordia University, N.Vidyarthi@concordia.ca

We study a class of quadratic capacitated p-location problems with single assignments where a non-convex quadratic term is introduced to account for the interaction cost between facilities and customer assignments. We propose an exact branch-and-cut algorithm based a Benders reformulation in which the network flow structure is exploited to efficiently separate cuts.

MC1 Autonomous, Connected, Electric, Shared (ACES) - Optimization, Prediction and Dynamic Network Modeling for Multimodal Urban Mobility

Salle: Amphithéâtre Banque Nationale
Président: Laporte, Gilbert, HEC Montréal

14h00 Autonomous, Connected, Electric, Shared (ACES) - Optimization, Prediction and Dynamic Network Modeling for Multimodal Urban Mobility

Mahmassani, Hani, Northwestern University, masmah@northwestern.edu

Transportation is undergoing deep and significant transformation, seeking to fulfill the promise of connected mobility for people and goods, while limiting its carbon footprint. Autonomous vehicles are potentially changing the economics ownership and use of private automobiles, likely accelerating trends towards greater use of app-based ride hailing and/or sharing by private TNCs (Transportation Network Companies). Several potential business models with varying degrees of ride sharing and public vs. private involvement in the delivery of mobility as a service are presented. Algorithms for shared autonomous fleet management and autonomous car sharing are discussed and illustrated on a small case application. These are then integrated in an intermodal dynamic network modeling framework, which incorporates an agent-based microsimulation of a transit urban network system with shared-ride autonomous vehicles (SAV) as first-mile feeders. The integrated mode choice and dynamic traveler assignment-simulation modeling framework is applied to the Chicago region to evaluate the mobility impact of new services.

MD1 Tutorial - Modern Optimization for Structured Machine Learning

Salle: CPA du Québec
Président: Potvin, Jean-Yves, Université de Montréal

15h30 Modern Optimization for Structured Machine Learning

Lacoste-Julien, Simon, Université de Montréal, slacoste@iro.umontreal.ca

MD2 Vehicle Routing II

Salle: Banque CIBC
Président: Vidal, Thibaut, Pontifical Catholic University of Rio de Janeiro

15h30 The mixed capacitated general routing problem with time-dependent demands

Ahabchane, Chahid, Polytechnique Montréal, ahabchane.chahid@gmail.com
Trépanier, Martin, Polytechnique Montréal, CIRRELT, mtrepanier@polymtl.ca
Langevin, André, Polytechnique Montréal, andre.langevin@polymtl.ca

The Mixed Capacitated General Routing Problem (MCGRP) is defined over a mixed graph, for which some nodes, arcs and edges must be serviced. The problem consists of determining a minimum cost solution that satisfies the demand. Some problems like snow plowing or salt spreading have a time-dependent demand which was ignored in previous studies. This variation of demand is due to weather or traffic conditions. We present two models without graph transformation and another with graph transformation to node routing. We used CPLEX to solve

small instances and we developed a Slack Induction by String Removal metaheuristic for large instances. The proposed model and metaheuristic were tested on problems derived from a set of classical instances of the MCGRP and CARP with some modifications.

15h55 The edge of time-dependent shortest path optimization in capacitated arc routing problems

Martinelli, Rafael, Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio), martinelli@puc-rio.br
Anh Pham, Tuan, University of Engineering and Technology, Vietnam National University, ptanh@anvita.com.vn
Vidal, Thibaut, Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio), vidalt@inf.puc-rio.br
Baffa, Augusto, Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio), abaffa@inf.puc-rio.br
Hoàng Hà, Minh, University of Engineering and Technology, National University Vietnam, mhhoang@anvita.com.vn
Hoai Nguyen, Xuan, IT R&D Center, Hanoi University, nxhoai@anvita.com.vn

We study time-dependent capacitated arc routing problems, and propose exact and heuristic solution methods. Our approaches use continuous quickest paths, calculated from historical traffic models at the network level. Through experiments on artificial and real datasets from Rio de Janeiro, we evaluate the benefits of time-dependent optimization in arc routing.

16h20 Ship routing with joint speed optimization

Homsi, Gabriel, CIRRELT, University of Montreal, gabriel.homsi@cirrelt.ca
Martinelli, Rafael, Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio), martinelli@puc-rio.br
Vidal, Thibaut, Pontifícia Universidade Católica do Rio de Janeiro, vidalt@inf.puc-rio.br

We study a maritime pickup-and-delivery problem with joint ship speed optimization. We discuss techniques to reduce the computational effort required to optimize speed (a convex optimization problem). We use these techniques to efficiently optimize speed on every local search move evaluation of a metaheuristic. Our experiments show the methodology efficiency.

16h45 Mining frequent patterns to drive the exploration of high-order neighborhoods

Vidal, Thibaut, Pontifical Catholic University of Rio de Janeiro, vidalt@inf.puc-rio.br
Arnold, Florian, University of Antwerp, Florian.Arnold@uantwerpen.be
Santana, Ítalo Gomes, Pontifical Catholic University of Rio de Janeiro, isantana@inf.puc-rio.br
Sörensen, Kenneth, University of Antwerp, kenneth.sorensen@uantwerpen.be

We use pattern mining to explore high-order neighborhoods in a local search. Each pattern, extracted from elite solutions, defines one move in which incompatible edges are disconnected, the pattern is inserted and the remaining route fragments are optimally reconnected. We report computational experiments and analyses on the capacitated vehicle routing problem.

MD3 Non-Convex Optimization

Salle: Demers Beaulne
Président: Papadimitriou, Dimitri, University of Antwerp

15h30 Optimisation globale multi-objectif pour des problèmes de moindres carrés à faible cardinalité

Ben Mhenni, Ramzi, LS2N, École centrale de Nantes, France, ramzi.benmhenni@ls2n.fr
Bourguignon, Sébastien, LS2N, École centrale de Nantes, France, sebastien.bourguignon@ec-nantes.fr
Ninin, Jordan, ENSTA-Bretagne, Lab-STICC, France, jordan.ninin@ensta-bretagne.fr
Mongeau, Marcel, ENAC, Université de Toulouse, France, marcel.mongeau@enac.fr

Carfantan, Hervé, IRAP, Université de Toulouse, France, herve.carfantan@irap.omp.eu

Nous proposons un algorithme branch-and-bound pour l'optimisation de critères de moindres carrés à faible cardinalité, abordée comme un problème bi-objectif. Le couplage d'une stratégie d'exploration et d'un algorithme de relaxation spécifiques permet de résoudre globalement et conjointement des problèmes de cardinalité variable.

15h55 Sparse cutting planes for nonconvex quadratically constrained quadratic programs

Dey, Santanu, Georgia Tech, santanu.dey@isye.gatech.edu
Kazachkov, Aleksandr M., Polytechnique Montréal, aleksandr.kazachkov@polymtl.ca
Lodi, Andrea, Polytechnique Montréal, andrea.lodi@polymtl.ca
Muñoz, Gonzalo, Polytechnique Montréal, gonzalo.munoz@polymtl.ca

Nonconvex quadratically-constrained quadratic programs (QCQPs) arise in a wide variety of real-life applications. However, interior point solvers struggle with the semidefinite programming relaxations for large instances, whereas using linear relaxations, particularly sparse ones, provides a scalable path forward. However, how to properly use such relaxations remains poorly understood. We investigate how to systematically incorporate sparse cutting planes in the solution process for nonconvex QCQPs. We analyze how to appropriately select sparse linear relaxations depending on the instance and present results of preliminary experiments illustrating the precise tradeoffs between sparsity and strength, as well as how to predict strength of cuts given a sparsity pattern.

16h20 Generalized surrogate duality for mixed-integer nonlinear programs

Gasse, Maxime, Polytechnique Montréal, maxime.gasse@polymtl.ca
Müller, Benjamin, Zuse Institute Berlin, benjamin.mueller@zib.de
Muñoz, Gonzalo, Polytechnique Montréal, gonzalo.munoz@polymtl.ca
Lodi, Andrea, Polytechnique Montréal, andrea.lodi@polymtl.ca

An important ingredient for solving optimization problems is a tight and tractable relaxation, usually required to be convex. Nonetheless, current solvers can often handle moderate presence of non-convexities. In this talk, we study non-convex surrogate relaxations (obtained via constraint aggregation) and show benefits and challenges of such relaxations. Non-convex optimization, surrogate duality, non-convex relaxations

16h45 Non-monotone adaptive trust-region method

Papadimitriou, Dimitri, University of Antwerp, dimitri.papadimitriou@uantwerpen.be

For solving nonconvex (unconstrained) minimization problems, we present an adaptive trust region algorithm that guarantees convergence to approximate second-order stationary points together and analyze its worst-case complexity. The method extends the generic nonlinear stepsize control framework by conditioning the (curvature-aware) update strategy for the trust-region radius to the actual model decrease. We then relax the monotonicity assumption of the objective function to propose a nonmonotonic variant of this algorithm.

MD4 Supply Chains and Logistics

Salle: Gérard-Parizeau
Président: Abrache, Jawad, Al Akhawayn University in Ifrane

15h30 Advertising and quality decisions in a supply chain facing collateral damage by product recall

Mukherjee, Arka, Concordia University, ar_mukh@live.concordia.ca
Chauhan, Satyaveer, Concordia University, Satyaveer.Chauhan@concordia.ca

We consider a supply chain with one manufacturer, one reliable supplier and one unreliable supplier who can issue a product recall. The recall negatively affects the profits of all the members. In such a scenario, we investigate the quality investment and advertising decisions of all the supply chain members. Differential game theory is used as the methodological framework for the study.

15h55 Optimization of closed loop, multi-echelon supply chain system from an integrated operational-financial and customer obsessed approach

Kimiagari, Salman, TRU, skimiagari@tru.ca
Mahbobi, Mohammad, TRU,
Wadhwa, Ashish, TRU, baniwadhwa92@gmail.com

Supply chain optimization is a systematic and plausible process of coordinating the flow of materials, services and information from the supplier to the end user. This study adopts a holistic approach considering both strategical and tactical decisions to develop a mathematical model using mixed integer linear programming approach to establishing a balance between the operational activities, the financial activities and the customer service. The study also assesses various constraints like demand, uncertainty of supply, risks, profit, etc. while performing the simulation of this robust stochastic model.

16h20 Bin packing models for logistics capacity planning

Crainic, Teodor Gabriel, CIRRELT - École des sciences de la gestion - UQÀM, TeodorGabriel.Crainic@cirrelt.ca
Djeumou Fomeni, Franklin, ESG-UQAM (CIRRELT), Franklin.DjeumouFomeni@cirrelt.ca
Rei, Walter, Université du Québec à Montréal, walter.rei@cirrelt.ca

We present two novel variants of the bin packing problem that have practical applications in logistics planning. These models are aimed at minimizing, simultaneously, the cost of selecting the bins and the costs of assigning items to bins, which may depend on other criteria than the volumes of the items. Some computational results will be discussed.

16h45 The Couscous game: A new online tool for better experiential learning in logistics and supply chain management Courses

Abrache, Jawad, Al Akhawayn University in Ifrane, J.Abrache@aui.ma

Abstract: Software tools have been used since the 1960s in teaching logistics and supply chain management (SCM) courses. The most notorious example of such tools is perhaps the so-called "Beer Game", which allow students to understand fundamental SCM concepts such as the "Bullwhip Effect" and the need for basic techniques for demand forecasting and inventory management. In this presentation, we introduce a new open source online SCM simulation prototype we developed at Al Akhawayn University within a larger project of revamping logistics and SCM courses with more effective experiential learning. We also present our students' and other users' preliminary insights from an initial use of the game in a real classroom environment.

MD5 Healthcare Optimization II

Salle: Hélène-Desmarais
Président: Lahrichi, Nadia, Polytechnique Montréal

15h30 The team orienteering problem with 2D time-varying profit in the context of rescue operations.

Qinxiao , Yu, , yuqinxiao@tju.edu.cn
Adulyasak, Yossiri, HEC Montréal, yossiri.adulyasak@hec.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca
Zhu, Ning, ,
Ma, Shoufeng, ,

This paper addresses the search and rescue (SAR) team routing and scheduling problem in the response phase of post-disaster circumstances, where numerous sites are destroyed and people are trapped in the affected area, but the number of SAR team is limited. We take the fact that the arrival time and service time effect the success of rescuing survivors into account, then model this problem as a team orienteering problem with time-varying profit. The objective is to maximize the number of survivors in the limited time by identifying a set of routes among candidate sites as well as deciding the duration of service time at each visited site. We formulate a mixed integer nonconvex programming model (MINLP) for the problem, and propose a Benders branch-and-cut algorithm and a hybrid heuristic to solve the problem with small size and large size, respectively. Computational experiments show that the proposed exact method is capable of solving instances where MINLP solver fails in finding the optimal solution within 2 hours, and the proposed heuristic could be quite effective in finding good quality solutions in a reasonable time.

15h55 Optimization of appointment grid and technologist scheduling

Ben Tayeb, Dina, , dina.bentayeb@polymtl.ca
Lahrichi, Nadia, Polytechnique Montréal, nadia.lahrichi@polymtl.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca

Our work concerns a simultaneous optimization of appointment grid and technologist scheduling in a radiology center. We develop a mixed integer programming model that provides an optimal allocation of personal resources to maximize the machine utilization and the number of treated patients. We evaluate the optimization model using a real case of the Magnetic Resonance Imaging in the CHUM radiology department.

16h20 A case study of Montreal emergency medical services using discrete-event simulation

Lavoie, Gabriel, Polytechnique, gabriel-2.lavoie@polymtl.ca
Lahrichi, Nadia, Polytechnique Montréal, nadia.lahrichi@polymtl.ca
Bélanger, Valérie, CIRRELT, HEC Montréal, valerie.3.belanger@hec.ca

Emergency medical services (EMS) provide pre-hospital care and transportation to hospitals following an emergency call. This article presents a simulation model of Urgences-santé, an EMS in Quebec. The model is validated using real data and is used to evaluate several scenarios aiming to improve the EMS performance.

16h45 A learning tabu search algorithm to improve the patient flow by determining a physician schedule

Niroumandrad, Nazgol, Polytechnique Montreal, nazgol.niroumandrad@polymtl.ca
Lahrichi, Nadia, Polytechnique Montréal, nadia.lahrichi@polymtl.ca

The period between the referral of a patient to a cancer center and the confirmation of the treatment plan is defined as the pretreatment phase which includes consultation with the physician, scan, treatment planning and finally the treatment. Physicians play a key role in this process and have been identified as bottlenecks since they must confirm each step. In this project, the goal is to construct a task schedule for physicians that improves the patient flow and shortens the pretreatment duration. We presented a MIP model for the problem and developed a tabu search algorithm, considering both deterministic and stochastic cases. We are improving the performance of tabu search by a learning mechanism. Experiments are conducted and show the benefit of using a learning mechanism under deterministic conditions.

MD6 OR/MS Scientific Writing Activity - Electricity

Salle: Marie-Husny
Président: Cherkesly, Marilène, ESG UQÀM

15h30 A flexibility product for water-heater aggregators on the electricity markets

Pied, Marie, Polytechnique Montréal / GERAD, xmarie.pied@gmail.com

Anjos, Miguel F., GERAD, Polytechnique Montréal, miguel-f.anjos@polymtl.ca
Malhamé, Roland, GERAD - Polytechnique Montréal, roland.malhame@polymtl.ca

Intermittent renewable energy, such as solar and wind, bring uncertainty into the grid. To increase their contribution into the energy mix, load management solutions are necessary. In this work, a mean field control of water-heaters is used to provide load flexibility to the grid while keeping the disturbance of the consumption, after the control, as low as possible. Mean Field Game - Smart Grid - Load Management

15h55 Energy management in hospitals using demand dispatch

Mahmoudzadeh Vaziri, Shabnam, Department of Mechanical, Industrial & Aerospace, Concordia University, Montral, Canada, shabnam_vaziri@yahoo.com
Rezaee, Babak, Faculty of Engineering, Industrial Engineering Department, Ferdowsi University of Mashhad, Mashhad, Iran, brezaee@um.ac.ir

In this paper, we present a bi-objective formulation for using renewable energy sources (RESs) in hospitals to minimize costs and dissatisfaction by scheduling activities of hospitals. Since the main goal of the hospital is providing health care services, they will decrease energy costs while maintaining the comfort of patients and surgeons using the proposed model.

16h20 Evaluation of the impact of the power production function approximation on the maintenance scheduling

Edom, Éloïse, GERAD, eloise.edom@gerad.ca
F. Anjos, Miguel, GERAD,
Côté, Pascal, Énergie électrique, Rio Tinto Aluminium,
Séguin, Sara, Université du Québec à Chicoutimi,

Maintenance planning for hydropower plants is a crucial problem. We evaluate the impact of the HPF formulation on the maintenance scheduling. We compare three approximations: first a convex hull approximation, then a piecewise linear approximation and third, a nonlinear approach using a polynomial function fitted on real data.

16h45 Optimal allocation of demand response resources considering the electric transmission network

Motta, Vinicius, , viniciusnmotta84@gmail.com
Gendreau, Michel, Polytechnique Montréal, Michel.Gendreau@cirrelt.ca
Anjos, Miguel F., GERAD, Polytechnique Montréal, miguel-f.anjos@polymtl.ca

The growing concern about the environmental impacts caused by energy generation has incentived investment in renewable energies and in demand response (DR), which creates several challenges when operating the grid. Thus, we develop a short-term horizon model for allocating optimally the DR and generators resources when supplying un- expected demand considering the network topology. demand response, semidefinite programming, OPF

MD7 Modeling and Optimization of Large Systems (Energy and Transportation)

Salle: Nancy et Michel-Gaucher
Président: Kuznetsova, Elizaveta, Polytechnique Montréal

15h30 A tight-and-cheap conic relaxation with accuracy metrics for the ACOPF problem

Bingane, Christian, Polytechnique Montréal, christian.bingane@polymtl.ca
Anjos, Miguel F., GERAD, Polytechnique Montréal, miguel-f.anjos@polymtl.ca
Le Digabel, Sebastien, Polytechnique Montréal, Sebastien.Le.Digabel@gerad.ca

Computational speed and global optimality are a key need for pratical algorithms of the OPF problem. Recently, we proposed a tight-and-cheap conic relaxation for the ACOPF problem that

offers a favourable trade-off between the standard second-order cone and the standard semidefinite relaxations for large-scale meshed networks in terms of optimality gap and computation time. In this paper, we show theoretically and numerically that this relaxation can be exact and can provide a global optimal solution for the ACOPF problem.

15h55 Optimal planning of long-term preventive maintenance operations on power transmission systems

Rocha, Mariana, Polytechnique Montréal, mariana.rocha@polymtl.ca
Anjos, Miguel F., GERAD, Polytechnique Montréal, miguel-f.anjos@polymtl.ca

The interruption of service of any electrical power system equipment due to maintenance should not affect network reliability, security and continuous power supply. The selection of the optimal period to remove a transmission line from the grid temporarily and which resources (workers, vehicles, others) should be assigned to each maintenance action, constitutes the transmission maintenance scheduling problem (TMS). We present a mixed-integer linear program formulation of the TMS problem for a regulated electricity market, throughout a long-term period of one year and considering a yearly budget limitation. The grid is modeled as a direct current power flow network, to guarantee it meets consumers' demand, and N-1 criteria constraints were designed to keep a reliable and safe operation.

16h20 Heuristic unsupervised learning algorithm for feature engineering

Etebarialamdari, Neda, , etebari.neda@gmail.com
Anjos, Miguel, Polytechniqe Montreal, miguel-f.anjos@polymtl.ca
Savard, Gilles, Polytechniqe Montreal, gilles.savard@polymtl.ca

Clustering and segmentation are of great importance in many real-world tasks. In this research, we propose a heuristic algorithm in order to automatically cluster the data. The clustered labels will be added as a new feature to an industrial dataset in order to evaluate the algorithm's performance in a forecasting task. Keyword: Feature engineering, heuristic, clustering

MD8 Inventory and Distribution

Salle: St-Hubert
Président: Legrain, Antoine, Polytechnique Montréal

15h30 Improved branch-and-cut algorithm for the inventory routing problem

Skålnes, Jørgen, Norwegian University of Science and Technology, jorgen.skalnes@ntnu.no
Stålhane, Magnus, Norwegian University of Science and Technology, magnus.staalhane@iot.ntnu.no
Andersson, Henrik, Norwegian University of Science and Technology, Henrik.Andersson@iot.ntnu.no
Desaulniers, Guy, GERAD and Polytechnique Montreal, guy.desaulniers@gerad.ca

Combining the valid inequalities from the current state-of-the-art branch-and-cut algorithm and branch-and-price algorithm together with a new concept, delivery patterns, we are able to obtain stronger dual bounds in the root node and obtain better best known solutions for the benchmark instances on the Inventory Routing Problem.

15h55 Distribution network design and inventory planning under uncertainty

Dems, Amira, HEC Montréal, amira.dems@polymtl.ca
Cordeau, Jean-François, HEC Montréal, jean-francois.cordeau@hec
Adulyasak, Yossiri, HEC Montréal, yossiri.adulyasak@hec.ca

This paper deals with an integrated planning problem where the distribution network design and inventory planning decisions are optimized simultaneously under demand uncertainty. Since the level of safety stocks to guarantee required service levels depends essentially on the supply lead time and the variability of the pooled demand, which are the result of the supply network decisions,

the integrated tool allows the planner to take into account this complex relationship and determine an optimal plan. To tackle this problem, first, we present an exact solution approach based on a branch-and-check framework and propose a new set of valid cuts to solve the general case when the demand can take any form. This approach, albeit general, is not highly scalable, thus we present a computational enhancement using inequalities derived from piecewise linear functions. We consider the case where the demand is represented by a normal distribution as well as a more general setting where the demand is irregular and represented by a negative binomial distribution. We present extensive computational results on datasets adapted from the literature to validate the proposed modeling and solution approaches. Then, we conduct several tests to study the sensitivity of the network design decisions to different cost and capacity scenarios. Finally, we evaluate the integrated solution against the sequential one, where the distribution network design and the inventory decisions are made separately.

16h20 Benders decomposition for a three-level lot sizing and replenishment problem.

Gruson, Matthieu, HEC Montréal/CIRRELT, matthieu.gruson@hec.ca
Cordeau, Jean-François, HEC Montreal, jean-francois.cordeau@hec
Jans, Raf, HEC Montréal, raf.jans@hec.ca

We address a three-level lot sizing and replenishment problem with a distribution structure (3LSPD). We use a Benders decomposition approach and develop a branch-and-cut algorithm to efficiently solve both a deterministic and a stochastic variant of the uncapacitated case of the problem. The algorithm we propose outperforms CPLEX.

16h45 Inventory management using an (s,S)-policy at the Bank of Canada

Legrain, Antoine, Polytechnique Montréal, antoine.legrain@cirrelt.ca
Patrick, Jonathan, Telfer School of Management, University of Ottawa,
Patrick@telfer.uottawa.ca

The Bank of Canada (BoC) has 43 Regional Distribution Centers (RDC) to ensure that there is sufficient inventory of each denomination of currency all across the country. Local banks can withdraw from the RDCs or deposit money into the RDCs. Thus the BoC is faced with a two-way inventory management problem where demand can be both positive (withdrawals) or negative (deposits) and where the Bank must avoid shortages and overcaps. We developed an adapted (s,S)-policy that has been implemented by the BoC through 2018 and has demonstrated a 20% drop in transportation costs compared to the previous years.

MD9 Applications II

Salle: Dutailier International
Président: Fortz, Bernard, Université Libre de Bruxelles

15h30 PAPmap: Partitioning-Assignment problem for distributed 3D mapping by UAV swarming

Costa, Leandro R., Polytechnique Montréal - GERAD, leandro.costa@polymtl.ca
Aloise, Daniel, Polytechnique Montréal, daniel.aloise@polymtl.ca
Lodi, Andrea, Polytechnique Montréal, andrea.lodi@polymtl.ca
Gianoli, Luca Giovanni, HumanITas, luca@humanitas.io

The unmanned aerial vehicle (UAV) swarming will shortly play an essential part in plenty of real-life applications. We propose the NP-hard problem: Partitioning-Assignment Problem for distributed 3D mapping by UAV swarming. The goal is to minimize the makespan of a 3D reconstruction procedure while respecting spatial, communication, and reliability constraints./Branch-and-cut; 3D reconstruction; UAV swarming;

15h55 Paint-waste management problem

Wang, Juyoung, University of Toronto, juyoung.wang@mail.utoronto.ca
Cevik, Mucahit, Ryerson University, mcevik@ryerson.ca

Parsaee, Amir Ali, Ryerson University, aparsaee@ryerson.ca
Amin, Saman Hassanzadeh, Ryerson University, saman.amin@ryerson.ca

We study paint-waste network-flow multi-objective optimization problem with three objective functions: cost, transportation risk and inconvenience. The problem will be decomposed into four logistic steps: waste generation nodes, collection centers, treatment centers and disposal sites. We present our experimental results and analysis on an Ontario-based case study.

16h20 Modeling employees' psychological well-being at work with artificial neural networks

Somers, Mark, New Jersey Institute of Technology, mark.somers@njit.edu
Casal, Jose, New Jersey Institute of Technology, jose.c.casal@njit.edu

Predictive models of well-being have yielded weak results leading to calls for new methods and new approaches. With a national probability sample of working adults in the United States, ANN's yielded significantly greater predictive accuracy than did multiple linear regression for two indices of well-being, work stress and life satisfaction.

16h45 New models and preprocessing techniques for segment routing optimization

Fortz, Bernard, Université Libre de Bruxelles, bernard.fortz@ulb.ac.be

Segment routing is a modern variant of source routing in computer networks, which is being developed within the SPRING and IPv6 working groups of the IETF. In a segment routed network, an ingress node may prepend a header to packets that contain a list of segments, which are instructions that are executed on subsequent nodes in the network. These instructions may be forwarding instructions, such as an instruction to forward a packet to a specific destination or interface. In this talk, we present models for traffic engineering in a network implementing segment routing on top of shortest paths routing protocols. We also present some pre-processing techniques that allow to decrease significantly the size of the resulting models, and present numerical experiments validating the approach on a large set of test instances.

MD10 Optimization based on Learning

Salle: TD Assurance Meloche Monnex
Président: Rimélé, Adrien, Polytechnique Montréal

15h30 A novel method based on the TLBO algorithm for influence maximization in social networks

Kimiagari, Salman, TRU, skimiagari@tru.ca
Taghizadeh, Azam, Shiraz University, skimiagari@tru.ca

IInfluence Maximization Problem (IMP) is to find an initial seed set in a graph of social networks, which maximize the spread of influence and this is an important part of viral marketing. However, computations of this problem are considered as an NP-hard optimization. The efficiency of the original algorithm (Greedy algorithm) for this problem was not as expected. This problem refers to multiples Monte-Carlo computations for discovering one influencer nodes. We propose a model for IMP based on Teaching-Learning Based Optimization (TLBO). We use this algorithm for the first time to solve the IMP, and in order to assess the proposed model, we test the model on real datasets to show the better time efficiency of the model.

15h55 Deep inverse optimization

Tan, Yongcong, Université Concordia, yingcong.tan@gmail.com
Daria, Terekhov, Concordia University, daria.terekhov@concordia.ca
Delong, Andrew, , andrew.delong@gmail.com

Abstract: Given a set of observations generated by an optimization process, the goal of inverse optimization is to determine likely parameters of that process. We cast inverse optimization as a

form of deep learning. Our method, called deep inverse optimization, is to unroll an iterative optimization process and then use backpropagation to learn parameters that generate the observations. We demonstrate that by back propagating through the interior point algorithm we can learn the coefficients determining the cost vector and the constraints, independently or jointly, for both non-parametric and parametric linear programs, starting from one or multiple observations. With this approach, inverse optimization can leverage concepts and algorithms from deep learning.

16h20 Learning graph elimination orderings

Liu, Defeng, Polytechnique Montreal, defeng.liu@polymtl.ca
Tanneau, Mathieu, Polytechnique Montreal, mathieu.tanneau@polymtl.ca
Lodi, Andrea, Polytechnique Montreal, andrea.lodi@polymtl.ca

The resolution of symmetric sparse linear systems typically employs Cholesky factorization, which potentially suffers from significant fill-in. Fill-in can be reduced by re-ordering the rows and columns of the matrix to be factored. We propose a learning framework, in order to learn efficient ordering heuristics.

16h45 Learning a storage policy for e-commerce warehouses

Rimélé, Adrien, Cirrelt, adrien.rimele@polymtl.ca
Grangier, Philippe, Element AI, philippe.grangier@elementai.com
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca
Gamache, Michel, Polytechnique Montréal, michel.gamache@polymtl.ca
Gendreau, Michel, Polytechnique Montréal, michel.gendreau@cirrelt.ca

We consider an Amazon-type warehouse where a fleet of robots stores and retrieves shelves of objects to fulfill customers' orders. To adapt to changing demand, one can dynamically modify the storage allocation of a shelf, with the goal of improving overall access time for future requests. We modelled this problem as a stochastic dynamic model and we propose a solution approach to learn a good storage policy using reinforcement learning on an associated partially observable MDP.

MD11 Transportation

Salle: TAL Gestion globale d'actifs inc.
Président: Munroe, Patrick, GERAD - Polytechnique Montréal

15h30 Optimization models for planning transit stop and service patterns operation

Mahmoodi Nesheli, Mahmood, University of Toronto, m.nesheli@utoronto.ca
Shalaby, Amer, University of Toronto, amer@ecf.utoronto.ca

Abstract: This study focuses on limited-stop and semi-express transit service operations. The development of strategies is performed in two steps: optimization and simulation. New mathematical programming models are proposed to find the best stop and service patterns for these strategies so as to minimize the total passenger travel time.

15h55 Dynamic shipping in hierarchical freight transportation network

Ponce, Diego, Concordia University, diegoponce85@gmail.com
Contreras, Ivan, Concordia, icontrer@encs.concordia.ca
Laporte, Gilbert, HEC Montréal, gilbert.laporte@cirrelt.ca

We define a problem which lets a retailer consolidate their products before deciding the delivery procedure with the aim of minimizing sorting, outsourcing and transportation costs. We consider different shipping options depending on the level the retailer reaches a delivery company which is in charge of the final shipment.

16h20 Challenges in air cargo transportation

Munroe, Patrick, GERAD - Polytechnique Montréal, patrick.munroe@gerad.ca
El Hallaoui, Issmail, GERAD, Polytechnique Montréal, issmail.elhallaoui@gerad.ca
Soumis, François, Polytechnique Montréal, francois.soumis@gerad.ca

In order to survive and stay ahead of the competition, airfreight carriers have to continuously make decisions regarding the use of their transportation network. Some decision-making tools are available to support them in their planning and operations. However, due to the difficulty of the problems involved, their quality is often poor, and they cannot be fully relied on. In this talk, we will discuss certain aspects of freight transportation that still represent a challenge in the air cargo industry. Relevant research questions and new approaches to deal with these issues will be presented.

16h45 An integer programming approach to re-optimize air cargo shipping plans

Zago, Paul, Gerad, paul.zago@polymtl.ca
Munroe, Patrick, GERAD - Polytechnique Montréal, patrick.munroe@gerad.ca
El Hallaoui, Issmail, GERAD, Polytechnique Montréal, issmail.elhallaoui@gerad.ca
Soumis, François, Polytechnique Montréal, francois.soumis@gerad.ca

An air cargo transporter receives demands from clients who want to transport some goods from a place to another. The purpose of this company is to maximize its benefits by having the best utilization of its network. In this talk, we will present some integer programming models that re-optimize an already existing shipping plan. We will focus on finding a good trade-off between the available capacity of the planes and the cost of the shipping plan.

17h30 Wine and Cheese - Salon L'Oréal

Mardi 14 mai 2019 / Tuesday May 14, 2019

TA1 Plenaries - A Thirty Years War: What it takes to get healthcare organizations to use OR (Sally Brailsford)

Salle: Amphithéâtre Banque Nationale
Président: Lahrichi, Nadia, Polytechnique Montréal

09h00 A Thirty Years War: What it takes to get healthcare organizations to use OR

Brailsford, Sally, University of Southampton, S.C.Brailsford@soton.ac.uk

Healthcare systems have been a massively popular application area for OR modelling since the 1950s. Nevertheless, there are surprisingly few reported examples where model results have actually been implemented in practice, compared with manufacturing industry, defence, or even other service industries like call centres or airlines. Many researchers, including me, have studied this conundrum and have attempted to explain it and identify the barriers, facilitators and possible solutions. In this talk I reflect on my personal experiences of success (hardly any) and failure (lots) in getting modelling used in practice over a 30-year career in OR, and address the question: Is healthcare really so very different from other sectors?

TB1 Tutorial - Introduction to Agent-Based Simulation

Salle: CPA du Québec
Président: Lehoux, Nadia, Université Laval

10h30 Introduction to Agent-Based Simulation

Frayret, Jean-Marc, Polytechnique Montréal, CIRRELT, jean-marc.frayret@polymtl.ca

TB2 Vehicle Routing III

Salle: Banque CIBC
Président: Cordeau, Jean-François, HEC Montréal

10h30 The multi-attribute two-echelon location-routing problem with fleet synchronization at intermediate facilities

Escobar-Vargas, David, Université de Montréal - CIRRELT, davesco24@gmail.com
Contardo, Claudio, ESG UQÀM / GERAD, claudio.contardo@gerad.ca
Crainic, Teodor Gabriel, Université du Québec à Montréal, TeodorGabriel.Crainic@cirrelt.ca

We study the multi-attribute two-echelon location-routing problem with fleet synchronization at intermediate facilities (MA-2ELRPFS). The problem definition involves both strategic and tactical planning to minimize distribution-related costs in urban logistics. We introduce the problem setting, present and compare two mixed-integer programming formulations and an exact solution framework for the MA-2ELRPFS. / City logistics, Two-echelon location-routing problem, Time-expanded networks

10h55 The delivery and installation routing problem

Ali, Ousmane, Université Laval, nassoma-wattara-ousmane.ali.1@ulaval.ca
Côté, Jean-François, Université de Montréal, cotejean@iro.umontreal.ca
Coelho, Leandro C., Université Laval, leandro.coelho@cirrelt.ca

We study a vehicle routing problem with time windows in which two heterogeneous fleets are used for delivery and installation of different products. Our setting is flexible enough to allow deliverymen to perform installations, and both fleets need to be synchronized at some customer's location. A mixed-integer linear programming model and a tailored adaptive large neighborhood search heuristic are developed to solve this new and general distribution and installation problem.

11h20 Parameter selection in granular local search for vehicle routing

Gauthier, Jean-Bertrand, GERAD - HEC Montréal, jean-bertrand.gauthier@gerad.ca
Schneider, Michael, RWTH Aachen University, schneider@dpo.rwth-aachen.de
Gschwind, Timo, Johannes Gutenberg Universität Mainz, gschwind@uni-mainz.de
Schroeder, Christian, RWTH Aachen University, schroeder@dpo.rwth-aachen.de

Despite being quite flexible in adapting to various optimization problems, metaheuristics are subject to a variety of parameters that affect their behavior. Parameter selection has been studied for multiple metaheuristics in various degrees which even sometimes comes down to prescribing specific values. We follow a statistical approach as many of our peers have done before us, but our intent is rather to try to identify recurring patterns in the local search behavior. Parameter selection, Granular local search, Vehicle routing

11h45 Multi-product production routing problem under decoupled planning periods

Cordeau, Jean-François, HEC Montreal, jean-francois.cordeau@hec
Jans, Raf, HEC Montréal, raf.jans@hec.ca
Chitsaz, Masoud, HEC Montréal, masoud.chitsaz@hec.ca

We investigate an integrated optimization problem including the production and transportation decisions where the production planning and routing period lengths are not the same. We mathematically formulate the problem under different practical scenarios for the production and route planning period lengths and present exact and heuristic solution methods.

TB3 Clustering

Salle: Demers Beaulne
Président: Chinneck, John, Carleton University

10h30 Application of maximum diameter and minimum split clustering

Poggi, Marcus, Pontifícia Universidade Católica do Rio de Janeiro, poggi@inf.puc-rio.br
Lopes, Helio, PUC-Rio, lopes@inf.puc-rio.br
Fiol González, Sonia, PUC-Rio, s.fiol1987@gmail.com
Pacheco, Toni, PUC-Rio, toni.s.pacheco@gmail.com
Tassara, Bruno, PUC-Rio, bptassara@gmail.com

Given objects and associated dissimilarity matrix find the minimum number of clusters with given maximum diameter and minimum split. We develop an algorithm with simple constructive heuristics, set partitioning formulation, 3-src cuts and column enumeration. The approach characterizes well large data sets' subgroups with very individual descriptions, eventually proving optimality.

10h55 On semi-supervised ellipsoidal clustering

Gribel, Daniel, CIRRELT, gribel.daniel@gmail.com
Gendreau, Michel, Polytechnique Montréal, Michel.Gendreau@cirrelt.ca
Vidal, Thibaut, Pontifical Catholic University of Rio de Janeiro, vidalt@inf.puc-rio.br

We study a minimum sum-of-squares clustering problem in the presence of semi-supervised information via pairwise "must-link" and "cannot-link" constraints. Our clusters can be elliptical, and therefore are represented by their centers and co-variance matrices. We conduct computational experiments to measure the benefits of semi-supervised information.

11h20 Post-separation classifier feature reduction

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

Classifier feature reduction tries to find the smallest set of features that allows acceptable separation of the data. This is time-consuming, e.g. wrapper methods require multiple solutions using different subsets of the features. We describe a new approach: (i) find a separating

hyperplane by any method, using all features, then (ii) find a different hyperplane that provides the same separation while using fewer features. The novelty is in the second step, which is based on new heuristics for finding sparse solutions to linear programs. Finding a separating hyperplane can be cast as an instance of the Maximum Feasible Subset problem (maxFS): given an infeasible set of linear constraints, find the largest cardinality feasible subset. There are good heuristics for this NP-hard problem. To convert: transform each data point into a linear inequality in the feature weights, then apply a maxFS heuristic to find a solution that satisfies as many of the inequalities as possible (i.e. correctly classifies as many of the data points as possible). We adapt this formulation for use with any hyperplane placement method: (i) find the hyperplane, (ii) convert only the correctly classified points to inequalities, (iii) find a sparse solution (i.e. one in which few variables are nonzero) to this feasible system. Few nonzero variables is the same as few features. The sparse solution algorithm is itself another variant of a maxFS solution heuristic. Experimental results are given.

TB4 Mathematical Modeling I

Salle: Gérard-Parizeau
Président: Frejinger, Emma, Université de Montréal

10h30 Élimination du treillis engendré par les contraintes d'égalité d'un problème d'optimisation linéaire en nombre entier par la construction d'un problème-nain.

Rouillon, Stéphane, UdeM (IVADO), stephane.rouillon@sympatico.ca

La technique présentée consiste à traiter initialement les contraintes d'égalité d'un problème d'optimisation linéaire afin de construire un "problème-nain". Celui-ci peut ensuite être résolu par les méthodes classiques ou par des heuristiques adaptées à la nouvelle structure.

10h55 Integer and constraint programming approaches to the discretizable molecular distance geometry problem

MacNeil, Moira, University of Toronto, m.macneil@mail.utoronto.ca
Bodur, Merve, University of Toronto, bodur@mie.utoronto.ca

We present the first Constraint Programming (CP) formulations for the Discretizable Molecular Distance Geometry Problem. We present infeasibility checks, symmetry breaking constraints, and domain reduction strategies for the CP models. Computational experiments show CP outperforms existing integer programming formulations, especially on large instances.

11h20 Piecewise linear approximation with a performance guarantee for solving MINLPs

Ngueveu, Sandra Ulrich, LAAS-CNRS / Université de Toulouse - INPT, ngueveu@laas.fr
Gendron, Bernard, Université de Montréal, CIRRELT, bernard.gendron@cirrelt.ca
Codsi, Julien, Université de Montréal, julien.codsi@umontreal.com

We present an efficient algorithm that approximates any arbitrary univariate non linear function by a piecewise linear function with a guaranteed relative epsilon-tolerance. Using this algorithm, we show how to approximate as a MILP with a guaranteed relative gap, any MINLP with separable non linear terms in the objective function. Computational results on a congested multicommodity network design problem will be presented.

11h45 Arc-based MILP reformulations of a flow capture bi-level program

Morin, Léonard Ryo, Université de Montréal, morinleo@iro.umontreal.ca
Gendron, Bernard, Université de Montréal, CIRRELT, bernard.gendron@cirrelt.ca
Frejinger, Emma, DIRO and CIRRELT, emma.frejinger@cirrelt.ca

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 several mixed integer linear programs which we then compare.

TB5 Healthcare Optimization III

Salle: Hélène-Desmarais
Président: Cevik, Mucahit, Sunnybrook Health Sciences Centre

10h30 Control of addictive behaviors with relapsing

El Ouardighi, Fouad, ESSEC Business School, elouardighi@essec.fr
Grass, Dieter, Vienna Technical University, dieter.grass@tuwien.ac.at

One important consequence of addictions is the high occurrence of relapsing after treatment, which often lies between 40 and 60% depending on the kind of addiction and population (Mc Lellan et al., 2000). While the importance of prevention-treatment policies against addictions is widely acknowledged in the economic literature, the consequences of relapsing on the effectiveness of such policies remain yet under-investigated. This paper seeks to bridge the gap by introducing a dynamic model where individuals can move back and forth between active addiction and temporary abstinence. Though both states are socially costly, active addiction promotes initiation by others while temporary abstinence discourages it. Using optimal control techniques, we evaluate how the tradeoff between prevention and treatment of addiction is affected by the occurrence of relapsing. We show that the trajectories of de-escalation from the addiction can be much more complex than what is obtained in the existing literature.

10h55 Large size ambulance routing problem

Garaix, Thierry, École Nationale Supérieure des Mines de Saint-Étienne, garaix@emse.fr
Xie, Xiaolan, École des Mines de Saint-Étienne, xie@emse.fr
Skiredj, Mohammed, École des Mines de Saint-Étienne, mohammed.skiredj@emse.fr

In this research we propose an adaptive large neighborhood search designed to solve ambulance routing problems. Good solutions are computed within 20 minutes for instances with 2000 requests, 300 drivers and crew recomposition and lunch break constraints. Experiments are conducted on instances from Hong-Kong and French medical transportation companies.

11h20 Multi-appointment, multi-stage outpatient scheduling at oncology clinics

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

Outpatient chemotherapy clinics are one of the most demanded multi-stage and multi-resource outpatient clinics in which patients must go through several interdependent stages. To coordinate all the required appointments of each patient properly while utilizing valuable resources efficiently, we propose an integrated model to schedule multiple appointment requests of different types of patients over a planning horizon. The proposed integrated model can be used as an online scheduling tool to accommodate arriving requests to the clinic over time. The performance of the model is evaluated using historical data obtained from a major cancer center in Canada. Furthermore, two sequential approaches are also proposed to assess the value of decisions' integration.

11h45 Integer programming models for the breast cancer screening problem

Cevik, Mucahit, Ryerson University, mcevik@ryerson.ca

Cost of mammography and lack of resources limit the widespread use of mammography for screening in many countries. We propose an integer programming model to investigate the breast cancer screening problem in a resource-constrained setting where the objective is to maximize total quality adjusted life years of the patients.

TB6 Green Vehicle Routing

Salle: Marie-Husny

Président: Laporte, Gilbert, HEC Montréal

10h30 Benchmark instances for green vehicle routing problems

Carroll, Paula, University College Dublin, Ireland, paula.carroll@ucd.ie

Transport accounts for approximately 25% of global CO2 emissions. We propose VRP instances that include geospatial data, e.g. road elevation, to support the test and development of Green Vehicle Routing Algorithms for Alternative Fuel Vehicles, particularly Electric Vehicles. Our work enables transport actions to mitigate the effects of climate change.

10h55 An exact solution method to the pollution routing problem

Stålhane, Magnus, Norwegian University of Science and Technology, stalham@iot.ntnu.no
Range, Troels Martin, NTNU, Troels.Martin.Range@rsyd.dk

The pollution routing problem extends the well-known vehicle routing problem, by minimizing speed- and load-dependent fuel costs on the vehicle routes, rather than the distance travelled. To solve this problem, we present a novel branch-price-and-cut algorithm. Computational results show that our method can solve benchmark instances of up to 50 customers to optimality within one hour.

11h20 ANNULE / Multi-facility green Weber problem

Atashi Khoei, Arsham, , arsham.khoei@metu.edu.tr
Sural, Haldun, Professor, hsural@metu.edu.tr
Tural, Mustafa Kemal, Assistant Professor, tural@metu.edu.tr

We formulate the multi-facility green Weber problem (MF-GWP) by mixed integer second order cone programming. For large instances, heuristics are proposed with relaxed formulations of MF-GWP and modifications of the approaches for the multi-facility Weber problem. The computational experiments compare the proposed approaches in terms of solution quality and time.

11h45 The electric fleet transition problem

Pelletier, Samuel, HEC Montréal, samuel.pelletier@hec.ca
Jabali, Ola, Politecnico di Milano, ola.jabali@polimi.it
Mendoza, Jorge, HEC Montréal, jorge.mendoza@hec.ca
Laporte, Gilbert, HEC Montréal, gilbert.laporte@cirrelt.ca

Several organizations need to transition to electric fleets in the next decades. Such transitions are often established by temporal targets, which dictate how many electric vehicles should be in the fleet by a given time period. We therefore present a fleet replacement problem which allows organizations to determine vehicle replacement plans that will respect such targets in a cost-effective way, and we draw managerial insights through numerical experiments.

TB7 Electricity Production and Distribution

Salle: Nancy et Michel-Gaucher
Président: Denault, Michel, HEC Montréal

10h30 Cold load pick-up management based on advanced service restoration in electricity distribution networks

Dzeletovic, Sanja, McGill University, sanja.dzeletovic@mail.mcgill.ca
Bouffard, François, McGill University, francois.bouffard@mcgill.ca

A methodology for service restoration with active management of cold load pick-up is developed. Re-connection schedules for feeder customers are calculated through the solution of a mixed-integer linear programming problem. Results of the proposed approach are compared against full feeder restoration. Machine learning approaches applied to historical post-outage data are being

explored for cold load pick-up modelling with an aim to improve the accuracy of service restoration decisions.

10h55 Flexibility management considering electricity transmission network limits and correlation of wind power

Huo, Yuchong, McGill University, yuchong.huo@mail.mcgill.ca
Bouffard, François, McGill University, francois.bouffard@mcgill.ca

Uncertainty associated with wind power generation in bulk power system operations requires increasingly systematic attention. As practical levels of wind power generation penetration keep on deepening in many power systems, it is now widely accepted that adequate supply of flexibility resources is essential to managing this uncertainty. This paper extends the notion of flexibility envelopes to network-constrained power systems and to systems with geographic wind power output correlation. Preliminary results indicate that flexibility envelopes are effective means of achieving flexibility adequacy.

11h20 Incorporating a PARMA statistical model in SDDP for hydroelectric system management.

Mbeutcha, Yves, Polytechnique Montréal, yvesmbeutcha@gmail.com
Gendreau, Michel, Polytechnique Montréal, Michel.Gendreau@cirrelt.ca
Émiel, Grégory, Hydro-Québec, emiel.gregory@hydro.qc.ca
Pina, jasson, PhD candidate, jepinaf@unal.edu.co

Résumé: Stochastic Dual Dynamic Programming (SDDP) is a widely used method to optimize the operations of a large hydrothermal system. The uncertainty on the future inflows in SDDP is usually represented by a linear time series like the family of Periodic Autoregressive (PAR) models. A model with a moving average component like the class of Periodic Autoregressive and Moving Average (PARMA) models can be more advantageous than pure autoregressive higher order models. We will compare the performance of the two-time series models on a hydroelectric system of Hydro-Quebec using the SDDP approach. Mots-clés: hydroelectric system management, Stochastic Dual Dynamic Programming, PARMA models.

11h45 Using stochastic optimization for policy analysis in the electricity sector

Rodriguez, Jesus, HEC Montreal, jesus.rodriguez@gerad.ca
Pineau, Pierre-Olivier, HEC Montréal, pierre-olivier.pineau@hec.ca
Denault, Michel, GERAD - HEC Montréal, michel.denault@hec.ca

In several regions the electricity sector will require major investments to achieve decarbonization targets and to upgrade and replace ageing power infrastructure. As transmission and generation expansion projects typically require several years or even decades to be completed, capacity investment decisions should be made well in advance, in the face of significant uncertainties related to electricity demand, environmental policies and investment and operation costs. We present a multi-stage stochastic program for capacity expansion in the electricity sector, considering the short-term variability of intermittent renewable energies and the long-term uncertainty of decarbonization policies, load profiles and fossil fuel costs. With reference to the North American Northeast Electricity sector, we show how this model can support the analysis of energy policy decisions.

TB8 Crew Scheduling

Salle: St-Hubert
Président: Quesnel, Frédéric, Polytechnique Montréal

10h30 Alternating Lagrangian decomposition for integrated airline crew scheduling problem

Zeighami, Vahid, Polytechnique Montréal, vahid.zeighami@polymtl.ca
Soumis, Francois, Polytechnique Montreal, Francois.Soumis@gerad.ca

The airline crew scheduling problem involves determining schedules for airline crew members such that all the scheduled flights over a planning horizon (usually a month) are covered and the constraints are satisfied. Because of its complexity, this problem is usually solved sequentially in two main steps: the crew pairing followed by the crew assignment. However, finding a globally optimal solution via the sequential approach may be impossible because the decision domain of the crew assignment problem is reduced by decisions made in the pairing problem. This study considers the crew scheduling problem in a personalized context where each pilot and copilot requests a set of preferred flights and vacations each month. We propose a model that completely integrates the crew pairing and personalized assignment problems to generate personalized monthly schedules for a given set of pilots and copilots simultaneously in a single optimization step. The model keeps the pairings in the two problems as similar as possible so that the propagation of perturbations arising during the operation is reduced. We develop an integrated algorithm that combines alternating Lagrangian decomposition, column generation, and dynamic constraint aggregation. We conduct computational experiments on a set of real instances from a major US carrier. Our integrated approach produces significant cost savings and better satisfaction of crew preferences compared with the traditional sequential approach.

10h55 Integrated bus driver rostering and days off scheduling problem

Er-Rbib, Safae, GERAD, Polytechnique Montréal, safae.er-rbib@gerad.ca
Desaulniers, Guy, GERAD and Polytechnique Montreal, guy.desaulniers@gerad.ca
Elhallaoui, Issmail, Associate Professor, Department of Mathematical and Industrial Engineering, Polytechnique Montreal, issmail.elhallaoui@polymtl.ca

We consider the integrated problem of assigning duties and days off to bus drivers 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 period between two working days. We model this problem as an integer linear program with big M constraints, then we apply the reformulation-linearization technique to derive a tight and equivalent linear model, we report computational results obtained on real-world instances.

11h20 The air crew pairing problem with language constraints

Soumis, François, Polytechnique Montréal, francois.soumis@gerad.ca
Desaulniers, Guy, GERAD and Polytechnique Montreal, guy.desaulniers@gerad.ca
Quesnel, Frédéric, Polytechnique Montréal, frederic.quesnel@gerad.ca

We propose an efficient solution method for the CPPLC, a variant of the air crew pairing problem with additional constraints limiting the amount of work performed in any language. We show that fewer language constraints are violated in the schedules when the CPPLC is used, compared to traditional approaches.

TB9 Methods and Models for Large Systems Optimization

Salle: Dutailier International
Président: Foguen Tchuendom, Rinel, Polytechnique Montréal

10h30 Optimal Control of Large-Scale Networks of Stochastic Linear Systems

Liu, Shu-Jun, McGill Visiting Professor, sjliu@cim.mcgill.ca
Caines, Peter, GERAD - McGill University, peterc@cim.mcgill.ca
Gao, Shuang, ,

Owing to the extremely large number of nodes and dynamic elements in large-scale complex networks, it is effectively impossible to achieve desired control objectives. In this work, we develop an approximate control theory for large-scale network stochastic linear systems by the use of stochastic control theory of limiting (infinite dimensional) stochastic systems. First, in order to represent arbitrary-size networks of linear systems with additive noise, dynamical stochastic system models are formulated in an appropriate infinite dimensional space. Second, control of the infinite dimensional system is analysed. Finally, from the stochastic control for the limit infinite

dimensional system we obtain feedback control laws for the network system, with guaranteed approximation errors. In particular, this is carried out within the framework of the linear quadratic regulator problem for large-scale network stochastic systems.

10h55 Optimal and approximate solutions to linear quadratic regulation of a class of graphon dynamical systems

Gao, Shuang, McGill, sgao.mcgill@gmail.com

In this paper, we study the linear quadratic regulation (LQR) problem for dynamical systems coupled over large- scale networks and obtain locally computable low-complexity solutions. The underlying large or even infinite networks are represented by graphons and the couplings appear in both the dynamics and the quadratic cost. The optimal solution is obtained for graphon dynamical systems where the graphons are exactly characterized by finite spectral summations. Based on this, we provide a suboptimal solution for problems with general graphon couplings via spectral approximations. The complexity of generating these control solutions involves solving d + 1 scalar Riccati equations where d is the number of non- zero eigenvalues in the graphon spectral representation. A numerical example is given to illustrate the explicit solution and demonstrate the simplicity of the solution.

11h20 An affine decision rule approximation for modeling uncertainty of demand response in smart grids

Aliakbari Sani, Sajad, 1988, aliakbarisani.sajad@gmail.com

In this research, we design a linear program to model expansion of smart energy systems. In this modeling, consumers are able to contribute to the network by means of flexible loads (demand response). We have considered this demand response uncertain. An affine adjustable robust optimization technique is used to cope with uncertainty in this problem. k

11h45 A quantilized mean field game approach to energy pricing with application to fleets of plug-in electric vehicles

Foguen Tchuendom, Rinel, Ecole Polytechnique à Montréal, rinel.foguen@gerad.ca

We consider the problem of designing the price of electricity by an energy provider to a pool of homogeneous loads. The energy provider is risk sensitive and considers that its energy production cost at any particular time is related to the instantaneous maximum excursion of the random aggregate demand of the loads. A statistical measure of this excursion is the α-quantile of the distribution of the individual electricity demands of the loads, or equivalently the value da at risk α, of the electricity demand per vehicle. The price is assumed to be a known and possibly time varying function of d_α. The loads are associated with individual price sensitive costs. For a very large number of loads, in particular a large fleet of electric vehicles, this results in a mean field game (MFG). The existence of an MFG equilibrium associated with a price trajectory, and the epsilon- Nash property of the resulting limiting control laws, are established in this work.

TB10 Machine Learning for Prediction and Choice Modeling

Salle: TD Assurance Meloche Monnex
Président: Lodi, Andrea, Polytechnique Montréal

10h30 Traffic detection and prediction with CNNs and regression analysis

Awasthi, Anjali, Professor, anjali.awasthi@concordia.ca
Amoei, Mohsen, Master's Student , m_amoei@encs.concordia.ca

An essential act for developing smart cities is having a profound understanding of the traffic flow. These objectives could be efficiently realized through Machine Learning applications. Traffic congestion can be viewed as a product of the interaction between demand and capacity. Periodic high-demand at specific bottlenecks during peak hours can result in chronic congestion. Big Data

generated from different sources could be leveraged to develop congestion measurement in real time. Our goal is to develop a model to apply computer vision, and data science approaches to detect traffic elements and predict future congestions.

10h55 Forecasting demand of container shipments

Laage, Greta, Polytechnique Montréal, greta.laage@polymtl.ca
Frejinger, Emma, DIRO and CIRRELT, emma.frejinger@cirrelt.ca
Savard, Gilles, Polytechnique Montréal, gilles.savard@polymtl.ca

Freight carriers require accurate demand forecasts to adequately plan their operations. We focus on forecasting short-term demand for container transportation by a rail carrier. We present prediction results of machine learning algorithms trained on real data and we assess the impact of demand forecast accuracy on so-called block plan solutions.

11h20 Predicting buses end-trip delay using machine learning algorithms to model planning effectiveness

Hannothiaux, Victor, Polytechnique Montréal, vhannothiaux@gmail.com
Lodi, Andrea, Polytechnique Montréal, andrea.lodi@polymtl.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca

Abstract: Service reliability is one of the key quality factors in public transport and resides on the difference between the expected service in time and comfort relative to the one perceived by the user. Therefore modeling bus end-trip arrival time using planning features could be used to assess planning effectiveness and robustness. The proposed method consisted in building and optimizing different machine-learning algorithms (Random Forest, Artificial Neural Network and Gradient Boosted Tree) for multi-label classification of end-trip bus delay. The tests were made on the Montréal public transport network with the support of the Giro company, and the results were therefore compared to classic modeling using probabilistic methods.

11h45 Choice modeling for halo effects

Sole, Claudio, Polytechnique Montreal, claudio.sole@polymtl.ca
Andrea, Lodi, Polytechnique Montreal, andrea.lodi@polymtl.ca
Jena, Sanjay Dominik, Université du Québec à Montréal, jena.sanjay-dominik@uqam.ca

Random Utility Maximization (RUM) is arguably the most adopted framework for modeling human choice. This framework, however, is unable to capture complex choice behaviors such as halo effects. This talk reviews the literature on choice models proposed to capture such effects and presents some preliminary results regarding their estimation. Choice models, halo effects, Machine Learning

TB11 Numerical Linear Algebra

Salle: TAL Gestion globale d'actifs inc.
Président: Montoison, Alexis, GERAD - Polytechnique Montréal

10h30 Loss of orthogonality in large scale matrix computations

Paige, Chris, School of Computer Science, McGill University, Montreal, Canada,
paige@cs.mcgill.ca

Many large scale matrix algorithms are based on orthogonality, but for efficiency this orthogonality is often obtained via short term recurrences. This can lead to both loss of orthogonality and loss of linear independence of computed vectors, yet with well designed algorithms high accuracy can still be obtained. Here we discuss a nice theoretical indicator of loss of orthogonality and linear independence, and for such short term recurrence algorithms show how it can lead to a related higher dimensional orthogonality that can be used to analyze and prove the effectiveness of such algorithms. We illustrate advantages and shortcomings of such algorithms with Cornelius

Lanczos' symmetric matrix tridiagonalization process, which is the basis for many of our most useful large sparse matrix algorithms.

10h55 A tridiagonalization method for symmetric and quasi-definite saddle-point systems

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

We propose an iterative method for symmetric saddle-point systems that splits the system into a least-squares and a least-norm problem. Our method typically requires fewer operator-vector products than MINRES, yet performs a comparable amount of work per iteration and has comparable storage requirements. We illustrate a generalization to elliptic norms.

11h20 Exploiting variable arithmetic in GMRES

Titley-Peloquin, David, McGill University, david.titley-peloquin@mcgill.ca
Simon, Ehouarn, Université de Toulouse, INP, IRIT, ehouarn.simon@enseeiht.fr
Toint, Philippe L., University of Namur, philippe.toint@fundp.ac.be
Gratton, Serge, CERFACS et ENSEEIHT, Toulouse, gratton@cerfacs.fr

Variable floating-point arithmetic precision (beyond IEEE single/double) is becoming increasingly available to users. We show how this can be exploited in MGS-GMRES for inexact matrix-vector products and inexact reorthogonalization without affecting the algorithm's convergence. This is joint work with Serge Gratton and Ehouarn Simon (INPT-ENSEEIHT) and Philippe Toint (Namur).

11h45 Krylov.jl : A Julia basket of hand-picked Krylov methods

Montoison, Alexis, , alexis.montoison@polymtl.ca
Orban, Dominique, GERAD - Polytechnique Montréal, dominique.orban@gerad.ca
Krylov.jl provides Julia implementations of certain of the most useful Krylov method for linear systems, least squares, and least norm problems, together with facilities for saddle-point systems. Those methods have been optimized to ensure performance in terms of time and memory. We illustrate those features on our implementation of DQGMRES, and memory improvements to MINRES. We also present future improvements, an implementation of a new method named BiLQ and multiple precision support.

TC1 Plenaries - Automated Design of Metaheuristic Algorithms: Methods, Applications and Perspectives

Salle: Amphithéâtre Banque Nationale
Président: Potvin, Jean-Yves, Université de Montréal

14h00 Automated Design of Metaheuristic Algorithms: Methods, Applications and Perspectives

López-Ibáñez, Manuel, The University of Manchester, manuel.lopez-ibanez@manchester.ac.uk

Metaheuristic algorithms are often defined as high-level recipes that must be adapted and configured for particular problems. Unfortunately, designing a metaheuristic and configuring its parameter settings can be a time-consuming and difficult task due to the large number of possible algorithmic components and parameter values, the diversity of problem instances and computational environment, and the stochasticity of the algorithms. Traditionally, design and configuration are carried out by means of a manual, human-intensive process guided mainly by the expertise and intuition of a human expert. In recent years, several methods for automatic algorithm configuration have shown that it is possible to identify high-performing designs and parameter settings given large and complex parameter spaces. The role of automatic configuration methods goes beyond the classical concept of parameter tuning. When combined with carefully-designed algorithmic frameworks, these methods allow a more effective exploitation of the space of algorithm designs. This talk will review the most prominent automatic configuration methods and discuss several applications, ranging from minimizing the time required by exact

solvers to find the optimum, to automatically designing multi-objective evolutionary algorithms according to multiple quality metrics. Recent promising results of automatic designed metaheuristics will be presented, giving a window into the potential future of metaheuristics research and development.

TD1 Tutorial - Collaborative Logistics in Practice – Challenges and Opportunities

Salle: CPA du Québec
Président: Lehoux, Nadia, Université Laval

15h30 Collaborative Logistics in Practice – Challenges and Opportunities

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

During recent years, horizontal collaboration in logistics has gained attention because of achieved potential benefits such as cost reduction, an increase in fulfillment rates, and a decrease in CO2 emissions owing to reductions in traveled distances. Successful real-world cases, however, are rare since horizontal cooperation in logistics is not usually sustainable. There are many reasons for this and in this presentation we describe a number of issues that may hinder otherwise efficient collaborations. One issue is the design of fair collaboration and its implementation and management over longer time. One example is to establish a cost or profit allocation. Business/market practical issues comprise the collaborative impact on the firms' strategical level and explain how agreements impact the whole market. There are also behavioral practical issues with human relationships challenges, for example, trust. We also describe a number of successful applications and their savings through collaboration. For these we also discuss how the practical issues were addressed. The applications cover examples from routing, transportation and network design.

TD2 Vehicle Routing IV

Salle: Banque CIBC
Président: Lehuédé, Fabien, IMT-Atlantique - LS2N

15h30 Dynamically routing UAVs in the aftermath of a severe tornado

Grogan, Sean, Polytechnique Montreal, sean.grogan@polymtl.ca
Pellerin, Robert, École Polytechnique de Montréal, robert.pellerin@polymtl.ca
Gamache, Michel, Polytechnique Montréal, michel.gamache@polymtl.ca

This presentation shows a case for using UAVs to assess damage after a tornado. Previous work uses a fixed search area and dispatches UAVs to assess potential tornado damage. This presentation will form the problem to a DVRP so UAVs can re-deploy to uncover the extent of the damage.

15h55 A mixed integer formulation for the locomotive routing problem with maintenance constraints

Miranda, Pedro, HEC Montreal, pedro.miranda@hec.ca
Cordeau, Jean-François, HEC Montreal, jean-francois.cordeau@hec.ca
Frejinger, Emma, DIRO and CIRRELT, emma.frejinger@cirrelt.ca

In this talk we address the Locomotive Routing Problem (LRP), a large-scale optimization problem faced by railroad companies that aims to determine the optimal sequence of trains each locomotive is assigned to, while considering locomotives maintenance requirements over the planning horizon. A mixed integer formulation and computational results are presented.

16h20 The heterogeneous multi-crew scheduling and routing problem in road restoration

Moreno Arteaga, Alfredo Daniel, Federal University of Sao Carlos, alfredmorenoarteaga@gmail.com
Alem, Douglas, University of Edinburgh Business School, douglas.alem@ed.ac.uk
Gendreau, Michel, Polytechnique Montréal, Michel.Gendreau@cirrelt.ca
Munari, Pedro, Federal University of Sao Carlos (UFSCar), pedro.munari@gmail.com

The heterogeneous multi-crew scheduling and routing problem consists of finding the schedule and route of crews that perform the restoration of damaged nodes in a network affected by disasters. Formulations and valid inequalities are proposed for the problem. The formulations are able to obtain good-quality solutions to realistically sized instances.

16h45 Optimization of a collaborative distribution network in the retail industry

He, Yun, IMT Atlantique, LS2N, Nantes, France, yun.he@imt-atlantique.fr
Hewitt, Mike, Loyola University Chicago, mhewitt3@luc.edu
Lehuédé, Fabien, IMT Atlantique, LS2N, fabien.lehuede@imt-atlantique.fr
Medina, Juliette, CRC Services, j.medina@4snetwork.com
Péton, Olivier, IMT Atlantique, LS2N, olivier.peton@imt-atlantique.fr

We consider a collaborative distribution application arising in the retail industry. An operational distribution problem is solved to determine how to transport orders from shippers to stores through a network of logistics hubs. This defines a complex integrated load plan design and vehicle routing problem. To solve it, a two steps approach integrates an extension of the Dynamic Discretization Discovery algorithm.

TD3 Stochastic Optimization II

Salle: Demers Beaulne
Président: Contreras, Ivan, Université Concordia

15h30 Stochastic single-allocation hub location

Kammerling, Nicolas, TU Dortmund University, kaemmerling@itl.tu-dortmund.de
Buchheim, Christoph, TU Dortmund University, christoph.buchheim@math.tu-dortmund.de
Naoum-Sawaya, Joe, Ivey Business School, Western University, jnaoum-sawaya@ivey.ca
Clausen, Uwe, TU Dortmund University, uwe.clausen@tu-dortmund.de
Rostami, Borzou, Polytechnique Montreal, borzou.rostami@cirrelt.ca

This paper presents a variation of the single allocation hub location problem under demand uncertainty. Namely, we consider variable allocations, meaning that the allocation of the spokes to the hubs can be altered after the uncertainty is realized. We model the problem as a two-stage stochastic program and reformulate it as a convex mixed-integer nonlinear program. We develop a customized solution approach based on cutting planes where the cut-generating subproblems are solved combinatorially, i.e. without an optimization solver. Extensive computational results show that the proposed cutting plane approach outperforms the direct solution of the problem using the state-of-the-art solver GUROBI as well the L-shaped decomposition, which is a common approach for addressing two-stage stochastic programs with recourse.

15h55 A branch-and-cut based heuristic for the bid construction problem with stochastic profits

Hammami, Farouk, CIRRELT, farouk.hammami@cirrelt.ca
Rekik, Monia, Université Laval, monia.rekik@fsa.ulaval.ca
Coelho, Leandro C., Université Laval, leandro.coelho@cirrelt.ca

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 in the transportation procurement auction in order to determine 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 conisder a BCP with stochastic prices through different scenarios and propose a hybrid heuristic to generate bids and associated prices while considering risks associated to bids' loss. These risks are handled as new constraints dynamically added via a branch-and-cut algorithm.

16h20 Stochastic integrated workforce training and operations planning for maintenance service providers

Tavakoli Kafiabad, Shayan, Concordia University, shayan.tavakolikafiabad@concordia.ca
Kazemi Zanjani, Masoumeh, Concordia University, masoumeh.kazemizanjani@concordia.ca
Nourelfath, Mustapha, Université Laval, Mustapha.Nourelfath@gmc.ulaval.ca

In this project, an integrated multi-period mathematical model is proposed to obtain the optimal procurement, production, inventory, and training plan with the goal of minimizing the total operations cost of maintenance service providers. Then, a multi-stage stochastic programming with recourse is proposed to deal with repair time uncertainty.

16h45 A two-stage robust model for perishable inventory management problems

Hooshangitabrizi, Pedram, Ph.D. Candidate, pedram.hooshangi@gmail.com
Contreras, Ivan, Concordia University and Interuniversity Research Centre on Enterprise Networks, Logistics and Transportation (CIRRELT), Montreal, Canada, icontrer@encs.concordia.ca
Bhuiyan, Nadia, Concordia University, Montreal, Canada, nadia.bhuiyan@concordia.ca
Hashemi Doulabi, Hossein, Concordia University and Interuniversity Research Centre on Enterprise Networks, Logistics and Transportation (CIRRELT), Montreal, Canada, hossein.hashemi@concordia.ca

Managing inventories of perishable items is a highly challenging task, mainly due to demand uncertainty, limited shelf life, and the multi-period nature of inventory control problems. In this work, we propose a two-stage robust optimization model that focuses on minimizing operational costs, as well as shortage and wastage. To solve the two-stage robust model, an effective and efficient column-and-constraint generation algorithm is proposed. Several computational experiments are conducted to show the performance of the developed algorithm.

TD4 Mathematical Modeling II

Salle: Gérard-Parizeau
Président: Soumis, Francois, Polytechnique Montréal

15h30 New Steiner travelling salesman problem formulation and its location extension

Rodríguez Pereira, Jessica, HEC Montréal, jessica.rodriguez@upc.edu
Fernandez, Elena, Universitat Politècnica de Catalunya, e.fernandez@upc.edu
Laporte, Gilbert, HEC Montréal, gilbert.laporte@cirrelt.ca
Benavent, Enrique, Universidad de Valencia , enrique.benavent@uv.es
Martinez-Sykora, Antonio, Southampton Business School, University of Southampton, United Kingdom,

In this work we present a new compact formulation with two-index variables and an exact branch-and-cut algorithm for the Steiner Traveling Salesman Problem (STSP). We also study its location extension (LSTSP). Computational results obtained confirm the good performance of the algorithms. Instances with up to 500 vertices are solved optimally.

15h55 A flexible natural formulation for the network design problem with vulnerability constraints

Arslan, Okan, HEC Montreal, okan.arslan@hec.ca
Jabali, Ola, Politecnico di Milano, ola.jabali@polimi.it
Laporte, Gilbert, HEC Montréal, gilbert.laporte@cirrelt.ca

Given a graph, a set of origin-destination (OD) pairs with communication requirements and an integer k, the network design problem with vulnerability constraints (NDPVC) is to identify a subgraph with the minimum total edge costs such that between each OD pair, there exist a hop-constrained primary path, and a hop-constrained backup path after any k-1 edges of the graph fail. We develop a natural formulation based on the notion of length-bounded cuts. Experimental results show that for single edge failures, our formulation increases the number of solved benchmark instances from 61% to over 95%. Our formulation also efficiently solves the NDPVC for multi-edge failures (k≥3).

16h20 On strengthening the RLT relaxations of mixed 0-1 polynomial programs

Djeumou Fomeni, Franklin, ESG-UQAM (CIRRELT), Franklin.DjeumouFomeni@cirrelt.ca
Kaparis, Konstantinos, Athens University of Economics and Business, k.kaparis@uom.edu.gr
Letchford, Adam, Lancaster University, a.n.letchford@lancaster.ac.uk

We present a procedure that generates strong cutting planes at any given relaxation level of the RLT hierarchy, by optimally weakening linear inequalities that are valid at any given higher RLT level. We also show that in some particular cases, the cutting planes are facets defining. Computational results will be discussed.

16h45 A comparison of different mathematical programming formulations for strategical cargo planification

Ouakil, Nabil, GERAD, ahmed-nabil.ouakil@polymtl.ca
Munroe, Patrick, GERAD - Polytechnique Montréal, patrick.munroe@gerad.ca
Soumis, François, Polytechnique Montréal, francois.soumis@gerad.ca

Cargo companies, just like any other company, are striving to do better and be more profitable. In order to do so, this continuous improvement has to include strategic decisions about evaluating and adapting the network, the company has to study the optimal shipment of the forcasted demand in the network for the following season. Given a set of demands to be transported from origins to destinations and a set of flights, the objective is to deliver the freight to destination through the network as efficiently as possible. However, operations are constrained by the physical characteristics of the infrastructure and the operational policies of the airports. To this end, we describe three different formulations of the problem and their implementations.

TD5 Risk Averse Decision Making

Salle: Hélène-Desmarais
Président: Delage, Erick, HEC Montréal

15h30 A Branch-and-Cut Approach for the Distributionally Robust Chance-Constrained Assignment Problem

Wang, Shanshan, Northwestern University and Beijing Institute of Technology, shshwang_bit@163.com
Li, Jinlin, Beijing Institute of Technology, jinlinli@bit.edu.cn
Sanjay, Mehrotra, Northwestern University, mehrotra@iems.northwestern.edu

We study a class of assignment problems with chance constraints that provide a probabilistic guarantee for bin capacity constraints, in which a set of items with random weights are assigned to the bins while minimizing the assignment cost. We firstly formulate chance-constrained assignment problem (CAP) as a 0-1 integer program with discrete distribution of random weights. We then extend (CAP) into distributionally robust chance-constrained assignment problem (DR-CAP), and robustify chance constraints by introducing a general family of ambiguity sets (e.g. moment matching set and Wasserstein set) with finite support. Moreover, we derive the bilinear integer reformulations for (CAP) and (DR-CAP) and propose two classes of valid inequalities. A Branch-and-Cut solution framework is proposed to solve (CAP) and (DR-CAP) respectively. An extensive study of surgery assignment problem using real data from a hospital is conducted.

15h55 Equal risk pricing under worst-case risk measure

Marzban, Saeed, HEC Montreal, saeed.marzban@hec.ca
Delage, Erick, GERAD, HEC Montréal, erick.delage@hec.ca
Li, Jonathan, University of Ottawa, jonathan.li@telfer.uottawa.ca

We study the equal risk framework in which the fair price of an option is the price that exposes both sides of a contract to the same level of risk. This framework takes into consideration both the perspective of the option writer and that of the buyer, which results in separate hedging strategies for each of them. In particular, we study the use of recursive risk measures by the option writer and the buyer for pricing and hedging options.

16h20 Probabilistic envelope constrained multiperiod stochastic EMS location model and decomposition scheme

Delage, Erick, HEC Montreal, Erick.delage@hec.ca
Li, Jinlin, Beijing Institute of Technology, jinlinli@bit.cn
Peng, Chun, HEC Montreal, chun.peng@hec.ca

This paper considers a multiperiod Emergency Medical Services (EMS) location problem and introduces two two-stage stochastic programming formulations that account for emergency demand uncertainty. While the first model considers both a constraint on the probability of covering the realized emergency demand and minimizing the expected cost of doing so, the second one employs probabilistic envelope constraints which allows us to the degradation of coverage under the more severe scenarios. These models give rise to large MIPs, which can be tackled by Branch-and-Benders-Cut method directly or using conservative approximation scheme. Finally, a practical study is conducted using historical data.

16h45 Adjustable robust optimization reformulations of two-stage worst-case regret minimization problems

Poursoltani, Mehran, GERAD, HEC Montréal, mehran.poursoltani@hec.ca
Zokaee, Shiva, GERAD, CIRRELT, Polytechnique Montréal, shiva.zokaee@polymtl.ca
Delage, Erick, GERAD, HEC Montréal, erick.delage@hec.ca

Within the context of optimization under uncertainty, a well-known alternative to minimizing expected value or the worst-case scenario, a.k.a. robust optimization, consists in minimizing regret. We demonstrate that two-stage worst-case regret minimization problems can be reformulated as two-stage robust optimization models. This empowers us to employ recent advanced approximate and exact solution schemes for these hard problems.

TD6 Black-Box Optimization

Salle: Marie-Husny
Président: Alarie, Stéphane, Institut de recherche d'Hydro-Québec

15h30 Nonlinear optimization with Artelys Knitro

Berge, Violette, Artelys Canada Inc., 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.

15h55 Deterministic maintenance scheduling for large stochastic systems using blackbox optimization and a decomposition method

Bittar, Thomas, EDF / Ecole des Ponts ParisTech, thomas.bittar@edf.fr

This work is motivated by the optimization of maintenance scheduling for components of hydroelectric power plants. We consider a system of several components (turbines, generators …) coupled by a common stock of spare parts and we seek the dates of preventive maintenance that minimize the expectation of the cost generated by the system. We use a decomposition method to tackle this high dimensional problem. The idea is to iteratively find the best maintenance policy on each component separately and then coordinate the components. The lower-dimensional subproblems on the individual components are solved using blackbox optimization.

16h20 An upper trust bound feasibility criterion for constrained Bayesian optimization.

Priem, Rémy, ONERA, DTIS, Université de Toulouse, Toulouse, France, remy.priem@onera.fr
Bartoli, Nathalie, ONERA, DTIS, Université de Toulouse, Toulouse, France, nathalie.bartoli@onera.fr
Diouane, Youssef, ISAE-SUPAERO, Université de Toulouse, Toulouse, 31055 Cedex 4, France, youssef.Diouane@isae-supaero.fr

In this talk, we propose to address efficiently black box constrained optimization problems. Our approach combines sequential enrichment and adaptive surrogate models by means of three ingredients: the Bayesian optimization framework, Gaussian process models of the constraints, and a feasibility criterion built using the uncertainty estimation of the constraints. / Constrained Bayesian optimization / Gaussian process / Global Optimization

16h45 Use of surrogate-based model search for parallel blackbox optimization

Alarie, Stéphane, Institut de recherche d'Hydro-Québec, alarie.stephane@ireq.ca
Talgorn, Bastien, Université McGill, bastientalgorn@yahoo.fr
Kokkolaras, Michael, McGill University, michael.kokkolaras@mcgill.ca

Blackbox problems are here solved with MADS on parallel computers. MADS generates $2n$ candidate solutions that can be simultaneously evaluated during the POLL step. The SEARCH step is however mostly sequential. Based on surrogates, proposition is made to also generate several candidates in the SEARCH. Results with NOMAD are presented. Blackbox Optimization ; Parallel Evaluations ; Surrogate-Based Models

TD7 Energy Management

Salle: Nancy et Michel-Gaucher
Président: Bastin, Fabian, Université de Montréal

15h30 La prévision de la demande pour la gestion du réseau électrique québécois: nouveaux enjeux et défis

Bazile, Rachel, Contrôle des Mouvements d'Énergie de la division TransÉnergie d'Hydro Québec, bazile.rachel@hydro.qc.ca
Milon, Olivier, TransEnergie, milon.olivier@hydro.qc.ca

Après un bref survol de l'approche paramétrique utilisée pour la prévision de la demande chez Hydro-Québec, cette présentation traitera de différentes avenues de développement actuellement à l'étude pour garantir des prévisions de qualité dans un contexte de transition énergétique et de contraintes de gestion plus importantes.

15h55 Profitability for power system planning

Guo, Cheng, University of Toronto, cguo@mie.utoronto.ca
Bodur, Merve, University of Toronto, bodur@mie.utoronto.ca

Power systems capacity expansion models have traditionally taken a centralized planner's perspective to find cost-optimal generation capacity to reliably meet load. Unfortunately, such models do not ensure individual generators are adequately remunerated. We present an expansion model that determines optimal generation/storage capacity investment decisions, while ensuring individual units achieve profitability.

16h20 Heating network optimal dimensioning

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

PLANHEAT is a collaborative research project aiming at developing an integrated simulation tool for heating and cooling systems. The final goal is to support local authorities in the selection, simulation and comparison of alternative low carbon and economically sustainable scenarios for district heating and cooling. Within this project, Artelys developed an algorithm to dimension a heating or cooling network, taking into account the optimal route given all the city's structural constraints. The techno-economic optimization considers both the investment cost and the operations cost.

16h45 Intelligent decision-making algorithm for energy storage systems.

Desage, Ysaël, DIRO, Université de Montréal, Ysael.Desage@me.com
Bastin, Fabian, DIRO, Université de Montréal, bastin@iro.umontreal.ca
Bouffard, François, Department of Electrical and Computer Engineering, McGill University, francois.bouffard@mcgill.ca

As the diversity and efficiency of energy resources continues to grow, the energy storage on a medium and large scale is one of the major challenges in today's energy sector. With this in mind, the present project aims to implement an intelligent decision-making policy based on dynamic stochastic programming and deep reinforcement learning. The goal is to optimize the behaviour of any agent with energy storage capacity, regardless of its nature, operating objective or technology. The changes resulting from the optimisation of the behaviour of all these agents will allow improvement in certain large-scale problems related to the production and distribution of energy on the electricity grid, a decrease in the individual bill for consumers, and also a direct benefit for the environment and sustainable development. Energy Storage; Smart Grid; Battery; Automated Learning; Reinforcement Learning; Stochastic Dynamic Programming.

TD8 Autonomous and Electric Vehicles

Salle: St-Hubert
Président: Mendoza, Jorge E., HEC Montréal

15h30 Model-predictive control of autonomous mobility-on-demand systems

Iglesias, Ramon, Stanford University, rdit@stanford.edu
Pavone, Marco, Stanford University, pavone@stanford.edu
Tsao, Matthew, Stanford University, mwtsao@stanford.edu
Rossi, Federico, NASA Jet Propulsion Lab, federico.rossi@jpl.nasa.gov

In this talk, we present a model-predictive control framework for Autonomous Mobility-on-Demand (AMoD) systems. The framework consists of a forecasting generative model and a stochastic optimization subproblem. We show via simulation that this approach vastly outperforms state-of-the-art fleet-level control algorithms and is more robust with respect to uncertain demand.

15h55 On the interaction between autonomous mobility-on-demand and the urban environment

Salazar, Mauro, Stanford University , samauro@stanford.edu
Solovey, Kiril, Stanford University, kirilsol@stanford.edu
Schiffer, Maximilian, TU München, schiffer@tum.de
Pavone, Marco, Stanford University, pavone@stanford.edu

This talk presents models and coordination policies for Autonomous Mobility-on-Demand (AMoD), wherein a fleet of self-driving vehicles provides on-demand mobility, potentially jointly with public transit. I will focus on the application of optimization methods to devise routing strategies for AMoD systems and assess their potential benefits.

16h20 Control of autonomous electric fleets for ridehail systems

Kullman, Nicholas, CIRRELT, nicholas.kullman@etu.univ-tours.fr
Cousineau, Martin, HEC, martin.cousineau@hec.ca
Goodson, Justin C., Saint Louis University, justin.goodson@slu.edu
Mendoza, Jorge E., CIRRELT, Jorge.Mendoza@cirrelt.ca

We consider a ridehail company operating a fleet of autonomous electric vehicles. The operator assigns vehicles to new requests and repositions/recharges vehicles in anticipation of future requests. We model the problem as an MDP, contrast solutions from deep reinforcement learning and approximate dynamic programming, and offer a dual bound.

16h45 Multi-period electric vehicle routing and charging scheduling problems

Echeverri, Laura C., LIFAT, laura.echeverriguzman@etu.univ-tours.fr
Froger, Aurélien, Inria, aurelien.froger@inria.fr
Mendoza, Jorge E., CIRRELT, Jorge.Mendoza@cirrelt.ca
Néron, Emmanuel, LIFAT, emmanuel.neron@univ-tours.fr

We consider a fleet of electric vehicles (EVs) that must serve customers over several days. EVs are charged at the depot, subject to the charging infrastructure constraints. We consider the effect of operational conditions on EV battery aging. We propose MILP formulations and a matheuristic approach to solve this problem. / Electric vehicle, battery degradation, mixed integer linear programming

TD9 Optimization, Statistics and Optimal Control

Salle: Dutailier International
Président: Forbes, James, McGill University

15h30 Estimation et test d'adéquation pour des modèles de copules à changement de régime, avec application

Thioub, Mamadou Yamar, HEC Montreal, mamadou-yamar.thioub@hec.ca

Dans cette présentation, j'exposerai différents aspects de la modélisation de la dépendance de séries temporelles univariées, par des modèles de copule avec changement de régime. Afin de faciliter l'utilisation des méthodologies, je présenterai les fonctionnalités de la librairie HMMcopula, qui a été développée pour ces modèles, et qui disponible sur CRAN. Test d'adéquation, séries temporelles, copules, modèles dynamiques

15h55 Multiscale Gaussian process regression for feature enhancement in laser-based bathymetric SLAM

Hitchcox, Thomas, McGill University, thomas.hitchcox@mail.mcgill.ca
Forbes, James Richard, McGill University, james.richard.forbes@mcgill.ca

This presentation will describe the application of Gaussian process regression to bathymetric SLAM, whereby two rounds of hyperparameter optimization are performed to extract and upsample keypoint sets from sparse laser scans of a subsea environment. Results from real data will be presented, including 3D scans of the Sweepstakes heritage shipwreck.

16h20 Synthesis of optimal yet robust controllers for negative imaginary systems

Lee, Ken, McGill University, ken.lee2@mail.mcgill.ca

There is an input-output stability theorem for a class of systems called negative imaginary. Such a system can be stabilized by strictly negative imaginary controllers. By exploiting the properties of negative imaginary systems, the optimal yet robust controller synthesis problem can be formulated as an optimization problem using linear matrix inequality constraints. robust control, optimal control, negative imaginary systems

16h45 System identification and optimal control of a fatigue testing rig for aircraft

Fortune, Robyn, McGill University - Graduate Student, robyn.fortune@mail.mcgill.ca
Forbes, James Richard, McGill University, james.richard.forbes@mcgill.ca

In this work, a technique called system identification was implemented in order to "identify" numerical models using data. The system ID methods involve a least-squares approach. They were applied to fatigue test rig data from the National Research Council. The resulting model was used to synthesize H-infinity-optimal controllers using linear matrix inequalities and convex optimization.

TD10 Coupling Operations Research and Machine Learning II

Salle: TD Assurance Meloche Monnex
Président: Carvalho, Margarida, Université Montréal

15h30 Non-parametric choice modeling with product-oriented market segmentation

Keshvari Fard, Milad, HEC Montréal, milad.keshvari-fard@hec.ca
Jena, Sanjay Dominik, Université de Montréal, sanjay.jena@cirrelt.ca
Charlin, Laurent, HEC Montréal, laurent.charlin@hec.ca

In this research we propose a non-parametric choice model to improve demand forecasting. Our algorithm first identifies the preference of different market segments for products, followed by computing ranking distributions over preference lists specific to each segment. Our results indicate a significant improvement in demand forecasting as well as computational efficiency over the state of art.

15h55 And-Or decision diagrams for multi-stage decision making under uncertainty

Babaki, Behrouz, Polytechnique Montreal, Behrouz.Babaki@polymtl.ca
Farnadi, Golnoosh, Polytechnique Montréal, golnoosh.farnadi@polymtl.ca
Pesant, Gilles, Polytechnique Montréal, gilles.pesant@polymtl.ca

Factored stochastic constraint programming (FSCP) is a formalism to represent multi-stage decision-making problems under uncertainty. On one hand, it relies on methods from constraint programming for making the decisions, and on the other hand, it uses principles from uncertainty reasoning to deal with a probabilistic environment. However, solving these problems is computationally challenging. FSCP problems often involve repeated subproblems which ideally should be solved once. In this work, we show how identifying and exploiting the identical subproblems can simplify solving the FSCP problems and leads to a compact representation of the solution.

16h20 Verifying individual fairness in machine learning

Farnadi, Golnoosh, Polytechnique Montréal, golnoosh.farnadi@polymtl.ca
Babaki, Behrouz, Polytechnique Montreal, Behrouz.Babaki@polymtl.ca
Pesant, Gilles, Polytechnique Montréal, gilles.pesant@polymtl.ca
Gendreau, Michel, Polytechnique Montréal, michel.gendreau@cirrelt.ca

Nowadays, machine learning tools are used in various decision making services and in domains that influence peoples' lives such as policing, employment, health care, and education. While many may assume that automation removes human bias from decision-making, it has been shown that bias can be part of the design of the algorithms or inherited from data that is used by the algorithm. Due to the large popularity and success of machine learning (ML) in various applications in recent years, in this paper we focus on verifying fairness in popular ML models. We propose an efficient and effective individual fairness verification approach based on MIP/CP formulation.

16h45 Social welfare on kidney transplantation

Carvalho, Margarida, Université de Montréal, m@margaridacarvalho.org

Andrea, Lodi, Polytechnique Montreal, andrea.lodi@polymtl.ca

Kidney exchange programs when modeled as non-cooperative games between different entities (hospitals, countries, regions) have proven to lead to social optimal outcomes. In this work, we discuss how the game outcome changes according with the data available about patients and donors.

TD11 Heuristics/Metaheuristics

Salle: TAL Gestion globale d'actifs inc.
Président: Camby, Eglantine, Université Libre de Bruxelles

15h30 A metaheuristic solution approach for large-scale stochastic mixed integer non-linear optimization of mineral value chains

Both, Christian, COSMO Stochastic Mine Planning Laboratory, McGill University, christian.both@mail.mcgill.ca
Dimitrakopoulos, Roussos, COSMO Stochastic Mine Planning Laboratory, Université McGill, roussos.dimitrakopoulos@mcgill.ca

An adaptive neighborhood search is presented for the non-linear stochastic optimization of mineral value chains, which typically requires a very large number of integer and continuous variables. Solutions obtained by the metaheuristic are compared to conventional packages when being applied on a real-world mining complex.

15h55 An infeasible start heuristic for the transit route network design problem

Oliker, Nurit, Postdoctoral fellow, Université de Montréal, nurit.oliker@umontreal.ca
Bekhor, Shlomo, Professor, Faculty of Civil and Environmental Engineering Technion - Israel Institute of Technology Haifa 32000, Israel, sbekhor@technion.ac.il

This study develops a heuristic model for the transit network design problem. The model includes a preliminary step of route set generation, followed by an iterative procedure that simultaneously selects the best routes and corresponding headways. Results show a significant reduction in the average travel time for a benchmark network.

16h20 Automatic combination of metaheuristic components

Parada, Victor, University of Santiago of Chile, victor.parada@usach.cl
Iturra, Sergio, University of Santiago of Chile,
Contreras-Bolton, Carlos, ,

The design of a heuristic algorithm to solve an optimization problem can also be seen as an optimization problem Such problem seeks to determine the best of the algorithms contained in the search space. The objective function corresponds to the computational performance of the algorithm measured in terms of computational time, complexity, number of instructions or number of elementary operations. The automatic design of algorithms has been explored for several combinatorial optimization problems. In this work, we extend this exploration towards the automatic design of metaheuristics to find solutions for the traveling salesman problem. The process is carried out with genetic programming. The resulting algorithms are combinations of well-known metaheuristics and in some cases present better computational performance than the existing algorithms for the set of selected test instances. Besides, from the algorithmic components selected it was possible to rediscover some of the existing metaheuristics.

16h45 VNS for solving the location of Phasor Measurement Units (PMU) and Wide Area Measurement Systems (WAMS) in transmission networks.

Camby, Eglantine, Université Libre de Bruxelles, ecamby@ulb.ac.be
Cruz, Marco, Laboratory of Telecommunications at Federal University of Espírito Santo, madrsc@yahoo.com

Rocha, Helder, Laboratory of Telecommunications at Federal University of Espírito Santo, helder.rocha@ufes.br
Paiva, Marcia, Laboratory of Telecommunications at Federal University of Espírito Santo, marcia.paiva@ufes.br
Segatto, Marcelo, Laboratory of Telecommunications at Federal University of Espírito Santo, segatto@ele.ufes.br
Caporossi, Gilles, HEC Montréal, gilles.caporossi@hec.ca

PMU were introduced in the 1990's: they are located on buses to bring accurate information on the network while WAMS make the connection between them. The main disadvantage of PMU is their cost. Accordingly, locating PMU in a tramission network became an optimisation problem. Here, we propose new algorithm based on the Variable Neighbourhood Search approach. Phasor Measurement Unit (PMU), Wide Area Measurement Systems (WAMS), Variable Neighbourhood Search, Communication infrastructure.

Mercredi 15 mai 2019 / Wednesday, May 15, 2019

WA1 Optimization in Julia

Salle: Banque CIBC
Président: Tanneau, Mathieu, Polytechnique Montréal

09h00 Stopping.jl : A framework to implement iterative optimization algorithms

Migot, Tangi, Univeristy of Guelph, tmigot@uoguelph.ca
Dussault, Jean-Pierre, Université de Sherbrooke, Jean-Pierre.Dussault@Usherbrooke.CA
Goyette, Samuel, Université de Sherbrooke, samuel.goyette@usherbrooke.ca

Due to the increasing need for sophisticated algorithms to solve optimization problems, the reusability of existing codes has become an important question for researchers and practitioners. In this talk, we present the Stopping package and initiate the discussion of an algorithmic framework for (iterative) optimization algorithms. Illustrations of this framework will include an active-set algorithm and a regularization-penalization-active set algorithm for MPCC.

09h25 A Julia module for polynomial optimization with complex variables applied to optimal power flow

Sliwak, Julie, RTE, julie.sliwak@rte-france.com
Anjos, Miguel F., GERAD, Polytechnique Montréal, miguel-f.anjos@polymtl.ca
Létocart, Lucas, LIPN, lucas.letocart@lipn.univ-paris13.fr
Maeght, Jean, RTE, jean.maeght@rte-france.com
Ruiz, Manuel, RTE, manuel.ruiz@rte-france.com
Traversi, Emiliano, LIPN, emiliano.traversi@lipn.univ-paris13.fr

There is currently no tool for polynomial optimization with complex variables, therefore such problems are usually directly converted to real variables. We propose a Julia module representing polynomial problems in complex variables. This module is applied to optimal power flow problems that naturally involve complex variables due to the alternating current.

09h50 Tulip.jl: An interior-point solver with abstract linear algebra

Tanneau, Mathieu, , mathieu.tanneau@polymtl.ca
Anjos, Miguel F., GERAD, Polytechnique Montréal, miguel-f.anjos@polymtl.ca
Lodi, Andrea, Polytechnique Montréal, andrea.lodi@polymtl.ca

Interior-point methods' remarkable performance stems from strong algorithmic foundations and efficient linear algebra. Motivated by structured linear programs that arise in decomposition methods, we develop a generic interior-point solver with abstract linear algebra. Computational results demonstrate that, combined with specialized factorization routines, our implementation outperforms state-of-the-art commercial solvers.

WA2 Networks

Salle: Demers Beaulne
Président: Pouya, Hamed, University of Toronto

09h00 Network models for multiobjective discrete optimization

Bergman, David, University of Connecticut, david.bergman@business.uconn.edu
Bodur, Merve, University of Toronto, bodur@mie.utoronto.ca
Cardonha, Carlos, IBM Research, carloscardonha@br.ibm.com
Cire, Andre Augusto, University of Toronto, acire@utsc.utoronto.ca

We propose a novel framework for solving multiobjective discrete optimization problems with an arbitrary number of objectives. We formulate these problems as network models, in that enumerating the Pareto frontier amounts to solving a multicriteria shortest path problem. Our proposed framework yields orders-of-magnitude performance improvements over existing state-of-the-art algorithms.

09h25 A nested column generation approach for the routing and spectrum assignment in flex-grid optical networks

Mohammed, Adham, Concordia University, adham.mohammed@concordia.ca
Jaumard, Brigitte, CIISE, Concordia University, bjaumard@ciise.concordia.ca

Efficient and scalable algorithms for solving the routing and spectrum assignment (RSA) problem in flex-grid optical networks are critical to maximize network efficiency. We propose a decomposition model and a nested column generation algorithm for solving the RSA problem. Numerical results are discussed on several data instances from the sndlib library.

09h50 No-disruption bandwidth recovery in optical networks

Pouya, Hamed, University of Toronto, h.pouya@utoronto.ca
Jaumard, Brigitte, CIISE, Concordia University, bjaumard@ciise.concordia.ca
Coudert, David, Université Côte d'Azur, david.coudert@inria.fr

Optical Software-Defined Networks provide flexible network operations while maintaining an efficient use of resources. We propose a no-disruption bandwidth recovery framework for fragmented optical networks based on Nested Column Generation technique. Experiments show that the defragmented provisioning is less than 2.5% away from the optimal provisioning for all test instances.

WA3 Humanitarian Operations Research

Salle: Gérard-Parizeau
Président: Keshvari Fard, Milad, HEC Montréal

09h00 Stochastic models for sealed reverse bid auction in humanitarian relief. A case study of the Colombian Red Cross

Cordeau, Jean-François, HEC Montreal, jean-francois.cordeau@hec
Rancourt, Marie-Eve, HEC Montréal, marie-eve.rancourt@hec.ca
Ortiz-Astorquiza, Camilo, Université de Montréal, camiloortiza@gmail.com
Guzmán-Cortés, Diana C., Universidad de La Sabana, dianaguzman.cortes@gmail.com
Guerrero, William J., Universidad de La Sabana, william.guerrero1@unisabana.edu.co

Humanitarian organizations need to guarantee relief aid procurement in case of disasters situations since the preparation phase. For achieving it, they can use procurement reverse auctions. This work is focused on the announcement construction and bid construction stages for a public call of the Colombian Red Cross, using stochastic programming.

09h25 Predictive models for food aid pre-positioning in humanitarian supply chains – A case study in South Sudan

Asaikar, Eeshaan, HEC Montréal, eeshaan.asaikar@hec.ca
Rancourt, Marie-Eve, HEC Montréal, marie-eve.rancourt@hec.ca
Bélanger, Valérie, CIRRELT, HEC Montréal, valerie.3.belanger@hec.ca

This research is based on a two-step approach to address food insecurity: 1) predictive modeling to estimate food-aid demand, 2) and inventory optimization to preposition supplies at strategic locations. This methodology is implemented and tested for the case of the World Food Programme's operations in South Sudan.

09h50 Budget management in international humanitarian organizations

Keshvari Fard, Milad, HEC Montréal, milad.keshvari-fard@hec.ca
Ljubic, Ivana, University of Vienna, ivana.ljubic@univie.ac.at
Papier, Felix, ESSEC Business School, papier@essec.edu

International Humanitarian Organizations (IHOs) run various missions and activities in several countries. Managing such large scale operations needs a meticulous planning regarding the missions to be done, the required skills and equipments, the target population, the human resources, etc., among other factors. Such decisions however, are tightly interconnected to the budget plans. Since the budget comes from donations, it is limited and its value is unknown beforehand, while a large part of it may be earmarked for specific countries or programs. The specific utility function of IHOs --which considers the social welfare of the beneficiaries as well as the fill rate of the planned missions--, renders budget management a challenging problem for IHOs. In this paper we model the problem as a two-stage decision process, where in the first stage the budget target for each national delegation is identified, and in the second stage, the optimal allocation of the non-earmarked budget among different countries is calculated. We then develop an efficient L-shaped algorithm as well as a fast heuristic to solve the problem. We use data from the International Committee of the Red Cross to extract our models' parameters, and conclude a number of interesting findings analytically and numerically. Our analysis indicates the importance of non-earmarked donations for the overall performance of IHOs. We also find out that putting a high pressure on IHO to fulfill the targeted missions (by donors, media, etc.) will result in a lower social welfare for beneficiaries. Finally our findings indicate that if donors allow the IHO to allocate the excessive earmarked donations to other delegations, the performance of IHO would improve significantly, and that the advantage of such scheme is increasing in the size of IHO.

WA4 Healthcare Optimization IV

Salle: Hélène-Desmarais
Président: Renaud, Marc-Andre, McGill University

09h00 CyberKnife radiation therapy treatment planning with column generation

Peyman, Kafaei, , peyman.kafaei@polymtl.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca
Chapados, Nicolas, Element AI, chapados@elementai.com

Stereotactic body radiation therapy (SBRS) is a non-surgical radiation therapy used to deliver precisely targeted radiation towards tumor in a patient's body. The main purpose of this work is to develop a mathematical programming model producing clinically accepted treatment plan which saves normal tissues. Column generation has proven to be useful for solving large-scale optimization problems in the field of Radiation Therapy, especially for Direct Aperture Optimization. We represent an algorithm based on Column Generation for CyberKnife delivery system, which finds the shape of the apertures by solving the sub-problems sequentially as well as the intensity of related radiation beams in the master problem.

09h25 Treatment planning in VMAT using column generation: comparing arc versus control-point based approaches

Dissler, Nina, Polytechnique Montreal, nina.dissler@polymtl.ca
Renaud, Marc-Andre, McGill University, marc-andre.renaud@mail.mcgill.ca
Lahrichi, Nadia, Polytechnique Montréal, nadia.lahrichi@polymtl.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca

VMAT is a sophisticated form of radiotherapy with a continuous rotation of the collimator around the patient. Optimisation methods are used to determine gantry speed, beam intensity and collimator leaf motions to target the tumor while avoiding surrounding sane tissues. Two approaches of column generation for the treatment planning problem are compared. On the one hand, generating beam aperture shapes in the pricing and then solving the master problem while ensuring that each aperture is compatible with the previous one. On the other hand optimizing simultaneously the gantry speed, dose intensity and leaf motions to generate arcs in the pricing

before solving the master problem. The problem is solved under technical constraints of the machine, while medical suggestions are taken into account in the objective functions. The treatment efficiency and computational time are compared between the two methods.

09h50 Robust mixed electron-photon radiation therapy treatment planning using the column generation method

Renaud, Marc-Andre, McGill University, marc-andre.renaud@mail.mcgill.ca
Serban, Monica, McGill University, monica.serban@mcgill.ca
Seuntjens, Jan, McGill University, jan.seuntjens@mcgill.ca

Mixed beam electron-photon radiation therapy (MBRT) is emerging as a potential technique to reduce radiation dose delivered to normal tissue without compromising target coverage for some superficial tumours. However, dose distributions delivered from charged particle beams are known to be non-robust to patient positioning errors. In this work, we develop a robust stochastic optimization model for MBRT planning based on the column generation method. The model is used to produce robust MBRT treatment plans for chest wall and soft tissue sarcoma treatment patients, and differences between robust and non-robust plans are analysed.

WA5 Derivative-Free Optimization I

Salle: Marie-Husny
Président: Le Digabel, Sebastien, Polytechnique Montréal

09h00 MADMS: Mesh adaptive direct multisearch for constrained blackbox multiobjective optimization

Salomon, Ludovic, Polytechnique Montréal, ludovic.salomon@gerad.ca
Le Digabel, Sebastien, Polytechnique Montréal, Sebastien.Le.Digabel@gerad.ca
Bigeon, Jean, Univ. Grenoble Alpes, CNRS, Grenoble INP, G-SCOP, F-38000 Grenoble, France, jean.bigeon@grenoble-inp.fr

The context of this work is derivative-free multiobjective optimization in the presence of two or more conflicting objective functions, considered as blackboxes for which no derivative information is available. A new extension of the Mesh Adaptive Direct Search (MADS) algorithm, called MADMS, is considered. This algorithm keeps a list of non-dominated points which converges to the Pareto front. As for the single-objective MADS algorithm, this method is built around an optional search step and a poll step. Under classical direct search assumptions, it is proved that this algorithm generates multiple subsequences of iterates which converge to local Pareto stationary points. Computational experiments show that this new approach is promising with respect to other state-of-the-art algorithms. derivative-free, multiobjective, direct search

09h25 Mesh-based constrained stochastic blackbox optimization using probabilistic estimates

Dzahini, Kwassi Joseph, Polytechnique Montréal, liljoseph92@yahoo.com
Audet, Charles, GERAD - Polytechnique Montréal, Charles.Audet@gerad.ca
Le Digabel, Sebastien, Polytechnique Montréal, Sebastien.Le.Digabel@gerad.ca

This work introduces STOMADS, a stochastic variant of the Mesh Adaptive Direct Search (MADS) algorithm designed for deterministic blackbox optimization. STOMADS considers the constrained optimization of an (unknown) objective function f whose values can only be computed with some random noise of an unknown distribution. The proposed algorithm uses an algorithmic concept similar to that of MADS and utilizes random estimates of true function values obtained from their stochastic observations to ensure improvements since the exact deterministic computable version of f is not available. Such estimates are required to be accurate with a sufficiently large but fixed probability and satisfy a certain variance condition. The ability of the proposed algorithm to generate an asymptotically dense set of search directions is then exploited to show that it converges to a Clarke stationary point with probability one, with the help of martingale theory.

09h50 **HYPERNOMAD: Hyper-parameter optimization of deep neural networks using mesh adaptive direct search**

Le Digabel, Sebastien, Polytechnique Montréal, Sebastien.Le.Digabel@gerad.ca
Lakhmiri, Dounia, Polytechnique Montréal, dounia.lakhmiri@gerad.ca
Tribes, Christophe, Polytechnique Montréal, christophe.tribes@polymtl.ca

The performance of deep neural networks is highly sensitive to the choice of the hyper-parameters that define the structure of the network and the learning process. When facing a new application, tuning a deep neural network is a tedious and time consuming process that is often described as a “dark art”. This work introduces the HYPERNOMAD package that applies the MADS derivative-free algorithm to solve this particular hyper-parameter optimization problem including the handling of categorical variables. This new approach is tested on the MNIST and CIFAR-10 datasets and achieves results comparable to the current state of the art.

WA6 Non-Linear Optimization Algorithms

Salle: Nancy et Michel-Gaucher
Président: Mestdagh, Guillaume, Polytechnique Montréal

09h00 **The conjugate residual method in linesearch and trust-region methods**

Dahito, Marie-Ange, École polytechnique, Palaiseau, marie-ange.dahito@polymtl.ca

Like the conjugate gradient method (CG), the conjugate residual method (CR) has desirable properties in linesearch and trust-region contexts for optimization. We investigate modifications that make CR suitable, even in the presence of negative curvature. CR performs as well as or better than CG, and yields savings in operator-vector products.

09h25 **Globalization of high order methods**

Goyette, Samuel, Université de Sherbrooke, samuel.goyette@polymtl.ca

We examine high-order optimization methods such as Chebyshev, Halley and Shamaanski's methods, which are extensions of Newton's method. We present a globalization of those methods based on a traditional trust-region scheme, and report convergence and numerical results.

09h50 **Scaled methods for computed tomography in cylindrical coordinates**

Mestdagh, Guillaume, Polytechnique Montréal, guillaume.mestdagh@gmail.com

Statistical X-ray computed tomography can lead to badly-scaled optimization problems with box constraints. We introduce modified versions of L-BFGS-B and TRON that use scaled directions to improve convergence without losing the simplicity of bound constraints. Results on simulated CT data are promising.

WA7 Primal Methods for Scheduling Problems

Salle: St-Hubert
Président: Quesnel, Frédéric, Polytechnique Montréal

09h00 **A large neighborhood search for multi-job shift scheduling of multi-skilled employees**

Attia, Dalia, PhD student, dalia.attia@polymtl.ca
Soumis, François, Polytechnique Montréal, francois.soumis@gerad.ca
Desaulniers, Guy, GERAD and Polytechnique Montreal, guy.desaulniers@gerad.ca

Multi-job shift scheduling of multi-skilled employees consists of finding schedules of employees with different skills, to fulfill the demand in employees for multiple jobs. This problem can be modelled and solved as a mathematical mixed integer problem. We propose a fast large

neighborhood search to solve the problem. For the LNS destroy procedure, we choose sub-scopes of job-day-employees causing high penalty on the cost function and remove the shift assignment of the employees in the selected sub-scopes. Then the repair procedure re-optimize the selected destroyed sub-scopes with the formal MIP. Preliminary results show good convergence for the metaheuristic.

09h25 Integral column generation for the set partitioning problems with side constraints

Tahir, Adil, , tadil.uh1@gmail.com
Desaulniers, Guy, GERAD and Polytechnique Montreal, guy.desaulniers@gerad.ca
Elhallaoui, Issmail, Associate Professor, Department of Mathematical and Industrial Engineering, Polytechnique Montreal, issmail.elhallaoui@polymtl.ca

We present a new version of integral column generation (ICG) heuristic that combines the integral simplex and column generation to solve set partitioning problems with side constraints and very large number of variables. ICG finds a sequence of integer solutions, with non-increasing cost, leading to high quality solutions in reasonable times. Computational experiments on instances of the airline crew pairing problem involving up to 1700 flights show that ICG clearly outperforms two popular column generation heuristics (the restricted master heuristic and the diving heuristic).

09h50 Integral column generation for a real-world rich vehicle routing problem : First application, challenges and issues

Messaoudi, Mayssoun, Polytechnique Montréal, Mayssoun.uster@gmail.com
El Hallaoui, Issmail, GERAD, Polytechnique Montréal, issmail.elhallaoui@gerad.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca

We present a real-life transportation problem arising in a third-party logistics (3PL) actor, who aims to optimize the last-mile delivery. Through this work, we present the first application of the primal-based approach to solve Rich Vehicle Routing Problems, namely the Integral Column Generation (ICG). The computational study, based on real instances reaching 199 customers, compare the ICG algorithm with a well-known column generation based Diving Heuristic (DH).

WA8 Applications III

Salle: Dutailier International
Président: Séguin, Sara, Université du Québec à Chicoutimi

09h00 Loading equipment planning considering optimization and simulation for the fulfillment of a production plan in open pit mining

Gonzalez, Hector, Universidad de Chile, hgonzalezriq@gmail.com
Morales, Nelson, Universidad de Chile, nelson.morales@amtc.cl
Manriquez, Fabian, Universidad de Chile, fmanriquez@ing.uchile.cl

Open pit mining is an equipment intensive process. By incorporating a simulation model together with an equipment assignment methodology, it was possible to capture the uncertainty of shovel-truck systems and achieve an adequate loading equipment allocation. This allows both minimizing operating costs and guaranteeing compliance with a production plan.

09h25 On-line car parking via 0-1 programming

Mladenovic, Marko, UPHF, marko.mladenovic@uphf.fr
Delot, Thierry, UPHF, thierry.delot@uphf.fr
Laporte, Gilbert, HEC Montréal, gilbert.laporte@cirrelt.ca
Wilbaut, Christophe, UPHF, christophe.wilbaut@uphf.fr

Cities suffer from high traffic congestion of which one of the main causes is the unorganized pursuit of available parking. We consider a general parking allocation scenario, in which the GPS data of a set of vehicles, such as current location and destination are available to a central agency, which will guide the vehicles toward a designated parking lot, instead to the entered destination.

In its natural form, the parking allocation problem is dynamic, i.e., its input is continuously updated. Therefore, standard static allocation, assignment, problems do not apply. In this paper, we solve several parking allocation policies through a 0-1 mathematical programming model with various degrees of dynamism. The proposed policies are empirically compared based on real data gathered from three European cities: Belgrade, Luxembourg, and Lyon.

09h50 Robotic process automation for financial services using integer programming

Séguin, Sara, UQAC, GERAD, sara.seguin@uqac.ca
Routhier, Guillaume, CGI, guillaume.routhier@cgi.com

Robotic Process Automation is used to automate repetitive tasks completed by humans on a computer. In the banking sector, millions of transactions are carried out every day and are constrained by market hours. We present a linear integer model to minimize the number of robots required to carry out the transactions, as well as their reconfigurations.

WA9 Mathematics and Graphs

Salle: TD Assurance Meloche Monnex
Président: Poggi, Marcus, Pontifícia Universidade Católica do Rio de Janeiro

09h00 Merging combinatorial design and optimization: The Oberwolfach problem

Salassa, Fabio, Politecnico di Torino, fabio.salassa@polito.it
Dragotto, Gabriele, Polytechnique Montreal, gabriele.dragotto@polymtl.ca
Traetta, Tommaso, Università di Brescia, tommaso.traetta@unibs.it
Buratti, Marco, Università degli Studi di Perugia, marco.buratti@unipg.it
Della Croce, Federico, Politecnico di Torino, federico.dellacroce@polito.it

The Oberwolfach Problem OP(F), posed by Gerhard Ringel in 1967, is a paradigmatic Combinatorial Design problem asking whether the complete graph K decomposes into edge disjoint copies of a 2-regular graph F of order v. In Combinatorial Design Theory, so-called difference methods represent a well-known solution technique and construct solutions in infinitely many cases exploiting symmetric and balanced structures. This approach reduces the problem to finding a well-structured 2-factor which allows us to build solutions that we call 1- or 2-rotational according to their symmetries. We tackle OP by modeling difference methods with Optimization tools, specifically Constraint Programming (CP) and Integer Programming (IP), and correspondingly solve instances with up to v=120 within 60s. In particular, we model the 2-rotational method by solving in cascade two subproblems, namely the binary and group labeling, respectively. A polynomial-time algorithm solves the binary labeling, while CP tackles the group labeling. Furthermore, we provide necessary conditions for the existence of some 1-rotational solutions which stem from computational results. This work shows thereby that both theoretical and empirical results may arise from the interaction between Combinatorial Design Theory and Operation Research.

09h25 A decomposition approach to solve the selective graph coloring problem in perfect graphs

Seker, Oylum, University of Toronto, oylum.seker@utoronto.ca
Ekim, Tinaz, Bogazici University, tinaz.ekim@boun.edu.tr
Taskin, Z. Caner, Bogazici University, caner.taskin@boun.edu.tr

We study the The Selective Graph Coloring Problem, and present a decomposition-based solution approach to solve the problem in perfect graphs. We conduct computational experiments and compare our results to those of an integer programming formulation and a state-of-the-art branch-and-price algorithm from the literature.

09h50 Dealing with outliers in process discovery

Poggi, Marcus, Pontifícia Universidade Católica do Rio de Janeiro, poggi@inf.puc-rio.br
Spyrides, Georges, PUC-RIo, gspyrides@inf.puc-rio.br

Lopes, Helio, PUC-Rio, lopes@inf.puc-rio.br

Business process can be represented by Petri nets. Given its event log(set of sequences of activities), one wants to find corresponding net. A MIP formulates this synthesis. We show, on Process Discovery Contest instances, allowing a percentage of not enforced sequences leads to nets with increased precision, simpler, keeping high fitness.

WA10 Facility Location

Salle: TAL Gestion globale d'actifs inc.
Président: Cherkesly, Marilène, Polytechnique Montréal

09h00 Heuristics for the dynamic facility location problem with modular capacities

Silva, Allyson, Université Laval, allyson.silva@cirrelt.ca
Aloise, Daniel, Polytechnique Montréal, daniel.aloise@polymtl.ca
Coelho, Leandro C., Université Laval, leandro.coelho@cirrelt.ca
Rocha, Caroline, Universidade Federal do Rio Grande do Norte, caroline.rocha@ect.ufrn.br

We study the Dynamic Facility Location Problem with Modular Capacities. A linear relaxation based heuristic (LRH) and a hybrid evolutionary heuristic using a genetic algorithm and a variable neighborhood descent (GA+VND) are proposed to solve it. Experiments are performed to compare their performance to a state-of-the-art mixed integer programming (MIP) formulation for the problem from the literature solved by CPLEX. For the existing benchmark instances, the solution generated by LRH improved by VND finds solutions within 0.03% of the optimal ones in less than half of the computation time of the state-of-the-art MIP. In order to yield a better representation of real-life scenarios, we introduce a new set of instances for which GA+VND proved to be an effective approach to solve the problem, outperforming both CPLEX and LRH methods.

09h25 A general covering location model including time-dependent and stochastic features

Marín, Alfredo, Universidad de Murcia,
Martínez-Merino, Luisa I., Concordia University, luisaisabel.mm@gmail.com
Rodríguez-Chía, Antonio M., University of Cádiz, antonio.rodriguezchia@uca.es
Saldanha-da-Gama, Francisco, Universidade de Lisboa, faconceicao@fc.ul.pt

This work presents a covering location problem including time-dependency and uncertainty. It generalizes most of the covering problems in the literature and its aim is to minimize the total expected operating cost ensuring that certain coverage constraints are satisfied. A formulation and a Lagrangian based heuristic are introduced.

09h50 The conditional p-dispersion problem

Cherkesly, Marilène, ESG UQÀM, cherkesly.marilene@uqam.ca
Contardo, Claudio, ESG UQÀM / GERAD, claudio.contardo@gerad.ca

We introduce the conditional p-dispersion problem, a variant of the p-dispersion problem, where initial facilities are given and p additional facilities need to be located to maximize the minimal distance between each pair of facilities. We propose an exact solution algorithm and conduct computational experiments to derive practical managerial insights.

MORSC 3rd anniversary

Salle: CPA du Québec
Président: Alameddine, Hyame, Concordia

10h45 Supply Chain Networks Against Time: From Food to Pharma

Nagurney, Anna, University of Massachusetts Amherst , nagurney@isenberg.umass.edu

Supply chains consist of networks of suppliers, manufacturers, transportation service providers, storage facilities and distributors, as well as retailers, and consumers. They serve as the critical infrastructure backbones for the provision of goods and services in our modern global economy. Supply chains have revolutionized the way in which products are sourced, produced, distributed, and consumed around the globe. They may involve thousands of stakeholders from suppliers and manufacturers to hundreds of thousands of demand points. Supply chains, however, are not just about complex manufactured products such as airplanes, automobiles, or computers. While many of the products of supply chains are durable goods that can be shipped and stored for a prolonged period prior to use, others are perishable -- from the food that we ingest, the medicines and vaccines that heal us and save lives, and, for the fashion-conscious -- the clothes that we wear. In this talk, I will overview our research that emphasizes multiple disciplines from engineering and operations research and management science to chemistry and physics, all with a unifying theme of supply chain networks, and associated perspectives, to model product deterioration over time and perishability. I will describe food supply chains, medical nuclear supply chains, electric power supply chains, and a case study in the pharmaceutical industry. I will also highlight recent results in supply chain quality competition. Free tickets available at: https://bit.ly/2Jfd3vY

WB1 Vehicle Routing V

Salle: Banque CIBC
Président: Renaud, Jacques, Université Laval, CIRRELT

10h45 Crowd-shipping with stochastic crowd drivers

Torres, Fabian, Polytechnique Montreal, fabian.torres@cirrelt.ca
Gendreau, Michel, Polytechnique Montréal, michel.gendreau@cirrelt.ca
Rei, Walter, Université du Québec à Montréal, walter.rei@cirrelt.ca

Crowd-shipping can provide the capacity needed to meet the growing demand of home deliveries in a cost-effective way. We consider a setting where delivery requests are fulfilled from a single depot by a fleet of Professional Vehicles (PV) and a pool of Stochastic Crowd Drivers (CD).

11h10 Compact routes for postal-VRPTW

Bretin, Alexis, Polytechnique Montréal, alexis.bretin@live.fr
Desaulniers, Guy, GERAD and Polytechnique Montreal, guy.desaulniers@gerad.ca
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca

We will present a Branch-and-Price-Based Large Neighborhood Search algorithm to solve the Vehicle Routing Problem with Time Windows that arises in postal services (parcel deliveries). Classic constraints and specific ones, such as minimum feeding curves of the sorting machines, have to be handled, as well as preferences for compact routes. Constraint Programming is used for pre-processing purpose.

11h35 Relaxations for pickup and delivery problems

Costa, Luciano, Polytechnique Montréal / GERAD, luciano.costa@gerad.ca
Contardo, Claudio, ESG UQÀM / GERAD, claudio.contardo@gerad.ca
Desaulniers, Guy, GERAD and Polytechnique Montreal, guy.desaulniers@gerad.ca

We propose a series of relaxation mechanisms aiming at reducing the computational burden arising from the handling of pairing and precedence constraints in pickup and delivery problems when solved by column generation. The relaxations are both at the master and subproblem levels. We provide computational evidence of the efficiency of the proposed mechanism.

12h00 The time-dependent shortest path and vehicle routing problem

Jaballah, Rabie, Université Laval, rabie.jaballah@cirrelt.ca
Veenstra, Marjolein, University of Groningen, mveenstramarjolein@gmail.com
Coelho, Leandro C., Université Laval, leandro.coelho@cirrelt.ca

Renaud, Jacques, Université Laval, CIRRELT, jacques.renaud@fsa.ulaval.ca

Many of today's logistics systems are based on variants of the well-known vehicle routing problem (VRP). In VRP one needs to answer a simple question: in which sequence should we visit a set of clients in order to minimize mainly the total distance. Advances in communications and real-time data acquisition technologies have made it possible to collect a huge amount of data on vehicles such as their driving speed and CO2 emission. This has led to what is known as the time-dependent VRP, in which the time (or cost) to move from one customer to another change depending on the starting time. In this work we integrate the time-dependent shortest path within the time-dependent VRP to create a more general and realistic problem called the time-dependent shortest path and vehicle routing problem (TDSPVRP). TDSPVRP effectively determines the path to take when visiting customers by considering both the real underlying street map and the real travel time to each them. We provide a mathematical formulation for the problem and also develop valid inequalities to strengthen this formulation which significantly improve the lower bounds. Given the size and difficulty of the problem, a heuristic based on the local search and simulated annealing is proposed. Finally, we provide a sensitivity analysis that highlights the importance of incorporating traffic in routing models and how ignoring traffic data can impose substantial delays.

WB2 Monte Carlo and Quasi-Monte Carlo Methods

Salle: Demers Beaulne
Président: L'Ecuyer, Pierre, Université de Montréal

10h45 Array-RQMC for option pricing under stochastic volatility models

Ben Abdellah, Amal, Diro, Université de Montréal, Canada, amal.ben.abdellah@umontreal.ca
L'Ecuyer, Pierre, Diro, Université de Montréal, Canada, lecuyer@iro.umontreal.ca
Puchhammer, Florian, Diro, Université de Montréal, Canada, florian.puchhammer@umontreal.ca

Problems from mathematical finance often consist in evaluating the expected value of some payoff function depending on quantities, such as stock prices, which satisfy stochastic differential equations driven by an underlying Brownian motion. The expectation can be expressed as a high-dimensional integral, with the dimension being the product of the number of Brownian motions and the number of time steps in the discretization. In this talk, we explore a different approach for RQMC simulation of Markov chains on a large number of steps, called Array-RQMC, which can help to improve the convergence rate, and significantly reduce the variance for a given computation budget. This method simulates $ n $ copies of the chain in parallel using a set of randomized RQMC point independently at each step, and sorts these copies using a specific sorting function after each step. We illustrate the large efficiency improvements on numerical examples for pricing option under a variance gamma process, and with Heston and Ornstein volatility model.

11h10 Variance reduction for chemical reaction networks with Array-RQMC

Puchhammer, Florian, Diro, Université de Montréal, Canada, florian.puchhammer@umontreal.ca
L'Ecuyer, Pierre, Université de Montréal, lecuyer@iro.umontreal.ca
Ben Abdellah, Amal, Diro, Université de Montréal, Canada, amal.ben.abdellah@umontreal.ca

Mathematical processes in molecular biology frequently rely on path simulation algorithms for discrete time Markov chains. For instance, the fixed step tau-leap method by Gillespie (2001), a modification of the Stochastic Simulation Algorithm or Gillespie Algorithm, can be used to study well-mixed chemically reacting systems. For the simulation of the sample paths, crude Monte Carlo (MC) is commonly seen as a viable approach, however, one might expect a smaller variance for more refined techniques. Very recently in 2018, Beentjes and Baker used randomized quasi-Monte Carlo (RQMC) for simulating chemical reaction networks with tau-leaping but the gain in terms of variance was limited. We examine the application of a different path simulation algorithm, Array-RQMC, to this problem, which has already proven to significantly outperform MC in many other applications. In the Array-RQMC algorithm, many chains are efficiently simulated in parallel,

however, the states need to be sorted after each step. Even though standard sorting procedures exist, they sometimes lack efficiency when the states are high-dimensional. In this talk we show empirically that combining Array-RQMC with tau-leaping for well-mixed chemical reaction networks can lead to a significantly faster convergence of the variance than MC. Moreover, we demonstrate that sorting with respect to a specific importance function of the states, which assigns to each state a real value, can outperform standard sorting procedures in this setting in terms of both efficiency and variance.

11h35 Problem-driven scenario generation in multistage stochastic optimization

Keutchayan, Julien, Polytechnique Montréal, j.keutchayan@gmail.com
Gendreau, Michel, Polytechnique Montréal, Michel.Gendreau@cirrelt.ca
Bastin, Fabian, Université de Montréal, bastin@iro.umontreal.ca

Multistage stochastic programming problems are characterized by a stochastic process (modeling the random parameters), an objective function (modeling the expected costs or rewards accumulated through time), and some feasible sets (constraining the decision variables). Due to their high complexity, they generally require an approximation step, done through scenario generation, that reduces their large dimension to a manageable size. Unlike most scenario generation methods, which focus exclusively on approximating the stochastic process, problem-driven ones aim at approximating the problem as a whole, i.e., by considering relevant features of the objective function and the constraints as well. In this presentation, we will develop a new problem-driven approach that extends the concept of worst-case error (initially developed for numerical integration methods like quasi-Monte Carlo) to a multistage stochastic programming setting. This leads to a new multistage measure, called the "figure of demerit", which can be used to generate scenario approximations better suited to problems, as the numerical experiments will demonstrate.

12h00 Monte Carlo and randomized Quasi-Monte Carlo density estimation by conditioning

L'Ecuyer, Pierre, Université de Montréal, lecuyer@iro.umontreal.ca
Puchhammer, Florian, Diro, Université de Montréal, Canada, florian.puchhammer@umontreal.ca
Ben Abdellah, Amal, Université de Montréal, Canada, amalbenabdellah@gmail.com

We are interested in estimating the density of a random variable X that can be sampled exactly by Monte Carlo (MC) simulation. The most standard approaches for this use either a histogram or a kernel density estimator. They give convergence rates for the mean integrated square error (MISE) that are slower than O(1/n), in terms of the same size n. We propose an approach that constructs a smooth estimator of the cumulative distribution function (cdf) and takes its sample derivative to estimate the density. One way to achieve the smoothing is via conditional Monte Carlo. We provide conditions under which the resulting density estimator is unbiased and the MISE converges as O(1/n). Moreover, combining this estimator with randomized quasi-Monte Carlo brings a much larger gain than for the standard density estimators, and makes the MISE convergence rate even faster than O(1/n).

WB3 Linear Algebra for Optimization

Salle: Gérard-Parizeau
Président: Montoison, Alexis, GERAD - Polytechnique Montréal

10h45 Some theory and algorithms for recovery of sparse integer-valued signals

Chang, Xiao-Wen, McGill University, chang@cs.mcgill.ca

In some applications the signal vector in a linear model is sparse and its entries are drawn from a finite alphabet following some distribution. We present some estimation theory and algorithms to recover the signal vector. Numerical examples are given to illustrate the effectiveness of the proposed algorithms.

11h10 The merits of keeping it smooth: Implementing a smooth exact penalty function for nonlinear programming

Estrin, Ron, Stanford University, restrin@stanford.edu

We develop a factorization-free algorithm for constrained optimization based on a penalty function proposed by Fletcher (1970). This penalty was historically considered computationally prohibitive. However, we develop and efficient approach to evaluate the penalty by solving structured linear systems. We demonstrate the merits of this approach on some PDE-constrained optimization problems.

11h35 Algorithm NCL for constrained optimization

Saunders, Michael, Stanford University, saunders@stanford.edu

We reimplement the LANCELOT augmented Lagrangian method as a short sequence of nonlinearly constrained subproblems that can be solved efficiently by IPOPT and KNITRO, with warm starts on each subproblem. NCL succeeds on degenerate tax policy models that can't be solved directly.

12h00 Minimizing convex quadratics with variable precision Krylov methods

Simon, Ehouarn, Université de Toulouse, INP, IRIT, ehouarn.simon@enseeiht.fr
Gratton, Serge, Université de Toulouse, INP, IRIT, serge.gratton@enseeiht.fr
Toint, Philippe L., University of Namur, philippe.toint@fundp.ac.be

Iterative algorithms for the solution of convex quadratic optimization problems are investigated, which exploit inaccurate matrix-vector products. Theoretical bounds on the performance of a Conjugate Gradients and a Full-Orthogonalization methods and new practical algorithms are derived. Numerical experiments suggest that these methods have significant potential, notably in the context of multi-precision computations.

WB4 Healthcare Optimization V

Salle: Hélène-Desmarais
Président: Raghavan, S. (Raghu), University of Maryland

10h45 Measuring the concordance of colon cancer patient pathways using inverse optimization

Timothy C.Y., Chan, University of Toronto, tcychan@mie.utoronto.ca
Shalaby, Yusuf, University of Toronto, yusuf.shalaby@mail.utoronto.ca
Yousefi, Nasrin, University of Toronto, nasrin.yousefi@mail.utoronto.ca

A sequence of activities that cancer patients should take as they go through the processes of diagnosis and treatment are called clinical pathways. However, many patients deviate from these clinical pathways. We develop a metric to measure the concordance of each patient’s pathway to the clinical pathways using an inverse optimization-based approach.

11h10 Operating theater weekly planning

Garaix, Thierry, École Nationale Supérieure des Mines de Saint-Étienne, garaix@emse.fr
Xie, Xiaolan, École des Mines de Saint-Étienne, xie@emse.fr
Bargetto, Roberto, École des Mines de Saint-Étienne, roberto.bargetto@emse.fr

In this research we propose a branch-and-cut-and-price algorithm able to solve a weekly operating theater planning problem. Surgeries of different specialties are selected from a waiting list. Operating rooms, surgeons and nurses define resource constraints. Our approach is compared againsIn this research we propose a branch-and-cut-and-price algorithm able to solve a weekly operating theater planning problem. Surgeries of different specialties are selected from a waiting list. Operating rooms, surgeons and nurses define resource constraints. Our approach is compared against state-of-the-art algorithm on 120 surgeries instances.

11h35 A mathematical model for blood collection planning using bloodmobile facilities and according to the logistic characteristics of blood

Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca
Desaulniers, Guy, GERAD - Polytechnique Montréal, Guy.Desaulniers@gerad.ca
Ghasemi, Elaheh, Polytechnique Montreal, ghasemi.egh@gmail.com

This study focuses on a real-life problem in the blood supply chain management. We propose a two-step routing model that aims at collecting enough blood units within the processing time limit while minimizing the distance traveled. To evaluate the performance of the proposed model several numerical examples are presented.

12h00 Fair liver transplant allocation: A scalable optimization model

Akshat, Shubham, University of Maryland, shubham_akshat@rhsmith.umd.edu
Gentry, Sommer, United States Naval Academy, gentry@usna.edu
Raghavan, S. (Raghu), University of Maryland, raghavan@umd.edu

U.S. Department of Health and Human Services is interested in increasing geographic equity in liver transplants. Organ supply to demand ratio is viewed as a good proxy for evaluating access to organs by patients on a waitlist by the transplant community. We assess the current state-of-affairs by comparing the organ supply to demand ratio at each transplant center. We then develop a nonlinear integer programming model that maximizes the minimum supply to demand ratio across all transplant centers. We discuss a variable transformation that enables linearization of this model. Our results indicate that the worst supply/demand ratio across transplant centers is improved upon significantly by our model. Further, the variation in this ratio across transplant centers is significantly reduced.

WB5 Derivative-Free Optimization II

Salle: Marie-Husny
Président: Audet, Charles, Polytechnique Montréal

10h45 Scaling of the output in mesh adaptive direct search

Audet, Charles, GERAD - Polytechnique Montréal, Charles.Audet@gerad.ca
Caporossi, Gilles, GERAD, HEC Montréal, gilles.caporossi@gerad.ca
Jacquet, Stéphane, Polytechnique Montréal, stephane.jacquet@gerad.ca

In blackbox optimisation algorithms, no derivatives are available and getting the output of the blackbox can take a lot of time. In 2006, Audet and Dennis proposed the algorithm MADS to solve blackbox problems with constraints. In 2016, dynamic scaling on mesh has been added to MADS to scale the input of the blackbox. Moreover, wrong scaling of the output of the blackbox can lead MADS to overestimate some constraints and converge to a local solution with a worse local optimum. This presentation compares three different scalings and the numerical results on analytical and blackbox problems.

11h10 Optimization of noisy blackbox with adaptive precision

Bouchet, Pierre-Yves, Polytechnique Montréal, pierre-yves.bouchet@polymtl.ca
Audet, Charles, GERAD - Polytechnique Montréal, Charles.Audet@gerad.ca

Blackbox optimization problems are sometimes affected by noisy objective function values where noise magnitude depends of computational intensity. The higher efforts are, the higher the statistical guarantees of precision are. This talk proposes a way to converge towards an optimal solution in controlled computation time, exploiting this tradeoff.

11h35 Estimation of the constraint violation function with binary, unrelaxable and hidden constraints in MADS.

Jacquet, Stéphane, , stephane.jacquet@gerad.ca
Audet, Charles, GERAD - Polytechnique Montréal, Charles.Audet@gerad.ca

Caporossi, Gilles, GERAD, HEC Montréal, gilles.caporossi@gerad.ca

In some industrial problems, no analytical expressions of the functions are available. The output of the function come from a blackbox, which can be either an experiment in a laboratory or from computer simulations. In 2006, Audet and Dennis proposed the algorithm MADS to solve blackbox problems with constraints. At first, the extrem barrier was used to handle the constraints by rejecting all the infeasible elements. Since, more flexible methods have been made to handle them. However, the extrem barrier is still the approach used for binary, unrelaxable and hidden constraints. This presentation suggests a way to handle this constraints in MADS by giving a dynamic surrogate of binary constraints calculated through regression models that come from supervised classification. Numerical results will show the improvements on blackbox problems.

12h00 Dynamic improvements of static surrogates in direct search optimization

Côté-Massicotte, Julien, Polytechnique Montréal, juliencotemassicotte@hotmail.fr
Audet, Charles, GERAD - Polytechnique Montréal, Charles.Audet@gerad.ca

The present work involves direct search algorithms guided by surrogate models. These models are classified into two categories: static surrogates and dynamic models. We introduce the hybrid quadratic model that dynamically corrects information from a static surrogate.

WB6 Energy Policy and Pricing

Salle: Nancy et Michel-Gaucher
Président: Kuznetsova, Elizaveta, Polytechnique Montréal

10h45 Optimization-based time-and-level-of-use price setting for an energy retailer

Gomez, Juan, Polytechnique Montréal, juan.gomez@polymtl.ca
Anjos, Miguel F., GERAD, Polytechnique Montréal, miguel-f.anjos@polymtl.ca
Brotcorne, Luce, INRIA Lille, luce.brotcorne@inria.fr

In our framework a retailer wants to determine the optimal Time-and-Level-of-Use tariffs (TLOU) to sell energy to a population of smart homes. TLOU is an energy price structure where the prices vary depending on the time and the level of consumption. This problem is formulated as a bilevel optimization problem. Demand-Response, Price-Setting, Bilevel Optimization

11h10 Strategic bidding for demand response aggregators: An inverse optimization approach

Awadalla, Mohamed, , mohamed.awadalla@mail.mcgill.ca
Bouffard, François, Professor, francois.bouffard@mcgill.ca

Abstract This paper presents optimal pricing design for Demand response in electricity market. The problem is formulated as a linear inverse optimization by an aggregator. Demand flexibility has been quantified and presumed to be the solution for the forward problem. The goal is to find the inversely optimal price signals to maximize the aggregator’s profit.

11h35 The Canadian contribution to limiting global warming below 2 degrees: Insights from NATEM

Bahn, Olivier, HEC Montréal, olivier.bahn@hec.ca
Vaillancourt, Kathleen, ESMIA Consultants, kathleen@esmia.ca
Sigvaldason, Oskar, SCMS Global, oskar@sigvaldason.com

This presentation identifies different decarbonization pathways that would allow Canada to participate in a global mitigation effort to prevent climate changes. We analyse four GHG mitigation scenarios with increasing levels of mitigation efforts for 2050 using the NATEM regional optimization model. The main transformations in the energy system include significant energy conservation and efficiency improvements, greater penetration of electricity in all end-use sectors (up to 64% of total consumption in 2050), as well as an important increased use of bioenergy in

2050. On the supply side, this translates into a rapid decarbonization of electricity production and a shift away from fossil fuel production and imports. Canadian energy systems; Decarbonization pathways; GHG emissions; TIMES modelling

12h00 Challenges in energy policies for the economic integration of prosumers in electric energy systems

Kuznetsova, Elizaveta, Polytechnique Montréal, kuznetsova.elizaveta@gmail.com
Anjos, Miguel F., Polytechnique Montréal, miguel-f.anjos@polymtl.ca

The accessibility and reducing cost of distributed renewable energy sources are stimulating the emergence of small-scale residential prosumers who can produce and consume electricity. Such prosumers may increase the uncertainty of consumption behavior, reduce consumption from the grid, and eventually disconnect from the grid. However, they may remain connected, and their energy potential can provide flexibility for the overall system. We present an analysis of energy policies promoting disconnection and propose a reconsideration of current schemes for the economic integration of prosumers in the energy system. Small-scale prosumer, renewable energy source, energy policy, electricity bill, energy and power charges, grid fees, feed-in-tariff

WB7 Decision Support Systems for Natural Resources Value Chains Operations Planning Optimization

Salle: St-Hubert
Président: Amazouz, Mouloud, NRCan

10h45 Designing a cellular hybrid manufacturing-remanufacturing system considering alternative process routings and contingency process routings

Hooshyar Telegraphi, Amirreza, PhD Candidate, amirrezatelegraph@gmail.com
Bulgak, Akif, Université Concordia, bulgak@encs.concordia.ca
Gendreau, Michel, Polytechnique Montréal, Michel.Gendreau@cirrelt.ca

In manufacturing systems, sustainability may be defined as producing products that use processes having less negative environmental impacts, safe for employees, and economically sound [1]. However, there has not been a universal definition for sustainable manufacturing systems up to now. For sustainable manufacturing systems, resorting to cellular manufacturing systems and reconfigurable manufacturing systems is highly recommended. In designing sustainable manufacturing systems, hybrid manufacturing-remanufacturing systems can also be applied because of their social, economic and environmental effects. In this talk, we present a mixed integer programming model for production planning problems and cell formation problems of an integrated reconfigurable cellular hybrid manufacturing-remanufacturing system featuring alternative process routings and contingency process routings. In the proposed model, machines have different capacities, capabilities, and availabilities. This implies that a part can have alternative process routings which yield many different and feasible cellular configurations. Such contingency process routings also enhance the flexibility issues in designing cellular manufacturing systems. Hence, re-routings of parts can be planned in the back-up process routings to prevent any interruptions in production contingent upon having any unavailability of machines in the main process routings. A numerical example is presented to illustrate the proposed mathematical model.

11h10 Reinforcement learning for forest value chain optimization

Ragab, Ahmed, Polytechnique Montreal, ahmed.ragab@polymtl.ca
lakhdhar, Ichrak, Natural Resources Canada (NRCan), ichrak.lakhdhar@canada.ca
Amazouz, Mouloud, Natural Resources Canada (NRCan), mouloud.amazouz@canada.ca

Forest value chain optimization (FVCO) represents a dynamic stochastic problem. A big challenge is to select the appropriate technique that finds the optimal actions in a huge number of states. Reinforcement learning can be a promising artificial intelligence (AI) technique used for that purpose.

11h35 Data-driven optimization of industrial process operations

Aubé, François, CanmetÉnergie, francois.aube@canada.ca
Amazouz, Mouloud, Natural Resources Canada (NRCan), mouloud.amazouz@canada.ca

Many industrial process control systems are partly adjusted by operators when unexpected events occur such as sudden decline in performance, quality, and change in regime or operating mode. Such duty is difficult due to the complexity of such processes. A machine learning approach is proposed to support operators in their decision making process to better handle such events and ensure real-time optimal operation.

12h00 Open big data and AI platform for efficient and sustainable natural resources operations

Amazouz, Mouloud, Natural Resources Canada (NRCan), mouloud.amazouz@canada.ca

Making environmentally, economically and socially sound and efficient decisions for natural resource management and exploitation has become increasingly difficult. Natural resource sectors stakeholders have access to too much raw data, too many decisions to make, and too little time to do any of it. In addition, the objectives are changing and the diversity of needs is growing. Only computer decision aids can help sort and process large amounts of data (Big data) and expand the ability to make good decisions in the face of these constraints. Artificial intelligence (AI) technology allows inclusion of knowledge processing in the decision support environment. AI and Big Data have started making major changes in the business world, as companies are utilizing the power of data analytics to affect positively their bottom line, resulting in increased productivity and revenues. Unfortunately, such changes are slow to come in the natural resource sectors – the forestry, mining, agriculture sectors, to name a few –, where most of the data collected today are not used, and the data that are used, not fully exploited. Despite the advances in technologies such as IoT, sensors, terrestrial Lidar, Aerial Lidar, Satellite Imaging and Drone based imaging that produce large amounts of data, and machine learning algorithms, the forest sector stakeholders are still struggling to make the right decisions. This is due to the unavailability of powerful decision support tools. Such tools should be able to automatically collect, integrate, prepare and process scattered Big data sets from different heterogeneous, structured and unstructured sources. In fact, foresters need to have easy access to data products to take the right decisions not raw data and generic commercial AI platforms. The main objective of the project, which will be presented in this talk, is to develop an open Big data and artificial intelligence (AI) platform for efficient and responsible development and use of Canada's Natural Resources. With a focus on multi-objective value chain optimization (VCO), the vision is to improve decision-making processes at the strategic, tactical and operations planning levels starting with the forest sector, in close collaboration with the Canadian Wood Fiber centre (CWFS).

WB8 Operations Research in Forestry

Salle: Dutailier International
Président: Rönnqvist, Mikael, Université Laval

10h45 Toward eco-efficiency while designing reverse logistics networks: The recycled wood case study

Trochu, Julien, ETS, julien.trochu.1@ens.etsmtl.ca
Chaabane, Amin, ETS, amin.chaabane@etsmtl.ca
Ouhimmou, Mustapha, ETS, mustapha.ouhimmou@etsmtl.ca

In this work, we present a reverse logistics network planning model that optimizes the wood recycling from the CRD industry. While aiming at maximizing the profit, our model also targets GHG emissions control and landfilling limitations to ensure the eco-efficiency of the recycling network. Reverse logistics, network design, optimization model, wood recycling, environmental considerations.

11h10 A two-stage stochastic model for production planning in sawmills

Simard, Vanessa, Université Laval, vanessa.simard.4@ulaval.ca
Rönnqvist, Mikael, Université Laval, mikael.ronnqvist@gmc.ulaval.ca
LeBel, Luc, Université Laval, luc.lebel@sbf.ulaval.ca
Lehoux, Nadia, Université Laval, nadia.lehoux@gmc.ulaval.ca

Sawmill activities are subject to supply uncertainty coming from uncontrollable forest yield. Because the availability of the resource is uncertain, the validity of production plans must be constantly verified to avoid stock shortage. We evaluate the potential improvement when using a multistage stochastic approach to plan production instead of a deterministic approach.

11h35 Analyzing the impact of implementing a logistics center for a complex forest network

Sarrazin, François, Université Laval, francois.sarrazin@forac.ulaval.ca
Lebel, Luc, Université Laval, Luc.Lebel@sbf.ulaval.ca
Lehoux, Nadia, Université Laval, nadia.lehoux@gmc.ulaval.ca

This paper analyses the interaction of a forest logistics center with its surrounding network. A profit maximization model is proposed and applied to case study. Results show that a logistics center could add up to $ 0.90 in profits per cubic metre of wood available for harvest for the network.

12h00 Network design of trails for harvesters and forwarders on harvest areas in order to reduce soil damage and improve efficiency

Rönnqvist, Mikael, Université Laval, mikael.ronnqvist@gmc.ulaval.ca
Flisberg, Patrik, Creative Optimization, patrik@creativeoptimization.se
Erik, Willén, Forestry Research Institute of Sweden, erik.willen@skogforsk.se

Avoiding soil damage after harvest and forwarding operations is very important. There are often contractual agreements to avoid damage and in the case it happens, there are often different forms of extra costs and penalties. In order to make a qualitative planning, there is a need of detailed information. The basic information is often provided by airborne laser scanning. This provides detail information on geometry, number of trees, their size and assortments. Another important aspect is so-called depth-to-water maps. The presence of water impacts the vulnerability of the soil against the machine systems. Information on the road system, location of round-wood piles, historical sites and areas selected for preservation is also necessary. With the information described, it is possible to make a pre-plan for the harvesters. However, it is also important to visit and inspect the harvest area in more detail. Often it turns out that some information is not correct and need to be revised. In order to make this re-planning onsite, it is necessary to have a system that can change this GIS information and to make re-optimization fast. In this presentation, we describe such a system developed for use in Sweden. Different versions have been tested and we describe the results and experiences using them at a set of harvest areas for two larger Swedish forest companies. The problem is a very large scale network design and we describe solution methods that guarantee fast solution times.

WB9 Coupling Operations Research and Machine Learning III

Salle: TD Assurance Meloche Monnex
Président: Frejinger, Emma, Université de Montréal

10h45 Machine learning for combinatorial optimization

Prouvost, Antoine, Polytechnique Montréal, antoine.prouvost@polymtl.ca
Bengio, Yoshua, Mila, UdeM, yoshua.bengio@mila.quebec
Andrea, Lodi, Polytechnique Montreal, andrea.lodi@polymtl.ca

Studying the optimal decisions of real-world (combinatorial) optimization problems (a field known as Operations Research) can lead to dramatic improvements and savings (with respect to non-optimal or informal ones). Given the hard nature of these problems, state-of-the-art methodologies

involve algorithmic decisions that either require too much computing time or are not mathematically well understood. Thus, machine learning looks like a promising candidate to effectively deal with those decisions. We draw inspiration from previous literature to derive a methodology that integrates machine learning in the framework of combinatorial optimization algorithms. We interpret optimization problems as data points for a specific distribution of instances and see how we can learn parts of the algorithm used to solve them. Under the machine learning methodology, we discuss what can and cannot be expected from learned algorithms.

11h10 Improving optimization bounds using machine learning: Decision diagrams meet deep reinforcement learning

Cappart, Quentin, Cirrelt, quentin.cappart@uclouvain.be
Goutierre, Emmanuel, Ecole Polytechnique, emmanuel.goutierre@polytechnique.edu
Bergman, David, University of Connecticut, david.bergman@uconn.edu
Rousseau, Louis-Martin, Polytechnique Montréal, louis-martin.rousseau@polymtl.ca

Finding tight bounds on the optimal solution is a critical element of practical solution methods for discrete optimization problems. In the last decade, decision diagrams (DDs) have brought a new perspective on obtaining upper and lower bounds that can be significantly better than classical bounding mechanisms, such as linear relaxations. It is well known that the quality of the bounds achieved through this flexible bounding method is highly reliant on the ordering of variables chosen for building the diagram, and finding an ordering that optimizes standard metrics is an NP-hard problem. In this paper, we propose an innovative and generic approach based on deep reinforcement learning for obtaining an ordering for tightening the bounds obtained with relaxed and restricted DDs. We apply the approach to both the Maximum Independent Set Problem and the Maximum Cut Problem. Experimental results on synthetic instances show that the deep reinforcement learning approach, by achieving tighter objective function bounds, generally outperforms ordering methods commonly used in the literature when the distribution of instances is known. To the best knowledge of the authors, this is the first paper to apply machine learning to directly improve relaxation bounds obtained by general-purpose bounding mechanisms for combinatorial optimization problems.

11h35 A deep reinforcement learning model for the single container loading problem

Yakin, Hajlaoui, Polytechnique Montréal, ENIT, yakin.hajlaoui@hotmail.com
Safa, Bhar Layeb, UR-OASIS, National Engineering School of Tunis, University of Tunis El Manar, Tunis, Tunisia , safa.layeb@enit.utm.tn
Jaoua, Amel, Université de Montréal, amel.jaoua@umontreal.ca
Gamache, Michel, Polytechnique Montréal, michel.gamache@polymtl.ca

In this work, we investigate the capability of the Deep Reinforcement Learning in solving the Single Container Loading Problem. The objective is to measure the effectiveness of this algorithmic approach in solving such NP-hard combinatorial optimization problem. Preliminary computational results on benchmark instances reveal the good performance of the proposed model.

12h00 A language processing algorithm for predicting tactical solutions to operational planning problems under uncertainty

Larsen, Eric, DIRO, Université de Montréal, eric.larsen@cirrelt.ca
Frejinger, Emma, DIRO and CIRRELT, emma.frejinger@cirrelt.ca

We address the fast prediction of tactical solutions (output) to operational problems (input), focusing on train load planning. We extend Larsen et al. 2018 (arXiv:1807.11876) by predicting more detailed, variable-length solutions. The machine learning model originates from language processing and we construct vocabularies and syntaxes describing the problem instances and solutions. Extensive numerical results demonstrate excellent predictive accuracy.

WB10 Operations Research and Computer Science in Transportation, Mobility and Logistics

Salle: TAL Gestion globale d'actifs inc.
Président: Gendron, Bernard, Université de Montréal

10h45 Parallel machine scheduling with periodic maintenance, job rejection and weighted sum of completion times

Krim, Hanane, Université Polytechnique Hauts-de-France, Hanane.Krim@uphf.fr
Benmansour, Rachid, INSEA, r.benmansour@insea.ac.ma
Duvivier, David, Université Polytechnique Hauts-de-France, David.Duvivier@uphf.fr
Potvin, Jean-Yves, Université de Montréal, potvin@iro.umontreal.ca
Zufferey, Nicolas, Geneva School of Economics and Management, N.Zufferey@unige.ch

We consider a bi-objective scheduling problem on two parallel, non identical machines with a periodic preventive maintenance policy. The two objectives involve minimization of job rejection costs and weighted sum of completion times. Two metaheuristics based on tabu search are proposed to solve this problem. Computational results on test instances of different sizes are reported.

11h10 Decision-aiding approach to embed persons with disability to public transport

Doric, Danijela, Université de Polytechnique Hauts-de-France (UPHF), LAMIH UMR CNRS 8201, danijela.doric@uphf.fr
Cimon, Yan, Université Laval, Faculté des sciences de l'administration, CIRRELT, , yan.cimon@cirrelt.ca
Crevits, Igor, Université de Polytechnique Hauts-de-France (UPHF), LAMIH UMR CNRS 8201, igor.crevits@uphf.fr
Hanafi, Saïd, Université de Polytechnique Hauts-de-France (UPHF), LAMIH UMR CNRS 8201, said.hanafi@uphf.fr

We focus on the decision-aiding approach to imbed of disabled persons to public transport, with the goal to provide full independence in their displacement. We propose to frame the transport chain depending on the information of the network in order to the meet needs and remove barriers for the disabled persons.

11h35 Variable neighborhood search for the set union knapsack problem

Gendron, Bernard, Université de Montréal, CIRRELT, bernard.gendron@cirrelt.ca
Hanafi, Saïd, Université de Polytechnique Hauts-de-France (UPHF), LAMIH UMR CNRS 8201, said.hanafi@uphf.fr
Todosijevic, Raca, LAMIH, Université de Valenciennes et du Hainaut- Cambrésis, raca.todosijevic@univ-valenciennes.fr

The set-union knapsack problem (SUKP) is a generalization of knapsack problem where an item corresponds to a set of elements. SUKP has various applications including information security systems. We propose a variable neighborhood search for the SUKP and the computational results on a set of benchmark instances show its efficiency.

12h00 Efficient matheuristics for multicommodity capacitated network design

Gendron, Bernard, Université de Montréal, CIRRELT, bernard.gendron@cirrelt.ca
Hanafi, Saïd, Université de Polytechnique Hauts-de-France (UPHF), LAMIH UMR CNRS 8201, said.hanafi@uphf.fr
Todosijevic, Raca, LAMIH, Université de Valenciennes et du Hainaut- Cambrésis, raca.todosijevic@univ-valenciennes.fr

We present matheuristics for the multicommodity capacitated fixed-charge network design problem (MCND). The matheuristics are based on combining iterative linear programming (ILP) methods and slope scaling (SS) heuristics. Each iteration alternates between solving a linear

program obtained by adding pseudo-cuts and a restricted mixed-integer programming (MIP) model. The SS heuristic is used as a warm start to a state-of-the-art generic method that solves the restricted MIP model. The resulting ILP/SS matheuristics are compared against state-of-the-art heuristics for the MCND on a set of large-scale difficult instances.