Activity Report 2017

Team INOCS

Integrated Optimization with Complex Structure

Inria teams are typically groups of researchers working on the definition of a common project, and objectives, with the goal to arrive at the creation of a project-team. Such project-teams may include other partners (universities or research institutions).

RESEARCH CENTER
Lille - Nord Europe

THEME
Optimization, machine learning and statistical methods

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Team INOCS

Creation of the Team: 2015 May 01

Keywords:

Computer Science and Digital Science:

A6. - Modeling, simulation and control
A6.1. - Mathematical Modeling
A6.2. - Scientific Computing, Numerical Analysis & Optimization
A6.2.3. - Probabilistic methods
A6.2.6. - Optimization
A9.6. - Decision support

Other Research Topics and Application Domains:

B4. - Energy
B4.3. - Renewable energy production
B4.4. - Energy delivery
B4.5. - Energy consumption
B6. - IT and telecom
B6.3.2. - Network protocols
B7. - Transport and logistics
B7.1. - Traffic management
B7.1.2. - Road traffic
B8.1. - Smart building/home
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B8.2. - Connected city
B8.4. - Security and personal assistance

1. Personnel

Research Scientists

Miguel Anjos [Inria, Advanced Research Position, from May 2017]
Luce Brotcorne [Team leader, Inria, Researcher, HDR]
Markus Sinnl [Inria, Researcher, from Oct 2017]

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Diego Cattaruzza [Ecole centrale de Lille, Associate Professor]
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Martine Labbé [Université libre de Bruxelles, Professor]
Maxime Ogier [Ecole centrale de Lille, Associate Professor]
Frédéric Semet [Ecole centrale de Lille, Professor]

Post-Doctoral Fellows

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Sebastien Michel [Inria, from Jun 2017 until Sep 2017]
Luis Salazar Zendeja [Inria, from Apr 2017 until Aug 2017]

Visiting Scientists

Claudio Arbib [Università degli Studi dell'Aquila, Feb 2017]
Victor Bucarey [Universidad de Chile, Dec 2017]
Paula Carroll [Centre for Business Analytics, School of Business, University College Dublin, Sep 2017]
Sebastián Dávila [Universidad de Chile, Dec 2017]
Anton Kleywegt [Georgia Institue of Technology, from Jun 2017 until Jul 2017]
Marina Leal [Universidad de Sevilla, from June until Oct 2017]
Paulo Macedo [Universidade Federal do Ceará, from Mar 2017 until Jul 2017]
Vladimir Marianov [Pontificia Universidad Católica de Chile, from Nov until Dec 2017]
Alfredo Marín [Universidad de Murcia, Oct 2017]
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Mercedes Pelegrin Garcia [Universidad de Murcia, from Sep 2017 until Dec 2017]

2. Overall Objectives

2.1. Introduction

INOCS is a cross-border "France-Belgium" project team in the Applied Mathematics Computation and Simulation Inria domain. The main goal of this team is the study of optimization problems involving complex structures. The scientific objectives of INOCS are related to modeling and methodological concerns. The INOCS team will focus on:

1. integrated models for problems with complex structure (CS) taking into account the whole structure of the problem;
2. on the development of solution methods taking explicitly into account *the nature and the structure of the decisions as well as the properties of the problem*.

Even if CS problems are in general NP-hard due to their complex nature, exact solution methods or matheuristics (heuristics based on exact optimization methods) will be developed by INOCS. The scientific contribution of INOCS will result in a toolbox of models and methods to solve challenging real life problems.

2.2. Schedule of tasks

The research program development of INOCS is to move alternatively:

- *from problems towards new approaches in optimization*: Models and solution algorithms will be developed to fit the structure and properties of the problem. From them, new generic approaches will be used to optimize problems with similar properties.
- *from innovative approaches towards problems*: The relevance of the proposed approaches will be assessed by designing new models and/or solution methods for various classes of problems. These models and methods will be based on the extension and integration of specific, well studied, models and methods.

Even if these two axes are developed sequentially in a first phase, their interactions will lead us to explore them jointly in the mid-term.

3. Research Program

3.1. Introduction

An optimization problem consists in finding a best solution from a set of feasible solutions. Such a problem can be typically modeled as a mathematical program in which decision variables must

1. satisfy a set of constraints that translate the feasibility of the solution and
2. optimize some (or several) objective function(s). Optimization problems are usually classified according to types of decision to be taken into strategic, tactical and operational problems.

We consider that an optimization problem presents a complex structure when it involves decisions of different types/nature (i.e. strategic, tactical or operational), and/or presenting some hierarchical leader-follower structure. The set of constraints may usually be partitioned into global constraints linking variables associated with the different types/nature of decision and constraints involving each type of variables separately. Optimization problems with a complex structure lead to extremely challenging problems since a global optimum with respect to the whole sets of decision variables and of constraints must be determined.

Significant progresses have been made in optimization to solve academic problems. Nowadays large-scale instances of some NP-Hard problems are routinely solved to optimality. *Our vision within INOCS is to make the same advances while addressing CS optimization problems*. To achieve this goal we aim to develop global solution approaches at the opposite of the current trend. INOCS team members have already proposed some successful methods following this research lines to model and solve CS problems (e.g. ANR project RESPET, Brotcorne *et al.* 2011, 2012, Gendron *et al.* 2009, Strack *et al.* 2009). However, these are preliminary attempts and a number of challenges regarding modeling and methodological issues have still to be met.

3.2. Modeling problems with complex structures

A classical optimization problem can be formulated as follows:

$$\begin{aligned} \min \quad & f(x) \\ s.t. \quad & x \in X. \end{aligned} \tag{1}$$

In this problem, X is the set of feasible solutions. Typically, in mathematical programming, X is defined by a set of constraints. x may be also limited to non-negative integer values.

INOCS team plan to address optimization problem where two types of decision are addressed jointly and are interrelated. More precisely, let us assume that variables x and y are associated with these decisions. A generic model for CS problems is the following:

$$\begin{array}{ll} \min & g(x,y) \\ s.\,t. & x \in X, \\ (x,y) & \in XY, \\ y & \in Y(x). \end{array} \tag{2}$$

In this model, X is the set of feasible values for x. XY is the set of feasible values for x and y jointly. This set is typically modeled through linking constraints. Last, $Y(x)$ is the set of feasible values for y for a given x. In INOCS, we do not assume that $Y(x)$ has any properties.

The INOCS team plans to model optimization CS problems according to three types of optimization paradigms: large scale complex structures optimization, bilevel optimization and robust/stochastic optimization. These paradigms instantiate specific variants of the generic model.

Large scale complex structures optimization problems can be formulated through the simplest variant of the generic model given above. In this case, it is assumed that $Y(x)$ does not depend on x. In such models, X and Y are associated with constraints on x and on y, XY are the linking constraints. x and y can take continuous or integer values. Note that all the problem data are deterministically known.

Bilevel programs allow the modeling of situations in which a decision-maker, hereafter the leader, optimizes his objective by taking explicitly into account the response of another decision maker or set of decision makers (the follower) to his/her decisions. Bilevel programs are closely related to Stackelberg (leader-follower) games as well as to the principal-agent paradigm in economics. In other words, bilevel programs can be considered as demand-offer equilibrium models where the demand is the result of another mathematical problem. Bilevel problems can be formulated through the generic CS model when $Y(x)$ corresponds to the optimal solutions of a mathematical program defined for a given x, i.e. $Y(x) = \operatorname{argmin}\{h(x,y) | y \in Y_2, (x,y) \in XY_2\}$ where Y_2 is defined by a set of constraints on y, and XY_2 is associated with the linking constraints.

In robust/stochastic optimization, it is assumed that the data related to a problem are subject to uncertainty. In stochastic optimization, probability distributions governing the data are known, and the objective function involves mathematical expectation(s). In robust optimization, uncertain data take value within specified sets, and the function to optimize is formulated in terms of a min-max objective typically (the solution must be optimal for the worst-case scenario). A standard modeling of uncertainty on data is obtained by defining a set of possible scenarios that can be described explicitly or implicitly. In stochastic optimization, in addition, a probability of occurrence is associated with each scenario and the expected objective value is optimized.

3.3. Solving problems with complex structures

Standard solution methods developed for CS problems solve independent sub-problems associated with each type of variables without explicitly integrating their interactions or integrating them iteratively in a heuristic way. However these subproblems are intrinsically linked and should be addressed jointly. In *mathematical optimization* a classical approach is to approximate the convex hull of the integer solutions of the model by its linear relaxation. The main solution methods are i) polyhedral solution methods which strengthen this linear relaxation by adding valid inequalities, ii) decomposition solution methods (Dantzig Wolfe, Lagrangian Relaxation, Benders decomposition) which aim to obtain a better approximation and solve it by generating extreme points/rays. Main challenges are i) the analysis of the strength of the cuts and their separations for polyhedral solution methods, ii) the decomposition schemes and iii) the extreme points/rays generations for the decomposition solution methods.

The main difficulty in solving *bilevel problems* is due to their non convexity and non differentiability. Even linear bilevel programs, where all functions involved are affine, are computationally challenging despite their apparent simplicity. Up to now, much research has been devoted to bilevel problems with linear or convex follower problems. In this case, the problem can be reformulated as a single-level program involving complementarity constraints, exemplifying the dual nature, continuous and combinatorial, of bilevel programs.

4. Application Domains

4.1. Energy

In energy, the team mainly focuses on pricing models for demand side management. Demand side management methods are traditionally used to control electricity demand which became quite irregular recently and resulted in inefficiency in supply. We have explored the relationship between energy suppliers and customers who are connected to a smart grid. The smart grid technology allows customers to keep track of hourly prices and shift their demand accordingly, and allows the provider to observe the actual demand response to its pricing strategy. We tackle pricing problems in energy according to the bilevel optimization approaches. Some research works in this domain are supported by bilateral grants with EDF.

4.2. Transportation and Logistics

In transportation and logistics, the team addresses mainly integrated problems, which require taking into account simultaneously different types of decision. Examples are location and routing, inventory management and routing or staff scheduling and warehouse operations management. Such problems occur from the supply chain design level to the logistic facility level. Some research works in this application domain are supported by bilateral grants/contrats with Colisweb, DHL, HappyChic, INFRABEL, or Kéolis.

4.3. Telecommunications

In telecommunications, the team mainly focuses on network design problems and on routing problems. Such problems are optimization problems with complex structure, since the optimization of capacity installation and traffic flow routing have to be addressed simultaneously. Some research works are conducted within a long-term cooperation with Nokia (formerly Alcatel-Lucent Bell Labs).

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Personnel

- Markus Sinnl joined us in October as Inria researcher.

5.1.2. Awards

- A joint team between Ecole des Mines de St Etienne and INOCS involving N. Absi, D. Cattaruzza, D. Feillet, M. Ogier, F. Semet won the scientific prize of the EURO/ROADEF Challenge 2016 devoted to an Inventory Routing Problem proposed by Air Liquid.

5.1.3. Publications & dissemination

- Martine Labbé was the EURO Plenary Speaker at the Conference of the International Federation of Operational Research Societies (IFORS) in Québec, Canada, July 2017 [42].

6. New Software and Platforms

6.1. dapcstp

A dual-ascent-based branch-and-bound framework for the prize-collecting Steiner tree and related problems

KEYWORDS: Mathematical Optimization - Systems Biology
FUNCTIONAL DESCRIPTION: Variants of the Steiner tree problem appear in a broad range of diverse applications, ranging from infrastructure network design to the analysis of biological networks and pattern recognition. In this software, we provide a branch-and-bound (B&B) framework for solving the asymmetric prize-collecting Steiner tree problem (APCSTP). Several well-known network design problems can be transformed to the APCSTP, including the Steiner tree problem (STP), prize-collecting Steiner tree problem (PCSTP), maximum-weight connected subgraph problem (MWCS) and the node-weighted Steiner tree problem (NW-STP).

- Contact: Markus Sinnl
- URL: https://github.com/mluipersbeck/dapcstp

6.2. HappyChic-ApproPick

KEYWORDS: Operational research - Optimization - Java
FUNCTIONAL DESCRIPTION: This software is a prototype developed for the bilateral contract with the company HappyChic. This software is a solver for an integrated warehouse order picking problem with manual picking operations. More precisely, the following problems are solved: (1) the assignment of references to storage positions, based on the iterative solving of minimum cost flow problems, (2) the division of clients orders into several parcels, respecting weight and size constraints, using a dynamic programming algorithm based on the split algorithm, (3) the batching of parcels into trolleys to perform picking tours, using a dynamic programming algorithm based on the split algorithm. The objective function is to minimize the total walking distance. This software is designed to deal with the large-sized industrial instances of HappyChic (considering hundreds of clients, thousands of positions and product references) in a short computation time (few minutes).

- Contact: Maxime Ogier

6.3. rcmwcs

A Relax-and-Cut Algorithm for Maximum Weight Connected Subgraph Problems
KEYWORDS: Mathematical Optimization - Systems Biology
FUNCTIONAL DESCRIPTION: Finding maximum weight connected subgraphs within networks is a fundamental combinatorial optimization problem both from a theoretical and a practical standpoint. One of the most prominent applications of this problem appears in Systems Biology and it corresponds to the detection of active subnetworks within gene interaction networks. The software is a framework to solve the model by means of Relax-and-Cut, i.e., Lagrangian relaxation combined with constraint generation.

- Contact: Markus Sinnl
- URL: https://msinnl.github.io/pages/rcmwcs.html

6.4. MIBLPsolver

A Solver for Mixed-Integer Bilevel Linear Problems
KEYWORD: Mathematical Optimization
FUNCTIONAL DESCRIPTION: Bilevel optimization problems are very challenging optimization models arising in many important practical contexts, including pricing mechanisms in the energy sector, airline and telecommunication industry, transportation networks, optimal expansion of gas networks, critical infrastructure defense, and machine learning. In this software, we present a new general purpose branch-and-cut framework for the exact solution of mixed-integer bilevel linear programs (MIBLP), which constitute a very significant subfamily of bilevel optimization problems.

- Contact: Markus Sinnl
- URL: https://msinnl.github.io/pages/bilevel.html

6.5. PARROT

Planning Adapter Performing ReRouting and Optimization of Timing

KEYWORDS: Decision aid - Railway - Scheduling

FUNCTIONAL DESCRIPTION: This is a decision support system addressing the problem of the rescheduling railway schedules on the Belgian network when maintenance operations are planned in the short term (2-3 weeks in advance). The deliverable is a software tool that will take as input: (1) the schedules initially planned for the different trains, (2) the initial routes of the trains, (3) maintenance operations / changes of elements in the form of constraints (unavailable routes etc.). He then provides in output: (1) the new train schedule, (2) the new routing of the fleet. The modifications must respect the constraints corresponding to the operations of maintenance. For example, in some cases it is common to leave at least a few minutes interval between two trains using the same track in the station. This constraint must then be propagated if a maintenance operation delays the arrival of a train. New schedules and routings have to be created following a specific goal. Changes made to schedules and routings must minimize: (1) variations on the time spent at the station, (2) the number of partially canceled trains (additional correspondence (s) or stations that are no longer served), (2) the number of fully canceled trains (no stations served).

- Contact: Martine Labbe

7. New Results

7.1. Large scale complex structure optimization

New decomposition methods for the time-dependent combined network design and routing problem: A significant amount of work has been focussed on the design of telecommunication networks. The performance of different Integer Programming models for various situations has been computationally assessed. One of the settings that has been thoroughly analyzed is a variant where routing decisions (for time-dependent traffic demand), and network design, are combined in a single optimization model. Solving this model with a state-of-the-art solver on representative network topologies, shows that this model quickly becomes intractable. With an extended formulation, both the number of continuous flow variables and the number of fixed charge capacity constraints are multiplied by a factor $|V|$ (where V represents the set of nodes) leading to large model. However, the linear relaxation of this extended formulation yields much better lower bounds. Nevertheless, even if the extended model provides stronger lower bounds than the aggregated formulation, it suffers from its huge size: solving the linear relaxation of the problem quickly becomes intractable when the network size increases, making the linear relaxation expensive to solve. This observation motivates the analysis of decomposition methods [21].

Convex piecewise linear unsplittable multicommodity flow problems We studied the multi-commodity flow problem with unsplittable flows, and piecewise-linear costs on the arcs. They show that this problem is NP-hard when there is more than one commodity. We propose a new MILP models for this problem, that was compared to two formulations commonly used in the literature. The computational experiments reveal that the new model is able to obtain very strong lower bounds, and is very efficient to solve the considered problem [22].

Tree Reconstruction Problems: We studied the problem of reconstructing a tree network by knowing only its set of terminal nodes and their pairwise distances, so that the reconstructed network has its total edge weight minimized. This problem has applications in several areas, namely the inference of phylogenetic trees and the inference of routing networks topology. Phylogenetic trees allow the understanding of the evolutionary history of species and can assist in the development of vaccines and the study of biodiversity. The knowledge of the routing network topology is the basis for network tomography algorithms and it is a key strategy to the development of more sophisticated and ambitious traffic control protocols and dynamic routing algorithms [24].

Distribution network configuration problems: A distribution network is a system aiming to transfer a certain type of resource from feeders to customers. Feeders are producers of a resource and customers have a certain demand in this resource that must be satisfied. Distribution networks can be represented on graphs and be subject to constraints that limit the number of intermediate nodes between some elements of the network (hop constraints) because of physical constraints. We used layered graphs for hop constrained problems to build extended formulations [16]. Preprocessing techniques allowed to reduce the size of the layered graphs used. The model was studied on the hop-constrained minimum margin problem in an electricity network. This problem consists of designing a connected electricity distribution network, and to assign customers to electricity feeders at a maximum number of hops so as to maximize the minimum capacity margin over the feeders to avoid an overload for any feeder.

Comparison of formulations and solution methods for location problems: We addressed two classes of location problems the Discrete Ordered Median Problem (DOMP) and the two-level uncapacitated facility location problem with single assignment constraints (TUFLP-S), an extension of the uncapacitated facility location problem. We presented several new formulations for the DOMP based on its similarity with some scheduling problems. Some of the new formulations present a considerably smaller number of constraints to define the problem with respect to some previously known formulations. Furthermore, the lower bounds provided by their linear relaxations improve the ones obtained with previous formulations in the literature even when strengthening is not applied. We also present a polyhedral study of the assignment polytope of our tightest formulation showing its proximity to the convex hull of the integer solutions of the problem. Several resolution approaches, among which we mention a branch and cut algorithm, are compared. Extensive computational results on two families of instances, namely randomly generated and from Beasley's OR-library, show the power of our methods for solving DOMP [28]. We also addressed the TUFLP-S for which we presented six mixed-integer programming models based on reformulation techniques and on the relaxation of the integrality of some of the variables associated with location decisions. We compared the models by carrying out extensive computational experiments on large, hard, artificial instances, as well as on instances derived from an industrial application in freight transportation [27].

New models and algorithms for integrated vehicle routing problems: We address a real-life inventory routing problem, which consists in designing routes and managing the inventories of the customers simultaneously. The problem was introduced during the 2016 ROADEF/EURO challenge. The proposed problem is original and complex for several reasons: the logistic ratio optimization objective, the hourly time-granularity for inventory constraints over a large planning horizon, the driver/trailer allocation management. Clearly, this problem is an optimization problem with complex structure, for which we propose an extended formulation that we address with a heuristic branch-price-and-cut method. Among the difficulties, that we had to face, are: the fractional objective function, the simultaneous generation of constraints and columns, and a complex pricing problem. We evaluate our approach on the benchmark instances proposed by the enterprise Air Liquide co-organiser of challenge. The solution method allowed the team including INOCS members to win the scientific prize of the ROADEF/EURO challenge 2016 [47]. We also addressed a rich Traveling Salesman Problem with Profits encountered in several real-life cases. We proposed a unified solution approach based on variable neighborhood search. Our approach includes two loading neighborhoods based on the solution of mathematical programs are proposed to intensify the search. They interact with the routing neighborhoods as it is commonly done in matheuristics. The performance of the proposed matheuristic is assessed on various instances proposed for the Orienteering Problem and the Orienteering Problem with Time Window including up to 288 customers. The computational results show that the proposed matheuristic is very competitive compared with the state-of-the-art methods. Extensive computational experiments on the new testbed confirm the efficiency of the matheuristic [30].

A heuristic approach to solve an integrated warehouse order picking problem: We study an integrated warehouse order picking problem with manual picking operations. The picking area of the warehouse is composed by a set of storage positions. The working day is divided in periods. For each period, each position contains several pieces of a unique product, and a set of customer orders has to be prepared. An order is a set of products, each associated with a quantity. The order pickers can prepare up to K parcels in a given picking route. The problem consists in jointly deciding: (1) the assignment of references to storage positions in the aisles which need to be filled up; (2) the division of orders into several parcels, respecting weight and size constraints; (3) the batching of parcels into groups of size K, that implicitly define the routing into the picking area. The objective function is to minimize the total walking distance. In order to deal with industrial instances of large size (considering hundreds of clients, thousands of positions and product references) in a short computation time, a heuristic method based on dynamic programming and minimum cost flow paradigms is proposed. Experimental results on an industrial benchmark have reported very good results with respect to the actual industrial solution [64].

New models for Load Scheduling for Residential Demand Response on Smart Grids. The residential load scheduling problem is concerned with finding an optimal schedule for the operation of residential loads so as to minimize the total cost of energy while aiming to respect a prescribed limit on the power level of the residence. We propose a mixed integer linear programming formulation of this problem that accounts for the consumption of appliances, generation from a photovoltaic system, and the availability of energy storage. A distinctive feature of our model is the use of operational patterns that capture the individual operational characteristics of each load, giving the model the capability to accommodate a wide range of possible operating patterns for the flexible loads. The proposed formulation optimizes the choice of operational pattern for each load over a given planning horizon. In this way, it generates a schedule that is optimal for a given planning horizon, unlike many alternatives based on controllers. The formulation can be incorporated into a variety of demand response systems, in particular because it can account for different aspects of the cost of energy, such as the cost of power capacity violations, to reflect the needs or requirements of the grid. Our computational results show that the proposed formulation is able to achieve electricity costs savings and to reduce peaks in the power consumption, by shifting the demand and by efficiently using a battery [52].

Lagrangian heuristics for SVM with feature selection: The focus of pattern classification is to recognize similarities in the data, categorizing them in different subsets. In many fields, such as the financial and the medical ones, classification of data (samples in Machine Learning language) is useful for analysis or diagnosis purposes. Quite often datasets are formed by a small number of samples, which in turn are characterized by a huge number of attributes (features). The handling of the entire feature set would be computationally very expensive and its outcome would lack from insight. For this reason, it is convenient to reduce the set of features which is expected to be easier to interpret and also easy to evaluate. However, it is not always easy to predict which of those are relevant for classification purposes. Hence it is necessary to screen off the relevant features from those which are irrelevant. The process that selects the features entering the subset of the relevant ones is known as Feature Selection (FS). The (FS) problem can be treated explicitly as a Mixed Binary Programming (MBP) one in the framework of the Support Vector Machine approach. We have discussed a Lagrangian-relaxation-based heuristics. In particular we embed into our objective function a weighted combination of the L^1 and L^0 norm of the normal to the separating hyperplane. We come out with a Mixed Binary Linear Programming problem which is suitable for a Lagrangian relaxation approach. Based on a property of the optimal multiplier setting, we apply a consolidated nonsmooth optimization ascent algorithm to solve the resulting Lagrangian dual. In the proposed approach we get, at every ascent step, both a lower bound on the optimal solution as well as a feasible solution at low computational cost [26].

Decomposition methods for tree-based network design problems: We studied different problems, where the underlying solution structure needs to have a tree-like topology and some additional constraints need to be fulfilled. For all these problems, we focused on solution approaches, which allow to tackle large-scale instances, as the application of these problems in areas like systems biology often has to deal with instances containing tens of thousands of nodes. In order to solve these problems efficiently, we turned to decomposition methods, like Benders decomposition, Lagrangian relaxation or relax-and-cut. The considered problems include the (prize-collecting) Steiner tree problem [17], [33], tree-star problems [32], the shared arborescence problem [34], the upgrading spanning tree problem [36] and for maximum-weight connected subgraph problems [35].

We also studied models arising in the design of switched Ethernet networks implementing the Multiple Spanning Tree Protocol [24]. In these problems, multiple spanning trees have to be established in a network to route demands partitioned into virtual local access networks. Different mixed-integer formulations for the problem have been proposed and compared, both theoretically and computationally.

Dynamic programming for the minimum-cost maximal knapsack packing problem: Given a set of items with profits and weights and a knapsack capacity, we studied the problem of finding a maximal knapsack packing that minimizes the profit of the selected items. We proposed an effective dynamic programming (DP) algorithm which has a pseudo-polynomial time complexity. We demonstrated the equivalence between this problem and the problem of finding a minimal knapsack cover that maximizes the profit of the selected items. In an extensive computational study on a large and diverse set of benchmark instances, we demonstrated that the new DP algorithm outperforms a state-of-the-art commercial mixed-integer programming (MIP) solver applied to the two best performing MIP models from the literature [25].

7.2. Bilevel Programming

Bilevel approaches for energy management problems: We have proposed the first bilevel pricing models to explore the relationship between energy suppliers and customers who are connected to a smart grid. Due to their definition, bilevel models enable to integrate customer response into the optimization process of supplier who aims to maximize revenue or minimize capacity requirements. In our setting, the energy provider acts as a leader (upper level) that takes into account a smart grid (lower level) that minimizes the sum of users' disutilities. The latter bases its decisions on the hourly prices set by the leader, as well as the schedule preferences set by the users for each task. Moreover the follower is able to produce renewable energy and store it. The pricing problems, we model, belong to the category of stochastic single leader single follower problems. A scenario based approach is based to solve the problem. For each scenario, the bilevel program is solved by rewriting it as a single level optimization program. Numerical results on randomly generated instances illustrate numerically the validity of the approach, which achieves an optimal trade-off between three objectives: revenue, user cost, and peak demand [53].

Network pricing problems with unit toll: In the so-called network pricing problem an authority owns some arcs of the network and tolls them, while users travel between their origin and destination choosing their minimum cost path. We consider a unit toll scheme, and in particular the cases where the authority is imposing either the same toll on all of its arcs, or a toll proportional to a given parameter particular to each arc (for instance a per kilometer toll). We show that if tolls are all equal then the complexity of the problem is polynomial, whereas in case of proportional tolls it is pseudo-polynomial, proposing ad-hoc solution algorithms and relating these problems to the parametric shortest path problem. We then address a robust approach using an interval representation to take into consideration uncertainty on parameters. We show how to modify the algorithms for the deterministic case to solve the robust counterparts, maintaining their complexity class [15].

New formulations for solving Stackelberg games: We analyzed general Stackelberg games (SGs) and Stackelberg security games (SSGs). SGs are hierarchical adversarial games where players select actions or strategies to optimize their payoffs in a sequential manner. SSGs are a type of SGs that arise in security applications, where the strategies of the player that acts first consist in protecting subsets of targets and the strategies of the followers consist in attacking one of the targets. We review existing mixed integer optimization formulations in both the general and the security setting and present new formulations for the the second one. We compare the SG formulations and the SSG formulations both from a theoretical and a computational point of view. We identify which formulations provide tighter linear relaxations and show that the strongest formulation for the security version is ideal in the case of one single attacker. Our computational experiments show that the new formulations can be solved in shorter times [66].

A branch and price algorithm for solving Stackelberg Security games: Mixed integer optimization formulations are an attractive alternative to solve Stackelberg Game problems thanks to the efficiency of state of the art mixed integer algorithms. In particular, decomposition algorithms, such as branch and price methods, make it possible to tackle instances large enough to represent games inspired in real world domains. We focus on Stackelberg Games that arise from a security application and investigate the use of a new branch and price method to solve its mixed integer optimization formulation. We prove that the algorithm provides upper and lower bounds on the optimal solution at every iteration and investigate the use of stabilization heuristics. Our preliminary computational results compare this solution approach with previous decomposition methods obtained from alternative integer programming formulations of Stackelberg games [29].

A new general-purpose algorithm for mixed-integer bilevel linear programs: We considered bilevel problems with continuous and discrete variables at both levels, with linear objectives and constraints (continuous upper level variables, if any, must not appear in the lower level problem). We proposed a general-purpose branch-and-cut exact solution method based on several new classes of valid inequalities, which also exploits a very effective bilevel-specific preprocessing procedure. An extensive computational study was presented to evaluate the performance of various solution methods on a common testbed of more than 800 instances from the literature and 60 randomly generated instances. Our new algorithm consistently outperformed (often by a large margin) alternative state-of-the-art methods from the literature, including methods exploiting problem-specific information for special instance classes. In particular, it solved to optimality more than 300 previously unsolved instances from the literature. To foster research on this challenging topic, our solver was made publicly available online [18], [19].

A mixed-integer programming based heuristic for generalized interdiction problems: We considered a subfamily of mixed-integer linear bilevel problems that we call Generalized Interdiction Problems. This class of problems includes, among others, the widely-studied interdiction problems, i.e., zero-sum Stackelberg games where two players (called the leader and the follower) share a set of items, and the leader can interdict the usage of certain items by the follower. Problems of this type can be modeled as Mixed-Integer Nonlinear Programming problems, whose exact solution can be very hard. We propose a new heuristic scheme based on a single-level and compact mixed-integer linear programming reformulation of the problem obtained by relaxing the integrality of the follower variables. A distinguished feature of our method is that general-purpose mixed-integer cutting planes for the follower problem are exploited, on the fly, to dynamically improve the reformulation. The resulting heuristic algorithm proved very effective on a large number of test instances, often providing an (almost) optimal solution within very short computing times. [20]

Unit Commitment under Market Equilibrium Constraints: Traditional (deterministic) models for the Unit Commitment problem (UC) assume that the net demand for each period is perfectly known in advance, or in more recent and more realistic approaches, that a set of possible demand scenarios is known (leading to stochastic or robust optimization problems). However, in practice, the demand is dictated by the amounts that can be sold by the producer at given prices on the day-ahead market. We modeled and solved the UC problem with a second level of decisions ensuring that the produced quantities are cleared at market equilibrium. In its simplest form, we are faced to a bilevel optimization problem where the first level is a MIP and the second level linear. As a first approach to the problem, we assumed that demand curves and offers of competitors in the market are known to the operator. Following the classical approach for these models, we turned the problem into a single-level program by rewriting and linearizing the first-order optimality conditions of the second level [50].

7.3. Robust/Stochastic programming

Decomposition method for stochastic staff management problems: We addressed an integrated shift scheduling and load assignment optimization problem for attended home delivery, which is a last-mile delivery service requiring the presence of the customer for the delivery. We were mainly interested in generating a daily master plan for each courier. We proposed a tactical problem integrating a shift scheduling problem and a load assignment problem under demand uncertainty, which was modeled as a two-stage stochastic programming model. This model integrates two types of decisions. First-stage decisions are related to the design of a schedule that includes the periods of the day in which each courier must work and the o-d pairs to visit at each time period. Second-stage decisions (recourse actions) consist of the allocation of a number of packages to be delivered at each time period, for each o-d pair, by each courier, such that the demand (number of packages to deliver) for each scenario is satisfied. Recourse is the ability to take corrective actions after a random event has taken place. The objective is to minimize the sum of the daily staffing cost plus the expected daily recourse cost. To solve this problem, we proposed and implemented a multi-cut integer L-shaped algorithm, where the second stage decomposes by time periods and by demand scenarios. To strengthen the first stage model, some valid inequalities are added, and some of the existing constraints are lifted. Moreover, we addressed the operational planning problem which aims to incorporate the tactical master plan solutions into the real-time allocation of client requests to the couriers. We proposed a mathematical model and a solution approach based on a column generation algorithm. The goal of this approach was to provide a tool to evaluate the robustness of the tactical plan, i.e. how well this plan reacts to new order requests arriving in real-time. Results on real-world based instances from a delivery company demonstrate that our approach provides robust tactical solutions that easily accommodate to fluctuations in customer orders, preventing additional costs related to the underutilization of couriers and the use of external couriers to satisfy all delivery requests [38], [65].

Decomposition method for the stochastic Steiner tree problem: We introduced a new algorithmic approach for solving the stochastic Steiner tree problem based on three procedures for computing lower bounds (dual ascent, Lagrangian relaxation, Benders decomposition). Our method is derived from a new integer linear programming formulation, which is shown to be strongest among all known formulations. The resulting method, which relies on an interplay of the dual information retrieved from the respective dual procedures, computes upper and lower bounds and combines them with several rules for fixing variables in order to decrease the size of problem instances. The effectiveness of our method is compared in an extensive computational study with the state-of-the-art exact approach, which employs a Benders decomposition based on two-stage branch-and-cut, and a genetic algorithm introduced during the DIMACS implementation challenge on Steiner trees. Our results indicate that the presented method significantly outperforms existing ones, both on benchmark instances from literature, as well as on large-scale telecommunication networks [31].

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

Fluxys (2016-2018). Study of optimization problems arising in the management of gas networks.

HappyChic (2017). Study of optimization problems arising in the warehouse management context.

Keolis (2017). Study of optimization problems arising in the management of mediation officers in public transportation.

8.2. Bilateral Grants with Industry

PARROT (Planning Adapter performing ReRouting and Optimization of Timing), part of BEWARE Fellowships Academia funded by the COFUND program of the European Union (FP7 - Marie Curie Actions). INFRABEL is the industrial partner of this project (2014-2018).

Design and Pricing of Electricity Services in a Competitive Environment within the Gaspard Monge Research Progam (PGMO) funded by the Fondation Mathématiques Jacques Hadamard. EDF is the industrial partner (2015-2018).

BENMIP: A generic bender decomposition-based (mixed) integer programming solver within the Gaspard Monge Research Progam (PGMO) funded by the Fondation Mathématiques Jacques Hadamard (2015-2017).

Robust Energy Offering under Market Equilibrium Constraints within the Gaspard Monge Research Progam (PGMO) funded by the Fondation Mathématiques Jacques Hadamard. EDF is the industrial partner (2017-2018).

8.3. Inria Innovation Lab

COLINOCS is an Inria Innovation Lab between Colisweb, a start-up company addressing last-mile delivery and INOCS, which was created at the end of 2016. This collaboration roots back to 2015, when a bilateral contract was devoted to optimization problems arising in courier scheduling. The main objective of this Innovation Lab is to model and solve optimization problems related to revenue management, transport mutualization, a better visibility on their activities for the couriers. See also: https://www.inria.fr/innovation/transfert-technologique/labos-communs-inria-pme/inria-innovation-labs/colinocs

9. Partnerships and Cooperations

9.1. Regional Initiatives

The ELSAT research program addresses the issues involved in sustainable transportation and mobility. Within ELSAT, INOCS is involved on two projects devoted to hybrid optimization methods in logistics and to city logistics in collaboration with LAMIH (University of Valenciennes), LGI2A (University of Artois) and LEOST (IFSTTAR). ELSAT is supported by the CPER 2015-2020 (State-Region Contract).

9.2. National Initiatives

9.2.1. ANR

ANR project PI-Commodality "Co-modal freight transportation chains: an approach based on physical internet" in collaboration with CGS-ARMINES (Paris), LAAS (Toulouse), DHL (2016 - 2018). The PI-co-modality project aims to design new sustainable logistic services between preset origins and destinations. It is based on innovative approaches both in terms of: 1) Logistics and transportation services: by considering the PI-internet approach, specifically: mesh logistics and transportation networks based on available capacities, by designing consistent integrated co-modal chains; 2) Methodology: by addressing the underlying problems according to two approaches: centralized and decentralized, by proposing news realistic models relevant for practitioner taking into account the consistency, by developing state-of-the-art decision making algorithms.

9.2.2. National Initiatives (Belgium)

Combinatorial Optimization: Meta-heuristics and Exact Methods (2012-2017), coordinator: Bernard Fortz (GOM-ULB/INOCS-Inria). Inter-university Attraction Pole funded by the Belgian Federal Science Policy Office. Study and modeling of combinatorial optimization problems; Advancements in algorithmic techniques; Implementation of solution methods for large-scale, practically relevant problems.

9.3. European Initiatives

9.3.1. Collaborations in European Programs, Except FP7 & H2020

Program: COST

Project acronym: TD1207

Project title: Mathematical Optimization in the Decision Support Systems for Efficient and Robust Energy Networks

Duration: 04/2014 - 04/2017

Coordinator: Thorsten Koch (ZIB, Germany)

INOCS partners: Bernard Fortz, Martine Labbé

Abstract: Energy Production and Distribution (EP&D) is among the biggest challenges of our time, since energy is a scarce resource whose efficient production and fair distribution is associated with many technical, economical, political and ethical issues like environmental protection and people health. EP&D networks have rapidly increased their size and complexity, e.g. with the introduction and interconnection of markets within the EU. Thus, there is an increasing need of systems supporting the operational, regulatory and design decisions through a highly inter-disciplinary approach, where experts of all the concerned fields contribute to the definition of appropriate mathematical models. This is particularly challenging because these models require the simultaneous use of many different mathematical optimization tools and the verification by experts of the underlying engineering and financial issues. The COST framework is instrumental for this Action to be able to coordinate the inter-disciplinary efforts of scientists and industrial players at the European level.

Program: JPI Urban Europe

Project acronym: e4-share

Project title: Models for Ecological, Economical, Efficient, Electric Car-Sharing

Duration: 10/2014 - 09/2017

Coordinator: Markus Leitner (University of Vienna, Austria)

Other partners:

- Austrian Institute of Technology, Austria
- Université Libre de Bruxelles (INOCS), Belgium
- University of Bologna, Italy
- tbw research GesmbH, Austria

Abstract: Car-sharing systems and the usage of electric cars become increasingly popular among urban citizens. Thus, providing vast opportunities to meet today's challenges in terms of environmental objectives, sustainability and living quality. Our society needs to manage a transformation process that ultimately shall lead to fewer emissions and less energy consumption while increasing the quality of public space available. In e4-share, the team will lay the foundations for efficient and economically viable electric car-sharing systems by studying and solving the optimization problems arising in their design and operations. A main goal is to derive generic methods and strategies for optimized planning and operating in particular for flexible variants which best meet preferences of customers but impose nontrivial challenges to operators. This project will develop novel, exact and heuristic, numerical methods for finding suitable solutions to the optimization problems arising at the various planning levels as well as new, innovative approaches considering these levels simultaneously.

9.4. International Initiatives

9.4.1. Inria International Labs

9.4.1.1. BIPLOS

Title: BIlevel Problems in LOgistics and Security

International Partner (Institution - Laboratory - Researcher):

Universidad de Chile (Chile) - Instituto Sistemas Complejos de Ingeieria (ISCI) - Ordonez Fernando

Start year: 2017

See also: https://project.inria.fr/biplos/

This projet is devoted to bilevel optimisation problems with application in the security and logistics domains. Stackelberg games, including one defender and several followers, and competitive location problems will be considered. Mixed integer linear optimisation models and efficient algorithms to solve them will be developed.

Related publications: [29], [11], [66].

9.4.2. Inria Associate Teams Not Involved in an Inria International Labs

9.4.2.1. North-European associated team

Title: Physical-internet services for city logistics

International Partner (Institution - Laboratory - Researcher):

Norwegian School of Economics - Stein Wallace

Start year: 2017

In this project, we consider an urban logistic terminal and new logistics services which could be developed according to a Physical Internet approach. The main objective is to evaluate the services using optimization models created within the project. We are developing optimization models to identify win-win cooperation between carriers based on supply and demand. We aim to explore how to include stochasticity in the description of the supplies and demands, as well as travel times, and to what extent the plans within a day can improve by such knowledge. The second task is to develop solution algorithms for these models. These are real scientific challenges as we are facing stochastic mixed integer problems.

9.4.3. Inria International Partners

9.4.3.1. Informal International Partners

Department of Statistics and Operations Research, University of Vienna, Austria.

Centre for Quantitative Methods and Operations Management, HEC-Liège, Belgique.

Interuniversity Centre on Entreprise Networks, Transportation and Logistics (CIRRELT), Montreal, Canada.

Department of Industrial Engineering, Universidad de Talca, Curicó, Chile.

Instituto Sistemas Complejos de Ingeniería (ISCI), Santiago, Chile.

The Centre for Business Analytics, University College Dublin, Ireland.

Department of Electrical, Electronic, and Information Engineering, University of Bologna, Italy.

Department of Electrical and Information Engineering, University of Padova, Italy.

Department of Mathematics, University of Aveiro, Portugal.

Department of Statistics and Operations Research, University of Lisbon, Portugal.

Instituto de Matemáticas, University of Seville, Spain.

Departamento de Estadística e Investigación Operativa, Universidad de Murcia, Spain.

Dipartimento di Matematica, Universita degli studi di Padova, Italy.

9.4.4. Participation in Other International Programs

STIC Algérie, University of Oran, Algeria.

9.5. International Research Visitors

9.5.1. Visits of International Scientists

9.5.1.1. Visiting Professors and Ph.D. students

Claudio Arbib, Professor at Università degli Studi dell'Aquila, Feb 2017.

Victor Bucarey, Postdoctoral researcher at Universidad de Chile, Dec 2017.

Paula Carroll, Professor at Centre for Business Analytics, School of Business, University College Dublin, Sep 2017.

Sebastián Dávila, Ph.D. student at Universidad de Chile, Dec 2017.

Bernard Gendron, Professor at Université de Montréal, Nov 2017.

Anton Kleywegt, Professor at Georgia Institue of Technology, from Jun 2017 until Jul 2017.

Marina Leal, Ph.D. student at Universidad de Sevilla, from Jun until Oct 2017.

Paulo Macedo, Ph.D. student at Universidade Federal do Ceará, from Mar 2017 until Jul 2017.

Vladimir Marianov, Professor at Pontificia Universidad Católica de Chile, from Nov until Dec 2017.

Alfredo Marín, Professor at Universidad de Murcia, Oct 2017.

Fernando Ordónez, Professor at Universidad de Chile, Sep 2017.

Juan José Palacios Alonso, Professor at Universidad de Oviedo, from Sep until Dec 2017.

Mercedes Pelegrin Garcia, Ph.D. student at Universidad de Murcia, from Sep 2017 until Dec 2017.

9.5.1.2. Internships

Juan Alejandro Gomez Herrera, Ecole Polytechnique de Montréal, from Apr 2017 until Jul 2017.

Sebastien Michel, Centrale Lille, from Jun 2017 until Sep 2017.

Luis Salazar Zendeja, University of Monterrey, Mexico, from Apr 2017 until Aug 2017.

Grégoire Pellissier, Université Blaise Pascal, Clermont-Ferrand, from June 2017 until Sept 2017.

10. Dissemination

10.1. Promoting Scientific Activities

10.1.1. Scientific Events Organisation

10.1.1.1. Member of the Organizing Committees

6th Winter School on Network Optimization, Estoril, Portugal, January 2017: Bernard Fortz.

Meeting of the EURO Working group on Pricing and Revenue Management, Amsterdam, Netherlands, June 2017: Luce Brotcorne.

10.1.2. Scientific Events Selection

10.1.2.1. Member of the Conference Program Committees

ORBEL 2017, Brussels, Belgium, February 2017: Bernard Fortz.

ROADEF2017 - 18ème Conférence de la Société Française de Recherche Opérationnelle et d'Aide à la Décision, Metz, France, February 2017: Luce Brotcorne, Bernard Fortz, Frédéric Semet.

International Network Optimization Conference (INOC) 2017, Lisbon, Portugal, March 2017: Bernard Fortz.

International Conference on Design of Reliable Communication Networks 2017 (DRCN 2017), Munich, March 2017: Martine Labbé.

Conference of the International Federation of Operational Research Societies, Quebec, Canada, July 2017: Luce Brotcorne, Bernard Fortz.

International Symposium on Locational Decisions (ISOLDE 2017), Toronto, July 2017 Martine Labbé.

INFORMS TSL Conference, Chicago, July 2017: Martine Labbé.

XLIX Brazilian Symposium on Operational Research (XLIX SBPO), Blumenau, Brazil, August 2017: Martine Labbé.

Computer Science Discovery 8 (CSD8), Mons, Belgium, August 2017: Martine Labbé.

10.1.3. Journal

10.1.3.1. Member of the Editorial Boards

EURO Journal on Computational Optimization: Martine Labbé - Editor in chief.

Computers and Operations Research: Luce Brotcorne - Associate editor.

INFORMS Journal on Computing: Bernard Fortz - Associate editor.

International Transactions in Operations Research: Bernard Fortz, Martine Labbé - Associate editors.

Transportation Science: Martine Labbé - Member of the Advisory Board.

10.1.3.2. Reviewer - Reviewing Activities

Annals of Operations Research, Applied Computing and Informatics, Central European Journal of Operations Research, Computers & Operations Research, Computational Optimization and Applications, Discrete Applied Mathematics, EURO Journal on Transportation and Logistics, European Journal of Operational Research, IISE Transactions, INFORMS Journal on Computing, International Journal of Management Science and Engineering Management, Mathematical Programming Computation, Networks, Omega, Operations Research, Optimization and Engineering, RAIRO - Operations Research, Transportation Science: Luce Brotcorne, Diego Cattaruzza, Bernard Fortz, Martine Labbé, Maxime Ogier, Frédéric Semet, Markus Sinnl.

10.1.4. Invited Talks

Conference of the International Federation of Operational Research Societies, Quebec, Canada, July 2017: Martine Labbé, EURO plenary lecturer [42].

Optimization 2017, Lisbon, Portugal, September 2017: Martine Labbé, plenary speaker [43].

Conférence ROAD 2017, Esatic, Abidjan, March 2017: Luce brotcorne, plenary speaker [37].

Network Optimization Workshop 2017, Viterbo, June 2017: Luce Brotcorne, Frédéric Semet, invited speaker [38], [61].

10.1.5. Leadership within the Scientific Community

EURO Working Group "Pricing and Revenue Management": Luce Brotcorne - coordinator.

EURO Working Group "European Network Optimization Group (ENOG)": Bernard Fortz - coordinator.

EURO Working Group "Vehicle routing and logistics optimization (VEROLOG)": Frédéric Semet - Member of the board.

SIAG/Optimization Prize committee: Martine Labbé - Chair.

ORBEL (Belgian Operations Research Society): Bernard Fortz - Member of the board of administration and treasurer.

ORBEL representative for EURO and IFORS: Bernard Fortz

CNRS GdR 3002 : Operations Research: Frédéric Semet - Member of the steering committee

10.1.6. Scientific Expertise

Scientific orientation committee of the Interuniversity Centre on Entreprise Networks, Transportation and Logistics (CIRRELT), Canada: Bernard Fortz, Frédéric Semet - Members.

Scientific Advisory Board of IWR and its Graduate school HGS MathComp, Heidelberg University: Martine Labbé - Member.

Centro de Matemática, Aplicaçoes Fundamentais e Investigaçao Operacional, University of Lisbon: Martine Labbé - Member.

Scientific committee of France-Netherlands Exchange Program: Luce Brotcorne - Member.

Evaluation committee for Inria/MITACS Exchange Program: Luce Brotcorne - Member.

Evaluation committee COST GTRI: Luce Brotcorne - Member.

President of the FRIA PE1 - jury 1: Bernard Fortz - Chair.

Scientific board of PICOM competitiveness cluster: Frédéric Semet - Member.

Agence Nationale de la Recherche (ANR): Luce Brotcorne, Frédéric Semet - Reviewer.

Fond de Recherche Nature et Technologie du Québec: Frédéric Semet - Reviewer.

Research Council of Norway: Frederic Semet - Reviewer.

10.1.7. Research Administration

Committee for the Technological Development (CDT): Luce Brotcorne - Member.

CRIStAL: Frédéric Semet - Deputy-director.

Scientific council of Centrale Lille: Frédéric Semet - Elected member.

10.2. Teaching - Supervision - Juries

10.2.1. Teaching

Master: Bernard Fortz, Recherche Opérationnelle et Applications, 30hrs, M1, Université de Mons (campus Charleroi), Belgique.

Master: Bernard Fortz, Continuous Optimization, 24hrs, M1 & M2, Université libre de Bruxelles, Belgique.

Master: Martine Labbé, Computer science seminar, 12hrs, M2, Université libre de Bruxelles, Belgique.

Master: Frédéric Semet, Non-linear Optimization, 30hrs, M2, Centrale Lille.

Master: Frédéric Semet, Operations Research, 28hrs, M2, Centrale Lille.

Master: Luce Brotcorne, Optimisation, 14hrs, M1, Polytech Lille.

Master: Luce Brotcorne, Recherche opétrationnelle, 16hrs, M1 apprentissage, Polytech Lille.

Master: Luce Brotcorne, Diego Cattaruzza, Maxime Ogier, Frédéric Semet, Numerical Analysis and Optimization, 132hrs, M1, Centrale Lille.

Master: Diego Cattaruzza, Maxime Ogier, Object-Oriented Programming, 48hrs, M1, Centrale Lille.

Master: Diego Cattaruzza, Maxime Ogier, Operations Research, 16hrs, M1, Centrale Lille.

Master: Frédéric Semet, Large-scale optimization methods, 24hrs, M1, Centrale Lille.

Licence: Diego Cattaruzza, Maxime Ogier, Object-Oriented Programming, 36hrs, L3, Centrale Lille.

Licence: Frédéric Semet, Advanced programming and Complexity, 24hrs, L3, Centrale Lille.

Licence: Diego Cattaruzza, Maxime Ogier, Object-Oriented Programming, 40hrs, L2, Centrale Lille.

Licence: Diego Cattaruzza, Web Technologies and Multimedia, 32hrs, L2, Centrale Lille.

Licence: Bernard Fortz, Algorithmique 1, 12hrs, L1, Université libre de Bruxelles, Belgique.

Licence: Bernard Fortz, Algorithmique 2, 24hrs, L1, Université libre de Bruxelles, Belgique.

Licence: Martine Labbé, Projets d'informatique 3 transdisciplinaire, 12hrs, L3, Université libre de Bruxelles, Belgique.

10.2.2. Supervision

PhD: Carlos Casorrán Amilburu, Models and algorithms for Solving Bimatrix Stackelberg games, Université libre de Bruxelles, October 2017, Martine Labbé [11].

PhD in progress: Jérôme De Boeck, Optimization problems in energy, from October 2015, Bernard Fortz.

PhD in progress: Burak Celik, Models and methods for Stackelberg games using bilevel optimization and mixed integer linear programming, from Nov 2016, Luce Brotcorne, Martine Labbé.

PhD in progress: Yaheng Cui, Models and methods for decentralized decision in logistics networks, from Oct 2016, Luce Brotcorne, Eric Ballot.

PhD in progress: Concepción Domínguez Sánchez, Mixed Integer Linear Models and Algorithms for Pricing Problems, from October 2017, Martine Labbé.

PhD in progress: Wenjuan Gu, Location routing for short and local fresh food supply chain, from Oct 2016, Maxime Ogier, Frédéric Semet.

PhD in progress: Léonard Von Niederhausern, Design and pricing of new services in energy in a competitive environment, from Oct 2015, Luce Brotcorne, Didier Aussel.

PhD in progress: Fränk Plein, Models and methods for the robust verification of booked capacities in gas networks in a decentralized setting, from October 2017, Martine Labbé.

PhD in progress: Luciano Porretta, Models and methods for the study of genetic associations, from May 2011, Bernard Fortz.

PhD in progress: Fabio Sciamannini, Column generation approaches for solving variants of node coloring problems, from October 2014, Bernard Fortz, Martine Labbé.

PhD in progress: Yuan Yuan, Vehicle Routing Problems with Synchronization for City Logistics, from Oct 2016, Diego Cattaruzza, Frédéric Semet.

10.2.3. Juries

PhD: "Quelques Algorithmes de Planification Ferroviaire sur Voie Unique", Laurent Daudet, Université de Paris Est. Frédéric Meunier. Luce Brotcorne - Reviewer.

PhD: "Formulations and algorithms for general and security Sackelberg games", Carlos Casorrán Amilburu, Université libre de Bruxelles. Martine Labbé et Fernando Ordóñez. Bernard Fortz - Examiner and Committee Secretary.

PhD: "The multi-terminal vertex separator problem: Complexity, Polyhedra and Algorithms", Youcef Magnouche, Université Paris Dauphine. Rihda Mahjoub. Frederic Semet - Committee Chair.

PhD: "Vehicle routing problems with road-network information", Ramza Ben Ticha, Université Clermont-Auvergne. Nabil Absi and Alain Quillot. Frédéric Semet - Reviewer and Committee Chair.

PhD: "Problèmes de tournées avec gestion de stock et prise en compte explicite de la consommation d'énergie", Yun He, Université Fédérale de Toulouse-Midi Pyrénées. Cyril Briant and Nicolas Jozefowiez. Frédéric Semet - Reviewer.

PhD: "Conception et optimisation d'un réseau de transport multimodal pour desservir des ports maritimes et leur hinterland", Yulong Zhao, Université de Nantes. N. Bostel and Pierre Dejax. Frédéric Semet - Examiner.

PhD: "Heterogeneous cluster computing for many-task exact optimization - Application to permutation problems", Jan Gmys, Université de Mons. Nouredine Melab and Daniel Tuyttens. Frederic Semet - Committee Secretary.

PhD: "Mathematical optmization for the visualization of complex datasets", Vanesa Guerrero Lozano, Universidad de Sevilla. Emilio Carrizosa Priego and Dolores Romero Morales. Martine Labbé - Examiner.

PhD: "Automatic algorithm configuration", Leslie Angélica P érez Cáceres, Université Libre de Bruxelles. Thomas Stuetzle. Martine Labbé - Examiner.

Habilitation: "Reformulations and decompositions of mixed integer linear and nonlinear programs", Fabio Furini, Université Paris-Dauphine. Ridha Mahjoub. Martine Labbé- Reviewer.

10.3. Popularization

L. Brotcorne, Club Logistique et Transport, Lille, September 2017.

11. Bibliography

Major publications by the team in recent years

[1] Q. Botton, B. Fortz, L. Gouveia, M. Poss. *Benders Decomposition for the Hop-Constrained Survivable Network Design Problem*, in "INFORMS Journal on Computing", 2013, vol. 25, n^o 1, pp. 13-26 [*DOI :* 10.1287/ijoc.1110.0472], http://joc.journal.informs.org/content/25/1/13.abstract

[2] L. Brotcorne, F. Cirinei, P. Marcotte, G. Savard. *An exact algorithm for the network pricing problem*, in "Discrete Optimization", 2011, vol. 8, n^o 2, pp. 246–258 [*DOI :* 10.1016/j.disopt.2010.09.003]

[3] L. Brotcorne, M. Labbé, P. Marcotte, G. Savard. *Joint design and pricing on a network*, in "Operation Research", 2008, vol. 56, pp. 1104-1115 [*DOI :* 10.1287/opre.1080.0617]

[4] D. Cattaruzza, N. Absi, D. Feillet. *The Multi-Trip Vehicle Routing Problem with Time Windows and Release Dates*, in "Transportation Science", 2016, vol. 50, n^o 2, pp. 676-693, https://doi.org/10.1287/trsc.2015.0608

[5] M. Fischetti, I. Ljubić, M. Monaci, M. Sinnl. *A New General-Purpose Algorithm for Mixed-Integer Bilevel Linear Programs*, in "Operations Research", December 2017, vol. 65, n^o 6, pp. 1615 - 1637 [*DOI :* 10.1287/opre.2017.1650], https://hal.inria.fr/hal-01666279

[6] B. Fortz, M. Labbé, F. Louveaux, M. Poss. *Stochastic binary problems with simple penalties for capacity constraints violations*, in "Mathematical Programming", 2013, vol. 138, pp. 199-221, http://dx.doi.org/10.1007/s10107-012-0520-4

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[8] S. García, M. Labbé, A. Marín. *Solving large p-median problems with a radius formulation*, in "INFORMS Journal on Computing", 2011, vol. 23, n^o 4, pp. 546–556

[9] B. Gendron, P.-V. Khuong, F. Semet. *A Lagrangian-Based Branch-and-Bound Algorithm for the Two-Level Uncapacitated Facility Location Problem with Single-Assignment Constraints*, in "Transportation Science", 2016, vol. 50, n^o 4, pp. 1286-1299, https://doi.org/10.1287/trsc.2016.0692

[10] M. Labbé, P. Marcotte, G. Savard. *A bilevel model of taxation and its application to optimal highway pricing*, in "Management science", 1998, vol. 44, n^o 12-part-1, pp. 1608–1622

Publications of the year

Doctoral Dissertations and Habilitation Theses

[11] C. Casorrán-Amilburu. *Formulations and Algorithms for General and Security Stackelberg Games*, Université libre de Bruxelles ; Universidad de Chile, October 2017, https://hal.inria.fr/tel-01666449

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