MONDAY 18

12h30-13h00	Welcome reception and buffet

13h00-13h30	Opening session

14h00-14h40 The Convex Hull Heuristic for Nonlinear 0-1 Programming Problems with Linear Constraints

Monique Guignard-Spielberg *and Aykut Ahlatcioglu*

The Convex Hull Heuristic (CHH) is a heuristic for 0-1 integer programming problems with a nonlinear objective function and linear constraints. It is a matheuristic in two ways: it is based on the mathematical programming algorithm called simplicial decomposition SD, and at each iteration, it calls a linear integer programming solver. Its purpose is to produce quickly near optimal solutions for convex and nonconvex problems. It is multi-start: following each restart, it repeatedly solves 0-1 programming problems with the original constraints and with a linear objective that depends on the previous iterations. We have tested it on a number of hard quadratic 0-1 optimization problems and present numerical results for quadratic assignment problems (QAP), generalized quadratic assignment problems (GQAP), cross-dock door assignment problems (CDAP), quadratic knapsack problems (QKP) and quadratic knapsack problems with a cardinality constraint (E-kQKP). We compare solution quality and solution times with results from the literature, when available.

14h40-15h20 Matheuristics for column generation stabilization: application to a technician routing and scheduling problem

Nicolas Dupin*, Rémi Parize and Talbi El-Ghazali*

This paper considers a Technician Routing and Scheduling Problem, where a Column Generation (CG) heuristic has been showed effective. This work propose new CG schemes to stabilize the CG process and thus to accelerate the CG matheuristics. Matheuristic resolution of CG subproblems allows to incorporate diversification of column generation. Furthermore, a tabu search matheuristic allows to generate aggressively columns at one iteration. Both techniques imply a better stability of the CG scheme, diversification being interesting for the first iteration whereas tabu intensification is especially useful for the last iterations. It implies a significant acceleration of the time required for CG.

15h20-16h00 Minimizing total completion time in the two-machine no-idle no-wait flow shop problem

Federico Della Croce*, Andrea Grosso and Fabio Salassa*

We consider the two-machine total completion time flow shop problem with additional requirements. These requirements are the so-called no-idle constraint where the machines must operate with no inserted idle time and the so-called no-wait constraint where jobs cannot wait between the end of an operation and the start of the following one. The problem is NP-hard in the strong sense. We propose a matheuristic approach that uses an ILP formulation based on positional completion times variables and exploits the structural properties of the problem. The proposed approach shows very competitive performances on instances with up 300 jobs in size.

16h00-16h30	Coffee Break

16h30-17h10 A Matheuristic for the combined master surgical scheduling and surgical cases assignment problem with bed levelling

Roberto Aringhieri, Paolo Landa and ***Simona Mancini***

The Master Surgical Scheduling and Surgical Cases Assignment is a relevant problem arising in healthcare. The problem consists into two decisions level. Firstly, ORs are assigned to specialties, and secondly, patients are selected and allocated to the Operating Rooms (ORs) assigned to each specialty. In ORs planning operations different performance criteria may be taken into account. Usually, patient priority maximization is the most common objectives in literature, but there are other important criteria such as the workload balance which aims for smooth bed occupancies in the departments. In this work we address a hierarchical multi-objective combined Master Surgical Scheduling and Surgical Cases Assignment problem with bed levelling and patient priority maximization. To solve the problem we propose a Multi-Neighborhood Local Search based Matheuristic in which several large neighborhoods are sequentially addressed by means of an Integer Programming (IP) model capable to exhaustively explore large neighborhoods in small computational times.

17h10-17h50 A set partitioning heuristic for the home health care routing and scheduling problem

Florian Grenouilleau*, Antoine Legrain, Nadia Lahrichi and Louis-Martin Rousseau*

The home health care routing and scheduling problem comprises the assignment and routing of a set of home care visits over the duration of a week. These services allow patients to remain in their own homes, thereby reducing governmental costs by decentralizing the care. In this work, we present a set partitioning heuristic which takes into account most of the industry's practical constraints. The developed method is based on a set partitioning formulation and a large neighborhood search framework. The algorithm solves a linear relaxation of a set partitioning model using the columns generated by the large neighborhood search. A constructive heuristic is then called to build an integer solution. Based on real instances provided by our industrial partner, the proposed method is able to provide a reduction in travel time by 37% and an increase by more than 16% in the continuity of care. We also provide a first public benchmark for this problem and evaluate the performance of our approach against an efficient ALNS approach to the problem.

18h30-20h30	Cocktail

TUESDAY 19

9h00-10h00 Hybrid Optimization: the many marriages of CP, MP, and SAT

Pascal Van Hentenryck

In recent years, novel hybridizations of constraint programming, mathematical programming, and satisfiability have emerged, primarily through novel frameworks building on top of column generation, Benders decomposition, and Lagrangian methods. This talk reviews some of the progress and opportunities in that space and their applications in scheduling and vehicle routing.

10h00-10h30	Coffee Break

10h30-11h10 Constructive matheuritic for container loading with complex practical constraints

Vittorio Maniezzo *and Marco A. Boschetti*

The container loading problem (CLP) of interest for this work consists in the orthogonal packing into a container of rectangular boxes of possibly widely different sizes. The actual case that motivated our research imposed a high number of practical constraints. It is well known that real-world container loading can require to deal with many and diverse operational constraints, which are rarely representatively considered in the optimization literature. The approach we propose takes into account most of the constraints reported in the literature, and other complex ones, such as varying container height, maximum weight per truck axel and box consolidation into bigger items, when content and destination permit, according to predefined patterns. It is also known that strongly constrained problems, with very sparse feasibility region, can preclude the effective use of basic heuristic or metaheuristic approaches, while lend themselves naturally to matheuristics. We propose a constructive greedy approach where, at each step, a look-ahead on an exponential set of possible extensions is evaluated by solving suitably defined knapsack instances. The use of the knapsack problem for estimating the best thing item has already been proposed for the 2D strip-packing problem, though we make a different use of the knapsack results. Moreover, the extensive use of knapsack bounds required specific adjustments to enable efficient computation.

11h10-11h50 Pattern based diving heuristics for a two-dimensional guillotine cutting-stock problem with leftovers

Francois Clautiaux, ***Ruslan Sadykov****, Francois Vanderbeck and Quentin Viaud*

We consider a variant of two-dimensional guillotine cutting-stock problem that arises when different bills of order (or batches) are considered consecutively. The raw material leftover of the last cutting pattern is not counted as waste as it can be reused for cutting the next batch. The objective is thus to maximize the length of the leftover. We propose a diving heuristic based on a Dantzig-Wolfe reformulation solved by column generation in which the pricing problem is solved using dynamic programming (DP). This DP generates so-called non-proper columns, i.e. cutting patterns that cannot participate in a feasible integer solution of the problem. We show how to adapt the standard diving heuristic to this "non-proper'' case while keeping its effectiveness. We also introduce the partial enumeration technique, which is designed to reduce the number of non-proper patterns in the solution space of the dynamic program. This technique helps to strengthen the lower bounds obtained by column generation and improve the quality of solutions found by the diving heuristic. Computational results are reported and compared on classical benchmarks from the literature as well as on new instances inspired from industrial data. According to these results, proposed diving algorithms outperform constructive and evolutionary heuristics.

11h50-12h30 A matheuristic approach for the design of multiproduct batch plants with parallel production lines

Floor Verbiest*, Trijntje Cornelissens and Johan Springael*

Batch processes are typically used to manufacture, among other, specialty and fine chemicals. As the construction of grass-root batch plants requires major investments, models for determining the optimal design of such plants have been developed over the past decades. These models are generally formulated as Mixed Integer Nonlinear Programming (MINLP) models which are solved exactly. In a previous study, we introduced the concept of parallel production lines as a design option into existing mathematical plant design models. The design problem now also aims at optimizing the number of production lines, their design and the allocation of products (and production quantities) to the installed lines. However, with this extension, the complexity increases significantly. To tackle this combinatorial divergence, we formulated a matheuristic solution approach which combines local search heuristics with exact MILP calculations. In this paper, the hybrid solution method is described and its performance, in comparison to an existing exact algorithm, is illustrated for several example problems. We found that our matheuristic obtained very good solutions in

significant lower computation time. As a consequence, this technique is suitable to solve more realistic instances and enables us to expand these design models with e.g. different objectives in the future.

12h30-14h00	Lunch

14h00-22h00	Excursion and dinner

Wednesday 20

9h00-10h00 Xpress Mosel - modern ways of developing mathematical optimization applications

Sebastien Lannez

The modelling and solving environment Xpress Mosel has recently been turned into free software. Mosel integrates with a variety of other languages and it has now also become possible to use alternative Mathematical Programming solvers from within the Mosel language, in addition to the FICO Xpress Solvers. In this contribution we show how other LP/MIP or NLP solvers can be connected to Mosel for use within the Mosel language. We will also demonstrate how to call Python, R or Java code from your Mosel application. We will conclude the talk with a presentation of the integrated development environment Xpress Workbench which allows model developers to deploy (and debug) optimization models as fully fledged web applications simply by adding some configurations.

10h00-10h30	Coffee Break

10h30-11h10 Hybrid approaches to optimize mixed-model assembly lines in low-volume manufacturing

Alexander Biele *and Lars Moench*

In this paper, a production planning problem for mixed-model assembly lines in low-volume manufacturing as can be found in aircraft manufacturing is considered. This type of manufacturing is labor-intensive. Low-volume production of huge-sized jobs, i.e. airplanes, is typical. Balancing labor costs and inventory holding costs assuming a given job sequence is the purpose of this paper. Therefore, worker assignments to each station and start times and processing times for each job on each station are determined. Two different mathematical models are proposed. The first formulation is a time-indexed linear formulation that allows for a flexible allocation of workers to periods and stations while the second one has a non-linear objective function and allows only for a fixed assignment of workers to stations. It is proven that the second formulation leads to a linear program with continuous decision variables if the values of the decision variables that determine the number of workers assigned to a station are given, while the first formulation contains even in this situation binary decision variables. Heuristics that hybridize the mathematical formulations with variable neighborhood search (VNS) techniques are proposed. Computational experiments on randomly generated problem instances and on real-world instances demonstrate the high performance of the heuristics.

11h10-11h50 Finding alternative solutions of interest for the cross-dock door assignment (CDAP) problem

Monique Guignard and ***Steven Kimbrough***

We explore the problem of discovering interesting non-optimal solutions ("solutions of interest'' or SoIs) in the context of the cross-dock door assignment problem (CDAP), a challenging integer programming problem that is quadratic in the objective. These solutions of interest may be feasible or infeasible, but potentially valuable for sensitivity analysis and other post-solution tasks. We compare the CHH (convex hull heuristic), a mathematical programming metaheuristic, with the FI-2Pop GA+SOI, an evolutionary computation metaheuristic.

11h50-12h30 Efficient and simple heuristics for the aircraft landing problem

***Amir Salehipour**, Mohammad Mahdi Ahmadian and Daniel Oron*

The Aircraft Landing Problem is a classical combinatorial optimization problem in which a set of arriving aircraft must be sequenced and scheduled to land on airport's runways, with the objective of minimizing total deviations from the estimated time of arrival. This work proposes two simple and efficient heuristics to solve the Aircraft Landing Problem on single runway. The proposed heuristics are based on rolling horizon, and iterated greedy frameworks. The motivation behind our work is to develop simple heuristics that are capable of delivering high quality solutions in a short amount of time. Due to the dynamic nature of the problem, i.e. flights arriving early, or late or even being canceled, operators will need to re-solve the problem on a regular basis and update landing schedules. This implies that fast algorithms are paramount. The computational experiments over a set of standard instances demonstrate that we fulfilled this aim, and that the proposed heuristics can obtain satisfactory and promising solutions in a short amount of time.

12h30-14h00	Lunch

14h00-14h40 Solving a special case of the graph edit distance problem with local branching

***Mostafa Darwiche**, Romain Raveaux, Donatello Conte and Vincent T'Kindt*

The Graph Edit Distance (GED) problem is a well-known graph matching problem. Solving the GED problem implies minimizing a dissimilarity measure between graphs that normally represent objects and patterns. It is known to be very flexible and can work on any type of graphs. GED^{EnA} (Edges no Attributes) is a sub-problem of GED that deals with a special type of graphs where edges do not carry attributes. Both are modeled as minimization problems and proven to be NP-Hard. Many heuristics are defined in the literature to give approximated solutions in a reasonable CPU time. Some other work have used mathematical programming to come up with Mixed Integer Linear Program (MILP) models. The present work takes advantage of a powerful MILP model and proposes a heuristic called Local Branching to solve the GED^{EnA} problem. Mainly, a MILP model is iteratively modified by adding additional constraints to define neighborhoods in the solution space which are explored using a black-box solver. A problem-dependent exploration is performed to find efficient solutions. Lastly, the proposed heuristic is evaluated w.r.t literature heuristics.

14h40-15h20 Analysis of a constructive matheuristic for the traveling umpire problem

***Reshma C. Chandrasekharan**, Tulio A. M. Toffolo and Tony Wauters*

The Traveling Umpire Problem (TUP) is a combinatorial optimization problem concerning the assignment of umpires to the games of a fixed double round-robin tournament. The TUP draws inspiration from the real world multi-objective Major League Baseball (MLB) umpire scheduling problem, but is, however, restricted to the single objective of minimizing total travel distance of the umpires. Several hard constraints are employed to enforce fairness when assigning umpires, making it a challenging optimization problem. The present work concerns a constructive matheuristic approach which focuses primarily on large benchmark instances. A decomposition-based approach is employed which sequentially solves Integer Programming (IP) formulations of the subproblems to arrive at a feasible solution for the entire problem. This constructive matheuristic efficiently generates feasible solutions and improves the best known solutions of large

benchmark instances of 26, 28, 30 and 32 teams well within the benchmark time limit. In addition, the algorithm is capable of producing feasible solutions for various small and medium benchmark instances competitive with those produced by other heuristic algorithms. The paper also details experiments conducted to evaluate various algorithmic design parameters such as subproblem size, overlap and objective functions.

15h20-16h00	Closing session