Programme Doctoral en Recherche Opérationnelle

Zinal Spring Seminar 2015, January 11–15

Draft program as of January 12, 2015

	Sunday 11	Monday 12	Tuesday 13	Wednesday 14	Thursday 15
07:30 - 08:30		Breakfast	Breakfast	Breakfast	Breakfast
08:30 - 10:00		Sim	Hochbaum	Sim	Hochbaum
10:00 - 10:30		Coffee	Coffee	Coffee	Coffee
10:30 - 12:00		Hochbaum	Sim	Hochbaum	Sim
12:00 - 17:00		Sport and discussions			
17:00 - 17:20		ORDECSYS	Robenek	Binder	
17:20 - 17:40			Valculescu	Ruiz Vargas	
17:40 - 18:00			Rihm	Nguyen	
18:00 - 18:20	Welcome cocktail		Norouzi-Fard	Kalaitzis	
18:20 - 18:40			Respen	Lamotte	
18:40 - 19:00					
19:30	Dinner	Dinner	Dinner	Dinner	

PhD talks on Tuesday 13: Chair Hochbaum
PhD talks on Wednesday 14: Chair Sim

Venue:
Hotel Europe
3961 Zinal
Tel.: 027 475 44 04

Public transport:
Station *Zinal Poste*

Sports options

- Skiing: http://www.rma.ch/anniviers/switzerland/ski-valais/winter-prices.html
  Bring your keycard from last year if possible.
- Tobogganing: Rent a toboggan for 12.- a day in every sports shop in Grimentz: http://www.valdanniviers.ch/tourism/luge-grimentz.html. Bus: Zinal 12:07 - Grimentz 12:26 and Grimentz 14:49 - Zinal 15:10 or Grimentz 16:22 - Zinal 16:43
- Ice Skating, for example in Zinal: Free entrance:
  http://www.valdanniviers.ch/tourism/skating-rinks-1609.html
- Curl'Charlette (a form of Curling): Equipment can be rented for free at the Tourist Office in Zinal. Max. 8 persons at the same time.

Keynote presentations

Melvyn Sim (NUS): **Robust Optimization**

Title: **Introduction to Robust Optimization and Conic Optimization**

Abstract: Provides the motivation of robust optimization from the modeling and decision analysis perspective. Introduces conic optimization as an extension of linear optimization with focus on second order conic programming (SOCP) models.

Title: **Classical Robust Optimization**

Abstract: Covers tractable reformulations of classical robust counterparts via conic techniques.

Title: **Distributionally Robust Optimization**

Abstract: Covers tractable reformulations of distributionally robust optimization problems with focus on safeguarding constraints.

Title: **Distributionally Robust Optimization Problems with Recourse**

Abstract: Introduce decision rules techniques for addressing distributionally robust optimization problems with recourse. Includes applications in project management and inventory control.

Dorit Hochbaum (UC Berkeley): **Monotone Inequalities and their Use in Efficient Integer Programming: Algorithms and Approximations**

In this series of lecture we explore integer programming problems with constraints that have a structure that is easily recognizable. Problems with such structure are commonplace and their presence implies immediately polynomial time algorithms that are based on flows.
We are interested here in integer optimization on constraints with at most two variables per inequality (2var), or constraints with at most three variables per inequality where one of the variables appear only in one constraint (3var). An inequality is said to be *monotone*, if the coefficients of the two variables in the inequality are of opposite signs and that the third variable appears in one constraint only.

Lecture 1

Abstract: We show that any monotone 2var integer program can be solved as a minimum cut problem on an associated graph. For a binary integer program on n variables and m constraints, the number of nodes in the graph is n and the number of arcs is m. For integer variables that can assume k_i values each the size of the graph is the sum of these k_i values. Though the size of this graph is pseudo-polynomial, it is proved that this complexity cannot be improved unless NP=P. We conclude that monotone 2var problems on bounded range are solvable in polynomial time, whereas monotone 2var problems on non-fixed ranges are *weakly NP-hard*, with several interesting implications.
In contrast to monotone 2var problems, non-monotone 2var problems, even on binary variables (the range is 1) are NP-hard. Any feasible non-monotone 2var integer programming problem has a polynomial time 2-approximation algorithm derived from solving the minimum cut problem on an associated graph.
Prominent NP-hard problems that can be formulated as 2var problems include: Independent set, vertex Cover, minimum satisfiability, min 2-SAT, the max clique represented as a min node deletion problem, several major submodular minimization problems and others. Interesting applications have been discovered to be polynomial time solvable, that are useful in data mining and image segmentation. Certain Rayleigh ratio problems and other ratio problems were shown to be polynomial time solvable with an extension of the techniques described.

Lecture 2

Abstract: We will show that monotone 3var integer programs on bounded range are solvable in polynomial time, also with a cut procedure on a related graph. For non-monotone 3var problems, that are NP-hard, the procedure generates superoptimal half integral solutions. However, unlike 2var problems, an approximate solution is not always possible to generate. Among the important applications of monotone 3var problems are the co-segmentation problem and the security alert problem.
An interesting special case of monotone 3var integer programs has the coefficients of the two variables of absolute value at most 1. For such binary coefficients we can solve convex minimization on monotone 3var constraints. We show that for the convex closure problem and the convex separation-deviation problem (often referred to as the Markov Random Fields problem) the approach delineated generates algorithms that are best possible in some provable sense. To establish best possibility we are utilizing results on the impossibility of strongly polynomial time for nonlin-

ear non quadratic objective on linear constraints problems. These problems have a vast array of applications that include: medical imaging, denoising and fidelity optimization (AKA total variation), ranking, and group decision problems.

Lecture 3

Abstract: In this lecture we will present several major applications of the technique for 2var or 3var monotone problems with a linear or ratio objective functions. In this lecture we will focus on the normalized cut problem and its applications in image segmentation and data mining.

Lecture 4

Abstract: We present convex nonlinear minimization problems over monotone 2var and 3var constraints. These problems include the convex closure problem, with applications to Bayesian estimation, and the Markov Random Field problem with applications to image segmentation groups decision making and aggregate ranking problems. It is shown that the resulting algorithms have best possible complexity and cannot be improve unless more efficient algorithms are devised for the minimum s,t-cut problem and the minimization of convex functions.

References

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Frédéric Babonneau: ORDECSYS: Presentation and projects overview

Abstract: ORDECSYS is a scientific consultancy company, a spin-off of the University of Geneva. It was founded in 2002 by Profesors Alain Haurie and Jean-PhilippeVial and its main objective is to provide private companies and public organisations with advanced operations research methods and techniques for decision-support in the domains of logistics, energy and environment. The talk will give an overview of the recent activities related to uncertainty and long-term energy modelling in the context of global energy transition (nuclear phase-out, renewable penetration, intermittency, stringent emissions abatement objectives, etc). In particular, the in-house robust ETEM model was developed through projects for the Swiss Federal Office of Energy, the Qatar foundation, the French Ministry of Energy, the EU FP7, etc.

PhD presentations

Tuesday 13: Chair Hochbaum

Tomas Robenek (EPFL)

Title: **Railway Passenger Service Timetabling - Passenger Point of View**

Abstract: The aim of this talk is to analyze and to improve the current planning process of the passenger railway service. At first, the state-of-the-art in research is presented. Given the recent changes in legislature allowing competitors to enter the railway industry in Europe, also known as liberalization of railways, the current way of planning does not reflect the situation anymore. The original planning is based on the accessibility/mobility concept provided by one carrier, whereas the competitive market consists of several carriers that are driven by the profit.
Moreover, the current practice does not define the ideal timetables (the initial most profitable timetables) and thus it is assumed that the Train Operating Companies (TOCs) use their historical data (train occupation, ticket sales, etc.) in order to construct the ideal timetables.
For the first time in this field, we tackle the problem of ideal timetables in railway industry from passenger behavior point of view. We propose the Ideal Train Timetabling Problem (ITTP) to create a list of train timetables for each TOC separately. The ITTP approach incorporates the passenger demand in the planning and its aim is to minimize the passengers' cost. The outcome of the ITTP is the ideal timetables (including connections between the trains), which then serve as inputs for the traditional Train Timetabling Problem (TTP).

References

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Discussants: Christos Kalaitzis, Antonin Danalet

Adrian-Claudiu Valculescu (EPFL)

Title: **Distinct point-line distances**

Abstract: Consider the following problem: given an arbitrary set P of n points in the plane, how many distinct distances from these points to lines spanned by P are there, for large n? In this talk, we sketch a proof of the lower bound $\Omega(n^{4/3})$ for these point-line distances under the assumption that not all the points lie on the same line, and state some related results. This is joint work with Micha Sharir, Shakhar Smorodinsky and Frank de Zeeuw.

References

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Discussants: Evanthia Kazagli, Napat Rujeerapaiboon

Tom Rihm (University of Bern)

Title: **An integer goal programming approach for a real-world shift scheduling problem**

Abstract: The shift scheduling problem under study consists of assigning employees to work shifts subject to a large variety of requirements related to work laws, work shift compatibility, workload balancing, and personal preferences of employees. Finding an assignment that fulfills all requirements is often impossible for real-world instances. However, not all requirements are equally important to the decision-maker, and the violation of some requirements is acceptable. We consider a real-world shift scheduling problem for which a mapping of requirement violations to integer acceptance values is given: e.g., for the requirement of an employee to have at least two weekends off, the violation of this requirement by one weekend receives a higher acceptance value than the violation by two weekends. The quality of a schedule is evaluated based on the number of requirement violations, with a reduction in the number of less-accepted violations being always preferred to any number of reductions in more-accepted violations. We propose a lexicographic goal programming approach, which builds on an efficient MILP model in which all requirements are treated as soft constraints. We report computational results for several instances.

References

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Discussants: Manuel Francesco Aprile, Salome Forrer

Ashkan Norouzi-Fard (EPFL)

Title: **Dynamic Facility Location via Exponential Clock**

Abstract: The *dynamic facility location problem* is a generalization of the classic facility location problem proposed by Eisenstat, Mathieu, and Schabanel to model the dynamics of evolving social/infrastructure networks. The generalization lies in that the distance metric between clients and facilities changes over time. This leads to a trade-off between optimizing the classic objective function and the "stability" of the solution: there is a switching cost charged every time a client changes the facility to which it is connected. While the standard linear program (LP) relaxation for the classic problem naturally extends to this problem, traditional LP-rounding techniques do not, as they are often sensitive to small changes in the metric resulting in frequent switches. We present a new LP-rounding algorithm for facility location problems, which yields the first constant approximation algorithm for the dynamic facility location problem. Our algorithm installs competing exponential clocks on the clients and facilities, and connect every client by the path that repeatedly follows the smallest clock in the neighborhood. The use of exponential clocks gives rise to several properties that distinguish our approach from previous LP-roundings for facility location problems. In particular, we use *no clustering* and we allow clients to connect through paths of *arbitrary lengths*. In fact, the clustering-free nature of our algorithm is crucial for applying our LP-rounding approach to the dynamic problem.

References

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Discussants: Stephane Bungener, Merve Kirci

Jean Respen (University of Geneva)

Title: **An integrated approach for inventory dispatching of luxury goods**

Abstract: The considered project aims at managing the dispatching of luxury watches of a famous Swiss brand around the globe. The considered supply chain is composed of three different levels: the factory, the wholesalers and the shops. The customers can only buy the watches at the different shops, which are located worldwide. The brand would like to improve its way to dispatch the produced watches from the factory to the different shops, whereas three types of perturbations can occur: (1) late delivery of raw material at the production's level; (2) unexpected deliveries from the wholesalers' level; (3) errors in the demand forecast at the customers' level).

References

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Discussants: Adrian Zimmermann, Igor Malinovic

Wednesday 14: Chair Sim

Stefan Binder (EPFL)

Title: **Generation and evaluation of passenger-oriented railway disposition timetables in case of severe disruptions**

Abstract: Delays are one of the major reasons for passenger dissatisfaction in the railway industry. Depending on the gravity of the delay, timetables, crew schedules or rolling stock may be affected. In this research, we address the issue of timetable recovery in case of severe disruptions. Once an initial delay has occurred, the original timetable needs to be updated to a so-called disposition timetable. This new timetable has to be conflict-free in terms of operational constraints (e.g., trains cannot use the same track section at the same time) and as convenient as possible for the passengers. The recent scientific literature on recovery models mainly focuses on the operational point of view, thus paying less attention to the impact of passenger dissatisfaction in case of disruptions. This observation is the motivation for introducing a hybrid methodology that takes the satisfaction of both parties (i.e., passengers and railway companies) into account. Our model focuses mainly on severe disruptions and can evaluate several recovery strategies (e.g., partial train cancellation, complete train cancellation, train addition, train replacement), based on a number of key performance indicators, such as passenger delay or number of connections. This model will assist train operating companies when evaluating the trade-off between economic and infrastructural feasibility of recovery schemes on the one hand side and passenger satisfaction on the other.

References

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Discussants: Oliver Strub, Stefano Moret

Andres Ruiz Vargas (EPFL)

Title: **Solving the stable set problem in terms of the odd cycle packing number**

Abstract: The stable set problem is as follows: given an undirected graph G find a maximum cardinality set of pairwise non-adjacent vertices. The problem is NP-hard to approximate with factor $n1 - e$ for any $e > 0[10, 22]$, where n is the number of vertices, and therefore there is no hope for good approximations in the general case. We study the stable set problem when restricted to graphs with bounded odd cycle packing number ocp(G), possibly by a function of n. This is the largest number of vertex-disjoint odd cycles in G. Equivalently, it is equal to the logarithm of the largest absolute value of a sub-determinant of the edge-node incidence matrix AG of G. Hence, if AG is totally unimodular ocp(G) = 0. Therefore, ocp(G) is a natural distance measure of AG to the set of totally unimodular matrices on a scale from 1 to n/3.
When ocp(G) = 0, the graph is bipartite and it is well known that stable set can be solved in polynomial time. Our results imply that the odd cycle packing number indeed strongly influences the approximability of stable set. More precisely, we obtain (i) a polynomial-time approximation scheme for graphs with $ocp(G) = o(n/logn)$. And (ii) an a-approximation algorithm for any graph where a smoothly increases from a constant to n as ocp(G) grows from $O(n/logn)$ to n/3. On the hardness side, we show that (iii) assuming the exponential-time hypothesis, stable set cannot be solved in polynomial time if $ocp(G) = O(log1 + en)$ for some $e > 0$. Finally, we (iv) generalize a theorem by Györi et al. [8] and show that graphs without odd cycles of small weight can be made bipartite by removing a small number of vertices. This allows us to extend some of our above results to the weighted stable set problem.
This is joint work with Adrian Bock, Yuri Faenza, Carsten Moldenhauer.

Discussants: Hossein Nassajian Mojarrad, Anna Fernández Antolín

Thi Viet Ly Nguyen (IDSIA)

Title: **Matheuristic Optimization for Robust Home Health Care Service**

Abstract: Nowadays, people are increasingly relying on home health care services to improve life expectancy. In our previous study [4], we had worked on the optimization problem of routing and scheduling the nurses, so that the patients are visited efficiently. In this paper, we consider uncertainty: some nurses could call sick and not be available. Under such a scenario, external nurses, who are more costly, would have to be hired to visit the patients of the missing nurses. To solve the problem with this uncertainty on the nurse availability, we first propose a new constructive heuristic to generate initial solutions. Then, we propose a matheuristic approach [3]: that hybridized a mathematical programming with a genetic algorithm [2]. To handle uncertainty, we follow the principles of robust optimization methodology proposed in [1]. In that approach, a degree of conservatism can be configured by the decision maker, which is, in our case, the maximum number of missing nurses. According to the degree of conservatism, the method identifies the worst-case scenario and finds a solution which works reliably even under that worst-case scenario.

References

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Discussants: Marjia Nikolic, Soroosh Shafieezadeh Abadeh

Christos Kalaitzis (EPFL)

Title: **Combinatorial Algorithm for Restricted Max-Min Fair Allocation**

Abstract: We study the basic allocation problem of assigning resources to players so as to maximize fairness. This is one of the few natural problems that enjoys the intriguing status of having a better estimation algorithm than approximation algorithm. Indeed, a certain configuration-LP can be used to estimate the value of the optimal allocation to within a factor of 4+?. In contrast, however, the best known approximation algorithm for the problem has an unspecified large constant guarantee.
In this paper we significantly narrow this gap by giving a 13-approximation algorithm for the problem. Our approach develops a local search technique introduced by Haxell for hypergraph matchings, and later used in this context by Asadpour, Feige, and Saberi. For our local search procedure to terminate in polynomial time, we introduce several new ideas such as lazy updates and greedy players. Besides the improved approximation guarantee, the highlight of our approach is that it is purely combinatorial and uses the configuration-LP only in the analysis.

References

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Discussants: Alfonso Cevallos, Iliya Markov

Raphaël Lamotte (EPFL)

Title: **Dynamic Traffic modelling: Approximating the equilibrium for peak periods in urban areas**

Abstract: This talk addresses the problem of the choice of departure time in cities subject to heavy congestion. The model originally developed by Vickrey (1) and extended by many authors was developed for bottlenecks with constant capacity. While this assumption might be reasonable for physical bottlenecks submitted to light congestion, empirical evidence shows that in urban networks, the trip completion rate strongly depends on the density (2). Several analytical approaches have been proposed to address this shortcoming, but they all rely on some simplifications. In this presentation, the impact of these simplifications on the traffic flow dynamics is evaluated using different scenarios. Then, a heuristic is proposed to approximate the equilibrium with more realistic assumptions and the results are compared with those that can be obtained with the previously mentioned simplifications. While analytical solutions assuming a constant capacity remain useful to design system optimum solutions, the heuristic proposed is complementary and allows addressing the user equilibrium problem. This talk concludes by presenting how this tool can be used to create strategies to alleviate peak-hour congestion in urban areas.

References

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Discussants: Ioannis Lamprou, Lauri Saarinen