EUSACOU Workshop

Wednesday 11 June, 2014
Tinbergen Institute

Program

11.00 - 12.15:
Leo van Iersel (CWI) Parameterized algorithms for reconstructing phylogenetic networks
Martijn van EE (VU) Approximation of a priori routing problems
René Sitters (VU) Polynomial time approximation schemes for the traveling repairman
and other minimum latency problems

12.15 - 13.45:
Lunch

13.45 - 15.00:
Neil Olver (VU) Steiner tree relaxations
Tobias Harks (UM) Resource competition on integral polymatroids
Bart de Keijzer (UoR Sapienza) Shapley Meets Shapley

15.00 - 15.30:
Break

15.30 - 16.45:
Tim Oosterwijk (UM) High multiplicity scheduling with switching costs for few products
Suzanne van der Ster (VU) Split scheduling with uniform setup times
José Verschae (U Chile) Strong LP formulations for scheduling splittable jobs on
unrelated machines

18.00 - . . . :
Dinner (Restaurant Papatya, Buitenbrouwersstraat 19)

Location
Tinbergen Institute
Room 1.60
Symphony Tower
Gustav Mahlerplein 117
1082 MS Amsterdam

Organizers
Leen Stougie (VU)
Tjark Vredeveld (UM)
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EU-IRSES grant EUSACOU (Grant nr. 247574)
Tinbergen Institute
Vrije Universiteit
Maastricht University
Suzanne van der Ster (Vrije Universiteit, Amsterdam)
Title: Split scheduling with uniform setup times
Abstract: We study a scheduling problem in which jobs may be split into parts, where the parts of a split job may be processed simultaneously on more than one machine. Each part of a job requires a setup time, however, on the machine where the job part is processed. During setup, a machine cannot process or set up any other job. We concentrate on the basic case in which setup times are job-, machine-, and sequence-independent. The result that will be presented is a polynomial-time algorithm for minimizing total completion time on two parallel identical machines.
This is joint work with Frans Schalekamp, Rene Sitters, Leen Stougie, Victor Verdugo, Anke van Zuylen.

José Verschae (Universidad de Chile, Santiago)
Title: Strong LP formulations for scheduling splittable jobs on unrelated machines
Abstract: We consider a natural scheduling problem where we need to assign a set of jobs to machines in order to minimize the makespan, i.e., the time where the last job finishes. In our variant jobs may be split into parts, where each part can be (simultaneously) processed on different machines. Splitting jobs can help balancing the load of the machines, but this is not for free: each part requires a setup time which increases the processing requirement of the job. I will introduce the problem and present approximation algorithms based on rounding and linear programming (LP) relaxations. Our main result is a \((1 + \varphi)\)-approximation algorithm, where \(\varphi = 1.618\) is the golden ratio. This ratio is best possible for this LP. On the negative side we show that the problem is NP-hard to approximate within a factor of 1.582.
This is joint work with J.R. Correa, A. Marchetti-Spaccamela, J. Matuschke, O. Svensson, L. Stougie and V. Verdugo.
Abstracts

Leo van Iersel (Centrum voor Wiskunde en Informatica, Amsterdam)
Title: Parameterized algorithms for reconstructing phylogenetic networks
Abstract: Phylogenetic networks are leaf-labelled directed acyclic graphs that are used to describe evolutionary histories. The hybridization number of a phylogenetic network is the number of vertices with indegree two (assuming without loss of generality that the maximum indegree is two). A phylogenetic tree is a phylogenetic network with hybridization number zero. The Hybridization Number problem takes as input a collection of phylogenetic trees and asks to construct a phylogenetic network that contains an embedding of each of the input trees and has smallest possibly hybridization number. If the input to this problem consists of any constant number of nonbinary trees, then we can reduce such an instance in polynomial time to a smaller instance whose size is bounded by a polynomial function of the hybridization number, i.e. this (mildly) restricted version of the problem admits a polynomial kernel. From this it follows directly that the problem is fixed-parameter tractable (FPT), i.e. that it can be solved in $O(f(k)\text{poly}(n))$ time, with $k$ the hybridization number, $n$ the number of leaves and $f$ some computable function. However, such an FPT algorithm can only be useful if the function $f$ does not grow too fast and it is still not clear whether an $O(c^k\text{poly}(n))$ time algorithms exists, for a constant $c$. Recently we have made progress in this direction by showing the existence of an $O(c^k\text{poly}(n))$ time algorithm for the case of three binary trees. Such an algorithm was already known to exist for two binary trees, but that algorithm could not easily be generalized to three trees. Moreover, it is still not clear whether such an algorithm remains possible for four or more binary trees, or for nonbinary trees.

This is joint work with Steven Kelk, Nela Lekic, Chris Whidden and Norbert Zeh.
Bart de Keijzer (Sapienza Università di Roma)
Title: Shapley Meets Shapley
Abstract: This talk will be about the problem of computing the Shapley value in matching games. Matching games constitute a fundamental class of cooperative games which help understand and model auctions and assignments. In a matching game, the value of a coalition of vertices is the weight of the maximum size matching in the subgraph induced by the coalition. The Shapley value is one of the most important solution concepts in cooperative game theory. After establishing some general insights, we show that the Shapley value of matching games can be computed in polynomial time for some special cases: graphs with maximum degree two, and graphs that have a small modular decomposition into cliques or cocliques (complete k-partite graphs are a notable special case of this). The latter result extends to various other well-known classes of graph-based cooperative games. We continue by showing that computing the Shapley value of unweighted matching games is #P-complete in general. Finally, a fully polynomial-time randomized approximation scheme (FPRAS) is presented. This FPRAS can be considered the best positive result conceivable, in view of the #P-completeness result.

This is joint work with Haris Aziz.

Tim Oosterwijk (Maastricht University)
Title: High multiplicity scheduling with switching costs for few products
Abstract: We study several variants of the single machine capacitated lot sizing problem with sequence-dependent setup costs and product-dependent inventory costs. Here we are given one machine and $k \geq 1$ types of products that need to be scheduled, each associated with a constant demand rate $d_i$, production rate $p_i$ and inventory costs per unit $h_i$. When the machine switches from producing product $i$ to product $j$, setup costs $s_{ij}$ are incurred. We distinguish three cases of the problem and characterize feasible instances. We prove the decision variants for $k = 1$ are in P and we provide an algorithm which outputs a polynomial-sized representation of an optimal schedule. We also solve one of the cases for $k = 2$ by proving results on the structure of the schedule.

This is joint work with Michaël Gabay, Alexander Grigoriev and Vincent Kreuzen.
Martijn van Ee (Vrije Universiteit, Amsterdam)
Title: Approximation of a priori routing problems
Abstract: The field of a priori optimization is an interesting subfield of stochastic combinatorial optimization that is well suited for routing problems. In this setting, there is a probability distribution over active sets, vertices that have to be visited. For a fixed tour, the solution on an active set is obtained by restricting the solution on the active set. In the a priori traveling salesman problem (TSP), the goal is to find a tour that minimizes the expected length. In the a priori traveling repairman problem (TRP), the goal is to find a tour that minimizes the expected sum of latencies. In this talk, I will show how we obtained the first constant-factor approximation for a priori TRP. I will also discuss how we reduced the approximation guarantee of a priori TSP from 4 to 3.5 in the independent decision model.

This is joint work with René Sitters.

René Sitters (Vrije Universiteit, Amsterdam)
Title: Polynomial time approximation schemes for the traveling repairman and other minimum latency problems
Abstract: We give a polynomial time, $(1 + \epsilon)$-approximation algorithm for the traveling repairman problem (TRP) in the Euclidean plane, on weighted planar graphs, and on weighted trees. This improves on the known quasi-polynomial time approximation schemes for these problems. The algorithm is based on a simple technique that reduces the TRP to what we call the segmented TSP. Here, we are given numbers $l_1, \ldots, l_K$ and $n_1, \ldots, n_K$ and we need to find a path that visits at least $n_h$ points within path distance $l_h$ from the starting point for all $h \in \{1, \ldots, K\}$. A solution is $\alpha$-approximate if at least $n_h$ points are visited within distance $\alpha l_h$. It is shown that any algorithm that is $\alpha$-approximate for every constant $K$ in some metric space, gives an $\alpha(1 + \epsilon)$-approximation for the TRP in the same metric space. Subsequently, approximation schemes are given for this segmented TSP problem in different metric spaces. The segmented TSP with only one segment ($K = 1$) is equivalent to the $k$-TSP for which a $(2 + \epsilon)$-approximation is known for a general metric space. Hence, this approach through the segmented TSP gives new impulse for improving on the 3.59-approximation for TRP in a general metric space. A similar reduction applies to many other minimum latency problems. To illustrate the strength of this approach we apply it to the well-studied scheduling problem of minimizing total weighted completion time under precedence constraints, $1|\text{prec}| \sum w_j C_j$, and present a polynomial time approximation scheme for the case of interval order precedence constraints. This improves on the known $3/2$-approximation for this problem. Both approximation schemes apply as well if release dates are added to the problem.
Neil Olver (Vrije Universiteit, Amsterdam)
Title: Steiner tree relaxations
Abstract: The Steiner tree problem - find the cheapest way of connecting some subset of the vertices of a given graph - is a fundamental one in network design. A recent algorithmic breakthrough of Byrka et al. for the problem is based on a particular rather complicated linear program relaxation. I will discuss some recent work on relating this relaxation to a very classical, much simpler relaxation (for a certain class of instances), and the algorithmic significance of this.

This is joint work with Andreas Feldman, Jochen Konemann and Laura Sanita.

Tobias Harks (Maastricht University)
Title: Resource competition on integral polymatroids
Abstract: We study competitive resource allocation problems in which a set of players distribute their demands integrally on a set of resources subject to player-specific submodular capacity constraints. Each player has to pay for each unit demand a cost that is a nondecreasing and convex function of the total allocation of that resource. This general model of resource allocation generalizes both singleton congestion games with integer-splittable demands and matroid congestion games with player-specific costs. As our main result, we give an algorithm computing a pure Nash equilibrium. The proof rests on a structural result on the sensitivity of optimal solutions minimizing some linear objective over an integral polymatroid base polyhedron which is of independent interest.

This is joint work with Max Klimm and Britta Peis.