ECCO XXVIII - 2015

28th Conference of the European Chapter on Combinatorial Optimization

Dept. of Economics and Business
University of Catania
May 28th - 30th, 2015

Program Committee

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Benedetto Matarazzo (Chairman)	University of Catania
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Contents

1. Location and Transportation

1.1 Conference Venue and local information

The conference will take place in Palazzo delle Scienze. It is located in the centre of Catania (Corso Italia, 55), close to the court, and was completed in the 1940. Today, it is the venue of Department of Economics and business.

The University of Catania is the oldest university in Sicily, and the 13th oldest in Italy. Its establishment dates back to 1434. It is composed of twenty departments, and students attending its courses are about 60,000. Catania is the second most populated city of Sicily and it sited at the foot of Etna, the highest active volcano in Europe born from a submarine eruption 500-600 thousand years ago, and it is on the Ionio sea. The rich history and culture of the town is due to different occupations of Greeks, Romans, Arabs, Normans, Svevians, Aragonites, Angió and Spanish, bringing with them their uses and knowledge inherited from Catania. Monuments and churches present in the city are the result of these different cultures. The city centre has been inserted in the World Heritage list of UNESCO and many important monuments can be visited there like the Duomo of Catania, Piazza Stesicoro, Ursino Castle, Palazzo del Seminario, Porta Uzeda, Palazzo degli Elefanti, the Cathedral, piazza teatro Bellini , Benedettini monastery only to mention some of them. Some interesting sightseeing walks of the town can be visited at the following webpage.

Catania is well connected with many other interesting sites. Buses for Etna, the airport, Palermo and various nearby towns depart from the squares near the railway station (there are several different bus lines with offices in front of the main square). Fontanarossa Airport is only about 20 minutes from Catania. There are also fairly frequent train departures to Taormina, Siracusa, Messina and the mainland. From Catania you can reach other wonderful places to visit and enjoy: Acitrezza, Aci Castello, Taormina for their seaside; Enna, the highest Italian province (931 metres), Piazza Armerina very well known for its churches and mosaics, Modica for the baroque churches and its chocolate well-known over the world, Siracusa for its archeolagical sites and museums, Ragusa, Noto, Erice, and many other wonderful places.

If you would like to combine good views to good dishes, then Catania is perfect for your scope. At every corner of the town you can find places where you can taste delicious plates like Pasta Norma (from one of the finest works of the famous composer Vincenzo Bellini), "arancini" (very tasteful rice balls), "pasta con le sarde", caponata, crespelle, "cannoli di ricotta", cassata, dishes based on the original pistacchio of Bronte and many other dishes.

1.2 Travel to Catania

The airport of Catania (one airport under two names: "Vincenzo Bellini", new name, or "Fontanarossa", former name) is well connected by several daily flights from the airports of Roma or Milano and other many Italian airports. There are also direct flights from/to some major European cities (London, Paris, Bruxelles, Munich, Madrid, Barcelona, Zurich, etc.).

1.3 Transport from the airport to the conference venue

Arriving at the airport of Catania you can take the city bus Alibus (there is one every 20 minutes) to reach the conference venue (Corso Italia stop) or the other suggested hotels (piazza Trento and piazza Verga stop), or you can take a taxi. Conference participants can also land to Palermo airport or to Trapani airport. If you land to Trapani airport, first you have to go to Palermo by bus and then to reach Catania you can take a bus. After arriving at the railway station you need to take the tube or the bus to reach conference venue (Palazzo delle Scienze) or the hotels.

2. Schedule Overview

Wednesday, May, 27th	16:00 - 19:30	Registration opens
Thursday, May, 28th	09:00 - 09:30	Conference Opening
	09:30 - 10:30	Plenary Talk by Jack Edmonds
		Coffee Break
	11:00 - 12:30	Morning Sessions
		Lunch Break
	14:00 - 15:00	Plenary Talk by Erwin Pesch
		Coffee Break
	15:30 - 17:30	Afternoon Sessions
Friday, May, 29th	09:00 - 10:00	Plenary Talk by Roman Słowiński
		Coffee Break
	10:30 - 12:00	Morning Sessions
		Lunch Break
	14:30 - 23:00	Social Activities
Saturday, May, 30th	09:00 - 10:00	Plenary Talk by Tamás Kis
		Coffee Break
	10:30 - 12:30	Morning Sessions
	12:30 - 12:45	Closing Session
	12:45 - 14:00	Lunch Break

Your name badge serves as a coffee and lunch voucher.

2.1 Registration

Conference material will be provided upon check-in at our registration desk. You can check in to the conference at the conference venue starting from Wednesday Afternoon. Last-minute changes to the conference program will be posted at the registration desk. If you need help with anything please also report to the registration desk.

Wednesday, May 27th	16:00 - 19:30	*Palazzo delle Scienze, Corso Italia 55, Catania*
Thursday, May 28th	08:30 - 17:30	*Palazzo delle Scienze, Corso Italia 55, Catania*
Friday, May 29th	08:30 - 14:30	*Palazzo delle Scienze, Corso Italia 55, Catania*

3. Social Program

The social activities, that will take place in Taormina on Friday, May 29th, will start at 14:30 from the "Palazzo delle Scienze".

We shall visit the Ancient Greek theatre and, then, we shall enjoy together the social banquet that will be held at the "Porta Messina" restaurant.

4. Session Overview

4.1 Thursday, May 28th, 2015

Conference Opening

Chair: Salvatore Greco, Benedetto Matarazzo

09:00 - 09:30	**Michela Cavallaro**	Director of the Department of Economics and Business / University of Catania
	Silvano Martello	ECCO board

Plenary Talk

Chair: Silvano Martello

09:30 - 10:30	**Existential Polytime and Polyhedral Combinatorics** *Jack Edmonds (York University)*	(→p.19)

Thursday, May 28th, 2015: Morning Sessions

Thursday 11:00 - 12:30, Session 1

Chair: Chris Potts

11:00 - 11:30	**Novel Formulations for General Stackelberg Games and Stackelberg Security Games** *Carlos Casorrán-Amilburu*, Bernard Fortz, Martine Labbé and Fernando Ordonez	(→p.19)
11:30 - 12:00	**Pairing Games and Markets** *Ahmet Alkan* and Alparslan Tuncay	(→p.19)
12:00 - 12:30	**Supplier Competition with Option Contracts for Discrete Blocks of Capacity** Edward Anderson, *Bo Chen* and Lusheng Shao	(→p.20)

Thursday 11:00 - 12:30, Session 2

Chair: Alain Hertz

11:00 - 11:30	**Dominating induced matchings in graphs containing no long claw** *Alain Hertz*, Vadim Lozin, Bernard Ries, Victor Zamaraev and Dominique de Werra	(→p.21)
11:30 - 12:00	**Asymptotically optimal algorithm for random UNI(0,1) k-cycles cover of the undirected graph** *Edward Kh. Gimadi*	(→p.21)
12:00 - 12:30	**Complexity results on dominating codes in graphs** *Olivier Hudry* and Antoine Lobstein	(→p.21)

Thursday 11:00 - 12:30, Session 3

Chair: Hande Yaman

11:00 - 11:30	**Traveling Salesman Problem with Sales** *Hande Yaman*	(→p.22)
11:30 - 12:00	**Bin Packing and Cutting Stock Problems: Mathematical Models and Exact Algorithms** *Maxence Delorme*, Manuel Iori and Silvano Martello	(→p.23)
12:00 - 12:30	**Online Algorithms for the Newsvendor Problem** *Esther Mohr*	(→p.23)

Thursday 11:00 - 12:30, Session 4

Chair: Vitaly Strusevich

11:00 - 11:30	**Differential Approximation Schemes for Minimizinng Quadratic Boolean Functions and Their Scheduling Applications** Rebecca Sarto Basso and *Vitaly Strusevich*	(→p.24)
11:30 - 12:00	**Scheduling fixed position maintenance operations** *Maciej Drozdowski*, Florian Jaehn and Radoslaw Paszkowski	(→p.25)
12:00 - 12:30	**Metaheuristics for discrete-continuous project scheduling with activities of identical processing rates** *Grzegorz Waligóra*	(→p.25)

Thursday 11:00 - 12:30, Session 5

Chair: Marek Mika

11:00 - 11:30	**Robust Multicast Capacity with Network Coding** Mohammad Raayatpanah, Hossein Ghasvari and Salman Khodayifar	(→p.27)
11:30 - 12:00	**Project scheduling problem with transportation network and on/off energy consumption model** *Marek Mika*	(→p.27)
12:00 - 12:30	**Polynomial Time Approximation Scheme for Euclidean Minimum-weight k-Size Cycle Cover Problem on the plane** *Michael Khachay* and Katherine Neznakhina	(→p.28)

Thursday 11:00 - 12:30, Session 6

Chair: Peter Gritzmann

11:00 - 11:30	**Approximation of the Largest Common Point Set Problem for an Application in Sheet Metal Forming** Peter Gritzmann, *Michael Ritter* and Felix Schmiedl	(→p.28)
11:30 - 12:00	**FPTAS for special case of a quadratic Euclidean bi-partitioning problem** Alexander Kelmanov and *Vladimir Khandeev*	(→p.29)
12:00 - 12:30	**NP-hardness of Euclidean Balanced Variance-based bi-Clustering Problem with Given Center of one Cluster** Alexander Kelmanov and *Artem Pyatkin*	(→p.29)

Thursday 11:00 - 12:30, Session 7

Chair: Gebrail Bekdaş

11:00 - 11:30	**Optimization of Tuned Mass Dampers for Mechanical Systems Subjected to Different Excitations** Gebrail Bekdaş and *Sinan Melih Nigdeli*	(→p.30)
11:30 - 12:00	**The p-maxian Problems** *Mohammadreza Galavii*	(→p.30)
12:00 - 12:30	**Efficiency of computer-aided platforms in supporting optimisation of media planning** Włodzimierz Rembisz, Szczepan Ruman and Jakub Gwizdak	(→p.31)

Plenary Talk

Chairman: Jacek Blazewicz

14:00 - 15:00	**Optimization Problems in Intermodal Transport** *Erwin Pesch (Universität Siegen)*	(→p.31)

Thursday, May 28th, 2015: Late Afternoon Sessions

Thursday 15:30 - 17:30, Session 1

Chair: Hadrien Mélot

15:30 - 16:00	**Minimum number of non-equivalent colorings for graphs with maximum degree at most n-3** Romain Absil, Eglantine Camby, Alain Hertz and *Hadrien Mélot*	(→p.32)
16:00 - 16:30	**Cycle polytope on bipartite graph** *Lamia Aoudia*, Méziane Aïder and Viet Hung Nguyen	(→p.32)
16:30 - 17:00	**Adapted Floyd-Warshall Algorithm for Solving a Problem of Traveling Visitor** *Milan Djordjevic*	(→p.33)
17:00 - 17:30	**Linearizable quadratic minimum spanning tree problems and related polynomially solvable special cases** *Ante Custic* and Abraham Punnen	(→p.33)

Thursday 15:30 - 17:30, Session 2

Chair: Malgorzata Sterna

15:30 - 16:00	**Late Work Scheduling in On-Line Mode** *Malgorzata Sterna*, Xin Chen, Xin Han and Jacek Blazewicz	(→p.34)
16:00 - 16:30	**On polynomial asymptotically optimal algorithms for some hard routing problems** Edward Kh. Gimadi and *Oxana Tsidulko*	(→p.34)
16:30 - 17:00	**Exact solution procedures for the resource-constrained project scheduling problem with general temporal constraints and calendars** *Stefan Kreter* and Jürgen Zimmermann	(→p.35)
17:00 - 17:30	**New mathematical models for order acceptance and scheduling problems** *Saeed Saffari* and Ceyda Oguz	(→p.36)

Thursday 15:30 - 17:30, Session 3

Chair: Gebrail Bekdaş

15:30 - 16:00	**A Memetic Algorithm for the periodic Inventory Routing Problem (IRP)** *Ioannis Mitsopoulos* and Stella Sofianopoulou	(→p.37)
16:00 - 16:30	**Variable neighborhood search heuristics for a test assembly design problem** *Mariona Vilà* and Jordi Pereira	(→p.37)
16:30 - 17:00	**Optimum Structural Design of Pin-Jointed Plane Frames Using the Flower Pollination Algorithm** Sinan Melih Nigdeli, *Gebrail Bekdaş* and Xin-She Yang	(→p.38)
17:00 - 17:30	**Heuristic approach for peptide assembly problem** *Marcin Borowski*	(→p.38)

Thursday 15:30 - 17:30, Session 4

Chair: Jadranka Skorin-Kapov

15:30 - 16:00	**Reliability Evaluation for coded packet networks** *Mohammad Raayatpanah*	(→p.39)
16:00 - 16:30	**On Monotonicity in Steiner Tree Network Games** Darko Skorin-Kapov and *Jadranka Skorin-Kapov*	(→p.39)
16:30 - 17:00	**Network construction problems with due dates** *Igor Averbakh* and Jorge Pereira	(→p.40)
17:00 - 17:30	**A fast polynomial time algorithm for minimum flow problem on dynamic network flows with time varying bounds** *Salman Khodayifar*	(→p.40)

Thursday 15:30 - 17:30, Session 5

Chair: Leo Liberti

15:30 - 16:00	**Generalized power diagrams, balanced k-means, and the representation of polycrystals** *Peter Gritzmann*	(→p.41)
16:00 - 16:30	**Generalizing facets of the Hop-Constrained Path Polytope** *Wolfgang F. Riedl*	(→p.41)
16:30 - 17:00	**Discretization vertex orders in distance geometry** *Leo Liberti*, Andrea Cassioli, Oktay Gunluk and Carlile Lavor	(→p.41)
17:00 - 17:30	**A discrete optimization approach for tracking particles in plasma** *Andreas Alpers* and Peter Gritzmann	(→p.42)

Thursday 15:30 - 17:30, Session 6

Chair: Bo Chen

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16:00 - 16:30	**An Approximation for Single-Channel Multi-Server Queues with Generally Distributed Inter-Arrival and Service Times** *Carlos Chaves* and Abhijit Gosavi	(→p.43)
16:30 - 17:00	**Sectorization: measures and an electromagnetism based approach** *José Soeiro Ferreira* and Ana Maria Rodrigues	(→p.43)
17:00 - 17:30	**Benders Cuts for Power System Design - A Geometric Perspective** *Paul Stursberg*	(→p.44)

Friday 15:30 - 17:30, Session 7

Chair: Marta Szachniuk

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16:00 - 16:30	**Applications of RNA trigonometric model** *Marta Szachniuk*, Tomasz Zok and Maciej Antczak	(→p.45)
16:30 - 17:00	**New in silico approach to assess RNA secondary structures with non-canonical base pairs** *Natalia Szostak*, Agnieszka Rybarczyk, Maciej Antczak, Tomasz Zok, Mariusz Popenda, Ryszard Adamiak, Jacek Blazewicz, and Marta Szachniuk	(→p.46)
17:00 - 17:30	**De novo genome assembly with the acceleration of GPU computing** *Aleksandra Swiercz*, Michal Kierzynka, Wojciech Frohmberg, Piotr Zurkowski, Jacek Blazewicz, Marta Kasprzak and Pawel Wojciechowski	(→p.47)

4.2 Friday, May 29th, 2015

Plenary Talk

Chairman: Benedetto Matarazzo

09:00 - 10:00	**Preference-driven evolutionary multiobjective combinatorial optimization with Choquet integral preference model** *Roman Słowiński (Poznan University of Technology and Polish Academy of Sciences)*	(→p.48)

Friday, May 29th, 2015: Morning Sessions

Friday 10:30 - 12:00, Session 1

Chair: Jan Weglarz

10:30 - 11:00	**Heuristic approaches for solving a machine scheduling problem with additional doubly-constrained resource** *Rafal Rozycki* and Jan Weglarz	(→p.49)
11:00 - 11:30	**Stability Analysis of Scenarios based Solutions for Robust Unrelated Parallel Machines Scheduling** Widad Naji, *Van-Dat Cung* and Marie-Laure Espinouse	(→p.50)
11:30 - 12:00	**Single machine scheduling to minimize total earliness-tardiness with unavailability period** Enrique Gerstl and *Gur Mosheiov*	(→p.52)

Friday 10:30 - 12:00, Session 2

Chair: Michel Minoux

Friday 10:30 - 12:00, Session 3

Chair: Edward Kh. Gimadi

10:30 - 11:00	**A MIP formulation and heuristic for a dynamic distribution network design problem - Case study in the automotive industry** *Mouna Kchaou Boujelben*, Celine Gicquel and Michel Minoux	(→p.53)
11:00 - 11:30	**An Exact Enumerative Algorithm for Counting Independent Sets** *Guillermo De Ita*, Raymundo Marcial-Romero and Yolanda Moyao	(→p.54)
11:30 - 12:00	**Euclidean k-cycles cover problem on maximum: asymptotically optimal approach** Edward Kh. Gimadi and *Ivan A. Rykov*	(→p.55)

Friday 10:30 - 12:00, Session 4

Chair: Mario Pavone

10:30 - 11:00	**Optimization-based heuristic for the Asymmetric Capacitated Vehicle Routing Problem** *Valeria Leggieri* and Mohamed Haouari	(→p.55)
11:00 - 11:30	**An intelligent extension of Variable Neighbourhood Search for labelling graph problems** *Sergio Consoli* and José Andrés Moreno Pérez	(→p.55)
11:30 - 12:00	**A binary artificial bee colony algorithm for optimal wind turbine placement in wind farms** *Alkin Yurtkuran* and Erdal Emel	(→p.56)

4.3 Saturday, May 30th, 2015

Plenary Talk

Chairman: Salvatore Greco

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Saturday, May 30th, 2015: Morning Sessions

Saturday 10:30 - 12:30, Session 1

Chair: Paolo Toth

10:30 - 11:00	**A Unified Method for Constrained Assortment and Pricing Problems under the Consumer Choice Models** *Ruxian Wang*	(→p.57)
11:00 - 11:30	**Rolling horizon approaches to the aircraft sequencing problem** Fabio Furini, Martin Philip Kidd, Carlo Alfredo Persiani and *Paolo Toth*	(→p.57)
11:30 - 12:00	**Workload Balancing at Intermodal Container Terminals and Sea Ports** *Dominik Kress*, Sebastian Meiswinkel and Erwin Pesch	(→p.58)
12:00 - 12:30	**Polynomially Solvable Knapsack Type Problems with Box Constraints on Combinatorial Structures** *Evgeny Gurevsky*, Sergey Kovalev and Mikhail Kovalyov	(→p.58)

Saturday 10:30 - 12:30, Session 2

Chair: José Figueira

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11:00 - 11:30	**Linear bilevel programs with multiple objectives at both levels** *Majid Zohrehbandian*	(→p.59)
11:30 - 12:00	**Multi-objective optimization in partitioning the healthcare system of Parana State in Brazil** *José Figueira*, Maria Teresinga Arns Steiner, Dilip Datta, Pedro José Steiner Neto and Cassius Tadeu Scarpin	(→p.60)
12:00 - 12:30	**Warehouse Selection based on Fuzzy ELECTRE** Babak Daneshvar Rouyendegh and Yousef Daneshvar Rouyandozagh	(→p.60)

Saturday 10:30 - 12:30, Session 3

Chair: Van-Dat Cung

10:30 - 11:00	**Mathematical models and approaches in problem of volume planning of ISS cosmonauts trainings** Sergey Bronnikov, *Alexander Lazarev*, Nikolai Morozov, Maksim Kharlamov and Denis Yadrentsev	(→p.61)
11:00 - 11:30	**Analytical Results for Online Conversion - An Introduction to Balanced Analysis** *Günter Schmidt*	(→p.61)
11:30 - 12:00	**Advanced web-site based trading platforms: Cloud Brokering, Internet Shopping, and more...** *Jedrzej Musial*	(→p.62)

Saturday 10:30 - 12:30, Session 4

Chair: Armen Asratian

10:30 - 11:00	**A generic approach for heterogeneous scheduling** *Giorgio Lucarelli*, Denis Trystram and Frederic Wagner	(→p.63)
11:00 - 11:30	**Single machine scheduling: an upper bound on maximum lateness** Alexander Lazarev and *Dmitry Arkhipov*	(→p.63)
11:30 - 12:00	**Transformations of edge colorings of graphs and their application in scheduling** *Armen Asratian* and Carl Johan Casselgren	(→p.64)

Saturday 10:30 - 12:30, Session 5

Chair: Gur Mosheiov

10:30 - 11:00	**Hybrid approach for the reconstruction of homogenous images** Fethi Jarray and Ghassen Tlig	(→p.64)
11:00 - 11:30	**Tag clouds for the web as an optimization problem** *Jakub Marszalkowski*, Łukasz Rusiecki, Hubert Narożny and Maciej Drozdowski	(→p.64)
11:30 - 12:00	**Interdiction of a CPM Project and Its Implications Within the Scope of Project Management** *Fatih Kasimoglu*, Ibrahim Akgun	(→p.65)

5. Abstracts

5.1 Thursday Morning Plenary Talk

Existential Polytime and Polyhedral Combinatorics

Jack Edmonds York University

For thousands of years the beautiful symmetries of a handful of polyhedra with few dimensions and facets have been at the center of refined mathematics. Since the advent of Turing's computers and operations research, beauty has been found in polyhedra regardless of symmetry, with dimensions and facets as numerous as the stars. Linear algebra is being nudged by great systems of linear inequalities as inputs. 'Polyhedra' means their solution sets. 'Existential polytime', i.e. NP, means reasonable to prove when true.

5.2 Thursday Morning Sessions

Novel Formulations for General Stackelberg Games and Stackelberg Security Games

Carlos Casorrán-Amilburu ULB, Belgium
Bernard Fortz Université Libre de Bruxelles, Départment d'Informatique, Belgium
Martine Labbé Université Libre de Bruxelles, Départment d'Informatique, Belgium
Fernando Ordonez Universidad de Chile, Chile

We categorize Stackelberg Game formulations present in the literature according to their use of big M constants and explore how they can be ordered in terms of tightness of their continuous relaxation. We present a novel formulation whose constraints do not require large positive constants. We provide tight values for these big M constants in each of the formulations and perform exhaustive computational experiments between formulations to see where we stand. We establish a relationship between the novel formulations provided for the General Stackelberg Games and for Security Games by means of a projection result and obtain convex hull-defining formulations when we restrict the problem to a single type of follower.

Pairing Games and Markets

Ahmet Alkan Sabanci University, Turkey
Alparslan Tuncay University of Chicago, USA

Pairing Games or Markets that we study here are the nonbipartite NTU generalization of the assignment game, or equivalently put, the roommate problem with payments and flexible utility transfer. Allowing for "half-partnerships" to form as well as full-partnerships, we call an allocation semistable (resp., stable) if it consists of half-partnerships and full-partnerships (resp., full-partnerships only) and there is no blocking pair. We call the set of all stable and semistable allocations the Equilibrium Set.

We show that the Equilibrium Set is nonempty. We actually spell out an iterative algorithm - a "Market Procedure" - that reaches the Equilibrium Set in a bounded number of steps. We also show that the Equilibrium Set consists either of stable allocations or of semistable allocations, and that it has has several notable properties such as "virtual convexity" and "the median property".

We additionally offer an analysis based on "prudent" blocking, introduce the solution concept of pseudostable allocations and show that they are a subset of the Demand Bargaining Set. We use elementary tools of graph theory and a representation theorem obtained here.

Supplier Competition with Option Contracts for Discrete Blocks of Capacity

Edward Anderson	University of Sydney, Australia
Bo Chen	University of Warwick, UK
Lusheng Shao	University of Melbourne, Australia

When a firm faces an uncertain demand, it is common to procure supply using some type of option or two-part contract. A typical version of this problem involves capacity being purchased in advance, with a separate payment made that applies only to the part of the capacity that is needed. We consider a discrete version of this problem in which competing suppliers choose a reservation price and an execution price for blocks of capacity, and the buyer, facing a known distribution of demand, needs to decide which blocks to reserve. We show how to solve the buyer's (combinatorial) problem efficiently and also show that suppliers can do no better than offer blocks at execution prices that match their costs (making profits only from the reservation portion of their bids). Finally we show that in an equilibrium the buyer selects the welfare maximizing set of blocks.

Dominating induced matchings in graphs containing no long claw

Alain Hertz	Polytechnique Montréal, Canada
Vadim Lozin	University of Warwick, UK
Bernard Ries	Université Paris Dauphine, France
Victor Zamaraev	University of Warwick, UK
Dominique de Werra	EPFL, Switzerland

An induced matching M in a graph G is dominating if every edge not in M shares exactly one vertex with an edge in M. The dominating induced matching problem (also known as efficient edge domination) asks whether a graph G contains a dominating induced matching. This problem is generally NP-complete, but polynomial-time solvable for graphs with some special properties. In particular, it is solvable in polynomial time for claw-free graphs. In the present paper, we study this problem for graphs containing no long claw, i.e. no induced subgraph obtained from the claw by subdividing each of its edges exactly once. To solve the problem in this class, we reduce it to the following question: given a graph G and a subset of its vertices, does G contain a matching saturating all vertices of the subset? We show that this question can be answered in polynomial time, thus providing a polynomial-time algorithm to solve the dominating induced matching problem for graphs containing no long claw.

Asymptotically optimal algorithm for random UNI(0,1) k-cycles cover of the undirected graph

Edward Kh. Gimadi	Sobolev Institute of Mathematics, SB RAS, Russian Federation

Let the edges of the complete undirected graph be assigned independent uniform [0,1] random edge weights. The problem under consideration is to cover the graph by k edge cycles of minimum total weight. We present an approximation algorithm with $O(n^3)$ running time and show that k-cycles cover produced by the algorithm is asymptotically optimal. The proof is performed using a polynomial time algorithm that finds the asymptotically optimal tour in the random symmetric travelling salesman problem (A. Frieze, 2004).

Complexity results on dominating codes in graphs

Olivier Hudry	Telecom ParisTech, France
Antoine Lobstein	Centre national de la recherche scientifique, France

Given an undirected, connected, graph $G = (V, E)$, a subset C of V is said to be a dominating code of G if any vertex belongs to C or admits a neighbour belonging to C. This can be extended, for any positive integer r, to r-dominating codes of G: C is said to be an r-dominating code (or simply $r - DC$) of G if,

for any vertex v of G, there exists a vertex x (possibly v itself) belonging to C such that the distance between v and x is at most r, where the considered distance is the usual distance provided by a shortest path between v and x in G.
A usual problem, arising from combinatorial optimization in graphs, consists in minimizing the size of an $r - DC$. The decision problem associated with this optimization problem is known to be NP-complete for $r = 1$. We investigate the complexity of several problems linked with domination in graphs, for any positive r:

- the computation of the minimum size of an $r - DC$;
- the search of an optimal $r - DC$;
- the existence and the computation of an optimal $r - DC$ containing a prescribed subset of vertices (also known as "membership problems").

We try to locate these problems inside the usual complexity classes of the polynomial hierarchy. More precisely, we show that the computation of the minimum size of an $r - DC$ belongs to the class called FL(NP) (also called F-$Theta_2$) and is L(NP)-hard (or also $Theta_2$-hard; remember that this means, broadly speaking, that we can solve this problem thanks to an algorithm which solves an NP-complete problem, by applying it a logarithmic number of times, and that the considered problem is among the hardest ones with such a property). Similarly, we show that the problem of the existence of an r-DC containing a prescribed subset of vertices is L(NP)-complete, while, for the search of optimal solutions, we show that they belong to FP(NP) (also called F-$Delta_2$; remember that this means, broadly speaking, that we can solve this problem thanks to an algorithm which solves an NP-complete problem, by applying it a polynomial number of times) and that they are L(NP)-hard.

Traveling Salesman Problem with Sales

Hande Yaman Bilkent University, Turkey

We study the problem of a traveling salesman who has a certain amount of a product and should decide where to sell his product to maximize profit. We call this problem the Traveling Salesman Problem with Sales (TSP-S). In TSP-S, the tour starts and ends at a depot. Each customer node has a certain demand. If the salesman decides to visit a node, he can sell a quantity that does not exceed the demand of the node. Given a fixed cost of visiting a node, a revenue per unit sold for each node and a cost associated with the tour, the salesman decides which nodes to visit, in which order and how much to sell at each node to maximize his profit. TSP-S is closely related to the profit maximizing TSP and the single node flow problem as it involves the choice of the nodes to visit

as well as the decision on the amount of product to sell at each visited node. We study valid inequalities for TSP-S and devise a branch-and-cut algorithm.

Bin Packing and Cutting Stock Problems: Mathematical Models and Exact Algorithms

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Given a set of weighted items and an unlimited number of identical capacitated bins, the Bin Packing Problem (BPP) consists in packing all the items into the minimum number of bins. The BPP is one of the most studied problems in the combinatorial optimization literature. The reasons of such an interest are: (1) the BPP can be understood intuitively, (2) the BPP can be useful in many real-world applications, such as computer science (machine assignment) or manufacturing (cutting stock), just to cite some, and (3) it can be extended to many other problems such as the multi-dimensional BPP, the BPP with incompatibilities or the BPP with precedences among items.
Our work consists in gathering in a survey the most important articles related to the BPP, whether they involve new algorithms for exactly solving the BPP or improvements of previous existing algorithms. Parts of the survey are also dedicated to the BPP lower bounds and a detailed description and comparison of the most important pseudo-polynomial models.
An important aspect of this work is the implementation and computational testing of some of the most common methods, such as the standard ILP approach, pseudo-polynomial formulations, constraint programming, branch-and-bound and branch-and-price algorithms. We also study the behaviour of such methods when the parameters of the test instances change (number of items, capacity of the bins) and we examine new sets of instances that are difficult to solve in practice. Finally, we relate the good performance of some recent and powerful approaches with the improvement of ILP solvers in the last decade.

Online Algorithms for the Newsvendor Problem

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This work considers the dilemma of a newspaper salesman - how many papers should he purchase each day to resell when he doesn't know the demand? Due to the fact that the newsvendor problem is simple but rich enough to capture the fundamentals of many operations management problems it serves as the building block for numerous models in inventory control, supply chain coordination, revenue management, and scheduling. Typically, the objective of the newsvendor is either to maximize the expected profit or to minimize the variance of profit, which is appropriate when the probability distributions of the market

demands are fully known. However in practice, demand distributions are often unknown to the newsvendor, in particular for products with short life-cycles. For example, most retailers are not able to forecast their customer's demand with accuracy due to few historical data or volatility. Hence, decision-makers to seek for alternative solutions to the newsboy problem that work with limited demand information. We present and analyze online algorithms that determine the newsvendors' optimal order quantity for the case where only sets of constants are available to characterize the demand, but no probability distributions. We employ competitive analysis which guarantees a certain performance level under all possible demand scenarios. For the goal to maximize the overall profit, we prove the competitive ratio of our online algorithm to be a lower bound. In addition, we test our algorithm under real world conditions, and compare the results to those by previous known online solutions. Our simulation runs indicate that online algorithms perform comparably, and to some extend better than stochastic approaches.

Differential Approximation Schemes for Minimizinng Quadratic Boolean Functions and Their Scheduling Applications

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The half-product function is a special form of a (pseudo) Boolean quadratic function that has been studied since the 1990s. The problems of minimizing such a function and its variants, with and without an additional knapsack constraints are of interest in their own right, and also due to numerous scheduling applications. In its pure form, the problem admits a fully polynomial-time approximation scheme (FPTAS), however, not for all relevant variants of the problem converting an FPTAS for a pure problem is possible(even for a half-product with an additive function); see [1, 3, 4].
Differential approximation is an alternative approach to measuring the quality of approximate solutions, which is achieved by determining a position of the value of an approximate solution between the best and the worst solutions. A differential polynomial-time approximation scheme (DFPTAS) is the best possible algorithm one can hope for under the differential approximation paradigm. Differential approximation has been studied for many problems of combinatorial optimization, often producing a striking contrasts with the results derived for traditional approximation, such as a worst-case ratio.
There is a noticeable lack of differential approximation studies of scheduling problems. One such result [2] considers a single machine scheduling problem of minimizing the weighted sum of the completions times with a machine non-availability interval. However, the problem admits a reformulation as the problem of minimizing a half-product function with a knapsack constraint.
In this paper, we show that the FPTAS by [1] available for the pure half-product

problem can be converted into an FPTAS for minimizing a half-product under a knapsack constraint. Further, we prove that these FPTASs actually perform as DFPTASs for minimizing a half-product, a half-product with an additive constant and their variants with knapsack constraints. These results imply that for all scheduling problems that admit reformulations in terms of half-product related problems there exist DFTASs with the best possible running times.

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Scheduling fixed position maintenance operations

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In this talk scheduling with fixed sequence positioning of maintenance operations is considered. A maintenance operation has a fixed position in a sequence of normal jobs if the maintenance has to be performed after at most some defined number of job changes on the machine. A problem of preemptive scheduling with ready times and due-dates on one machine is considered. We show that this problem is computationally hard in general. Special cases of scheduling for C_{max} criterion or for L_{max} criterion with equal ready times are polynomially solvable. After determining a set of dominance properties a branch and bound algorithm using local search for upper bounds is proposed.

Metaheuristics for discrete-continuous project scheduling with activities of identical processing rates

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Discrete-continuous project scheduling problems with positive discounted cash flows and maximization of the Net Present Value (NPV) are considered. In

such problems activities of a project simultaneously require discrete and continuous resources for their execution. We deal with a class of these problems with an arbitrary number of discrete resources and one continuous, renewable resource. Activities are nonpreemptable, and the processing rate of each activity is the same continuous, increasing, and concave function of the amount of the continuous resource allotted to the activity at a time. The problem is to find a precedence- and discrete resource-feasible schedule and, simultaneously, a continuous resource allocation, that maximize the NPV. Three common payment models - Lump Sum Payment (LSP), Payments at Activity Completion (PAC) times, and payments in Equal Time Intervals (ETI) are analyzed. We discuss the general methodology for solving the considered problem, which consists in a decomposition into a discrete and a continuous part. We show that under identical processing rates of activities the representation of the solution to the discrete part of the problem could be simplified to the form of an activity list. The solution of the continuous part requires, in general, solving a nonlinear mathematical programming problem. Formulations of mathematical programming problems finding an optimal continuous resource allocation for each payment model are presented. A local search approach is discussed for the case of identical processing rate functions of activities. Applications of three well-known metaheuristics - Simulated Annealing, Tabu Search, and Genetic Algorithm are proposed. The algorithms are compared on a basis of computational experiments. Optimal solutions are used as reference solutions for small problems, whereas Random Sampling technique is used for comparison for larger numbers of activities.

The experiments show that the metaheuristic approaches evidently outperform random search which means that it is reasonable to apply such approaches to the considered class of problems. From among the three metaheuristics GA performs best, producing results better than SA and TS in every aspect. It confirms the efficiency of the GA algorithm, originally developed for the classical discrete RCPSP, also to discrete-continuous project scheduling in which the same solution representation is used. From between SA and TS we can state that SA produces better results for smaller problem sizes, and, under an assumed number of activities, for smaller values of the discount rate, whereas TS performs better for larger problems as well as for larger values of the discount rate. Besides, for periodic payments TS gets better when the number of payments grows, whereas SA prefers payments made more rarely, and becomes most effective for one payment at the end (the LSP model). Finally, the comparison to optimal solutions shows that if optimum schedules are strongly required, feasible sequences of activity sets have to be examined, not activity lists, even for identical processing rate functions.

The future research can be carried out in three directions. Firstly, improvements of the proposed metaheuristics are very likely possible and/or implementing other (also hybrid) metaheuristic approaches. Secondly, generalizing the considered problem can be done in several ways, e.g., by incorporating negative

cash flows or multiple execution modes of activities. Finally, heuristic procedures for allocating the continuous resource should be developed, in order to shorten the computational times, as well as to analyze larger problem instances.

Robust Multicast Capacity with Network Coding

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Network coding is a technique which can be used to improve the performance and capacity of multicast communications by performing encoding operations at intermediate nodes. In this paper, we address the problem of capacity provisioning in a network subject to demand uncertainty, when a network coded multicast is applied as the data delivery mechanism. We propose a robust optimization model for this problem and optimize the worst-case system performance.

Project scheduling problem with transportation network and on/off energy consumption model

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Project scheduling problems are considered in the literature are considered in the literature for more than fifty years. During this time, many new variants and extensions of this problem have been developed. One of the most considered variant is known as resource-constrained project scheduling problem (RCPSP). The multimode version of this problem (MRCPSP) is a well-known NP-hard optimization problem, where the set of nonpreemptable activities of the project have to be executed using/consuming renewable and/or nonrenewable resources from a given set. Activities of the project are precedence related with strict finish-start precedence constraints. Each activity can be executed in one of several execution modes, which differ among themselves in the processing times and resource requirements. In this work we consider an extension of this problem in which resources are distributed over several locations, which are connected via transportation network. Some resources can be transferred between these locations using the transportation network. So, there is another type of operation - transfer of resources, which can be carried out between two locations if and only if there exist a path in the transportation network that connect both locations and its parameters are at least equal to the required ones. It is assumed that resources are powered by a common energy source, and the energy is consumed even if the resource becomes idle. Energy consumption by the idle resource can be disconnecting it from power supply and turning on again if it will be required by another activity. Of course, the operations of turning on and

off power supply for a given resource also require energy. Its consumption in this case is greater than in the idle state. So, these two operations are modelled as setup and removal operation with determined costs and execution times. As in many other similar models the due date for the entire project is determined. The objective is to find a time and resource feasible schedule that minimizes the costs of energy consumption. Some algorithms have been developed to find both a feasible resource allocations and the best schedule.

Polynomial Time Approximation Scheme for Euclidean Minimum-weight k-Size Cycle Cover Problem on the plane

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For a fixed natural number k, the Minimum-weight k-Size Cycle Cover Problem (Min-k-SCCP) is studied. The problem is a simple generalization of the well-known Traveling Salesman Problem (TSP) and has the following mathematical statement. For a complete weighted digraph (with loops), it is required to find a minimum-weight cover (of the vertex set) by k vertex-disjoint cycles. An optimal solution of the problem can be treated as the cheapest plan for visiting the given set of nodes by a team of k collaborating salesmen.
We show that Min-k-SCCP is strongly NP-hard both in the general case and in special metric and Euclidean settings. For the Euclidean Min-k-SCCP on the plane, we propose a polynomial time approximation scheme (PTAS) extending the famous result obtained by S.Arora for Euclidean TSP. Actually, for any fixed $c > 1$, the scheme finds a $(1 + 1/c)$-approximate solution of the Euclidean Min-k-SCCP on the plane in $O(n^3(\log n)^{O}(c))$ time.

Approximation of the Largest Common Point Set Problem for an Application in Sheet Metal Forming

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Michael Ritter	Technische Universität München, Germany
Felix Schmiedl	Technische Universität München, Germany

In sheet metal forming, flexible manufacturing systems are essential for producing individualized components, but they often involve a significant amount of manual labour. To increase the degree of automation for these production processes the desired target geometry can be subdivided into smaller shapes for which a production strategy can then be derived from a small number of templates with known production strategy.
This method requires the solution of a geometric optimization problem known as "largest common point set" to identify suitably transformed copies of the given

templates within the desired target geometry. The problem is generally known to be NP-hard for certain sets of admissible transformation. We present and analyze an efficient approximation algorithm for this problem which produces an affine transformation with minimal approximation error by aligning carefully selected subsets of points called wide bases. Furthermore, we describe a generalization of the algorithm for multi-criteria optimization problems, investigate the specific problem setting and adapt the algorithm for the application in sheet metal forming.

FPTAS for special case of a quadratic Euclidean bi-partitioning problem

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We consider one strongly NP-hard problem of partitioning a finite set of points in Euclidean space into two clusters under the criterion of minimum sum-of-squared distances from the elements of clusters to their centers.
It is assumed that the center of one of clusters is given at a desirable point (without loss of generality at the origin).
The center of the second one is unknown and is determined as the mean value over all elements in this cluster.
It is proved that, unless P equals NP, in the general case of the problem there is no fully polynomial-time approximation scheme (FPTAS) and such a scheme is provided for the case when the dimension of the space is fixed.

NP-hardness of Euclidean Balanced Variance-based bi-Clustering Problem with Given Center of one Cluster

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Given a finite set of points of Euclidean space, we try to partition it into two clusters minimizing the sum of weights of the clusters multiplied by their cardinalities. By the weight of the cluster we mean the sum of squared distances from the elements of the cluster to its center. The center of one cluster is given while for the second cluster it is unknown (so, it is presented by the centroid, i.e. the vector equal to the mean value of the elements of the cluster. It is

proved that this problem is strongly NP-hard and that in general there is no FPTAS for it

Optimization of Tuned Mass Dampers for Mechanical Systems Subjected to Different Excitations

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Tuned mass dampers (TMD) are implement on mechanical systems and vibrations are reduced according to optimum mass, stiffness and damping of the additional degree to the system. Equations of motions of mechanical systems are coupled differential equations which can be only solved by using numerical iterations. For that reason, it is not to possible to derive equations for optimum design variables if the main system have inherent damping. For that reason, metaheuristic algorithms can be used in order find the optimum values. In processes employing metaheuristic algorithms, the optimization is possible by assuming random design variables and updating these variables according to algorithm properties. In this study, harmony search algorithm is employed for optimization of TMDs on system exciting by different ground displacements. Harmony search is a music inspired method using random variables. In the proposed method, set of design variables are defined by random numbers within a solution range and stored in a harmony matrix. After the generation of the matrix, it is updated by adding new set of variables and eliminating worst one. In generation of new variables, initial range or a range around the existing variables in harmony matrix is used. As a numerical example, a system with 1 s period (1 Hz frequency) and 5% damping ratio is used to find an optimum TMD. Design variables such as mass ratio, period and damping ratio of TMD are found for a pulse and a sinus excitation. For both loading cases, optimum mass ratios are between %9.5 and %10 while optimum periods of TMDs are slightly lower than the period of the main system. The optimum damping ratios of TMDs are between 5% and 6%. The optimum TMDs are effective to reduce maximum displacement of main system by 66% and 62% for sinus and pulse excitations, respectively. As a conclusion, the proposed method is a feasible method for optimization of TMDs in order to reduce mechanical vibrations.

The p-maxian Problems

Galavii Mohammadreza Zabol University, Iran (Islamic Republic of)

Let $G = (V, E)$ be a graph with vertex set V and edge set E. A location problem in which all vertices are associated with negative weights is called obnoxious facility location problem. Two different types of objective functions for obnoxious p-median problems can be investigated: the sum of the minimum weighted distances from X in G with $|X| = p$ to all vertices and the sum of the

weighted minimum distances. For the first model, we introduce a new definition say dominating pair or dominating path. For instance a tree has dominating path. We prove that only two vertices namely dominating pair play a role and all other points of the p-maxian (i.e., the optimal solution of the p-median problem) can be chosen arbitrarily.
The question is which graphs have the dominating path. In this paper we try to answer the question.

Efficiency of computer-aided platforms in supporting optimisation of media planning

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Szczepan Ruman	ADBA S.A., Poland
Jakub Gwizdak	ADBA S.A., Poland

Efficient TV spot schedule composition is of utmost importance for media planner or advertisers. This paper presents a novel approach for solving a problem of small effectiveness of traditional methods.
New method described in article is dedicated for broadcast TV i.e. linear TV. A genetic algorithm is proposed to solve this problem. An automated computer system is further developed to demonstrate the practicality of the chosen approach. Furthermore, the system robustness and efficiency is demonstrated using the base TV advertisement parameters such as GRP (gross rating point), CPP (cost per point), Reach, Effective Reach and TRP (target rating point).
Highly sophisticated computer-aided platforms with the robust optimization capabilities of genetic algorithms will be presented and compared with traditional methods and algorithms. In addition a method of combining genetic algorithms and dynamic algorithms to work successively will be presented and compared with a method using genetic algorithms only.

5.3 Thursday Afternoon Plenary Talk

Optimization Problems in Intermodal Transport

Erwin Pesch Universität Siegen, Germany

Attracting a higher share of freight traffic on rail requires freight handling in railway yards that is more efficient, and which includes technical innovations as well as the development of suitable optimization approaches and decision-support systems. In this talk we will review some optimization problems of container processing in railway yards, and analyze basic decision problems and solution approaches for the two most important yard types: conventional railroad and modern railrail transshipment yards. Furthermore, we review some of the

relevant literature and identify open research challenges. Additionally we address a scheduling problem that arises in intermodal container transportation, where containers need to be transported between customers (shippers or receivers) and container terminals (rail or maritime) and vice versa. The solution method can be applied to other problems as well.

5.4 Thursday Afternoon Sessions

Minimum number of non-equivalent colorings for graphs with maximum degree at most n-3

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Eglantine Camby	Université Libre de Bruxelles, Belgium
Alain Hertz	Ecole Polytechnique de Montréal, Canada
Hadrien Mélot	Université de Mons, Belgium

The Bell number B(G) of a graph G counts its number of non-equivalent colorings. In a recent paper, Hertz and Mélot gave several bounds on B(G) when the maximum degree Delta(G) is bounded. Their paper ends with some open problems and we solve one of them in this contribution: we characterize graphs that minimize B(G) when Delta(G) = n-3.

Cycle polytope on bipartite graph

Lamia Aoudia	USTHB, Algeria
Méziane Aïder	University of Sciences and Technology Houari Boumédiène, Algeria
Viet Hung Nguyen	University Paris 6, France

The aim of this work is to give a convex hull of 4-cycle on a wider class of complete bipartite graphs.
Given a bipartite graph K_{nm} and a weight function defined on the edges, the minimum weight 4-cycle problem consist on finding a 4-cycle with a minimum weight. This problem can be easily solved by a complete enumeration of the 4-cycle of K_{nm}. For each cycle, let X its incident vector. The 4-cycle polytope denoted $4CP$ is the convex hull of the incident vector of 4-cycles in K_{nm}. The minimum weight cycle problem is clearly equivalent to minimize the weight function over the 4-cycle polyope.
In this paper we are mainly interested on the facial structure of such polytope. Thus we ennumerate some inequalities defining facets for $4CP$ on K_{nm} and give a complete description for small bipartite graphs.

Adapted Floyd-Warshall Algorithm for Solving a Problem of Traveling Visitor

Milan Djordjevic American University of the Middle East, Kuwait

We consider an Adapted Floyd Warshall-Algorithm for solving a problem when visitor wants to visit all interesting sites in a city exactly once and to come back to the hotel. Since, the visitors use streets, walking trails and pedestrian zones, the goal is to minimize the visitors traveling. A problem of Traveling Visitor is then similar to the Traveling Salesman Problem (TSP) with a difference that the traveling visitors, during her visit of sites, can not fly over buildings in the city, instead she have to go around these obstacles. That means that euclidean distances, like those in a TSP, does not count in this case. The tested benchmarks of a problem are combined from real instances made by using tourist maps and instances of modified cases from TSPLIB. We compared two methods for solving a problem. Preliminary result shows that proposed algorithm outperforms a naive algorithm for solving this problem.

Linearizable quadratic minimum spanning tree problems and related polynomially solvable special cases

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Abraham Punnen Simon Fraser University, Canada

The quadratic minimum spanning tree problem (QMST) is a generalization of the minimum spanning tree problem (MST) and the quadratic assignment problem. We say that a QMST instance is linearizable if we can assign new weights to edges of the associated graph such that for each spanning tree, its original QMST objective function value is equal to the corresponding MST objective function value with respect to the new edge-weights. We provide complete characterization of QMST instances that are linearizable on classes of graphs whose biconnected components are either a clique, a biclique or a cycle. This class includes complete graphs, complete bipartite graphs, cycles, cactus graphs, among others. The characterization also provides a linear time algorithm to construct the equivalent MST and hence the linearizable instances of QMST are polynomially solvable although the general QMST is NP-hard even on graphs with very simple structure such as a wheel.

Late Work Scheduling in On-Line Mode

Malgorzata Sterna	Poznan University of Technology, Institute of Computing Science, Poland
Xin Chen	Dalian University of Technology, School of Software Technology, China
Xin Han	Dalian University of Technology, School of Software Technology, China
Jacek Blazewicz	Poznan University of Technology, Institute of Computing Science, Poland

Real world scheduling problems are usually strictly related to time. Hence the objective functions based on due dates are a very attractive and widely explored subject of research. A significant part of scheduling literature is devoted to classical objective functions involving lateness, tardiness or the number of tardy jobs. Late work performance measure estimates the quality of a solution on the basis of the duration of late parts of particular jobs, combining the features of tardiness and the number of tardy jobs. Late work criteria have been used for nearly 30 years, but they have not been analyzed in on-line mode yet.
We consider the problem of scheduling jobs on parallel identical machines with the total late work criterion and a common due date, both offline and online versions. In offline as well as in online case, jobs arriving into the system, have to be assigned and scheduled on two identical machines, preferably before the given due date, in order to minimizing their late parts. But in off-line case all jobs are known in advance, while in on-line case they appear in the system one by one ("online over list" model).
Determining the complexity status of offline problem was necessary to initiate studies on its online version. For the offline case, we proved - by the transformation from the partition problem - that the problem for two machines is NP-hard. Moreover, we gave a dynamic programming method which can solve the two-machine problem in pseudo-polynomial time, proving its binary NP-hardness.
For the online version, we proposed an algorithm for an arbitrary number of machines with constant competitive ratio (which represents the distance between the optimal offline solution and any online solution). Moreover, we showed the optimality of this scheduling policy for two identical machines, that means that the competitive ratio matches the lower bound (which determines the smallest error made by any online algorithm).

On polynomial asymptotically optimal algorithms for some hard routing problems

Edward Kh. Gimadi	Sobolev Institute of Mathematics, SB RAS, Russian Federation
Oxana Tsidulko	Sobolev Institute of Mathematics, SB RAS, Russian Federation

In this paper we consider three important modifications of the well known traveling salesman problem. The first problem is the m peripatetic salesman problem with different weight functions for each salesman. Given a complete directed or undirected n-vertex graph G with weight functions $w_i, 1 \leq i \leq m$, the problem is to find m edge-disjoint Hamiltonian cycles of minimal total weight.
The other problems are the m-cycle cover problem and the m-chain cover problem, where, given a complete weighted graph G, we are to find m cycles (chains) of minimal total weight, such that every vertex in G belongs to exactly one cycle (chain).
All of these problems are NP-hard.
For these problems we propose approximation polynomial algorithms based on the greedy idea. The performance ratios of the algorithms are established for the input data, in which the weights of the edges in G are independent and identically distributed random real numbers with uniform distribution in $[a_n, b_n]$, $0 < a_n < b_n$, or exponential distribution in $[a_n, \infty), a_n > 0$.
Under above assumptions, we prove that these algorithms are asymptotically optimal, if $m = o(n)$ and some extra conditions on the distribution parameters are held.

Exact solution procedures for the resource-constrained project scheduling problem with general temporal constraints and calendars

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Jürgen Zimmermann Clausthal University of Technology, Germany

The project scheduling problem that we investigate is concerned with the assignment of execution time intervals to activities such that given temporal constraints between activities are satisfied, the prescribed resource capacities are not exceeded, and the project duration is minimized. Temporal constraints are given by general minimum and maximum time lags. For projects with a short-term planning horizon, breaks like week-ends or holidays have to be incorporated, where some of the renewable resources needed are not available. Therefore, we have to distinguish between activities that can be interrupted during breaks as well as activities that must be performed without interruption. The first group contains, e.g., assembling, drilling, and cutting processes, or activities of the quality management that must be executed manually in order to maintain a preferred level of quality. The second group contains, e.g., heating, cooling, drying, and pouring processes, or training activities, where staff have to travel over long distances to reach off-site training locations. For some interruptible activities, a start-up phase must be used during which the activity has to be processed without suspending the execution. In addition, some renewable resources, e.g., machines, stay blocked or engaged, respectively, during breaks and other renewable resources, e.g., staff, are released during breaks.

In this talk we give a mathematical formulation for the described resource-constrained project scheduling problem with general temporal constraints and calendars and present exact solution procedures and corresponding performance results.

New mathematical models for order acceptance and scheduling problems

Saeed Saffari Koc University, Turkey
Ceyda Oguz Koc University, Turkey

We consider two different order acceptance and scheduling problems. In the first problem, a set of n orders with data including processing times, due dates, maximum revenues, and importance weights should be processed on a single machine. The objective is to maximize total revenue, where the revenue from an order is a function of its tardiness and deadline. Using time indexed formulation, we model the problem which enables us to solve the benchmark instances of 10, 20, 75, and 100 orders within a reasonable time which outperforms the results obtained by previous works in the literature. To make our model more efficient, we use three new valid inequalities by which we can expedite running process in some groups of instances. We then analyze our result, and show that our valid inequalities can reduce the average optimality gap compared to the previous works.
In the second problem, a set of n orders including all data of our first problem along with deadlines, release dates, as well as setup times between two consecutively processed orders are considered. After modeling the problem using time-indexed formulations, we solve it for all the benchmark instances of 10, 15, 20, 25, 50, and 100 jobs, and we obtain near optimal upper bounds and lower bounds.
To find upper bounds, we use the minimum solution of two methods. In the first method, we relax some of the variables, and keep others as binary. Since this relaxation may result in large CPU times, we stop the branch and bound process after CPU time of one hour. In the second method, we relax all the variables, and add four valid inequalities to the problem. We then solve this problem to the optimality. Finally, we show that this method improves the upper bounds for most of the instances.
To obtain lower bounds, we use an idea of our first problem, and change the second problem so that we remove most of constraints and variables, and reduce the running time. Then we find the cases in which the above-mentioned idea works, and for other cases, we develop a simple heuristic algorithm which makes use of the optimal solution of the latter problem as an initial solution, and finds near optimal solutions for the second problem.

A Memetic Algorithm for the periodic Inventory Routing Problem (IRP)

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Stella Sofianopoulou University of Piraeus, Greece

The periodic IRP combines inventory control and transportation decisions over a finite period of time, which is repeated to infinity. The goal is to define a delivery schedule so as to minimize the sum of inventory and routing costs throughout the time period. In contrast to other research efforts, we address the case where customer inventory capacity is considered finite.
Memetic Computing has drawn attention over the past decade due to its successful implementations in a wide range of real world problems. Memetic Algorithms are essentially population-based optimization methods enhanced by local search techniques in continuous and discrete search spaces.
In this work a Memetic Algorithm is proposed that incorporates previously applied as well as newly introduced Local Search operators. The algorithm is tested on a series of problem instances. The results show that the method is robust and efficient.
We also assess the impact of certain modifications regarding the core elements of the Memetic Algorithm, Parent Crossover procedure and Local Search operators. Parent Crossover is conducted using multiple cutting points and the slight modifications of the Local Search operators result in a broader neighborhood scanning. The efficiency of the algorithm is boosted whereas the increase in computational time is kept to a minimum.

Variable neighborhood search heuristics for a test assembly design problem

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Test assembly design problems appear in the areas of psychology and education, among others. The goal of these problems is to construct one or multiple tests to evaluate examinees on some criteria. This paper studies a recent formulation of the problem known as the one-dimensional minimax bin-packing problem with bin size constraints (MINIMAX_BSC). In the MINIMAX_BSC, items are initially divided into sets and multiple tests need to be constructed using a single item from each set, while minimizing the difference in difficulty among the tests. We first show that the problem is NP-Hard, which remained an open question. Second, we propose three different local search neighborhoods derived from the exact resolution of special cases of the problem, and combine them into a Variable Neighborhood Search (VNS) metaheuristic. Finally, we test

the proposed algorithm using real-life-based instances. The results show that the algorithm is able to obtain optimal or near-optimal solutions for instances with item pools with up to 60.000 items. Consequently, the algorithm is a viable option to design large-scale tests, as well as to provide tests for online small-sized situations, such as those found in e-learning platforms.

Optimum Structural Design of Pin-Jointed Plane Frames Using the Flower Pollination Algorithm

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The optimum designs of structural systems are very important to many applications, and such problems are generally coupled and the solutions of different freedoms can depend on each other. Therefore, to find their solutions can be very challenging. Metaheuristic algorithms are suitable and effective to deal with structural engineering problems. In this paper, a novel approach for optimum structural designs of pin-jointed plane frames is proposed. Flower Pollination Algorithm is employed in the optimization process. The newly developed algorithm was inspired by the characteristics of flowering plants. The objective function is to minimize the total weight of bars by optimizing the angles of bars with respect to the ground. The design constraints are the limitations of joint displacements, which are obtained by solving coupled equations. Since the angles of bars are to be optimized, the proposed method is utilized for topology optimization. As a numerical example, the design of a pin-jointed plane frame with a fixed base has been optimized. The vertical displacements of the two joints of the pin-jointed plane frame are limited to 5 mm. The system is loaded at two joints and cross-sectional areas of the bars were taken as the same and constant. For that reason, the minimization of the total lengths is equivalent to the weight optimization. The optimum topology of the system was found for design variables which are the two angles of bars respect to the ground. Since the system is symmetrical, half the system was solved and optimized. The optimum results and the final objective function values were compared with those obtained by other methods such as genetic algorithm and cuckoo search. The results show that the proposed method is more effective than the compared methods in terms of the objective function values.

Heuristic approach for peptide assembly problem

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Determination of amino acid sequences is very important issue of modern molecular biology. Acquisition of knowledge about peptide structure is an important

step in discovering their three-dimensional structure and therefore their functionality. Reading sequences of amino acids is called sequencing. There is no analytical method that allows to sequence long peptide chain but methods for determining short peptide sequences are available. The approach to determine long peptide sequence is to cut it into many short pieces, sequence them and assemble these fragments together. There is a need to apply computational methods for assembly process. In our work a peptide assembly problem with errors coming from the digestion phase is considered. The dedicated heuristics to solve this problem is proposed and results of a computational experiment are presented. The results clearly show that the new method strongly outperform other algorithms known from the literature.

Reliability Evaluation for coded packet networks

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In the most of communication networks, the capacity of each arc is stochastic due to failure, maintenance, and etc. The probability that a given amount of data can be sent through the network with stochastic capacity according to a routing policy is named as the system reliability. In this paper, such a probability is evaluated when a network coded multicast employs as the data delivery mechanism with stochastic capacity. An efficient algorithm is proposed to evaluate the system reliability over coded packet networks. The ability of proposed approach to illustrate the reliability evaluation is tested over random graphs.

On Monotonicity in Steiner Tree Network Games

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We investigate the cost allocation strategy associated with the problem of providing some service of common interest from a source node to a number of network nodes (users), via the minimum cost directed Steiner tree. The cost of such a service is distributed among its receivers who may be individuals or organizations with possibly conflicting interests. The objective of this work is to develop a reasonably fair and efficient cost allocation scheme associated with the above cost allocation problem. Since finding the optimal Steiner tree is an NP-hard problem, the input to our cost allocation problem is the best known Steiner tree obtained using some heuristic. In order to allocate the cost of this Steiner tree to the users (receiver nodes), we formulate the associated Steiner Tree game in characteristic function form. We construct a simple (polynomial) primal-dual based cost allocation scheme which satisfies some network monotonic properties. For a special case when all network nodes are users (no Steiner nodes) the above allocation scheme would produce core points and the addition

of new nodes (users and/or Steiner nodes) would not increase the cost to any existing user. Namely, there would be no incentive for any network user to block network growth.

Network construction problems with due dates

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We consider problems of planning construction activities for building a new transportation network or restoring a network partially destroyed as a result of a disaster. Construction is performed by a server (construction crew) that has a constant construction speed. The server can travel within the already constructed part of the network, with travel times negligible with respect to construction times. A vertex is recovered when it becomes connected to the initial location of the server (depot) by an already constructed path. Due dates for recovery times are associated with vertices. The problem is to obtain a construction schedule that minimizes the maximum lateness of the vertices. We present mixed-integer linear programming formulations, lower bounds, a branch-and-bound algorithm, and results of computational experiments.

A fast polynomial time algorithm for minimum flow problem on dynamic network flows with time varying bounds

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Flow variations over time generalize standard network flows by introducing an element of time. In contrast to the classical case of static flows, a flow over time in such a network specifies a flow rate entering an arc for each point in time. In this setting, the capacity of an arc limits the rate of flow into the arc at each point in time. Traditionally, flows over time are solved in time-expanded networks that contain one copy of the original network for each discrete time step. While this method makes available the whole algorithmic toolbox developed for static network flows, its drawback is the enormous size of the time-expanded network. In this paper, we will extend the results about the minimum flow problem to network flows in which the time-varying lower bounds can involve both the source and the sink node (as in Salehi Fathabadi et. al., 2012) and also additional node other than the source and the sink. It is shown that this problem for set 0,1,,T of time points in a network with nodes and arcs can be solved by at most minimum flow computations, by suitably extending the dynamic minimum flow algorithm (Salehi Fathabadi et. al., 2012) and reoptimization techniques. Running time of presented algorithm is.

Generalized power diagrams, balanced k-means, and the representation of polycrystals

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Based on a discrete convex maximization model we give an efficient algorithm for computing feasible generalized power diagams with near-optimal separation properties. Further, we show how this approach can be used to generalize the classical k-means algorithms from data analysis so that it becomes capable of handling weighted point sets and prescribed lower and upper bounds on the cluster sizes. (This part is joint work with S. Borgwardt and A. Brieden).
Also we indicate how to handle the discrete inverse problem from material science to compute grain maps i.e., representations of polycrystals, based only on measured data on the volume, center and, possibly, moments of their grains. (This part is joined work with A. Alpers, A. Brieden, A. Lyckegaard and H. Poulsen)

Generalizing facets of the Hop-Constrained Path Polytope

Wolfgang F. Riedl Technische Universität München, Germany

The Hop-Constrained Shortest Path Problem (HSPP) looks for a shortest (elementary) (s,t)-path that does not use more than k arcs. It arises, for example, in the design of telecommunication networks to guarantee a minimum level of service quality.

In this talk, we will focus on Cardinality-Path Inequalities, a special class of inequalities needed for the description of the integer hull of the corresponding polytope. Besides the HSPP, these inequalities induce facets of various related path or cycle polytopes with cardinality constraints. We will present two generalizations of this family of inequalities and deduce a procedure that allows us to obtain - given a family of inequalities possessing a certain symmetric structure - a generalized family of facet-defining inequalities.

Discretization vertex orders in distance geometry

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Andrea Cassioli Mosek, Denmark
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When a weighted graph is an instance of the Distance Geometry Problem (DGP), certain types of vertex orders (called discretization orders) allow the use of a very efficient, precise and robust discrete search algorithm (called Branch-and-Prune). Accordingly, finding such orders is critically important in order to

solve DGPs in practice. We discuss three types of discretization orders, the complexity of determining their existence in a given graph, the inclusion relations between the three order existence problems, and methods for finding them.

A discrete optimization approach for tracking particles in plasma

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Peter Gritzmann TU Muenchen, Germany

A common experimental technique for studying the flow of plasma is to trace the movement of microparticles in the plasma. Typically, the microparticles may glow by themselves or scatter light from a volumetric illumination of the measurement volume. The challenge is to trace pixel-sized particles from measurements that are taken from several directions. In this talk, we give a discrete optimization approach for this task and discuss its performance on real data.

The talk is based on the papers:

(*) J. Zhu, J. Gao, A. Ehn, M. Aldn, Z. Li, D. Moseev, Y. Kusano, M. Salewski, A. Alpers, P. Gritzmann, M. Schwenk: "Measurements of 3D Slip Velocities and Plasma Column Lengths of a Gliding Arc Discharge," Applied Physics Letters, 106 (4), pp. 044101-14, 2015,

(*) A. Alpers, P. Gritzmann, D. Moseev, M. Salewski: "3D Particle Tracking Velocimetry using Dynamic Discrete Tomography," Computer Physics Communications, 187 (1), pp. 130136, 2015.

Valid inequalities for the pooling problem

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We study the pooling problem, a non convex problem that aims at deciding about how to compose final products. In particular, final product consist of a mixture of raw material that might be blended into pools. Crucial constraints are quality constraints, i.e. requirements on the quality of certain attributes of the final products. They can be computed as linear combination of the quality of raw material qualities.
We propose strong valid inequalities and show their effectiveness through computational results.

An Approximation for Single-Channel Multi-Server Queues with Generally Distributed Inter-Arrival and Service Times

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Single-channel multiple-server queues with generally distributed inter-arrival and service times are found in numerous settings, e.g., airports and manufacturing systems. Unfortunately, exact models for such systems require distributions for the underlying random variables. Often, data for fitting distributions is not available, and one must determine estimates of mean waiting times and queue lengths on the basis of means and variances of the underlying random variables. Under heavy traffic, excellent approximations already exist for this purpose. We present a new approximation method for medium traffic, which is based on scaling the coefficient of variation of the service time as well as existing single-server approximations for GI/G/1 queues from the paper of Kraemer and Langenbach-Belz and that of Marchal. We find encouraging numerical evidence for gamma distributed inter-arrival times, often found in many settings, and double-tapering distributions, such as normal, triangular, and gamma, for the service time.

Sectorization: measures and an electromagnetism based approach

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Sectorization means dividing a set of basic units into sectors or parts, a procedure that occurs in several contexts, such as political, health and school districting, social networks and sales territory or airspace assignment, to achieve some goal or to facilitate an activity. This presentation will focus on three main issues: Measures, a new approach to sectorization problems and an application in waste collection.

When designing or comparing sectors different characteristics are usually taken into account. Some are commonly used, and they are related to the concepts of contiguity, equilibrium and compactness. These fundamental characteristics will be addressed, by defining new generic measures and by proposing a new measure, desirability, connected with the idea of preference.

A new approach to sectorization inspired in Coulomb's Law, which establishes a relation of force between electrically charged points, will be proposed. A charged point represents a small region with specific characteristics/values creating relations of attraction/repulsion with the others (two by two), proportional to the charges and inversely proportional to their distance.

Finally, a real case about sectorization and vehicle routing in solid waste collection will be mentioned.

Benders Cuts for Power System Design - A Geometric Perspective

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For optimisation problems with a large number of variables and constraints, decomposition is a well-established technique to to reduce the computational effort required to solve the problem. A large problem is decomposed into a master problem and several small, quickly solvable subproblems. Iteratively, information acquired in the master problem and subproblems is exchanged and for many approaches, finite convergence to the optimal solution can be guaranteed.

In Benders Decomposition, the information obtained from solving the subproblems is represented in the form of cutting planes, that are iteratively added to the master problem. A number of methods have been proposed to select these cuts in a way that improves convergence to the optimal solution. In our talk, we provide a geometric perspective on the problem of selecting Benders cuts. This allows us to acquire a better understanding of different cut selection criteria from the literature as well as the parameters used in these criteria. We then proceed by using these insights to propose a number of improvements and apply the new cut selection criteria to a problem from power system design.

Combinatorial models of the protein substructures alignment

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Computationally derived protein 3D models exhibit deviations from the corresponding reference structures. Thus, there is a need to develop structural quality assessment methods, that can be used to reliably identify limitations of structural models in order to choose native-like models. Several methods have been proposed to address this challenge in single mode assessment and consensus mode assessment to rank several models proposed for the same target molecule. Consensus-based methods perform generally well, but they are hard to use for researchers mainly focused on analysis of a single structure. Unfortunately, the performance of single model methods is relatively poor with reference to consensus methods.
To fill this gap we proposed a novel approach for quality assessment of a single

model, which is based on the paradigm of local protein substructures, called descriptors. The concept of local descriptors of protein structures was already defined and applied in several studies. It was intended to proteins, but can be used for RNAs as well. In this paper we focused on protein structure analysis.
Proposed approach has been realized by means of combinatorial modeling. An optimization problem has been formulated, which is a little bit simplified in comparison to real-world perspective, but it nicely fits our requirements regarding constraints and quality of solutions. Next, it has been proved, that considered problem is equivalent to the assignment problem, thus can be solved in polynomial time.
Proposed methodologies can be successfully applied in the process of protein model quality assessment, where, having in mind large number of descriptors that have to be analyzed as well as large number of descriptors comparison operations that have to be done, they lead the process of assessment to be more efficient and more accurate. Suggested solutions of the considered problems can make the protein evaluation process more interactive from the domain expert point of view. With the proposed algorithms also new libraries of protein descriptors can be derived and applied during protein structure modeling experiments.

Applications of RNA trigonometric model

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Currently, we observe a growing importance of computing science in supporting experimental research. In contemporary biology, chemistry and physics, working with computational models of problems often replaces traditional experiment or assists in its performance. Hereby presented research, conducted in the area of bioinformatics aims to help in the acquisition of knowledge about RNA 3D structures, being crucial for better understanding of mechanisms that govern various cellular processes, identification of new diseases, designing drugs, etc. The three-dimensional structure is always described in one of several existing notations that allow for further processing of structural information. One of them is trigonometric representation, constituted by a set of dihedral angles.
Here, we show the details of trigonometric model of the RNA structure, we compare it to the algebraic one and we provide examples of its usage in computational study of RNA structures.

New in silico approach to assess RNA secondary structures with non-canonical base pairs

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RNA function depends on its structure, therefore an appropriate recognition of the latter is of great importance. One particular concern is the assessment of base-base interactions, described as the secondary structure. It greatly facilitates an interpretation of RNA function and allows for structure analysis on the tertiary level. The RNA secondary structure can be predicted from sequence using in silico methods often adjusted with experimental data, or assessed from 3D structure atom coordinates. Computational approaches consider mostly Watson-Crick and wobble base pairs. Handling of non-canonical interactions, important for a full description of RNA structure, is still a challenge.

Here we present novel two-step in silico approach to asses RNA secondary structures with non-canonical base pairs. Its idea is based on predicting the RNA 3D structure from sequence or secondary structure that describes canonical base pairs only, and next, back-calculating the extended secondary structure from atom coordinates. We have integrate in a computational pipeline the functionality of two fully automated, high fidelity methods: RNAComposer for the 3D RNA structure prediction and RNApdbee for base pair annotation. We have benchmarked our pipeline on 2559 RNAs sequences with the size up to 500 nucleotides obtaining better accuracy in non-canonical base pair assessment than the compared methods that directly predict RNA secondary structure.

De novo genome assembly with the acceleration of GPU computing

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Deoxyribonucleic acid (DNA) can be found in every cell of a living organism. It carries genetic information necessary for its functioning. DNA is composed of small molecules, called nucleotides. Depending on the species the length of a DNA sequence may vary from 10^6 of nucleotides for bacterial genome to $3 * 10^9$ for human genome or even longer for plant genomes. No method exists which could read a sequence of nucleotides at once. Usually one can read only very short fragments of DNA. Present-day technology allows to read billions of short DNA fragments at once [1].

In the de novo genome assembly, the next step in the process of reading a DNA sequence, the short DNA fragments (of length up to a few hundreds of nucleotides) are merged together in order to reconstruct the original genome sequence, or a fragment of it. Short DNA fragments may contain errors like insertions, deletions or mismatches, and may come from both strands of a DNA helix. Huge number of DNA sequences force the implementation of time-efficient algorithms which optimize the memory usage. DNA assembly problem is strongly NP-hard, because even its simplified version, shortest common superstring problem is strongly NP-hard.

Here we propose a method for genome reconstruction from short DNA fragments which performs calculation on GPU processors. The method consists of a few steps. In the first step the method calculates which fragments overlap. Due to a large number of sequences, and the fact that sequences may contain errors, it's not possible to calculate the alignments for all the pairs of sequences.

Thus, the pairs which are likely to overlap are selected for further comparison. The proposed algorithm for selecting the pairs consists in decomposition of each fragment into the set of k-mers, and then sorting. For the selected pairs the alignment score is calculated with the semi-global version of the Needelman-Wunsch algorithm with the implementation on GPU [2]. In the next step of the assembly method the graph is constructed in which the short DNA fragments are on the nodes, and the calculated feasible alignments of each pair of fragments induce arcs of the two respective nodes. In this graph we search for a path, or several paths, which are composed of the disjunctive set of nodes. Each path represents a fragment of genome sequence. The method has been tested on the real data experiment of the C.elegans genome. The results are of high quality, i.e. the obtained genome fragments align with 99.9% of similarity to the original genome.

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5.5 Friday Morning Plenary Talk

Preference-driven evolutionary multiobjective combinatorial optimization with Choquet integral preference model

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We present an interactive evolutionary multiobjective optimization method applicable to both continuous and combinatorial problems. The search is driven by users preferences elicited in form of pairwise comparisons of some non-dominated solutions in successive generations. When choosing the mathematical form of the preference model guiding the search, one faces the usual dilemma: if the preference model is too simplistic (say, linear), it is unlikely to be able to represent adequately the users preferences expressed through the pairwise comparisons; on the other hand, if the preference model is too versatile, a lot of preference information is required from the user to narrow down the models parameters to a useful degree, i.e., such that the preference relation implied by the model is sufficiently richer than the dominance relation and thus helpful to converge to the most preferred part of the Pareto front. For this reason, we propose

a method called NEMO-II-Ch that adapts to the complexity of users preferences in the course of successive generations. It starts with a linear additive model, and switches to 2-additive Choquet integral, a preference model permitting to represent interaction between objectives, once the linear additive model is not able to represent the preference information iteratively supplied by the user in terms of pairwise comparisons of feasible solutions. Computational experiments with continuous and combinatorial multiobjective optimization problems prove a good convergence of the proposed method to the most preferred region of the Pareto front for a simulated artificial user. The test problems of the multiobjective combinatorial optimization type are those of knapsack and travelling salesman.

5.6 Friday Morning Sessions

Heuristic approaches for solving a machine scheduling problem with additional doubly-constrained resource

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We consider a problem of scheduling preemptable, independent jobs on parallel, identical machines under an additional, continuous, doubly-constrained resource with the schedule length criterion. The considered problem belongs to the class of discrete-continuous scheduling problems, where processing rate of a job depends on its temporal usage of the continuous resource. A job is characterized by both: a size and a continuous, increasing processing rate function.
The known exact method for solving the problem requires the solution of a complex non-linear mathematical programming problem. The number of variables in such the problem grows exponentially with the size of an instance.
Thus, we propose two heuristic approaches to solve the problem. Simplicity and avoidance of the non-linear solver - these are the main assumptions for the designed algorithms. The proposed two algorithms allocate two categories of resources to jobs, namely: discrete (machines) and continuous ones. They differ with a sequence of actions. The continuous resource is allocated to jobs ahead to the discrete one in the first algorithm. A particular amount of the resource allocated to a job is calculated basing on a given simple rule. Then the classical McNaughton algorithm finds the final schedule. Of course the rule used in step one should guarantee the feasibility of such schedule.
Second heuristic algorithm utilizes the concept of jobs grouping. Jobs with the same processing rate function belong to a single group. The algorithm shares the available machines among groups of jobs in the first step. Then a modified McNaughton algorithm is used for each group to find the final sequence of jobs on each machine. Finally the optimal continuous resource allocation for jobs allows to find the schedule length. We assume the forms of processing rate

functions guarantying that the final step of the algorithm is performed analytically.
Both heuristic approaches are compared basing on results of a computational experiment.

Stability Analysis of Scenarios based Solutions for Robust Unrelated Parallel Machines Scheduling

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Unrelated parallel machines are same function machines that have job dependent speeds to accomplish the processing requirements of jobs. Scheduling on unrelated parallel machines is a common problem in many applications like semiconductors manufacturing [1, 2, 3], textile industry [4], Printed Wiring Board manufacturing line [5], and multiprocessor computer applications [6], etc.
In this study, we consider the scheduling problem on unrelated parallel machines under job processing time uncertainties where the objective is to minimize the makespan. The splitting is allowed: each job can be split into parts and these parts are assigned to the machines with parallel processing, that is, for every job, more than one of its parts can be processed at the same time on different machines. According to Graham et al.s notation [7], this problem is stated as Rm/Split/Cmax.
From modeling point of view, the splitting unrelated parallel machine problem with makespan minimization is a relaxed version of the preepemtive problem (Rm/pmtn/Cmax). Thus, solving (Rm/Split/Cmax) is reduced to find the optimal allocation and no order of sequence is needed to be calculated. Lawler and Labetoulle [6] have shown that the optimal allocation of (Rm/pmtn/Cmax) can be obtained in polynomial time by using a linear programming model. Consequently, the split problem (Rm/Split/Cmax) is solved in polynomial time by a linear program.
However, manufacturing industries environnement are subject to numerous factors of uncertainty (such as demand fluctuations, skills of operators). Thus, the job processing times can be shorter or longer than expected. Consequently, the optimal solution calculated from the nominal instance is usually suboptimal when applied to the real instances. Generally, the deterministic resolution has limitations to hedge against job processing time uncertainties. This ascertain-

ment confirms the necessity to provide reliable solutions that recognizes the presence of plausible data instances other than the nominal instance. These motivate us to study the problem (Rm/Split/Cmax) under job processing time uncertainties. Two criteria are explored for reliability purpose: robustness and stability. By robustness we mean the ability of solution to withstand the worse-case of unexpected but likely processing time realizations without need to be repaired, and by stability we mean the ability of solution to conserve the same resources allocation when the real scenarios vary around the nominal instance. In other words, we search for a robust solution that has also the least negative impact on the workshop nervousness (e.g. frequent changes in the number of operators and machine settings).
Based on the discrete robust optimization framework of Kouvelis and Yu [8], we propose to incorporate the jobs processing time uncertainties in the (Rm/Split/Cmax) without making any assumption on the probability distribution of the uncertain values. Hence, we structure the uncertainty of processing times by mean of discrete scenarios. The scenario representation is very useful from practical point of view since in a lot of activities sectors experts are able to define a set of instances that capture all the potential future realizations of processing times.
In a previous study [9], in order to identify a robust solution, we computed a set of feasible solutions from several scenarios including the solutions corresponding to special scenarios, such as the worse- case scenario, the average scenario, and the median scenario. The use of those scenarios is very common in industry. We applied each solution in term of jobs allocation to the set of real scenarios and then we calculated the maximal cost (makespan) resulting from this solution. We have shown that the solutions corresponding to the worse-case scenario, the average scenario and the median scenario are more robust than the solutions from the other scenarios. We call these solutions robust artificial solutions.
In this work, we develop an approach to compare the stability of the robust artificial solutions. We generate iteratively a set of N scenarios around the nominal scenario according to a level of uncertainty. The number of real scenarios is fixed to 2 scenarios (including the nominal one) for the first iteration. We increase the number of real scenarios as the number of iterations increases in order to enlarge the uncertainty set. For the iteration k we calculate the robust artificial solutions and we compare these solutions obtained for k real scenarios to those obtained for (k-1) real scenarios in order to measure the deviation between the new solutions and their previous ones. This deviation is measured through two indicators: the variance of the machine loads and the machines allocation changes. We have carried out a numerical experiment to investigate the stability of robust artificial solutions. To generate the scenarios around the nominal instance, we fixed the level of uncertainty to 10% .The results show that the solutions based on the worse-case scenario is more stable than the solution based on the median scenario, and this latter is more stable than the solution based on the average scenario. It means that the worse-case scenario and the median scenario solutions can absorb a large set of uncertain-

ties around the nominal instances with the least changes in the initial resources allocation. Consequently, even if the solution based on the worse-case scenario is more cost expensive, it may be favorable to workshop where machine allocation nervousness could generate additional costs. In contrary, the solution based on the average scenario, in spite of its moderate cost, may generate additional costs because of its instability properties. Concerning the solution based on the median scenario, in spite of its stability properties, it is less robust than the worse-case and average scenarios solutions. Consequently, we conclude that the worse-case scenario solution could be considered as reliable since it is robust and stable. Other levels of uncertainties will be tested to check whether the worse-case scenarios solutions will still be reliable or not.

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Single machine scheduling to minimize total earliness-tardiness with unavailability period

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We study several versions of a single-machine scheduling problem, where the machine is unavailable for processing for a pre-specified time period. In the basic problem, a common due-date for all the jobs is assumed, and the objective function is minimizing total earliness-tardiness. We consider first the setting that no idle times are allowed. We then extend the problem to general earliness and tardiness cost functions, to the case of job-dependent weights, and to the setting that idle times are allowed. All these problems are known to be NP-hard. We introduce in all cases efficient pseudo-polynomial dynamic programming algorithms.

A MIP formulation and heuristic for a dynamic distribution network design problem Case study in the automotive industry

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Celine Gicquel	RI - Université Paris Sud, France
Michel Minoux	University Pierre et Marie Curie, France

In this work, we study one of the key supply chain planning problems at the strategic level, namely supply chain network design. Using a mixed integer program, we model a multi-period multi-product distribution network design problem capturing several operational features arising from a case study in the automotive industry. The overall network consists of 3 levels: plants, distribution centres (DCs) and customers (grouped into districts). We assume that the number and the location of the plants as well as the number and the location of the customers are fixed. Given a dynamic demand and a list of potential DCs, our objective is to locate DCs and to assign districts to them while minimizing distribution costs. As the planning horizon considered is not very long (one year divided into four time-periods illustrating the seasonality in car distribution) and DCs are related to fixed-term contracts, DCs opened at the beginning of the planning horizon have to be operational over all the time-periods.

Through a pre-processing dynamic clustering procedure, we propose an original way of modeling the impact of demand variation on delivery routes and costs. This enables us to reach a good trade-off between the representation of operational details in the model and its computational tractability. Using real life data from our case study, we carry out several numerical experiments in order to investigate computation times and network decisions/costs. We evaluate the difference between using static assignments and using dynamic assignments in terms of costs and location decisions. Actually a company can decide to keep the same distribution flows over the whole planning horizon in order to simplify day-to-day operations. However, this choice leads to additional costs that will be estimated in our numerical experiments. Then, we compare the results given

by the multi-period problem with those given by the single-period one, with a focus on network structure. Finally, to cope with the computational difficulties shown by numerical results, we also investigate a heuristic procedure to solve large size instances of the multi-period distribution network design problem.

An Exact Enumerative Algorithm for Counting Independent Sets

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Raymundo Marcial-Romero	Fac. de Ingeniera, UAEMEX, Mexico
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Given G a (simple, finite, undirected) graph, we present a bottom-up procedure to compute $i(G)$ in an incremental way. Our procedure begins with the computation of a maximum induced subgraph from G that does not have intersecting cycles, let us call the subgraph G_0, and let $CC = \{E(G) - E(G_0)\}$ be the set of edges forming intersecting cycles in G_0. In each new iteration i of the procedure, a new edge $e_i = \{u, v\} \in CC$ is considered in order to form $G_i = (G_{i-1} \wedge e_i)$. Later, we compute $i(G_i)$ based on the previous value obtained in $i(G_{i-1})$, by applying the edge reduction rule, given as:

$$i(G_i) = i(G_{i-1} \wedge e_i) = i(G_{i-1}) - i(G_{i-1} - (N[u] \cup N[v])) \tag{5.1}$$

The time-complexity of our procedure depends on the size of CC. We show some cases where $i(G)$ is computed efficiently. For example, we show that if an input graph is acyclic, or it has cycles which are independent from each other, then $i(G)$ is computed efficiently, using a previous algorithm designed for this purpose [1].
Furthermore, given a cycle G with intersecting cycles, if each $G_{i-1} - (N[u] \cup N[v])$ in the decomposition of G in (5.1) has not intersecting cycles, then $i(G)$ is computed in polynomial time. Our method provides the efficient computation of $i(G)$ for several kinds of graphs.
On the other hand, if any $G_{i-1} - (N[u] \cup N[v])$ in (5.1) has intersecting cycles, then we can apply our proposal in a recursive way. As a consequence, we have a recursive procedure for computing $i(G)$ based on the decomposition of G in maximum induced subgraphs without intersecting cycles.

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Euclidean k-cycles cover problem on maximum: asymptotically optimal approach

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Let the complete graph be given in d-dimensional Euclidean space. The problem under consideration is to cover the graph by k edge cycles of maximum total weight. An approximation algorithm with time complexity $O(n^3)$ is presented. We show that for $k = o(n)$ the algorithm is asymptotically optimal with the relative error $O(n^{-\frac{2}{d+1}})$.

Optimization-based heuristic for the Asymmetric Capacitated Vehicle Routing Problem

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Mohamed Haouari	College of Engineering Qatar University, Qatar

We consider the Asymmetric Capacitated Vehicle Routing problem, which is a particular case of the standard Capacitated Vehicle Routing Problem in which the costs on the arcs are not symmetric. We propose an optimization based heuristic that is based on the following approaches. The problem is decomposed into two subproblems that are solved sequentially: first we solve the MIP relation of a compact formulation of the ACVRP including assignment variables and relaxing the integrality constraints on the arc variables and then as many independent Asymmetric Travelling Salesman Problems as the number of vehicles. Starting for several feasible solutions we solve a sequence of r-vehicle ACVRPs (with $r = 2, 3$) on a restricted set of nodes in order to improve the quality of the initial solutions. We further reduce the number of arcs of the graph on which we solve the r-vehicles ACVRPs considering for each node only p of its neighbors. The heuristic is relatively easy to be coded and it provides reasonably good solutions within an acceptable CPU time.

An intelligent extension of Variable Neighbourhood Search for labelling graph problems

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José Andrés Moreno Pérez	Universidad de La Laguna, Spain

We describe an extension of the Variable Neighbourhood Search (VNS) metaheuristic, which integrates the basic VNS with other complementary approaches from machine learning, statistics and experimental algorithmic, in order to pro-

duce high-quality performance and to completely automate the resulting optimization strategy. The resulting intelligent VNS has been successfully applied to a class of labelling graph optimization problems where the solution space consists of a subset of a finite reference set. These problems are the labelled spanning tree and forest problems, which are both formulated on undirected labelled graphs, i.e. graphs where each edge has a label assigned in a finite set of labels L. The problems consist on selecting the subset of labels such that the subgraph generated by these labels has an optimal spanning tree, or forest, respectively. Both problems have several applications in the real world, where one aims to ensure connectivity by means of homogeneous connections.

A binary artificial bee colony algorithm for optimal wind turbine placement in wind farms

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Erdal Emel Uludag University, Turkey

This study presents a binary artificial bee colony algorithm for optimal placement of wind turbines within a wind farm. The objective is to maximize the power output using minimum number of wind turbines. Moreover, linear wake model is used to calculate downstream wind speed. Artificial bee colony algorithm (ABC) is one of the recently introduced swarm based meta-heuristic algorithms. ABC mimics the foraging behavior of honey bee swarms. In this paper, an improved binary version of ABC is proposed and tested on several cases. Three cases are considered (a) unidirectional uniform wind, (b) uniform wind with variable direction, and (c) non-uniform wind with variable direction. Experiments are conducted and proposed ABC is compared to other efficient meta-heuristic algorithms. Results reveal that proposed algorithm is very efficient.

5.7 Saturday Morning Plenary Talk

Machine scheduling with non-renewable resources

Tamás Kis Hungarian Academy of Sciences, Hungary

In the talk we overview recent developments in machine scheduling with additional non-renewable resources, like raw materials, money, etc. We will consider problems with resource consuming as well as resource producing jobs, and we will show the connections between these problems, and variants of the knapsack problem. From these connections, we will derive approximation algorithms and inapproximability results for various scheduling problems in the class mentioned above.

5.8 Saturday Morning Sessions

A Unified Method for Constrained Assortment and Pricing Problems under the Consumer Choice Models

Ruxian Wang Johns Hopkins University, Carey Business School, USA

In this paper, we propose a unified method to the joint constrained assortment and pricing optimization problems under the multi-stage consumer choice models. The goal is to select the product sets to offer and determine their prices so as to maximize the total expected profit per, assuming that the customers purchase behavior follows the multi-stage logit choice models with the multinomial logit as special cases. In addition to characterizing the optimality conditions, we have made several contributions for this increasingly popular topic comparing to the existing literature. The efficient prices of all the products in each nest are uniquely determined by the desired adjusted markup although it may be impossible to achieve the same level due to price-bound constraints. The desired adjusted markups at the nest level are also linked to a common variable. The product selection search space in each nest is reduced to the set of efficient assortments of polynomial size. Finally, the joint assortment and pricing optimization problem can be reduced to finding the fixed points of a single-dimensional piecewise decreasing function with jump discontinuance. Furthermore, the optimization process can be visualized so it clearly shows how the model parameters, product set constraints and price bounds affect the optimal product sets to offer and their corresponding prices.

Rolling horizon approaches to the aircraft sequencing problem

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Martin Philip Kidd DEI, University of Bologna, Italy
Carlo Alfredo Persiani ENAV S.p.A, Italian Agency for Air Navigation, Italy
Paolo Toth DEI, University of Bologna, Italy

In a scenario characterized by a continuous growth of air transportation demand, the runways of large airports serve hundreds of aircraft every day. Aircraft sequencing is a challenging problem that aims to increase runway capacity in order to reduce delays as well as the workload of air traffic controllers. In many cases, the air traffic controllers solve the problem using the simple "first-come-first-serve" (FCFS) rule. In this paper, we present a rolling horizon approach which partitions a sequence of aircraft into chunks and solves the Aircraft Sequencing Problem (ASP) individually for each of these chunks. Some rules for deciding how to partition a given aircraft sequence are proposed and their effects on the solution quality investigated. Moreover, two Mixed Integer Linear Programming (MILP) models for the ASP are reviewed in order to formalize the problem, and a tabu search heuristic is proposed for finding solutions to the

ASP in a short computing time. Finally, we develop an Iterative Rolling Horizon Algorithm (IRHA) which, using different chunking rules, is able to find solutions significantly improving on those found by the FCFS rule for real-world air traffic instances from Milano Linate Airport.

Workload Balancing at Intermodal Container Terminals and Sea Ports

Dominik Kress	University of Siegen, Germany
Sebastian Meiswinkel	University of Siegen, Germany
Erwin Pesch	University of Siegen, Germany

We introduce and analyze the Partitioning Min-Max Weighted Matching (PMMWM) Problem. Applications of PMMWM arise in the field of balancing workload at intermodal container terminals and sea ports. PMMWM combines the problem of partitioning a set of vertices of a bipartite graph into disjoint subsets of restricted size and the strongly NP-hard Min-Max Weighted Matching (MMWM) Problem, that has recently been introduced in the literature. In contrast to PMMWM, the latter problem assumes the partitioning to be given. We propose a MILP formulation for PMMWM and prove that the problem is NP-hard in the strong sense. Two heuristic frameworks that decompose the problem into its partitioning and matching components are presented. Both of them outperform standard optimization software and classical metaheuristic approaches for the integrated problem. Our extensive computational study proves that the algorithms provide high quality solutions within reasonable time.

Polynomially Solvable Knapsack Type Problems with Box Constraints on Combinatorial Structures

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Sergey Kovalev	INSEEC Business School ECE Lyon, France
Mikhail Kovalyov	United Institute of Informatics Problems, National Academy of Sciences of Belarus, Minsk, Belarus

We study knapsack type problems defined on a given set E or on combinatorial structures of this set such as simple paths or spanning trees in directed or undirected graph with E being the set of arcs or edges, respectively. The variables of the studied problems obey box constraints and their smallest and largest contributions to the objective function are given constants. These problems can be viewed as generalizations of the risk minimization problems introduced in [1] and [2]. To solve them, we suggest an original approach leading to the polynomial time algorithms that are faster than the algorithms developed earlier for the risk minimization problems.

We also study a reverse version of the knapsack type problems, where the roles of the objective function and the constraint are switched. These problems generalize the reverse risk minimization problem introduced in [3]. Based on our approach, we present polynomial time algorithms for their resolution, which outperform the algorithms in [3]. Finally, we show how to solve a bi-criteria version of the studied problems, in which the knapsack type constraint becomes the second objective function to be minimized or maximized.

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Ressource constrained multiobjective linear assignment problem

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While reading the literature about multi-objective combinatorial optimization(MOCO), the assignment problems emerges as one of the most studied ones. A very simple problem in its single objective version, its difficulty is a real challenge that has drawn the interest of many researchers among the high scientific society (dealing with MOCO).
We wondered how this difficulty would increase if we added an additional constraint (as simple as it could be, in a first time, say a constraint on resources)? How could we make use of existing results and methods from the MOLAP (multiobjective optimization linear assignment problem) for solving the problem we are interested in? Those are some of the questions we are trying to bring some answers along the present paper.

Linear bilevel programs with multiple objectives at both levels

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Multiobjective BLP (MOBLP) problems are the special case of BLP problems which require every feasible solution of upper level problem to satisfy the Pareto optimality conditions of a lower level muliobjective optimization problem. In

this paper, we use the relationship between linear MOBLP problems and MOLP problems along with results for vector minimization of an upper level multi-objective function over the efficient set of an MOLP problem for finding a compromise solution, which is the closest feasible solution of MOBLP to the ideal point. Numerical example is provided to illustrate the approach.

Multi-objective optimization in partitioning the healthcare system of Parana State in Brazil

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Maria Teresinga Arns Steiner	Pontifical Catholic University of Paraná, Brazil
Dilip Datta	School of Engineering, Tezpur University, India
Pedro José Steiner Neto	Federal University of Paraná, Brazil
Cassius Tadeu Scarpin	Federal University of Paraná, Brazil

Motivated by a proposal of the local authority for improving the existing healthcare system in the Parana State in Brazil, this article presents an optimization-based model for developing a better system for patients by aggregating various health services offered in the municipalities of Parana into some microregions. The problem is formulated as a multi-objective partitioning of the nodes of an undirected graph (or network) with the municipalities as the nodes and the roads connecting them as the edges of the graph. Maximizing the population homogeneity in the microregions, maximizing the variety of medical procedures offered in the microregions, and minimizing the inter-microregion distances to be traveled by patients are considered as three objective functions of the problem. An integer-coded multi-objective genetic algorithm is adopted as the optimization tool, which yields a significant improvement to the existing healthcare system map of the Parana State. The results obtained may have a strong impact on the healthcare system management in Parana. The model proposed here could be a useful tool to aid the decision-making in health management, as well as for better organization of any healthcare system, including those of other Brazilian states.

Warehouse Selection based on Fuzzy ELECTRE

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Yousef Daneshvar Rouyandozagh	Gazi University, Turkey

Warehouse selection has a critical effect on the performance of countless companies. In this paper, we present and develop a model for new Warehouse selection based on the combination of Fuzzy and Elimination Et Choix Traduisant La REalite (ELECTRE) extensive evaluation method. The process of evaluat-

ing qualitative and quantitative scale should be combined. The proposed hybrid models enable different Decision-Makers (DMs) on the assessment, and use Fuzzy numbers (FN). In order to indicate the validity of the suggested hybrid model, an example is provided to demonstrate and clarify the proposed analysis procedure. Also, an empirical experiment is conducted to validation the effectiveness. The results indicates that the applicability of the proposed hybrid FELECTRE Model.

Mathematical models and approaches in problem of volume planning of ISS cosmonauts trainings

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Alexander Lazarev	V.A. Trapeznikov Institute of Control Science of Russian Academy of Sciences, Russian Federation
Nikolai Morozov	Lomonosov MSU, Russian Federation
Maksim Kharlamov	YU. A. Gagarin Research & Test Cosmonaut Training Center, Russian Federation
Denis Yadrentsev	YU. A. Gagarin Research & Test Cosmonaut Training Center, Russian Federation

To prepare cosmonauts for the mission on the International Space Station Cosmonaut Training Center must provide trainings for all sorts of the operations and emergencies. All the operations and emergencies combined into sets named onboard systems.
In general three crew qualification levels are defined; user level, operator level and specialist level. For every onboard system a set of minimum qualifications needed to safely operate and maintain the system is pre-defined. Each crewmember, while being specialist for some systems, will be operator or only user for other systems. Consequently, the training programme for each crewmember is individually tailored to his or her set of tasks and pre-defined qualification levels.
The following problem has been considered, the pre-defined set of minimum qualification levels should be distributed between members of a crew with minimum training time differences.
In this paper we compare different possible mathematical models and propose two heuristic algorithms with complexity of O(n) operations based on peculiarities of the problem. Both have been compared with the results received from Constraint Programming method.

Analytical Results for Online Conversion - An Introduction to Balanced Analysis

Günter Schmidt Saarland University, Germany

We present online algorithms for the solution of financial conversion problems. Financial conversion is the task to exchange assets over time to maximize terminal wealth. Exchange rates appear online and cannot be predicted. No probabilities and distributions are known. We investigate the problem structure, show how performance can be guaranteed and prove the optimality of the approach. The results are based on balanced analysis which is related to primal-dual approaches in mathematical programming. The talk covers results of the paper

Mohr, E., Ahmad, I., Schmidt, G., Online Algorithms for Conversion Problems: A Survey, Surveys in Operations Research and Management Science 19. pp. 87-104, 2014.

Advanced web-site based trading platforms: Cloud Brokering, Internet Shopping, and more...

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One can say that electronic commerce (e-commerce) is one of the fastest developing fields of computing science (based on operational research, combinatorial optimization). However, it is worth noticing that e-commerce is a giant hybrid built in additional areas such as logistics, economy and social sciences. E-commerce is an industry, which focuses on selling and buying products and services through web pages. Online shopping, fitting into a business-to-consumer (B2C) sub-category, is one of the key business activities offered over the Internet. It has become increasingly popular over the past decade.

Cloud computing is, undoubtedly, one of the main existing computing paradigms nowadays. In the last years, it raised the interest of both academic and industrial worlds thanks to their interesting properties, such as elasticity, flexibility, or computational power, among many others. Cloud computing provides a stack composed of different kinds of services to users: Infrastructure as a Service (IaaS), dealing with resources as servers, storage, or networks; Platform as a Service (PaaS), which provide an operating system as well as a set of tools and services to the user; or Software as a Service (SaaS), that allows providers to grant customers with access to licensed software. The figure of cloud broker arises as an intermediary entity between cloud providers and users to help the latter ones in the process of choosing the most appropriate services among those offered by the different CSPs, according to their particular needs. There are different services that cloud brokers can provide, from simply finding the best deals among a set of clouds for the user requirements to defining the best possible design to deploy the user's application in the cloud. Additionally, the cloud broker can consider the QoS and SLA from the CSPs as parameters to compare with the results from the historical data or log analysis based on the

on-running services of the cloud users, in order to ensure high QoS. One can notice many similarities between cloud brokering and Internet shopping issues motivated by the problem of buying multiple products from different e-commerce web sites. During the conference the author present many links to different e-commerce trading options were cloud computing, cloud brokering, e-commerce, Internet shopping, and some new others approaches come together.

A generic approach for heterogeneous scheduling

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Denis Trystram Grenoble University, France
Frederic Wagner Grenoble University, France

This work aims at studying efficient scheduling strategies in the context of hybrid parallel multi-core platforms composed of two kind of resources, namely standard multicores and accelerators (GPUs). We put emphasis on general purpose policies developed at the middleware level (by opposition to codes tuned by the expert users for specific applications). We survey several recent results in various situations (off-line/on-line scheduling, for independent tasks, precedence relations, sequential and parallel tasks), which allow us to derive a general methodology for managing hybrid resources.

Single machine scheduling: an upper bound on maximum lateness

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The following classical NP-complete scheduling problem is considered. There is a single machine and a set of jobs to be processed. The goal is to construct an optimal schedule with respect to criterion minimization of maximum lateness. We construct the measure of insolubility E for a set of polynomial solvable instances. Then, we project the considered instance on 3n-dimensional unit sphere and we estimate an upper bound on a metric distance between the considered instance and polynomial solvable area equals $E < 1$ when parameters of jobs are real and $E < 1/sqrt2$ when parameters of jobs are positive. We also present some bad instances to prove that the bound is tight for a considered set of polynomial solvable areas. In addition we present some properties of instances with the largest metric distances. Analysis of the efficiency of suggested method and numerical experiments are also presented.

Transformations of edge colorings of graphs and their application in scheduling

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A proper edge t-coloring of a graph G is an assignment of the colors $1, 2, \ldots, t$ to the edges of G, one color to each edge, such that no pair of adjacent edges receive the same color.
Edge coloring problems appear in many places with seemingly no or little connections to coloring. For example, many problems on school timetables can be formulated in terms of edge colorings of bipartite graphs.

Unfortunately the most interesting optimization problems on proper edge colorings are NP-hard even for bipartite graphs.

Let f be a proper edge coloring of G and let H be a subgraph of G induced by two colors a and b. By switching the colors a and b on a connected component of H we obtain another proper edge coloring of G.
This operation is called an interchange involving the colors a and b.

Hybrid approach for the reconstruction of homogenous images

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The basic problem of discrete tomography consists in reconstructing a binary image from its discrete orthogonal projections. A quadratic time algorithm has been proposed to solve the problem in 1954 but the number of possible solution is very huge. To refine the reconstruction many additional properties are integrated to the image to reconstruct such as convexity and periodicity.

In this paper, we are concerned with the reconstruction of binary images with homogeneous regions.

Tag clouds for the web as an optimization problem

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Łukasz Rusiecki	Poznan University of Technology, Poland
Hubert Narożny	Poznan University of Technology, Poland
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Tag cloud is a form of data visualization casting a set of tags: words, phrases, topics or items onto a two-dimensional plane. It is widely used on web pages, but also elsewhere when there is a need to summarize a text body, search results or other textual data. Constructing a tag cloud can be seen as a combinatorial optimization problem: tags with their bounding boxes can be treated as rectangles and as such are subject to rectangle packing.
A new approach to the problem of constructing an arrangement of the tags in a tag cloud will be presented. The corresponding algorithms improve usability, readability and aesthetics of the cloud. For this purpose beauty rules coming from typography, and ways of quantifying them into an objective function will be discussed. Mathematical formalization of this approach will lead to a new version of bin packing problem. Solvability of this problem with exact and greedy algorithms will be discussed. Finally, hyper- and metaheuristic algorithms tailored for the problem will be outlined.

Interdiction of a CPM Project and Its Implications Within the Scope of Project Management

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There are two opponents in a classic network interdiction problem, one being the network owner, the other being the interdictor/attacker, and each side has enough information about the other one. While the network user wishes to run the network in an optimal way, the interdictor with its limited resources tries to hinder the network owner from running the network efficiently. In this study, we investigate the network interdiction problem within the context of project management. We assume that the project owner strives to minimize the completion time of a Critical Path Method (CPM) based project in accordance with the activity durations and precedence relationships while an opponent tries to maximize it with resources available for interdiction. We first develop a bi-level mixed-integer programming model for the interdiction of a CPM project. We then convert the bi-level model to a single-level model, which is solvable through standard optimization packages. Next, we discuss an algorithm to find the earliest and latest start times of activities in case of interdiction. We also develop an algorithm to find efficient solutions in terms of interdiction resources and the maximum project completion time from the interdictor‘s perspective. Finally, we present some insights for decision makers obtained from a sample application. The findings may enhance a better project management in an environment where an opponent can adversely affect the project management process by delaying some activities.

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