Technische Universität München

ECCO XXVII – CO 2014 Joint Conference

27th Conference of the European Chapter on Combinatorial Optimization

Technische Universität München
Department of Mathematics
May 1st - 3rd, 2014

A very warm and cordial

WELCOME

to the ECCO XXVII – CO 2014 in Munich.

We are very happy that you all came to Munich to contribute to the success of the conference. We will have a very interesting and versatile scientific program of more than 80 talks on a wide range of topics in combinatorial optimization. The conference will even have two satellite events on very practical challenges in tomography and forestry.

ECCO XXVII – CO 2014 will be a truely international event with 105 participants from 21 different countries, mostly from, but not at all restriced to, Europe.

Munich, the capital of Bavaria within the Federal Republic of Germany is a very lively and fascinating city. We hope that at least some of you will take the chance to stay over the weekend to enjoy the city and its great Alpine vicinity. In any case we have prepared for all of you a program which, of course, is focussing on the scientific exchange but which nevertheless tries to address the unity of brain, body and soul. In particular, we will have an extended welcome reception in TU München's bel étage with a splendid view over the city on Wednesday night. Also, you should not miss our excursion on Friday afternoon, the guided tour through the residence of the Bavarian emperors. Afterwards you might want to take the chance to stroll through the old part of Munich before we all reconvene in the Ratskeller below the city hall at the Marienplatz for our conference dinner – (moderately) Bavarian style, of course.

This booklet contains a lot of (as we think) useful information, the complete program and the abstracts of the talks. If you should have any additional questions do not hesitate to contact any members of our local team: they can be identified by their badge.

Let me close this short welcome with a few words of thanks. First, we thank you all for coming to Munich and contributing to this meeting. Second, we thank ECCO and CO for choosing the TU München as the 2014 site of this conference and the Program Committee for helping to put together an attractive scientific program. Third, we would like to thank the TU München and the Department of Mathematics for their support. Finally, special thanks go to the co-members of the local organizing team, Steffen Borgwardt, Rene Brandenberg, Andreas Brieden, and Michael Ritter for their continuing invaluable work.

We wish you all an interesting meeting and an enjoyable time in Munich.

Peter Gritzmann
TU München

We warmly welcome you to the ECCO XXVII – CO 2014 conference on Combinatorial Optimization, on the Garching research campus of the Technische Universität München. ECCO is the European Chapter on Combinatorial Optimization, which was formed as a EURO Working Group in 1987, and holds an annual meeting that usually takes place in May. CO is a series of conferences that started in the UK in 1977 with meetings held every two years. It is has recently become a tradition that the CO meetings alternate between being held in the UK and being joint with ECCO.

We fully expect that this meeting will provide a stimulating opportunity for researchers from around the globe to exchange knowledge of recent developments in the theory and application of Combinatorial Optimization. The scientific program of the conference is expected to be of high quality with the lectures to be delivered by the three eminent plenary speakers providing a particular highlight.

It is appropriate to use this opportunity to express our appreciation to all of those who have contributed to the preparation of this conference, and in particular to Peter Gritzmann who chaired both the Program and the Organizing Committees.

We wish you all a stimulating and enjoyable conference.

Silvano Martello
Coordinator of ECCO

Chris Potts
Coordinator of the CO conference series

Program Committee

Peter Gritzmann (Chairman)	Technische Universität München
Jacek Blazewicz	Poznan University of Technology
Van-Dat Cung	Université de Grenoble
Alain Hertz	Ecole Polytechnique de Montréal
Silvano Martello	University of Bologna
Chris Potts	University of Southampton
Dolores Romero Morales	University of Oxford
Vitaly Strusevich	University of Greenwich
Paolo Toth	University of Bologna

Organizing Committee

Peter Gritzmann (Chairman)	Technische Universität München
Steffen Borgwardt	Technische Universität München
René Brandenberg	Technische Universität München
Andreas Brieden	Universität der Bundeswehr München
Michael Ritter	Technische Universität München
Gerhard Wilhelm Weber	Middle East Technical University

Legal Notice

Contents

1 Schedule Overview

Wednesday, April 30th	from 20:00	Welcome Reception "On Top of TUM" with a spectacular view over Munich *TUM Main Campus, Arcisstr. 21, München*
Thursday, May 1st	09:00 – 09:30	Conference Opening
	09:30 – 10:30	Plenary Talk by Martin Grötschel
		Coffee Break
	11:00 – 12:30	Morning Sessions
		Lunch Break
	14:00 – 15:30	Early Afternoon Sessions
		Coffee Break
	16:00 – 19:00	Late Afternoon and Evening Sessions
Friday, May 2nd	09:00 – 10:00	Plenary Talk by David S. Johnson
		Coffee Break
	10:30 – 12:00	Morning Sessions
		Lunch Break
	13:30 – 15:00	Afternoon Sessions
	16:00 – 18:00	Social Program: Guided Tour of the Munich Residence *Residenzstr. 1, München*
	from 19:00	Conference Dinner at Restaurant "Ratskeller" *Marienplatz 8, München*
Saturday, May 3rd	09:00 – 10:00	Plenary Talk by Salvatore Greco
		Coffee Break
	10:30 – 12:00	Morning Sessions
		Lunch Break

A lunch buffet is available for those who booked it in advance. Your name badge serves as a lunch voucher, it will carry the word "Lunch" for those who booked this option. If you have not booked the lunch option you may still do so at the registration desk at a rate of 25.00 € for all three conference days (there is no option for only one or two days available, even if you arrive late).

2 Location and Transportation

2.1 Conference Venue

ECCO XXVII – CO 2014 takes place at the Technische Universität München, more precisely in the MI building on the Garching research campus. The campus is located north of Munich, between the city center and the airport and about 20km from each of these two destinations as indicated in Figure 1.

2.2 Registration

Conference material will be provided upon check-in at our registration desk. You can check in to the conference at the reception on Wednesday (Vorhoelzer Forum, see *Social Program* for more information and the precise location) and at the conference venue on Thursday and Friday. 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. During the conference, the registration desk can be reached by telephone at +49 160 952 280 64.

Wednesday, April 30th	20:00 - 22:00	*Vorhoelzer Forum, TUM Main Campus, Arcisstr. 21, München*
Thursday, May 1st	08:30 - 16:00	*Conference Venue, Boltzmannstr. 3, Garching b. München*
Friday, May 2nd	08:30 - 12:00	*Conference Venue, Boltzmannstr. 3, Garching b. München*

Emergency Phone

The conference registration desk can be reached by telephone at +49 160 952 280 64 during conference hours.

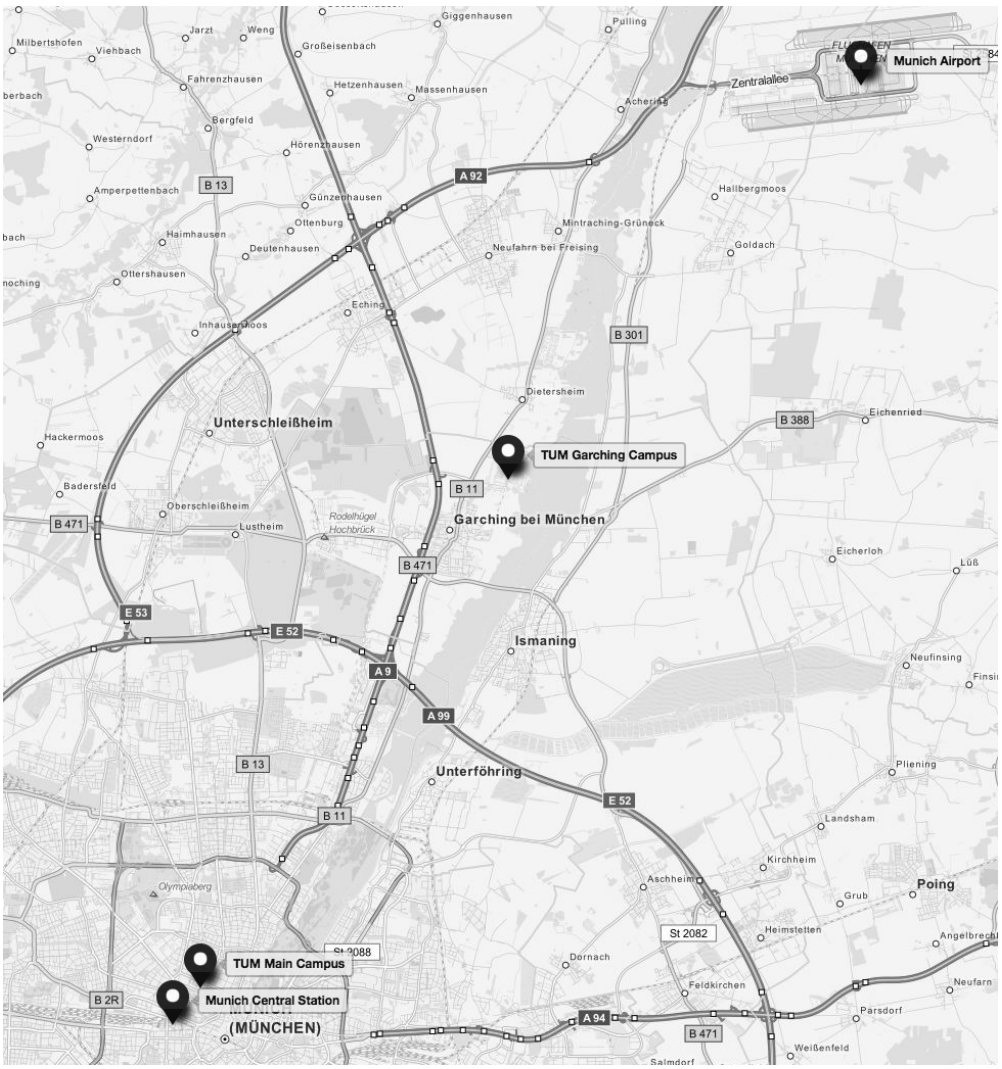

Figure 1: The conference location at TUM Garching Campus.

2.3 Getting to and from the Conference Venue

The conference venue is on TUM Garching Campus north of Munich (Boltzmannstr. 3, Garching b. München) and can most conveniently be reached by public transport from the city center and from the airport. Of course, getting there by car or taxi is also an option. The campus is about 20km from both the city center and from the airport.

Public Transport

The conference venue at Garching campus can be reached best by subway. You need to take the subway line U6 (blue line) to "Garching Forschungszentrum" (last stop), the travel time from Marienplatz (city center) is about 25 minutes. Exit the train and follow the signs to "Mathematik/Informatik" (MI buidling). Precise travel times and instructions from your individual location can be found online by consulting the MVV (local transport authority) website at `www.mvv-muenchen.de`.

Please be aware that May 1st is a national holiday in Germany, so the trains and busses are on the "Sunday schedule". In particular, the U6 to Garching (and back) goes every 20 minutes only.

from Munich (north or city center): Take the subway line U6 to "Garching Forschungszentrum" (last stop). Coming from the city center, you might have to first take another subway line and change later for the U6. In particular, the U6 departs from "Goetheplatz", "Sendlinger Tor", "Marienplatz", "Odeonsplatz", "Universität", "Münchner Freiheit", "Nordfriedhof" or "Alte Heide".

from Garching: Take the subway line U6 to "Garching Forschungszentrum".

from Munich central station: Take the subway lines U1 or U2 (dark green or red line) to "Sendlinger Tor". At Sendlinger Tor, change to the subway line U6 (blue line) to "Garching Forschungszentrum". Alternatively, you may take the subway lines U4 or U5 (light green and brown line) to "Odeonsplatz", where you can also change to the U6 to "Garching Forschungszentrum".

from Munich "Theresienwiese": If you are staying near Theresienwiese, take the subway line U5 (brown line) to "Odeonsplatz", where you can then change to the U6 to "Garching Forschungszentrum".

from Munich airport to the city center: To get to the city center from the airport, take the train lines S1 or S8 which stop at "Marienplatz" (center) and "Hauptbahnhof" (central station). Due to construction works, if you arrive late at night you might have to change at "Pasing" (line S1) or "Ostbahnhof" (line S8) to get to Marienplatz or any other train station in the city center. This also applies throughout the day on Saturday, so be sure to plan for some delays for your trip back to the airport. Note that on Saturday there is a convenient connection to the airport directly from the conference venue that avoids these construction works.

from Munich airport to the conference venue: Except for May 1st, there is a quick connection (about 40 minutes) to the conference venue: Take the S1 train at the airport, get off at "Neufahrn" and take the bus 690. Get off at "Garching Forschungszentrum". On holidays (such as May 1st) the bus is not running. On May 1st, take the S1 train at the airport, get off at Marienplatz and change there to subway line U6 to "Garching Forschungszentrum". The journey will take around 90 minutes, so taking a taxi may be the preferable option when you arrive on May 1st.

from the conference venue to Munich airport: Your easiest connection is to take the bus 690 from the campus to "Neufahrn Bahnhof" (final stop of the bus line). At Neufahrn, get on the train S1 to the airport. The bus runs hourly at 10:06, 11:06, 12:06, 13:06, 14:06 and 15:06 on Saturday, the trip to the airport will take around 40 minutes.

Tickets for Public Transport

As a rule, public transport tickets have to be validated before you board a subway or a train. There are validating machines at the platform access or sometimes at the platform itself. If you take a bus or a tramway, these machines are onboard and you validate your ticket right after boarding. Tickets can be obtained at vending machines at every subway or train station and at vending machines on board the buses and tramways. A day ticket entitling you to unlimited public transport for a whole day is often cheaper than two one-way tickets, hence our general advice is to get a day ticket (which also means you have to think of validating the ticket only once a day).

from Munich: Your cheapest option is getting a "München XXL Tageskarte Single" for 8.10 € for each of the three conference days. This entitles you to unlimited public transport for a single person in the city center and to Garching (but not to the airport). For the days where you need to get to or from the airport, get a "Tageskarte Gesamtnetz" for 11.70 € instead. This entitles you to unlimited public transport for a single person in the city center, to Garching and to the airport.

to/from the airport: For the days of arrival and departure get a "Single-Tageskarte Gesamtnetz" for 11.70 €. That ticket entitles you to unlimited public transport in the Munich area, including the city center, Garching and the airport.

from Garching: You will need a "Kurzstrecke" ticket to get to or from "Garching Forschungszentrum". This ticket is valid for one trip only, so you need to buy another one to get back to your hotel. Also, this ticket may not be used to get to central Munich. If you intend to do so (e. g. for the conference dinner), we recommend you get a "München XXL" ticket that is valid for the whole day and may be used to get around in Garching and in Munich, see above.

sightseeing: If you can spend some extra time for sightseeing the "CityTourCard" may be an interesting option. It serves as a one- or three-day ticket, and while it is a little more expensive than ordinary day tickets it offers a number of discounts for tourist attractions and and some restaurants. For more details, consult the website `www.mvv-muenchen.de/en/tickets-fares/tickets/day-tickets/citytourcard/index.html`.

Car Travel and Taxi

If you are planning to come by car, there is the address of the conference venue for using a GPS: Boltzmannstraße 3, 85748 Garching bei München, Germany

Coming from the city center simply follow the signs to the airport. This will eventually get you onto highway A9 heading north (direction Nürnberg). Take the exit Garching Nord (exit no. 70) and turn right. Cross the B11 at the traffic lights to enter the campus. There is a large parking lot free of charge behind the conference building. Please note that a daily fee of 0.50 € is charged for the parking lot in front of the building.

Please note that parking is limited in the city center, so if you are attending the welcome reception on Wednesday evening, public transport is recommended. The address for the reception venue is: Arcisstraße 21, 80333 München, Germay

A taxi from the city center to Garching campus will usually not be much faster than public transport and cost you around 38.00 € (one way). Getting to the airport by taxi is about 65.00 € from the city center and about 36.00 € from Garching campus.

2.4 Sightseeing

Can you spend some extra time in Munich? Or do you have a few hours left before your flight heads back? Make the best of your time and see some of the sights that Munich has to offer! There is a little web-based tool developed by the discrete optimization group of our department to help you do just that: Go to `www-m9.ma.tum.de/material/sightseeing-osm/?language=english`, enter the time you have available, your starting point and some preferences regarding what you would like to see and get a tour suggestion complete with links to descriptions of the sights you are going to visit.

For an overview of Munich's main attractions and current events visit `www.muenchen.de` or `www.muenchen.de/int/en`.

3 Social Program

3.1 Wednesday, April 30th, 2014 at 20:00

Welcome Reception "On Top of TUM" with a spectacular view

We are looking forward to seeing you in Munich! Our welcome reception on April 30th will take place at the "Vorhoelzer Forum" on top of the main buildings of Technische Universität München in the heart of Munich in the center of Munich's museum quarter. The "Vorhoelzer Forum" is at the fifth floor with a spacious roof terrace which allows a spectacular view over Munich and where you can enjoy drinks and snacks. Also, we will provide you with all conference material.

Directions: The main campus is located at *Arcisstr. 21, 80333 München*. It can be reached most conveniently by subway: Take the subway line U2 (red line) to "Königsplatz", it is only a short walk from there (see the map in Figure 2). Enter at the main entrance on Arcisstraße 21, then take the aisle to the left. At the end of the aisle take the elevator to the 5th floor which will get you directly to the "Vorhoelzer Forum". There will be signs put up to guide you from the main entrance.

3.2 Friday, May 2nd, 2014

Guided Tour of the Munich Residence at 16:00

On Friday afternoon, we will meet at Munich Residence, once the city castle of the Bavarian dukes, princes and emperors. We have organized a guided tour (in English) lasting about 90 minutes.

After that, you will have a chance to discover the historic center of Munich on your own. You can visit the Marienplatz with its gothic style town hall, the Frauenkirche or enjoy a great view from the tower of St. Peter (and get some exercise by climbing the 299 steps to the top). Also, many other sights, cafés and pubs are nearby.

Directions: The Munich Residence is very close to the city center at Marienplatz. We will be going there by subway directly from the conference venue. If you want to go on your own, take the subway to either "Marienplatz" or "Odeonsplatz" and walk from there (see the map in Figure 2 for directions).

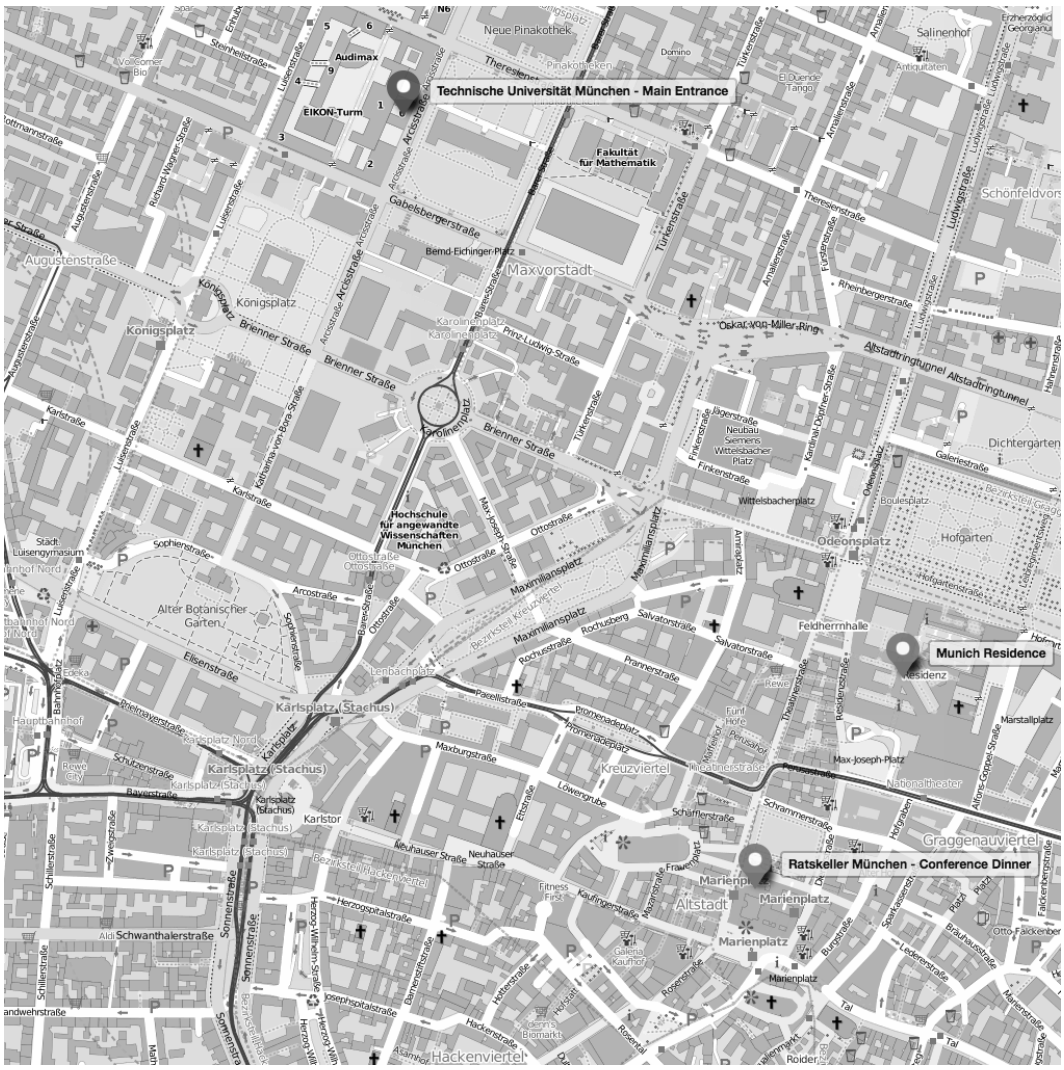

Figure 2: TUM main campus, Munich Residence and conference dinner location.

Conference Dinner at Ratskeller München at 19:00

At 19:00, we will rejoin for our conference dinner at the Ratskeller München at the Marienplatz, where we will enjoy a Bavarian evening and taste the famous Bavarian beer. Food and drinks are included in the conference fee. The conference dinner is kindly supported by FICO, a leading analytics software company.

4 Session Overview

4.1 Conference Opening

Chair: Peter Gritzmann

9:00	**Welcome**	Gero Friesecke, Head of the Mathematics Department Silvano Martello, ECCO board Chris Potts, CO Peter Gritzmann

4.2 Thursday Plenary Talk

Thursday 9:30 - 10:30, Plenary Talk

Chair: Peter Gritzmann **Room HS 3**

09:30 - 09:55	**Combinatorial Optimization in Transport and Logistics** *Martin Grötschel*	(→p.23)

4.3 Thursday, May 1st, 2014: Morning Sessions

Thursday 11:00 - 12:30, Session 1

Chair: Petra Bauer — **Room 00.09.022**

11:00 - 11:25	**A generalization of maximum cardinality bin packing for mixed criticality scheduling** *Yasmina Seddik*, József Békési, Zdenek Hanzálek	(→p.24)
11:30 - 11:55	**A note on the one-dimensional minimax bin-packing problem with bin size constraints** *Mariona Vilà*, Jordi Pereira	(→p.24)
12:00 - 12:25	**2D packing of website graphical components for faster multi-channel download** *Jakub Marszalkowski*, Maciej Drozdowski, Jan Mizgajski, Dariusz Mokwa	(→p.26)

Thursday 11:00 - 12:30, Session 2

Chair: Eranda Cela — **Room 00.07.014**

11:00 - 11:25	**Optimization Techniques for Workforce Scheduling on Production Networks** *Ute Ziegler*, Simone Göttlich	(→p.26)
11:30 - 11:55	**Pharmacy Duty Scheduling Problem: Exact and Heuristic Approaches** Gokhan Ceyhan, Fatih Kocaturk, *Ozgur Ozpeynirci*	(→p.27)
12:00 - 12:25	**Single Machine Just-in-Time Scheduling Problems with Two Competing Agents** *Gur Mosheiov*	(→p.27)

Thursday 11:00 - 12:30, Session 3

Chair: Carl Georg Heise — **Room 02.08.011**

11:00 - 11:25	**Counting the number of non-equivalent vertex colorings of a graph** *Alain Hertz*, Hadrien Mélot	(→p.28)
11:30 - 11:55	**Integral Simplex Using Decomposition with Primal Cuts** *Samuel Rosat*, Issmail Elhallaoui, François Soumis, Andrea Lodi	(→p.28)
12:00 - 12:25	**Flow Shops with Synchronous Movement** *Stefan Waldherr*, Sigrid Knust	(→p.29)

Thursday 11:00 - 12:30, Session 4

Chair: Paolo Dulio **Room 02.04.011**

11:00 - 11:25	**Superiorization via Feasibility-Seeking Projection Methods and Applications** *Yair Censor*	(→p.29)
11:30 - 11:55	**A survey on discrete tomography** *Christoph Dürr*	(→p.30)
12:00 - 12:25	**Mathematics of discrete tomography** *Robert Tijdeman*	(→p.30)

4.4 Thursday, May 1st, 2014: Early Afternoon Sessions

Thursday 14:00 - 15:30, Session 1

Chair: Ulrich Pferschy **Room 00.07.014**

14:00 - 14:25	**A holistic model for rail-rail transshipment yard scheduling problem** *Mateusz Cichenski*, Jacek Blazewicz, Grzegorz Pawlak, Erwin Pesch	(→p.30)
14:30 - 14:55	**Heuristic methods for the track/level rescheduling problem** *Maram Al Jabari*, Mohamed Kharbeche, Ameer Al-Salem, Abdelmagid S. Hamouda	(→p.31)
15:00 - 15:25	**Generalized convexity in multiobjective mathematical programming. An application to a cutting stock problem.** *Manuel Arana-Jimenez*, Gracia Maria Nieto-Gallardo	(→p.32)

Thursday 14:00 - 15:30, Session 2

Chair: Erwin Pesch **Room 03.08.011**

14:00 - 14:25	**Scheduling Injection Molding Machines** *Aydin Sipahioglu*, Tugba Sarac	(→p.32)
14:30 - 14:55	**Improving Coffman and Sethi's Bound for LPT Scheduling** James D. Blocher, *Sergey Sevastyanov*	(→p.33)
15:00 - 15:25	**Competitive analysis for non-preemptive average stretch** *Abhinav Srivastav*, Denis Trystram	(→p.33)

Thursday 14:00 - 15:30, Session 3

Chair: Stefan Pickl — **Room 00.09.022**

14:00 - 14:25	**A fast algorithm for determining partial sample sizes in the German Census** *Ulf Friedrich*, Ralf Münnich, Sven de Vries, Matthias Wagner	(→p.35)
14:30 - 14:55	**On the constant objective value property for combinatorial optimization problems** *Ante Custic*, Bettina Klinz	(→p.36)

Thursday 14:00 - 15:30, Session 4

Chair: Andreas Alpers — **Room 02.04.011**

14:00 - 14:25	**Uniqueness Reconstruction Models in Tomography** *Paolo Dulio*, Sara Brunetti, Carla Peri	(→p.36)
14:30 - 14:55	**Discrete Tomography and plane partitions** *Carla Peri*, Paolo Dulio	(→p.37)
15:00 - 15:25	**Discrete Tomography for Bounded Sets** *Sara Brunetti*, Paolo Dulio, Carla Peri	(→p.37)

4.5 Thursday, May 1st, 2014: Late Afternoon Sessions

Thursday 16:00 - 18:00, Session 1

Chair: Oliver Bastert — **Room 00.07.014**

16:00 - 16:25	**Vehicle Routing Problems with Soft Constraints** *Philip Kilby*, Charles Gretton	(→p.38)
16:30 - 16:55	**An Economical Analysis of a Capacitated Vehicle Routing Problem** *Natalia C. Duarte Ferrin*, Pierre Lemaire, Van-Dat Cung, Iragaël Joly	(→p.39)
17:00 - 17:25	**The vehicle routing problem with job availability constraints** *Benjamin Charles Shelbourne*, Chris Potts, Maria Battarra	(→p.40)
17:30 - 17:55	**Multi-objective Module Family Design Methodology for Modular Product** *Yonanda Adhitama*, Wolfgang Rosenstiel	(→p.40)

Thursday 16:00 - 17:30, Session 2

Chair: Jacek Błażewicz **Room 02.08.011**

16:00 - 16:25	**Graph clustering and biomolecules** *Maciej Miłostan*	(→p.41)
16:30 - 16:55	**Methods for peptide sequence finding** *Marcin Borowski*	(→p.41)
17:00 - 17:25	**Selected strategies for comparative assessment of 3D RNA structural models** *Piotr Lukasiak*	(→p.42)

Thursday 16:00 - 17:30, Session 3

Chair: Vitaly Strusevich **Room 03.08.011**

16:00 - 16:25	**Recent Advances to Discrete-Continuous Optimal Control of Stochastic Hybrid Systems with Jumps** *Gerhard-Wilhelm Weber*	(→p.43)
16:30 - 16:55	**An approximation algorithm for aligning point clouds under affine transformations** *Felix Schmiedl*	(→p.43)
17:00 - 17:25	**An ANP and Intuitionistic Fuzzy TOPSIS Hybrid Model for Evaluation of MCDM** *Babak Daneshvar Rouyendegh*	(→p.44)

Thursday 16:00 - 17:30, Session 4

Chair: Bernard Ries **Room 00.09.022**

16:00 - 16:25	**Models and Algorithms for Packing into the Smallest Square** *Silvano Martello*, Michele Monaci	(→p.44)
16:30 - 16:55	**Integer linear programming solutions of the min-sum set cover problem** *Vaclav Lin*	(→p.45)
17:00 - 17:25	**Well-solvable cases of the QAP with block-structured matrices** *Eranda Cela*, Vladimir Deineko, Gerhard Woeginger	(→p.45)

Thursday 16:00 - 17:00, Session 5

Chair: Kees Joost Batenburg **Room 02.04.011**

16:00 - 16:25	**Combinatorial problems in X-ray diffraction tomography** Andreas Alpers, Peter Gritzmann, *Carl Georg Heise*, Anusch Taraz	(→p.45)
16:30 - 16:55	**Dynamic discrete tomography** *Andreas Alpers*, Peter Gritzmann	(→p.46)

4.6 Thursday, May 1st, 2014: Satellite Evening

Thursday 17:00 - 19:00, Challenges in Discrete Tomography

Chair: Andreas Alpers, Kees Joost Batenburg **Room 02.04.011**

17:00 - 17:25	**Binary Tomographic Reconstruction** *Stephane Roux*, Hugo Leclerc, Francois Hild	(→p.46)
17:30 - 18:15	**Tomography as a Computational Science** *Kees Joost Batenburg*	(→p.47)

4.7 Friday Plenary Talk

Friday 9:00 - 10:00, Plenary Talk

Chair: Silvano Martello — **Room HS 3**

09:00 - 10:00 **Open and Closed Problems in NP-Completeness** (→p.48)
David S. Johnson

4.8 Friday, May 2nd, 2014: Morning Sessions

Friday 10:30 - 12:00, Session 1

Chair: Sara Brunetti — **Room 02.08.011**

10:30 - 10:55 **Scheduling divisible loads with hierarchical memory and energy constraints** (→p.48)
Jędrzej Marszałkowski, Maciej Drozdwoski

11:00 - 11:25 **High-level Optimisation of Robotic Lines with Respect to Power Consumption and Given Production Cycle Time** (→p.49)
Libor Bukata, Premysl Sucha

11:30 - 11:55 **An enumeration procedure for assembly line balancing problems with resource constraints** (→p.49)
Mariona Vilà, Jordi Pereira

Friday 10:30 - 12:00, Session 2

Chair: Yair Censor — **Room 00.07.014**

10:30 - 10:55 **New Semidefinite Programming Relaxations for the Linear Ordering and the Traveling Salesman Problem** (→p.51)
Philipp Hungerländer

11:00 - 11:25 **Generating subtour constraints for the TSP from pure integer solutions** (→p.51)
Ulrich Pferschy, *Rostislav Staněk*

11:30 - 11:55 **A complete characterization of facet-defining Jump Inequalities for the Hop-Constrained Path Polytope** (→p.52)
Wolfgang Ferdinand Riedl

Friday 10:30 - 12:00, Session 3

Chair: Christophe Picouleau **Room 03.08.011**

10:30 - 10:55	**Tactical Fixed Job Scheduling with Spread-Time Constraints** Shuyu Zhou, Xiandong Zhang, *Bo Chen*, Steef van de Velde	(→p.52)
11:00 - 11:25	**Minimizing total completion time of a time-dependent scheduling problem by iterative improvements** *Stanislaw Gawiejnowicz*, Wieslaw Kurc	(→p.53)
11:30 - 11:55	**Time-Indexed Modelling for Scheduling and Tool Loading in Flexible Manufacturing Systems** *Selin Ozpeynirci*	(→p.53)

Friday 10:30 - 12:00, Session 4

Chair: Gerhard-Wilhelm Weber **Room 00.09.022**

10:30 - 10:55	**A column generation-based approach for partitioning with equity constraint: application to school canteen meat supply** *Maxime Ogier*, Nicolas Catusse, Van-Dat Cung, Julien Boissière	(→p.54)
11:00 - 11:25	**Optimizing Bank Revenues in Collection Processes** Ekrem Duman, Fatih Ecevit, *Ayse Buyukkaya*, Umut Kapucu, Necip Boytaz	(→p.55)
11:30 - 11:55	**On the buffer management in car production system** *Wojciech Wojciechowicz*, Grzegorz Pawlak	(→p.55)

Friday 10:30 - 12:00, Herausforderungen in der Waldwirtschaft (in German)

Chair: Steffen Alexander Borgwardt **Room 02.04.011**

10:30 - 10:55	**Praktische Herausforderungen des freiwilligen Landtausch** *Stefan Schaffner*, Markus Lechner	(→p.56)
11:00 - 11:25	**Waldpflegeverträge in der Praxis - Herausforderungen für ein effizientes Management** *Stefan Schaffner*, Markus Lechner	(→p.57)
11:30 - 11:55	**Erstellung valider Statistiken aus Waldbesitzer-Eigentumsverzeichnissen** *Stefan Schaffner*, Markus Lechner	(→p.58)

4.9 Friday, May 2nd, 2014: Afternoon Sessions

Friday 13:30 - 15:00, Session 1

Chair: Andreas Brieden **Room 00.07.014**

13:30 - 13:55	**Energy grids - improving transportation models for transmission capacity expansion** *Paul Stursberg*, René Brandenberg, Michael Ritter	(→p.59)
14:00 - 14:25	**Modeling Thermal Start-up Costs in a Unit Commitment Problem** *Matthias Silbernagl*, Matthias Huber	(→p.60)

Friday 13:30 - 15:00, Session 2

Chair: Alain Hertz **Room 02.08.011**

13:30 - 13:55	**Servicing stationary objects in a linear working zone of a mobile processor: scheduling problem in the case of non-zero ready dates** *Nadezhda Dunichkina*, Yuri Fedosenko, Dmitry Kogan, Anton Pushkin	(→p.60)
14:00 - 14:25	**Formulations for Minimizing Tour Duration of the Symmetric Traveling Salesman Problem with Time Windows** *İmdat Kara*, Tusan Derya	(→p.61)

Friday 13:30 - 15:00, Session 3

Chair: Manuel Arana-Jimenez **Room 00.09.022**

13:30 - 13:55	**Cellular Manufacturing Layout Design in a Wheel Rim Manufacturing Industry : A Case Study** *Feristah Ozcelik*, Nidanur Eğercioğlu, Melike Gültekin	(→p.62)
14:00 - 14:25	**Discovering functionally related genes by analyzing the topology of biological networks** *Marek Blazewicz*, Klaus Ecker	(→p.62)

Friday 13:30 - 15:00, Session 4

Chair: Christoph Dürr **Room 02.04.011**

13:30 - 13:55	**A fast and efficient algorithm for feature selection problem** *Alkin Yurtkuran*, Erdal Emel	(→p.63)
14:00 - 14:25	**A heuristic algorithm for a variant of student – project allocation problem with preferences** *Alkin Yurtkuran*, Erdal Emel	(→p.63)

4.10 Saturday Plenary Talk

Saturday 9:00 - 10:00, Plenary Talk

Chair: Chris N. Potts — **Room HS 3**

09:00 - 10:00	**Interactive Multiobjective Optimization using Dominance-based Rough Set Approach** *Salvatore Greco*, Benedetto Matarazzo, Roman Słowińsk	(→p.64)

4.11 Saturday, May 3rd, 2014: Morning Sessions

Saturday Slot 1, Session 1

Chair: Bo Chen — **Room 00.07.014**

10:30 - 10:55	**Large scale nonlinear programming in practice** *Zsolt Csizmadia*	(→p.65)
11:00 - 11:25	**Making optimization accessible** *Oliver Bastert*	(→p.65)
11:30 - 11:55	**Convex Maximization for data segmentation** *Andreas Brieden*, Peter Gritzmann	(→p.65)

Saturday Slot 1, Session 2

Chair: Michael Ritter — **Room 00.09.022**

10:30 - 10:55	**Matroid optimisation problems with some non-linear monomials in the objective function** *Anja Fischer*, Frank Fischer, Thomas McCormick	(→p.66)
11:00 - 11:25	**On the diameter of (2,n)- and (3,n)-transportation polytopes** *Steffen Borgwardt*, Jesus De Loera, Elisabeth Finhold	(→p.66)
11:30 - 11:55	**Optimal Gear Train Synthesis - A Combinatorial Model and a Mixed Integer Linear Approach** Peter Gritzmann, Philipp Gwinner, Bernd-Robert Höhn, *Fabian Klemm*, Patricia Rachinger, Michael Ritter, Karsten Stahl	(→p.67)

Saturday Slot 1, Session 3

Chair: Sergey Sevastyanov **Room 02.04.011**

10:30 - 10:55	**Power of Preemption on Uniform Parallel Machines** *Alan James Soper*, Vitaly Strusevich	(→p.67)
11:00 - 11:25	**Makespan minimization for parallel machines scheduling with resource constraints** *Emine Akyol*, Tugba Sarac	(→p.68)
11:30 - 11:55	**A genetic algorithm for identical parallel machine scheduling problem with shared resources** Tugba Sarac, *Emine Akyol*	(→p.68)

Saturday Slot 1, Session 4

Chair: René Brandenberg **Room 02.08.011**

10:30 - 10:55	**The Shortest Path Game** Andreas Darmann, *Ulrich Pferschy*, Joachim Schauer	(→p.69)
11:00 - 11:25	**Minimum size extensible graph for (near) perfect matchings** *Christophe Picouleau*, Marie-Christine Costa, Dominique de Werra	(→p.68)
11:30 - 11:55	**Contraction Blockers** *Bernard Ries*, Daniel Paulusma, Christophe Picouleau, Oznur Yasar	(→p.70)

Saturday Slot 1, Session 5

Chair: Van-Dat Cung **Room 03.08.011**

10:30 - 10:55	**A Mixed Integer Programming Approach for Game Industry** *Stefan Emet*	(→p.71)
11:00 - 11:25	**On the symmetries of MILP feasible sets** *Gustavo Dias*, Leo Liberti	(→p.71)
11:30 - 11:55	**A trust region method for solving grey-box MINLP** Andrew Conn, Claudia D'Ambrosio, Leo Liberti, Claire Lizon, *Ky Vu*	(→p.72)

5 Abstracts

5.1 Thursday Plenary Talk

Combinatorial Optimization in Transport and Logistics

Martin Grötschel
ZIB, TU Berlin and MATHEON, Berlin, Germany

Day:	Thu, May 01
Time:	09:30
Room:	HS 3

Travelling salesman, Chinese postman and shortest path problems are combinatorial optimization problems with obvious applications in transport and logistics. These problems have a rich theory, they have undergone extensive computational studies, theoretically and/or practically good solution algorithms exist, and thus, they can be viewed as "solved" for the majority of their practical applications.

Most problems arising in transport, traffic and logistics are not so nicely structured, though. They often come with various combinations of side constraints such as capacity, depot and ordering constraints as well as time windows, with online or real-time requirements and possibly multiple objective functions. Routing/dispatching/scheduling problems of this sort are notoriously difficult and a typical playground for heuristics.

In the last 30 years my research group has covered a large variety of problems arising in public transport, logistics, general transportation, machine and emergency scheduling, etc. Our aim is to solve these problems to optimality or, if this is impossible, to provide at least instance specific quality guarantees that are acceptable in practice.

In my lecture I will first give a broad survey on these problems as well as on successful solution approaches and will then concentrate on cases that we are currently working on. These include train scheduling (high-speed trains (ICEs) in Germany with uncommon "regularity requirements") and a quite unusual problem where vehicles have to be scheduled and routed "optimally" to catch trucks on the German Autobahn that try to avoid the payment of road tolls. Needless to say, that these inspection vehicles have to satisfy several nonstandard legal requirements.

5.2 Thursday, May 1st, 2014: Morning Sessions

A generalization of maximum cardinality bin packing for mixed criticality scheduling

Yasmina Seddik	Czech Technical University, Czech Republic
József Békési	University of Szeged, Hungary
Zdenek Hanzálek	Czech Technical University, Czech Republic

Day:	Thu, May 01
Time:	11:00
Room:	00.09.022

In recent years, mixed-criticality scheduling has aroused increasing interest as it represents a challenging issue on real time embedded systems. In many real time embedded systems, tasks with different levels of criticality share the same resource. Tasks with high criticality must be guaranteed, and they can use some additional resource time if they could not complete by their regular processing time. However, this prolongation implies that some lower criticality tasks are skipped, since the resource is scarce. Overall, on one hand the high-criticality tasks must be guaranteed, and on the other hand the common resource should be used efficiently by skipping only few low-criticality tasks. We propose a new model to schedule nonpreemptive mixed-criticality tasks that meets both these requirements.

We consider two levels of criticality (Hi and Lo), and we show that this model is equivalent to an extension of maximum cardinality bin packing problem. In maximum cardinality bin packing problem, a set of bins (of equal or different sizes) is given, as well as a set of items, each with its own size. The goal is to maximize the number of packed items. We deal here with a generalization of this problem, where, in addition, there is a fixed number of "free" storage units. These units can be assigned to the bins to extend their capacity, in order to maximize the number of packed items. To the best of our knowledge, this problem, which is strongly NP-hard, does not appear in the literature.

We propose an extension of the Shortest Piece First (SPF) algorithm which takes into account the additional "free" storage units, and show that its worst-case approximation ratio is 1/2. Moreover, we present some bounds which show that the extensions of some classical algorithms in bin packing have a worst-case approximation guarantee at best equal to 2/3.

Future work will consist in finding polynomial time approximation algorithms with better ratio than 1/2.

A note on the one-dimensional minimax bin-packing problem with bin size constraints

Mariona Vilà	Universitat Politècnica de Catalunya, Spain
Jordi Pereira	Universidad Católica del Norte, Chile

Day:	Thu, May 01
Time:	11:30
Room:	00.09.022

The one-dimensional minimax bin-packing problem with bin size constraints, MINIMAX_BSC, is a recently proposed problem [1], which can be seen a special case of the bin-packing problem that appears in test design in the area of psychology, [3], among others.

The problem can be defined as follows: There are T sets, each composed of B items with an associated weight. A solution of the problem is an assignment of all of the items to B different groups so that every group contains exactly one item of each set. The optimal solution is the one that minimises the maximum sum of the weights of the items in any group. In the context of test design, the items represent questions, each question with a level of difficulty; the sets represent groupings of questions that have comparable difficulty; and the final groups represent questionnaires, each of which has one question from each set.

In [1], the MINIMAX_BSC was introduced. The authors propose a mixed zero-one integer linear programming model, and used the CPLEX commercial software to solve the model. Because this method could not verify optimality on large instances, they also proposed a simulated annealing (SA) algorithm to obtain near-optimal solutions. The paper does not study the complexity of the problem but conjectures that the special case with B=2 might be solvable in polynomial time.

In this work, we show that this special case is NP-hard and that the general problem is strongly NP-hard, by proving that the PARTITION problem and the 3-PARTITION, see [2], problem can be reduced to the problem on hand.

We also propose a pseudo-polynomial algorithm for the 2-bins case, and a $O(T \cdot B \cdot \log B)$ greedy heuristic for the general problem with an absolute performance guarantee equal to the maximum difference between the weights of the items in any set.

The rationale behind the greedy algorithm is to maintain the difference among the weights of different groups within some limits. It can be proved that the maximum difference of the accumulated weights between any two groups in the proposed constructive procedure is bounded by the largest difference between any two items of the same set. Therefore, the derived constructive procedure has an absolute performance guarantee equal to the maximum difference between the weights of the items in any set.

The proposed heuristic is finally tested on the instances used in [1]. The results indicate that the average gap between the solution provided by the heuristic and a trivial lower bound is below 0.07%. The heuristic is also very fast, with running times below 0.02 seconds for instances with up to 6000 items and 300 sets.

[1] Brusco M.J.; Köhn, H.F.; Steinley D.; Exact and approximate methods for a one-dimensional minimax bin-packing problem. Annals of Operation Research, 206: 611-626 (2013)

[2] Garey M.; Johnson D.; Computers and Intractability. W.H. Freeman, New York (1979)

[3] Van der Linden, W.J. Linear models for optimal test design. New York: Springer (2005)

2D packing of website graphical components for faster multichannel download

Jakub Marszalkowski	Poznan University of Technology, Poland
Maciej Drozdowski	Poznan University of Technology, Poland
Jan Mizgajski	Poznan University of Technology, Poland
Dariusz Mokwa	Poznan University of Technology, Poland

Day:	Thu, May 01
Time:	12:00
Room:	00.09.022

CSS sprite packing is a technology of joining multiple images to speed up websites. The CSS sprite packing problem has combinatorial core because it involves 2D packing, but it is also deeply determined by the realities of web technologies. Though this problem is ten years old now, not much progress has been made in all these years. We will start our presentation with an overview of the currently available methods for automatic CSS sprite packing to show where this technology is now, what are the main misconceptions, and problems to solve. A solution to the CSS sprite packing problem must take into account properties of JPEG and PNG formats and multichannel download capabilities of modern browsers. An objective function modeling web communication time will be proposed. Then, a new heuristic algorithm utilizing 2D packing algorithms will be presented. This algorithm is evaluated in a series of computational experiments involving images from real world applications used as benchmarks. A comparison with other currently available solutions will be given.

Optimization Techniques for Workforce Scheduling on Production Networks

Ute Ziegler	University of Mannheim, Germany
Simone Göttlich	University of Mannheim, Germany

Day:	Thu, May 01
Time:	11:00
Room:	00.07.014

We present a workforce scheduling problem for production networks. The underlying dynamics of buffer levels, processing capacities and production flows are modelled by a coupled system of ordinary differential equations. The model is transformed into a linear mixed integer optimization problem in order to be able to apply Branch and Bound algorithms. We show a strategy on speeding up the computation time by adapting branching rules and integrating feasible solutions to the subproblems of the Branch and Bound tree. We present computational results, highlight several model properties and discuss effects of tuning techniques.

Pharmacy Duty Scheduling Problem: Exact and Heuristic Approaches

Gokhan Ceyhan — Department of Industrial Engineering, Middle East Technical University, Ankara, Turkey
Fatih Kocaturk — Department of Mathematics, Izmir University of Economics, Izmir, Turkey
Ozgur Ozpeynirci — Department of Logistics Management, Izmir University of Economics, Izmir, Turkey

Day:	Thu, May 01
Time:	11:30
Room:	00.07.014

In this study, we work on the Pharmacy Duty Scheduling (PDS) problem, where a subset of pharmacies should be on duty on national holidays, at weekends and at nights in order to be able to satisfy the emergency drug needs of the society. PDS problem is a multi-period p-median problem with special side constraints and it is an NP-hard problem. We present exact and heuristic algorithms for PDS. We introduce a reformulation of the problem using Dantzig-Wolfe decomposition and propose a branch-and-price algorithm that works on the reformulation of the problem. We develop heuristic algorithms using the variable neighborhood search approach. We propose several variants of the exact and heuristic approaches and test their performance on randomly generated instances and report the computational test results. We also use heuristics on real data for the pharmacies in central İzmir, and obtain significant improvements. This study is supported by the Scientific and Technological Research Council of Turkey, Grant 111M107.

Single Machine Just-in-Time Scheduling Problems with Two Competing Agents

Gur Mosheiov — Hebrew University of Jerusalem, Israel

Day:	Thu, May 01
Time:	12:00
Room:	00.07.014

In scheduling problems with two competing agents, each one of the agents has his own set of jobs to be processed and his own objective function, and both share a common processor. In the single-machine problem studied in this paper, the goal is to find a joint schedule that minimizes the total deviation of the job completion times of the first agent from a common due-date, subject to an upper bound on the maximum deviation of job completion times of the second agent. The problem is shown to be NP-hard even for a non-restrictive due-date, and a pseudo-polynomial dynamic program is introduced and tested numerically. For the case of a restrictive due-date, a faster pseudo polynomial dynamic program is presented. We also study the multi-agent case, which is proved to be strongly NP-hard. A simple heuristic for this case is introduced, which is tested numerically against a lower bound, obtained by extending the dynamic programming algorithm.

Counting the number of non-equivalent vertex colorings of a graph

Alain Hertz École Polytechnique de Montréal, Canada
Hadrien Mélot Université de Mons, Belgium

Day:	Thu, May 01
Time:	11:00
Room:	02.08.011

We study the number P(G) of non-equivalent ways of coloring a given graph G, also known as the (graphical) Bell number of G. We show some similarities and differences between this graph invariant and the well known chromatic polynomial. We then relate P(G) to Stirling numbers of the second kind, and to Bell, Fibonacci, and Lucas numbers, by computing the values of this invariant for some families of graphs. We finally study upper and lower bounds on P(G) for graphs with fixed maximum degree.

Integral Simplex Using Decomposition with Primal Cuts

Samuel Rosat GERAD, Montréal, Canada
Polytechnique Montréal, Canada
Issmail Elhallaoui GERAD, Montréal, Canada
Polytechnique Montréal, Canada
François Soumis GERAD, Montréal, Canada
Polytechnique Montréal, Canada
Andrea Lodi DEI, University of Bologna, Italy

Day:	Thu, May 01
Time:	11:30
Room:	02.08.011

The integral simplex using decomposition (ISUD) algorithm of Zaghrouti et al. (2013) is a dynamic constraint reduction method that aims at solving the popular set partitioning problem (SPP). We show that algorithm ISUD belongs to the class of primal algorithms, i.e., algorithms that furnish an improving sequence of feasible solutions by solving, at each iteration, an augmentation problem that either determines an improving direction, or asserts that the current solution is optimal. To show how ISUD is related to primal algorithms, we introduce a new augmentation problem called MRA. This link with primal algorithms had never been done before. We show that MRA canonically induces a decomposition of the augmentation problem and deepens the understanding of ISUD as well as provides a straightforward justification of the practical use of this decomposition. Finally, we characterize cuts that can be used within this decomposition and relate them to primal cuts. Promising computational results of these cuts are shown: on some mid-size aircrew scheduling problems (approximately 800 constraints and 8,000 variables), the mean optimality gap drops from 33.92% to 0.21%. This work is a proof of concept and will possibly be extended to more generic algorithm for binary programming.

Flow Shops with Synchronous Movement

Stefan Waldherr Universität Osnabrück, Germany
Sigrid Knust Universität Osnabrück, Germany

Day:	Thu, May 01
Time:	12:00
Room:	02.08.011

In this talk we discuss flow shop problems with synchronous movement which are a variant of a non-preemptive permutation flow shop. Jobs have to be moved from one machine to the next by an unpaced synchronous transportation system, which implies that the processing is organized in synchronized cycles. This means that in each cycle the current jobs start at the same time on the corresponding machines and after processing have to wait until the last job is finished. Afterwards, all jobs are moved to the next machine simultaneously.

Besides the general situation we also investigate special cases involving machine dominance which means that the processing times of all jobs on a dominating machine are at least as large as the processing times of all jobs on the other machines. Especially, we discuss flow shops with synchronous movement for a small number of dominating machines (one or two) and different objective functions.

Superiorization via Feasibility-Seeking Projection Methods and Applications

Yair Censor University of Haifa, Israel

Day:	Thu, May 01
Time:	11:00
Room:	02.04.011

The Superiorization Methodology is a novel approach to constrained optimization. Many iterative feasibility-seeking algorithms for finding a constraints-compatible solution are perturbation resilient in the sense that, even if certain changes are made at the end of each iterative step, the algorithm still produces a constraints-compatible solution. This is exploited by using permitted changes to steer the feasibility-seeking algorithm to a solution that is not only constraints-compatible, but is also desirable according to a specified optimization criterion although it not necessarily minimizes that criterion. The approach is applicable to many iterative procedures and optimization criteria used in medical physics and other applications. Juxtaposing the superiorization methodology with the well-known subgradient projections method for constrained minimization reveals the motivation of the approach.

A survey on discrete tomography

Christoph Dürr Sorbonne Universités, Université Pierre et Marie Curie, CNRS, France

Day:	Thu, May 01
Time:	11:30
Room:	02.04.011

Construct a bi-partite graph with prescribed degree sequences. Find air bubbles in a metal piece from orthogonal measurements. Construct a pixelized image of a heart from a small number of digitalized X-ray pictures. All these are applications of discrete tomography. Formally it is the area of reconstructing d-dimensional discrete objects from (d-1)-dimensional projections, under problem specific constraints. This survey will describe different techniques that used in the reconstruction process as well as NP-hardness proof techniques in that area.

Mathematics of discrete tomography

Robert Tijdeman Leiden University, The Netherlands

Day:	Thu, May 01
Time:	12:00
Room:	02.04.011

A survey will be given of the mathematical structure of the possible originals, when the line sums in finitely many directions of a function defined on a rectangular grid are given. This will be done both from an algebraic and from a geometric point of view.

As a new feature it will be described what can be said if the function is defined on a triangular grid and the line sums are in the 3 or 6 natural directions which are treated symmetrically.

5.3 Thursday, May 1st, 2014: Early Afternoon Sessions

A holistic model for rail-rail transshipment yard scheduling problem

Mateusz Cichenski Poznan University of Technology, Poland
Jacek Blazewicz Poznan University of Technology, Poland
Grzegorz Pawlak Poznan University of Technology, Poland
Erwin Pesch University of Siegen, Germany

Day:	Thu, May 01
Time:	14:00
Room:	00.07.014

In a modern rail-rail yards huge gantry cranes move containers between different train cars, so that hub-and-spoke railway systems can exist. In this context, we consider the transshipment yard scheduling problem (TYSP) where the containers that arrive to the hub need to reach their destinations by being moved to the proper train. In the literature the problem is decomposed into five sub problems which are solved separately. First, we need to assign the trains to bundles, namely groups of trains that visit the yard at the same time. Next we have to assign each train a

parking position in the yard. Then we have to determine the positions of containers on trains and next we assign the container moves to cranes. Finally, we determine the sequence of containers moves per crane.

The holistic model is a new proposition to solve TYSP, which joins all of the sub problems into a single mathematical model. It also extends the formulation by enabling the use of multiple trains per destination. The benefits of this approach is that we can define more robust and complex objective functions to include the key characteristics from each of the sub problems. The initial computational results were compared to the results obtained for the bundling problem using the number of split moves as an objective function. A split move occurs when a container needs to be put into a storage before it goes to its destination train, which increases the makespan of the bundle processing by cranes.

The proposed model is a new approach to solve the transshipment yard scheduling problem and the initial results indicates that the problem can be solved without the use of decomposition techniques.

Heuristic methods for the track/level rescheduling problem

Maram Al Jabari	Mechanical and Industrial Engineering Department, Qatar University
Mohamed Kharbeche	Mechanical and Industrial Engineering Department, Qatar University
Ameer Al-Salem	Mechanical and Industrial Engineering Department, Qatar University
Abdelmagid S. Hamouda	Mechanical and Industrial Engineering Department, Qatar University

Day:	Thu, May 01
Time:	14:30
Room:	00.07.014

We propose a heuristic based optimization methods for the track/level rescheduling problem. The main objective of this problem is to develop a recovery plan for the initial flights' schedule to solve conflicting or flights' time changes issues by determining alternate flight schedules with a minimal change from original track and level schedules and minimizing the total delay. To achieve this goal, a nonlinear optimization model along with linearization techniques have been developed and solved heuristically using commercial solvers. Computational results show good performance in terms of solution quality and computational time for large-sized instances.

Generalized convexity in multiobjective mathematical programming. An application to a cutting stock problem.

Manuel Arana-Jimenez University of Cádiz, Spain
Gracia Maria Nieto-Gallardo IES Asta Regia (Jerez de la Frontera), Spain

Day:	Thu, May 01
Time:	15:00
Room:	00.07.014

This work is focused on the search for efficient solutions for multiobjective mathematical programming problems through the study of optimality conditions and the properties of the involved functions. For this purpose, optimality results are proposed under new classes of functions based on generalized convexity. This type of technics can be explored and extended to other kind of optmization problems, such as cutting stock problems, whose discussion is commented.

Scheduling Injection Molding Machines

Aydin Sipahioglu Eskisehir Osmangazi University, Turkey
Tugba Sarac Eskisehir Osmangazi University, Turkey

Day:	Thu, May 01
Time:	14:00
Room:	03.08.011

Scheduling injection molding machines is a special case of the identical parallel machine scheduling problem. In production of plastic parts using injection, setup times may increase considerably especially in changing of color. In order to produce a part in an injection machine, it is required that a mould of product should be fixed to the relevant machine. However, each mould may not be fixed every kind of injection machine. Additionally, two parts having same shape but different colors may be produce by using same mould. Furthermore, even if the plastic injection machines are identical with respect to production time, they are not exactly alternative of each other due to having these kinds of special conditions.

In this study, unlike the classical parallel machine scheduling problem with sequence dependent setup time, machine eligibility restriction and common resource usage are also considered. In order to solve this problem, a two stepped solution approach having two different mathematical models is proposed. In the first step; an assignment problem is solved for assigning jobs to the machines and in the second step; job sequences are determined for each machines considering mould constraints and results of the first model. To show the performance of the proposed approach, randomly generated instances are solved using the solvers of GAMS software and obtained results are presented.

Improving Coffman and Sethi's Bound for LPT Scheduling

James D. Blocher — Kelley School of Business, Indiana University, USA
Sergey Sevastyanov — Sobolev Institute of Mathematics (Russian Federation)

Day:	Thu, May 01
Time:	14:30
Room:	03.08.011

Given n jobs to be scheduled on m identical parallel machines, the problem P Cmax is to find a schedule which minimizes the makespan. This is an NP-hard problem. However, the longest processing time (LPT) heuristic, while being efficient in time, also does quite well in the sense that its relative error approaches zero with high probability when the number of jobs infinitely increases. Let $\omega_L(I)$ and $\omega_O(I)$ denote the length of the LPT and of the optimal schedules for a given instance I, respectively. Graham (1969) provided an a priori bound on the relative error $\rho_L(I) = (\omega_L(I) - \omega_O(I))/\omega_O(I)$ of the LPT algorithm in the worst case: $\rho_L(I) \leq 1/3(1 - 1/m)$.

The a posteriori bound developed by Coffman and Sethi (1976) includes another parameter k(I) which means the number of tasks processed on the critical machine in the LPT-schedule for the instance I. In terms of this parameter, they proved the bound:

$\rho_L(I) \leq 1/k(I)(1 - 1/m) = u_C(I)$, if $k(I) \geq 3$.

They also claimed that in the case that $k(I) \leq 2$ the LPT algorithm provides an optimal schedule.

(As shown further by Chen (1993), this is true only for $k(I) = 1$.)

We prove that the Coffman and Sethi's bound can be improved on to:

$\rho_L(I) \leq 1/K(I)(1 - 1/m) = u_B(I)$,

where instead of the number of jobs on the critical machine (k(I)) we use the maximum number of jobs on a machine (K(I)) in the truncated LPT schedule (constructed only till the critical job). As we show, the ratio $u_C(I)/u_B(I)$ of these two bounds may be arbitrarily large.

Competitive analysis for non-preemptive average stretch

Abhinav Srivastav — Laboratoire d'Informatique de Grenoble, France
Denis Trystram — Laboratoire d'Informatique de Grenoble, France

Day:	Thu, May 01
Time:	15:00
Room:	03.08.011

We present in this talk the classical scheduling problem of jobs with release dates on single and identical parallel machines. The objective is to schedule these jobs so as to guarantee the "fair" quality of service(QoS) to the individual jobs. However in general, it is difficult to quantify such objective. There are many ways in which fairness has been previously defined in scheduling context such as throughput, response time, completion time, etc. In this work we investigate "stretch" as the QoS for each job. Stretch is defined as factor by which a job is slowed down with respect to time it takes on unloaded system[1]. Then the objective is to schedule the jobs so as to minimize

average stretch for all the instances of non-preemptive schedules. The focus in this talk will be on two different machine environments: single machine, and identical parallel machines. Prior works on this problem have been limited to preemptive case. Muthukrishnan et al.[2] showed that SRPT is 2-competitive for average stretch for preemptive average stretch on single machine while it is 14-competitive for parallel identical machine. A more general case of the average stretch is the problem of minimizing weighted flow time. There is no online algorithm with bounded competitive ratio is known for the non-preemptive weighted flow time problem. Though, Bansal et al.[6] showed using resource augmentation that there is an O(1)-speed O(1)-approximation for offline version of the problem. Leonardi et al.[3] and Kellerer et al.[4] showed strong the lower bounds for simpler case of average flow time on single machine and identical parallel machine.

Considering that such strong lower bounds exist, we assume additional information on the processing time. In this work, we extend the understanding of the competitiveness of stretch for non-preemptive schedule by presenting the new competitive ratio for an existing algorithm. We show that the Shortest processing time provides constant competitive ratio O(P) for any instance of average stretch in O(n log n) time on single machine and identical parallel machines, respectively where P is assumed as the ratio of maximum processing time and minimum processing time for all jobs and m is number of identical machines. Note that the problem is still strongly NP-hard even with this assumption. It is also shown that no deterministic algorithm can achieve better than this competitive ratio. The analysis presented in this work for single machine doesn't use any recently developed approximation techniques but instead it is based on careful observation on structure of the schedule generated by Shortest remaining processing time algorithm. On other hand, the analysis for identical parallel machine is derived from insight of resource argumentation developed over recent years.

For the analysis of SPT on single machine, first we show the similarity between SRPT and SPT structure. Next, we derive a non-preemptive schedule by changing SRPT into an intermediate schedule (POS) based on order of completion time and then it is shown that this intermediate schedule gives constant performance guarantee under our assumption. We also show that SRPT schedule is a lower bound for optimal non-preemptive average stretch on single machine. Hence providing a constant order approximation for single machine case. Furthermore, we show that this technique cannot be extended to identical machine parallel as similarity between SRPT and SPT no longer holds. Therefore, for analysis of the SPT on identical parallel machines, the same set jobs are scheduled on m-speed single machine in order of starting time as given by SPT algorithm on m-identical machines. This new schedule is constant approximation to the schedule generate by SPT on m speed single machine. Finally, combining our work and the results of Chou et al.[5], it is shown that SPT on m machines is also constant competitive to the optimal non-preemptive schedule.

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A fast algorithm for determining partial sample sizes in the German Census

Ulf Friedrich	University of Trier, Department of Mathematics, Germany
Ralf Münnich	University of Trier, Department of Economics and Social Statistics, Germany
Sven de Vries	University of Trier, Department of Mathematics, Germany
Matthias Wagner	University of Trier, Department of Mathematics, Germany

Day:	Thu, May 01
Time:	14:00
Room:	00.09.022

In stratified random sampling, minimizing the variance of a total estimate leads to the optimal allocation by Neyman (1934) and Tschuprow (1923). Classical algorithms for this problem yield real-valued rather than integer-valued solutions.

We presents three integer-valued optimization algorithms which solve the problem of minimizing a separable convex function with upper and lower boundary conditions. We begin by identifying the polymatroid structure of the feasible region and show that it can be solved by Greedy-type strategies. Subsequently, we develop a polynomial-time algorithm using a binary search based on the concept of "super-medians".

As an application, the algorithms are used to solve the German Census 2011 allocation problem, an optimal allocation problem in stratified random sampling respecting box constraints. Numerical results show the practical relevance of this approach.

On the constant objective value property for combinatorial optimization problems

Ante Custic Graz University of Technology, Austria
Bettina Klinz Graz University of Technology, Austria

Day:	Thu, May 01
Time:	14:30
Room:	00.09.022

For a given combinatorial optimization problem we want to characterize the space of all instances for which every feasible solution has the same objective value. In the case of linear combinatorial optimization problems, such instances are in 1:1 correspondence to the notion of admissible transformations, i.e. transformations of the instances that preserve the relative order of objective values of all feasible solutions. Admissible transformations can be used to solve the problem or to find good lower bounds.

In this talk we will focus mainly on multidimensional assignment problems. We show that for the axial and for the planar d-dimensional assignment problem the instances with constant objective value property are characterized by sum-decomposable arrays. We give a counterexample to show that this is not the case for more general multidimensional assignment problems.

The talk is concluded with comments on results for other types of combinatorial optimization problems.

Uniqueness Reconstruction Models in Tomography

Paolo Dulio Politecnico di Milano, Italy
University of Siena, Italy
Sara Brunetti University of Siena, Italy
Carla Peri Università Cattolica S.C., Italy

Day:	Thu, May 01
Time:	14:00
Room:	02.04.011

Switching components play a key role in the study of possible different objects matching a same set of given tomographic data. Understanding the behavior of such configurations is of basic importance, also in view of efficient reconstruction algorithms.

The talk aims in surveying the main known algebraic, combinatorial and geometric properties of switching components, pointing out their influence in recent results on uniqueness theoretical models concerning tomographic reconstruction from a finite number of projections.

Special classes of geometric objects are considered and discussed. Examples in 2D and 3D are also provided, as well as perspective and some open problems.

Discrete Tomography and plane partitions

Carla Peri Università Cattolica S.C., Italy
Paolo Dulio Politecnico di Milano, Italy
University of Siena, Italy

Day:	Thu, May 01
Time:	14:30
Room:	02.04.011

A plane partition is an integral matrix with weakly decreasing rows and columns. Each plane partition has associated, in a natural way, a pyramid in $\mathbb{Z}^3$, and this provides an interesting link with discrete tomography and its typical problems, where concepts of uniqueness and additivity play a key role. Here both concepts are defined with respect to two-dimensional X-rays parallel to the coordinate planes. There is no loss of generality by assuming that the X-rays of a lattice set are weakly decreasing. Under this assumption any set of uniqueness is a pyramid. Fishburn, Lagarias, Reeds, Shepp provided complete sets of obstructions for uniqueness and additivity (bad configurations and weakly bad configurations) and showed that additivity is a sufficient condition for uniqueness. With a particular combinatorial argument, they also exhibited an example of pyramid which is a non-additive set of uniqueness. Vallejo showed that there is no upper bound on the sizes of the (weakly) bad configurations one needs to consider to determine uniqueness or additivity.

We present a characterization of non-additive pyramids in terms of inequalities for the entries of their associated plane partitions. As a consequence, we provide a canonical procedure for checking the existence of (weakly) bad configurations, and an algorithm which constructs minimal pyramids (with respect to the number of levels) with assigned projection of a bad configuration.

Discrete Tomography for Bounded Sets

Sara Brunetti University of Siena, Italy
Paolo Dulio Politecnico di Milano, Italy
University of Siena, Italy
Carla Peri Università Cattolica S.C., Italy

Day:	Thu, May 01
Time:	15:00
Room:	02.04.011

Problems of Discrete Tomography concern the recovery of finite sets of points in $\mathbb{Z}^n$ from their X-rays in a given set S of directions. Uniqueness in the reconstruction ensures that the computed set of points is the original one. We consider the following setting: Every finite set of points, a so called bounded set, is contained in any finite multidimensional grid A. In this context, uniqueness issues concern the determination of any set S of directions for which every bounded set in A is S-unique. To this aim, notice that it is easy to find some degenerate directions which allow unique reconstruction of all the bounded sets in A: for instance, one can take a direction with so large (or so small) slope, with respect to A, such that each line with this slope meets A in no more than a single point. This leads to the notion of "valid" set of directions, introduced by Hajdu and Tijdeman which excludes by further considerations these trivial cases.

Results on the minimal number of directions ensuring uniqueness are settled in the planar case and in higher dimensions. Finally, we discuss some related problems and their computational aspects.

5.4 Thursday, May 1st, 2014: Late Afternoon Sessions

Vehicle Routing Problems with Soft Constraints

Philip Kilby NICTA Optimisation Research Group and ANU, Australia
The Australian National University
Charles Gretton NICTA Optimisation Research Group and ANU, Australia
The Australian National University

Day:	Thu, May 01
Time:	16:00
Room:	00.07.014

In the classical Vehicle Routing Problem, constraints such as the capacity constraint are "hard": a solution is invalid if the capacity of a vehicle is exceeded. User preferences can be described using "soft" constraints. Soft constraints impose penalties on solutions which feature undesirable qualities. For example, a truck may have a maximum capacity of 100 units, but the driver would prefer if the vehicle was not loaded above 90 units, as cargo access becomes difficult beyond that.

This paper looks at a variety of soft constraints. As well as soft capacity and time-window constraints, we consider route shape penalties that aim to increase the visual appeal of routes, including convex hull area penalties, p-median style penalties and a bending energy penalty. We also look at a number of balance constraints, including load and duration balancing constraints that seek to distribute work evenly among drivers.

The main contribution of the paper is to study implementation issues around soft constraints. We have developed a search framework that employs a general insertion-style construction method that accommodates a large variety of soft constraints. We examine the behaviour of construction using different classes of soft constraints. We find that some classes offer good guidance, leading the search to find solutions which do not exhibit penalised features. Other constraints, such as soft time-windows, can lead to poor insertion decisions that result in low quality solutions overall. We look at ways of mitigating undesirable interactions between insertion-style methods and soft constraints.

An Economical Analysis of a Capacitated Vehicle Routing Problem

Natalia C. Duarte Ferrin	Grenoble-INP / UJF-Grenoble 1 / CNRS, G-SCOP UMR5272 Grenoble, F-38031, France
Pierre Lemaire	Grenoble-INP / UJF-Grenoble 1 / CNRS, G-SCOP UMR5272 Grenoble, F-38031, France
Van-Dat Cung	Grenoble-INP / UJF-Grenoble 1 / CNRS, G-SCOP UMR5272 Grenoble, F-38031, France
Iragaël Joly	INRA / UPMF-Grenoble 2, GAEL UMR1215 Grenoble, F-38040, France

Day:	Thu, May 01
Time:	16:30
Room:	00.07.014

The Vehicle Routing Problem (VRP) is a well-known and extensively studied problem in the Operations Research literature. Many variants exist, such as VRP with time windows, multi-period VRP, VRP with stochastic clients, etc). In this presentation, we are concerned with the classical Capacitated VRP (CVRP). For this problem, we are given n clients, a hub, costs c_{ij} for traveling from a client/hub I to a client/hub j, and a capacity for the vehicle. The CVRP aims at assigning each client to a vehicle and then at finding the visiting order of the clients, so that the total distance traveled by all vehicle is minimized. Exact linear programming models are known for this problem [2].

From an economical point of view, we deal with a transportation system and we want to find its allocative efficiency, that is the minimum cost required to insure a precribe output (the output being delivering the demand to each client). More precisely, given the number of vehicles, their capacity, the traveling costs (as function of exogenous parameters such as cost of time, cost of gasoline), an efficient solution must be found, that is one that minimizes the cost for the expected output. The allocative efficiency is a well-known economical concept, and several functions are known to be apt to model the allocative efficiency of a system (e.g., Cobb-Douglas, translog, quadratic, Leontief) [1].

The purpose of this work is to study the CVRP problem from an economical point of view, that is to consider that the optimal solution of the CVRP is on the efficiency frontier, and then to try to guess, through several types of regression, the functional form of this frontier. This functional form should be defined as a function of the natural economical parameters (e.g., the cost for gasoline, and not directly the aggregated c_{ij}). The issues are to find an appropriate function, to compute its parameters, and to study its variations with regards to each parameters (typically resulting in the shadows or marginal costs of each resource, such as the cost of the gasoline, or the capacity of a vehicle). Ultimately, we would like to determine hypotheses under which one can accurately guess the optimal value of CVRP without having to actually compute it. The model and the preliminary experiments and results shall be presented.

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[2] Toth, P.,Vigo, D. “Models, relaxations and exact approaches for the capacitated vehicle routing problem”, Discrete Applied Mathematics 123, 2002, Pag. 487 – 512.

The vehicle routing problem with job availability constraints

Benjamin Charles Shelbourne	University of Southampton, United Kingdom	
Chris Potts	University of Southampton, United Kingdom	
Maria Battarra	University of Southampton, United Kingdom	

Day:	Thu, May 01
Time:	17:00
Room:	00.07.014

We describe a novel vehicle routing and scheduling problem which generalises the capacitated vehicle routing problem to include release dates, due dates and weights per unit of tardiness for each order. An order becomes available at the depot on its release date; a route cannot begin until all assigned orders are available. Tardy deliveries are individually weighted per unit of tardiness, and the objective is to minimise a weighted sum of the total distance travelled and weighted tardiness. Varying the objective weight produces instances with different emphasis on the separate routing and scheduling objectives. This study attempts to integrate concepts and experience from both machine scheduling and vehicle routing, with both practical and theoretical motivations.

We propose heuristics to solve instances of practical size and difficulty. We have designed a path-relinking algorithm, a population-based method involving strategic recombination of solutions and population diversity control. The performance of this approach on the problem considered is compared to a standard iterated local search. These approaches both utilise the same neighbourhood search component; featuring a move evaluation technique achieving logarithmic complexity, and efficient neighbourhood exploration strategies.

A set of benchmark instances has been generated to capture a sufficient variety of instance types for this investigation, and using these extensive computational testing has been performed. Some preliminary results from these experiments will be presented.

Multi-objective Module Family Design Methodology for Modular Product

Yonanda Adhitama	Robert Bosch GmbH, Germany	
Wolfgang Rosenstiel	Department of Computer Science, University of Tübingen	

Day:	Thu, May 01
Time:	17:30
Room:	00.07.014

Modular structure based products have been chosen by industries to provide sufficient variety of their products to the market. The success of the modular structure based products relies on the variants of their modules. In this work, a multi-objective product family design that aims to develop a module family for a modular product is discussed. Enterprise considerations such as market share and cost-savings benefits are integrated with the product family design. A representation scheme is introduced to enable us to integrate the qualitative market segmentation grid (MSG) with the scalability evaluation which plays a significant role in determining the appropriate configuration of the module products as well as the final products in different market niches.

The combinatorial problem with large number of module configurations is solved through the implementation of genetic algorithm of NSGA-II. The design of a family of application-specific integrated circuits (ASIC) for modular structure based electronic control units (ECU) is used to demonstrate the proposed approach.

Graph clustering and biomolecules

Maciej Miłostan Poznan University of Technology, Institute of Computer Science, Poland

Day:	Thu, May 01
Time:	16:00
Room:	02.08.011

Graph clustering aims in finding related vertices in a graph. Usually such a technique is an unsupervised and does not take into account labels or classes. The underlying paradigm is that the distinct clusters have substantially higher number of inner edges than outer ones. Inner edges connect vertices belonging to a given cluster, outer ones connect vertices in a particular cluster with those outside of it.

We show an application of graph clustering methods to the selected problems from the field of structural analysis of biomolecules. Variety of structural information and relations between molecules or their elementary building blocks can be depicted as graphs and analyze using a number of OR methods.

Particular examples of problems where graph based approaches can be applied, are contact graphs and maps analysis, identification of rigid bodies, protein domain delination, analysis of interaction networks and more.

This work is supported by NCN (National Science Center of Poland) - grant number 2012-05-B/ST6-03026.

Methods for peptide sequence finding

Marcin Borowski Poznan University of Technology, Poland

Day:	Thu, May 01
Time:	16:30
Room:	02.08.011

In recent years we have witnessed a massive flow of new biological data. Large-scale sequencing projects throughtout the world turn out new sequences, and create new challenges for investigators. These ongoing sequencing efforts have already uncovered the sequences of over 100,000 proteins.

Determining amino acid sequences of protein molecules is one of the most important issues in molecular biology because these sequences determine protein structure and functionality. The existing direct methods for reading amino acid sequence can be applied only for short sequences.

The recognition of whole long peptide / protein sequence generaly base on information stored in databases - in this way it is impossible to identify novel peptide / protein or protein not stored in databases.

That is the reason of using two step methods: assembly level methods (combinatorial methods of assemlby short amino acid sequence fragments into whole peptide / protein) and sequencing level methods (especially de novo peptide sequencing approach).

De novo methods are essential to identify proteins when the genomes are not known but they are also extremely useful even when the genomes are known since they are not affected by errors in a search database. Another advantage of de novo methods is that the partial sequence can be used to search for post translation modifications or for the identification of mutations by homology based software.

The tandem mass spectrometry fragments a large number of molecules of the same peptide sequence into charged prefix and suffix subsequences, and then measures mass/ charge ratios of this ions. The de novo peptide sequencing problem is to reconstruct the peptide sequence from a given tandem mass spectral data o k ions. By simplicity transforming the spectral data into an special graph G = (V, E). In some cases posttranslational modifications or other exceptions may lead to difficulties and errors in de novo identification process. To improve quality of identification and reduce number of possible error, modification of approach and algorithm based on dynamic programming has been proposed [CKT+]. The new approach is based on constructing meta-spectra from few repetitions of biochemical experiment The next step is to transform such a spectra data into directed graph, where V = 2k + 2. The solution can be found in O(V + E) time and O(V) space using dynamic programming.

Our approach has been tested on few peptides of known sequences.

[CKT] T. Chen, M. Y. Kao, M. Tepel, J. Rush, G. M. Church. A dynamic programming approach to de novo peptide sequencing via tandem mass spectrometry. Journal of Computational Biology, 8:325–337, 2001.

Selected strategies for comparative assessment of 3D RNA structural models

Piotr Lukasiak Institute of Bioorganic Chemistry, Polish Academy of Sciences, Poland
Poznan University of Technology, Poland

Day:	Thu, May 01
Time:	17:00
Room:	02.08.011

RNA is an important group of biomolecules. In analogy to proteins, the function of RNA depends (between others) on its structure, which is encoded in the linear sequence. The 3D RNA structure should be find through biological experiment or through computational modelling. Because of that, the number of tools and methodologies for RNA tertiary structure prediction growing rapidly, but simultaneously, the demand for methods and tools to evaluate those artificial models rises as well.

Here, we present RNAlyzer, a web server for comparative evaluation of RNA structures.

An idea behind RNAlyzer is to use well known quality measures such as Root Mean Square Deviation or Deformation Index and apply them to evaluate models at different levels of precision defined by user. These levels of precision are achieved by comparing set of atoms in a given (successively increasing) range between models and reference structure.

This approach allows to identify well and poorly predicted regions of the RNA structural models in addition to its overall quality. Our methodology driven by the idea of local 3D neighborhood of atoms in a model equipped with powerful visualization tools gives a unique opportunity to receive detailed and intuitive analysis of biomolecules.

The main feature of RNAlyzer is the ability to generate analysis in graphical form that can be intuitively analyzed by researchers who have little experience in RNA structure manipulation, superposition and in extraction of fragments, but who are interested in quickly obtaining absolute and relative measures of accuracy of models with respect to individual fragments as well as entire structures.

Recent Advances to Discrete-Continuous Optimal Control of Stochastic Hybrid Systems with Jumps

Gerhard-Wilhelm Weber METU, Germany

Day:	Thu, May 01
Time:	16:00
Room:	03.08.011

In this presentation, we contribute to the hybrid, e.g., mixed continuous-discrete dynamics of stochastic differential equations with jumps and to its optimal control. Those hybrid systems allow the representation of random regime switches and are of growing importance in economics, finance, science and engineering. We introduce two new approaches to this area of stochastic optimal control: one is based on the finding of closed-form solutions, the other one on a discrete-time numerical approximation scheme. The presentation ends with a conclusion and an outlook to future studies.

An approximation algorithm for aligning point clouds under affine transformations

Felix Schmiedl Technische Universität München, Germany

Day:	Thu, May 01
Time:	16:30
Room:	03.08.011

Recognizing special structures in certain objects is a key problem in computer vision with manifold applications ranging from synthetic drug design to image analysis and segmentation.

A common approach to this problem is the alignment of point clouds, i.e. one tries to find a transformation of a certain type (e.g. translation, isometry, affine transformation), which best aligns two point clouds with respect to a given measure.

We will present a mathematical analysis of a well-known algorithm adapted to affine transformations, which computes candidate transformations by aligning small subsets - called bases - of the point sets. We identify special properties of such bases which allow for a bound on the approximation ratio of the transformation and establish that such bases always exist.

An ANP and Intuitionistic Fuzzy TOPSIS Hybrid Model for Evaluation of MCDM

Babak Daneshvar Rouyendegh Atilim University, Turkey

Day:	Thu, May 01
Time:	17:00
Room:	03.08.011

A hybrid approach of ANP and Intuitionistic Fuzzy TOPSIS is proposed for Multiple Criteria Decision Making (MCDM). The study employees an evaluation methodology based on the AHP-IFT where uncertainly is handled with linguistic values. A numerical example is provided to demonstrate the proposed analysis procedure. The present model provides an accurate and essay classification of e- commerce web sites (EWS) performance. Also human judgment has taken part in this process.

Models and Algorithms for Packing into the Smallest Square

Silvano Martello University of Bologna, Italy
Michele Monaci University of Padova, Italy

Day:	Thu, May 01
Time:	16:00
Room:	00.09.022

We consider the problem of determining the smallest square into which a given set of rectangular items can be packed. We present an ILP model, an exact approach based on iterated execution of a two-dimensional packing algorithm, and a randomized metaheuristic. We computationally evaluate the average performance of the proposed approaches, which are valid both for the case where the rectangles have fixed orientation and the case where they can be rotated by 90 degrees, on a large set of instances, including a number of classical benchmarks from the literature, for both cases above, and for the special case where the items are squares.

Integer linear programming solutions of the min-sum set cover problem

Vaclav Lin Institute of Information Theory and Automation, AS CR, Czech Republic

Day:	Thu, May 01
Time:	16:30
Room:	00.09.022

Min-sum set cover is an NP-complete problem that can be seen as a minimum latency version of the well known set-cover problem. We are given a finite set U and a collection of its subsets C, and our task is to order the sets in C in such a way that the average cover time of each element of U is minimized.

We may also consider a weighted version where the elements of U have positive weights and sets in C have positive costs. One of applications of this problem is in sequential diagnosis - elements of U may be viewed as components of a system to be tested and elements of C may be viewed as tests. The goal is to construct a test sequence with least expected cost.

We provide a simple proof of NP-completeness of the problem. We also give several ILP formulations for solving the problem and report on computational experience with the SCIP solver.

Well-solvable cases of the QAP with block-structured matrices

Eranda Cela Department of Optimization and Discrete Mathematics, TU Graz, Austria
Vladimir Deineko Warwick Business School, The University of Warwick, United Kingdom
Gerhard Woeginger Department of Mathematics and Computer Science, TU Eindhoven, Netherlands

Day:	Thu, May 01
Time:	17:00
Room:	00.09.022

We investigate special cases of the quadratic assignment problem (QAP) where one of the two underlying matrices carries a simple block structure. In the special case where the second underlying matrix is a monotone anti-Monge matrix, we derive a polynomial time result for a certain class of cut problems. In the special case where the second underlying matrix is a product matrix, we identify two sets of conditions on the block structure that make this QAP polynomially solvable respectively NP-hard.

Combinatorial problems in X-ray diffraction tomography

Andreas Alpers Department of Mathematics, Technische Universität München, Germany
Peter Gritzmann Department of Mathematics, Technische Universität München, Germany
Carl Georg Heise Technische Universität Hamburg-Harburg, Germany
Anusch Taraz Technische Universität Hamburg-Harburg, Germany

Day:	Thu, May 01
Time:	16:00
Room:	02.04.011

We develop and study a new model for X-ray diffraction tomography in rather general terms abstracting from experimental setup details. The model is applicable, for instance, in the so-called 3D-diffraction technique (3DXRD), which has been developed to study small crystals (grains) within bulk materials. Giving a theoretical foundation we show that one can reformulate several intermediate tasks as well-known (although hard) mathematical problems such as finding hypergraph matchings or clusterings. Further, we give examples of how different heuristic and exact algorithms allow for a fast and accurate grain reconstruction.

Dynamic discrete tomography

Andreas Alpers Department of Mathematics, Technische Universität München, Germany
Peter Gritzmann Department of Mathematics, Technische Universität München, Germany

Day:	Thu, May 01
Time:	16:30
Room:	02.04.011

A central task in discrete tomography is to reconstruct finite points sets from projections, a task that can be formulated as solving a specific integer linear program. In this talk we introduce corresponding dynamic versions where the positions of the points depend on a time parameter. Applications in plasma physics are discussed along with algorithmic results.

5.5 Thursday, May 1st, 2014: Satellite Evening

Binary Tomographic Reconstruction

Stephane Roux CNRS, France
Hugo Leclerc CNRS, France
Francois Hild CNRS, France

Day:	Thu, May 01
Time:	17:00
Room:	02.04.011

The binary tomographic reconstruction problem consists of finding a binary image from (very) few projections (line sum of pixels) along given directions [1]. An efficient heuristic algorithm is introduced [2]. The first (initialization) step is similar to the traditional "filtered back projection" algorithm used for standard tomographic reconstructions, but based on a non-linear transform, $s = \psi(p) = log(p/(1-p))$, of the probability, p, of pixels be 1-valued. A basic binarization produces an initial guess for the reconstructed image. The second step is an iterated correction of the reconstructed image. The difference between the known projection and that computed from the current image estimate is used to adjust the corresponding s values by a constant along each projection ray. Spatial regularization through convolution with a Gaussian is introduced in the second step after each iteration with a progressively smaller and smaller width.

The algorithm is shown to be efficient, providing error-free reconstructions on megapixel images with tens of projection, within minute computation time as obtained on a variety of examples.

However, the minimum number of projections depends on the "complexity" of the image. Defining the latter remains an open issue, and different classes of complexities can be envisioned. An index based on the length of "domain boundaries" (0-1 neighboring pixels) provides a good indication on the number of needed projections.

References

[1] Batenburg, K.J., J. Math. Imaging and Vision 27, 175-191, (2007)

[2] Roux, S., Leclerc, H., Hild, F., J. Math. Imaging and Vision (2014), in press DOI:10.1007/s10851-013-0465-0

Tomography as a Computational Science

Kees Joost Batenburg Centrum Wiskunde & Informatica, Amsterdam, The Netherlands

Day:	Thu, May 01
Time:	17:30
Room:	02.04.011

X-ray tomography has developed into an advanced field of experimental research, utilizing not just the absorption contrast, but also phase, chemical and directional information to characterize the interior structure of the scanned object. Achieving the best possible results is becoming more and more an interdisciplinary effort, combining state-of-the-art experimental hardware, careful experiment design, mathematical modeling, customized algorithms and high performance computing.

In this lecture I will give an overview of the interplay between the many disciplines involved in this field, and the tension between the goals of the different communities that need to work together. On one side of the spectrum, there are the experiments, which often lack quantifiable goals and quality measures. On the other side of the spectrum, there are purely mathematical results for which the route towards practical applications is often unclear. I will sketch a generic approach for building bridges between these contexts and provide examples on how theory can lead to concrete applications.

5.6 Friday Plenary Talk

Open and Closed Problems in NP-Completeness

David S. Johnson
Columbia University, United States of America

Day:	Fri, May 02
Time:	09:00
Room:	HS 3

The Theory of NP-Completeness today provides links between the many areas of computer science, together with important questions in mathematics, operations research, economics, and even the physical sciences. A resolution to its central question, whether P equals NP, will now win you a $1,000,000 Millenium Prize. A "yes" answer might yield a wide-ranging technological and scientific revolution, while a "no" answer will at least allow the Internet commerce industry to feel a bit more secure.

In this talk I say a little about the history (and pre-history) of the theory, which was initiated in 1971 by Steven Cook and Leonid Levin, independently, and then broadly illustrated by Richard Karp in 1972. I survey some of the major NP-completeness and polynomial-time solvability results since then, as well as the many failed attempts at proving (or disproving) P = NP. I conclude with an exploration of the ways in which the theory has expanded from feasibility and optimization questions to ones about approximation, greatly assisted by the alternative characterization of NP in terms of "probabilistically checkable proofs" in the early 1990s, and list some of the key open questions remaining in this domain.

5.7 Friday, May 2nd, 2014: Morning Sessions

Scheduling divisible loads with hierarchical memory and energy constraints

Jędrzej Marszałkowski Poznan University of Technology, Poland
Maciej Drozdwoski Poznan University of Technology, Poland

Day:	Fri, May 02
Time:	10:30
Room:	02.08.011

In this presentation we study scheduling divisible computations in parallel systems with hierarchical memory. Divisible loads are data-parallel computations allowing for partitioning the work into pieces of arbitrary size. These parts can be processed in parallel independently of each other.

Since computer memory is hierarchical, speed of referencing it depends on the size of allocated memory blocks. Consequently, processing time and energy consumption depend non-linearly on the size of load assigned to a computer.

We consider two criteria of quality: schedule length and energy usage. A scheduling algorithm minimizing makespan under energy constraint based on linear programming is proposed. An alternative algorithm based on distributing load pieces of fixed size is proposed. Both algorithms are compared by simulation.

High-level Optimisation of Robotic Lines with Respect to Power Consumption and Given Production Cycle Time

Libor Bukata The Czech Technical University in Prague, Czech Republic
Premysl Sucha The Czech Technical University in Prague, Czech Republic

Day:	Fri, May 02
Time:	11:00
Room:	02.08.011

These days not only throughput is a key-aspect of designing robotic lines, but also the energy consumption is getting more and more important as the cost of electricity was rising during the last decades. As a consequence it is not surprising that industrial companies are interested in finding energy efficient solutions.

In our work we propose a completely novel mathematical formulation of the energy optimization problem for robotic lines. In contrast to the existing works our solution considers different trajectories of robots, gravity and order of robot operations from the global point of view. Moreover, our mathematical formulation takes into account the robot's power save modes (e.g. using brakes or bus-power-off if supported), to which the robot in a stationary position can switch after a transitional time, to save even more energy. The optimal solution to the problem is the one which is both the most energy efficient and meeting the desired production cycle time. As our approach is high-level, the point-to-point robot's movements for different speeds and trajectories have to be simulated by an external tool and used as an input for our algorithm. Having had the line structure and data from simulations the problem can be solved using Integer Linear Programming. As the large-scale ILP problem is difficult to solve we proposed to decompose it into smaller independent sub-problems corresponding to individual robots using the Lagrangian relaxation method. However, the tightness of the resulting lower bound and performance of the method need to be investigated in the future research. The preliminary experiments on generated instances confirmed the correctness of the proposed model and revealed a high potential for reducing energy consumption of robotic lines.

An enumeration procedure for assembly line balancing problems with resource constraints

Mariona Vilà Universitat Politècnica de Catalunya, Spain
Jordi Pereira Universidad Católica del Norte, Chile

Day:	Fri, May 02
Time:	11:30
Room:	02.08.011

This work studies an assembly line balancing problem. The assembly line balancing problem consists in assigning the assembly work (which is divided into elementary tasks) to the stations of the line subject to linear constraints on the availability of resources on each station. The basic formulation, known as the SALBP-1, [4], considers only one resource, the operation times of each task, which is limited by the desired production rate of the line.

Linear constraints are a generalisation of any constraint on the cumulative usage of resources, which can be used to model concepts such as the classical operation times, some cases in which different models are produced on the same line, space and ergonomic constraints or incompatibilities between tasks, among others. An extensive review of assembly line balancing problems, which includes references to problems under the previous assumptions, can be found in [1].

This work proposes three new classes of lower bounds for the problem. The first class is derived from the existence of incompatibilities between tasks, and it is based on identifying cliques on an auxiliary graph. This bound is an extension of a similar method for the bin-packing problem with conflicts [2]. The second class is based on a destructive bounding procedure for the SALBP-1 presented in [6] and it is based on assimilating the feasibility problem to a maximum flow problem on a bipartite graph. Finally, the third class is an extension of the one-machine scheduling bound [3] for the SALBP-1, which is based in relaxing this problem to a one-machine scheduling problem with deliveries.

These bounds and some new dominance rules are then used on a station-oriented enumerative procedure based on the Branch, Bound and Remember scheme [5]. The efficiency of the final algorithm is tested with a series of computational experiments on different benchmark sets found in the literature, and the results are compared with previous enumerative procedures.

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New Semidefinite Programming Relaxations for the Linear Ordering and the Traveling Salesman Problem

Philipp Hungerländer Universität Klagenfurt, Austria

Day:	Fri, May 02
Time:	10:30
Room:	00.07.014

We consider new semidefinite programming (SDP) relaxations based on position variables that can be applied to the linear ordering problem and the asymmetric traveling salesman problem. We compare our new relaxations with well-known SDP and LP bounds from the literature, e.g. our relaxation is not dominated by the Held-Karp bound, or vice versa. Finally we propose an exact SDP approach for the Target Visitation Problem, which is a combination of the linear ordering and the traveling salesman problem, and demonstrate its efficiency on a variety of benchmark instances.

Generating subtour constraints for the TSP from pure integer solutions

Ulrich Pferschy University of Graz, Austria
Rostislav Staněk University of Graz, Austria

Day:	Fri, May 02
Time:	11:00
Room:	00.07.014

The traveling salesman problem (TSP) is one of the most prominent combinatorial optimization problems. Given a complete graph G = (V, E) and non-negative distances d for every edge, the TSP asks for a shortest tour through all vertices with respect to the distances d. The method of choice for solving the TSP to optimality is a branch-and-bound-and-cut approach. Usually the integrality constraints are relaxed first and all separation processes to identify violated inequalities are done on fractional solutions.

In our approach we try to exploit the impressive performance of current ILP-solvers and work only with integer solutions without ever interfering with fractional solutions. We stick to a very simple ILP-model and relax the subtour constraints only. The resulting problem is solved to integer optimality, violated constraints (which are trivial to find) are added and the process is repeated until a feasible solution is found.

In order to speed up the algorithm we pursue several attempts to find as many „relevant“ subtours as possible, without adding too many irrelevant subtour constraints. These attempts are mainly based on the clustering of vertices with additional insights gained from empirical observations and random graph theory. Computational results are performed on test instances taken from the TSPLIB95 and on random Euclidean graphs.

A complete characterization of facet-defining Jump Inequalities for the Hop-Constrained Path Polytope

Wolfgang Ferdinand Riedl Technische Universität München, Germany

Day:	Fri, May 02
Time:	11:30
Room:	00.07.014

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

We will present a complete characterization of facet-defining Jump Inequalities, i.e. sufficient and necessary conditions for a Jump Inequality to define a facet of the corresponding polytope. Furthermore, we will present the structure of arcs that can be lifted in case the inquality does not define a facet.

Tactical Fixed Job Scheduling with Spread-Time Constraints

Shuyu Zhou	Erasmus University, The Netherlands
	East China University of Science and Technology, China
Xiandong Zhang	Fudan University, China
Bo Chen	University of Warwick, United Kingdom
Steef van de Velde	Erasmus University, The Netherlands

Day:	Fri, May 02
Time:	10:30
Room:	03.08.011

We address the tactical fixed job scheduling problem with spread-time constraints. In such a problem, there are a fixed number of classes of machines and a fixed number of groups of jobs. Jobs of the same group can only be processed by machines of a given set of classes. All jobs have their fixed start and end times. Each machine is associated with a cost according to its machine class. Machines have spread-time constraints, with which each machine is only available for L consecutive time units from the start time of the earliest job assigned to it. The objective is to minimize the total cost of the machines used to process all the jobs. For this strongly NP-hard problem, we develop a branch-and-price algorithm, which solves instances with up to 300 jobs, as compared with CPLEX, which cannot solve instances of 100 jobs. We further investigate the influence of machine flexibility by computational experiments. Our results show that limited machine flexibility is sufficient in most situations.

Minimizing total completion time of a time-dependent scheduling problem by iterative improvements

Stanislaw Gawiejnowicz Adam Mickiewicz University, Poland
Wieslaw Kurc Adam Mickiewicz University, Poland

Day:	Fri, May 02
Time:	11:00
Room:	03.08.011

We consider a single machine time-dependent scheduling problem with total completion time criterion. The processing times of jobs depend on when the jobs start and are described by linear functions. For this problem, first we formulate some preliminary results showing how to improve a schedule by sequences of mutual exchanges of two jobs. Next, we introduce a new necessary condition of schedule optimality which, compared to the necessary condition known in literature, allows further reducing the number of possible optimal schedules in the case when input data diameter is sufficiently small. Finally, we present a heuristic based on iterative improvements of constructed schedules and report results of computational experiments with the algorithm.

Time-Indexed Modelling for Scheduling and Tool Loading in Flexible Manufacturing Systems

Selin Ozpeynirci İzmir University of Economics, Turkey

Day:	Fri, May 02
Time:	11:30
Room:	03.08.011

In this study, we consider the scheduling and tool loading problems simultaneously in flexible manufacturing systems. There are a number of jobs that must be processed on a group of parallel computer numerically controlled (CNC) machines. Every machine is eligible to process all the jobs but the processing times of the operations on different machines may vary due to the speed or age of the machine. An operation must be assigned to exactly one machine and preemption is not allowed. Each job requires a set of machine tools to be processed. The number of tool copies available in the system is limited due to economic restrictions. The problem is to schedule the jobs and the required tools so that the makespan is minimized. We present a time-indexed mathematical model of the problem. Time-indexed mathematical models have been used to formulate different types of problems, including the scheduling problems. They gain the attention of researchers with their many advantages like strong bounds provided by linear programming relaxations and approximation algorithms that can be developed based on these models. However, time-indexed formulations also have a major disadvantage which is their size. Due to time index, the number of variables and constraints can be extremely large even for small sized problems. The problem considered in this study is NP-hard and finding the optimal solution with time-indexed model is not possible in reasonable time. Hence, a heuristic approach based on the mathematical model is developed and the performances with respect to time and solution quality are presented. A part of this work is supported by the Scientific and Technological Research Council of Turkey, grant no: 110M492.

A column generation-based approach for partitioning with equity constraint: application to school canteen meat supply

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Day:	Fri, May 02
Time:	10:30
Room:	00.09.022

In France, schools are grouped in order to set up public calls for tender to purchase meat. It consists in proposing, for each category of meat, a partitioning of the set of schools. In the context of short and local supply chain, the objective of this partitioning is to allow a maximum number of suppliers, in particular the local ones, to respond to the calls.

Data are a set of schools with their location and demand, a set of suppliers with their location, scope of action and minimal profitability ratio, and a selling price of the meat. A meat supplier respond to a call for tender if (1) all the schools are inside his scope of action, and (2) the delivery of the schools within one route achieve a minimal profitability ratio. For every subset of schools, an average profitability ratio can be computed, based on the ones of the suppliers who can respond. The problem has an original constraint: the profitability ratios of the parts of the solution need to be balanced. Otherwise, suppliers may choose to respond only to the tenders with high profitability ratios.

The optimization problem studied is NP-hard as a generalization of Set Partitioning. A formulation of the problem as an Integer Linear Program is proposed. As the number of variables (parts) is too large, a column generation-based approach is proposed. The formulation has a weak linear relaxation, hence we propose to modify the objective function. An objective for the profitability ratio is added with a unit penalty cost in case of deviation of this objective for the chosen parts. The linear relaxation of this reformulation gives better bounds and the problem within its initial formulation can be solved right after the column generation process with good results. However, the modification of the objective function makes the problem of finding new columns with implicit description hard to formulate. Hence a heuristic method to search new columns is proposed, without guarantee on the optimality of the solution. Some results on real case instances are presented, and compared to exact solutions for small instances using CPLEX12.6 and a local search method for larger instances.

Optimizing Bank Revenues in Collection Processes

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Fatih Ecevit	Bogazici University, Turkey
Ayse Buyukkaya	Intertech, Turkey
Umut Kapucu	Intertech, Turkey
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Day:	Fri, May 02
Time:	11:00
Room:	00.09.022

When bank customers fail to pay the amount they owe to their bank related with a credit product (credit cards, overdraft accounts or installment loans), the bank starts a collection process. This collection process typically lasts three months after which the customer is labeled as defaulted and a legal follow-up (litigation) period is started. Banks try to minimize the percentage of credit amounts that go to litigation since it affects the bank performance in various aspects. Because of this banks try to maximize the collections before litigation. For this they take various actions (typically in increasing harshness).

In this study we approach this problem from a bit different perspective and try to maximize not the short term collections but the long term revenues from customers. More specifically we note the fact that, taking a harsher action in the first days of delinquency might increase the collection probability but customer may become offended and stop working with the bank after the payment. In such a case, the bank will lose the potential future profits from that customer. In our model we consider these churn effects also and try to maximize long term revenues from customers.

On the buffer management in car production system

Wojciech Wojciechowicz	Poznan University of Technology, Poland
Grzegorz Pawlak	Poznan University of Technology, Poland

Day:	Fri, May 02
Time:	11:30
Room:	00.09.022

In the modern car factories, to satisfy customer's demand on products and minimize costs, multi-model assembly lines are used. Many of them have already applied Just in Time (JiT) policy, which minimalizes the inventories kept in the factory. Just in Sequence (JiS) policy (which ensure, that subproducts ale delivered not only in minimal volume – but also in right order) is considered as a next step in factory optimization. But the JiS policy needs a predictable sequence and stable production processes, to be applied.

In this work we consider optimisation of modern car production systems by introducing JiS enabling system management algorithms. The work was inspired by challenges as noted in real production systems, where the process stability is a key issue for applying the JIS policy.

The subject of the research was a scheduling problem noted in real car production system. A model of such production system was proposed and analysed. The key decision points were identified

and examined. The problem have been formalised and computational complexity analysed. Consequently, a new algorithm was proposed. The sequence quality coefficient factor was used as a goal function to evaluate the system behaviour in the production process.

Praktische Herausforderungen des freiwilligen Landtausch

Stefan Schaffner Bayerische Forstverwaltung, Germany
Markus Lechner Bayerische Forstverwaltung, Germany

Day:	Fri, May 02
Time:	10:30
Room:	02.04.011

Das Land Bayern hat eine Waldfläche von rund 2,5 Mio Hektar. Bei fast 60% dieser Fläche beträgt die durchschnittliche Flurstücksgröße aber nur rund 0,9 ha. Die Bewirtschaftung des Privatwaldes wird insbesondere durch die Kleinteiligkeit der Waldgrundstücksverhältnisse erschwert, woraus sich viele alltägliche Probleme ergeben (erschwerte Zugänglichkeit der einzelnen Waldgrundstücke, lange Besitzgrenzen, ...).

Eine Möglichkeit diese Probleme zu überwinden ist der freiwillige Landtausch. Dieser Tausch kann in einem gesetzlich geregelten Verfahren (Flurbereinigungsgesetz) für freiwillig teilnehmende Eigentümer rechtssicher und sehr kostengünstig mit Unterstützung staatlicher Verwaltungen vollzogen werden. Alleine 10 teilnehmende Waldbesitzer mit je 30 Flurstücken ergäbe 10 hoch 300 verschiedene Tauschkombinationen, die nicht mehr händelbar sind.

Um die kleinteilige Besitzstruktur a) zu analysieren und b) durch das Instrument „freiwilliger Landtausch“ zu verbessern, wurde in Kooperation mit dem Zentrum für Mathematik der Technischen Universität München ein intuitiv zu bedienendes Instrument entwickelt, mit dem die Forstverwaltung ihre praktischen Aufgaben bei der Beurteilung von Waldfluren und bei der Beratung zum freiwilligen Landtausch sehr viel einfacher und zielgenauer erfüllen kann.

Mit der vorliegenden Programmentwicklung ist die Forstverwaltung nun in der Lage, die Vielzahl der relevanten Eingangsgrößen (Eigentümerverteilung, geometrische Form der Flurstücke und Lage zueinander, vorhandene Erschließung, ...) und deren Variationsmöglichkeiten für die Belange des Landtausches händelbar zu machen. Forstverwaltung und Waldbesitzer können durch die Kennwerte (Grenzlängen, Arrondierungsgrad angrenzender Flurstücke mit gleichem Eigentümer, Erschließungsgrad, ect. jeweils vor und nach Tausch) und durch die grafische Darstellung der Ist-Situation und von möglichen (rechneroptimierten) Tauschmöglichkeiten sehr viel schneller die Vorteile eines freiwilligen Landtausches erkennen.

Waldpflegeverträge in der Praxis - Herausforderungen für ein effizientes Management

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Day:	Fri, May 02
Time:	11:00
Room:	02.04.011

Eine jährlich zunehmende Zahl der 500.000 Waldeigentümer (Besitzstände) in Bayern entscheidet sich bei der Bewirtschaftung ihres Waldes für einen Waldpflegevertrag mit einer Waldbesitzervereinigung. Ein Waldpflegevertrag regelt, welche Tätigkeiten eine Waldbesitzervereinigung für einen Waldbesitzer auf dessen meist vertreut in einem Gebiet liegenden Waldparzellen erledigen soll. Das Spektrum an Arbeiten reicht dabei von Grenzmarkierung, über Verkehrssicherungsbegänge, über die Kulturbegründung, die Jugendpflege über den Holzeinschlag, die Vermarktung des Holzes bis hin zur Wahrnehmung bei verbandlichen oder behördlichen Terminen.

Durch die „spontanen“ Entscheidungen der Waldbesitzer entstand typischerweise eine schrottschussartige räumliche Verteilung der Vertragsflächen im Gebiet einer Waldbesitzervereinigung. Die Steuerung der zu erfüllenden Maßnahmen geschieht aktuell intuitiv von den Mitarbeitern, die hierfür sowohl die Flächen als auch die zu erledigenden Aufgaben „im Kopf“ haben müssen und entsprechend entscheiden. Mit wachsender Zahl an Flächen und an Verträgen stoßen die Mitarbeiter zunehmend an die Grenzen, intuitiv „optimale Lösungen“ zu finden.

Gerade Klein- und Kleinstvertragsflächen beinhalten gewaltige betriebswirtschaftliche Rentabilitätsherausforderungen. Methoden eines effizienten Managements der Aufgabenerfüllung fallen in den Bereich von Traveling Salesman Problemen kombiniert mit Zeitfenstern für bestimmte Tätigkeiten.

Im Idealfall sollten mathematische Algorithmen und ein Software-System entstehen, das einem Mitarbeiter einer Waldbesitzervereinigung automatisiert vorschlägt, welche Flächen und welche Maßnahmen optimal zu behandeln sind und zwar unter folgenden Fallkonstellationen

a) Ein Mitarbeiter kann seinen vollständigen Arbeitstag frei für Maßnahmen gestalten.

b) Ein Mitarbeiter hat ein Zeitfenster von beliebiger, aber fixer Dauer (z.B. 3 Stunden) und befindet sich an einem definierten Punkt xy im Gebiet.

Zudem sind Methoden einer gerechten Entgeltfindung für Vertragsflächen wichtig, gerade wenn Maßnahmen im Zusammenhang mit anderen Flächen und Tätigkeiten erbracht werden, aber einzeln in Rechnung gestellt werden. Eine weitere weiterführende Frage fällt in den Bereich der strategischen Wachstumsplanung für Waldpflegeverträge: Wo ist es sinnvoll — bei gegebener aktueller Verteilung der bestehenden Waldpflegevertragsflächen – durch Werbung und aktive Maßnahmen räumlich benachbarte Flächen zu akquirieren?

Erstellung valider Statistiken aus Waldbesitzer-Eigentumsverzeichnissen

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Markus Lechner Bayerische Forstverwaltung, Germany

Day:	Fri, May 02
Time:	11:30
Room:	02.04.011

Für viele forstpolitischen Fragestellungen und für den praktischen Verwaltungsvollzug ist es notwendig auf eine valide Statistik über die Anzahl der Waldeigentümer und die Gesamtsumme ihrer Waldeigentumsflächen zurückzugreifen. In Bayern gibt es rund 700.000 natürliche oder juristische Personen, die Eigentumsrechte an über 2 Millionen Waldgrundstücken haben.

Die Eigentumsverzeichnisse geben Auskunft über die Rechtsverhältnisse und die Waldgrößen eines jeden Flurstückes. Die Gesamtwaldeigentumsgröße (Forstbetriebes oder Eigentumsstand) ist aber über diese Daten nicht direkt zugänglich. Die Entscheidung, welcher „Forstbetriebsgrößenklasse“ und welcher Eigentumsart ein Grundstück im Wald zuzuordnen ist, wurde bislang wesentlich auf die Ortskenntnisse der Forstämter bzw. nach 2005 der Ämter für Ernährung, Landwirtschaft und Forsten gestützt. Entscheidend ist hierzu eine genaue Kenntnis der Revierleiter und Revierleiterinnen über die tatsächlichen Eigentumsverhältnisse (Eigentumsarten, z.B. Privat-, Staats- oder Kommunalwald und Eigentumsgrößenklassen) im jeweiligen Zuständigkeitsbereich. Die Verfügbarkeit moderner Informationstechnologie lässt aber in Zukunft eine weitgehend automatisierte und systematische Zuordnung der Stichprobenpunkte zu Eigentumsarten und Größenklassen zu.

Die Herausforderungen bei der Analyse der Eigentumsstrukturen beruht im Wesentlichen darauf, dass im Datensatz gleiche Personen-Identitäten z.T. mit verschiedener Schreibweise bzw. auftretenden Zahlen- und Buchstabendrehern vorkommen können. Dies betrifft Personen, die Rechtsverhältnisse zu mehr als einem Flurstück haben und damit mehrfach in den Datensätzen erfasst sind.

Dabei sind die Fehlerquellen aufgrund unterschiedlicher Schreibweisen bei insgesamt über 2,9 Millionen Eigentumseinträge bei über 2,09 Millionen Flurstücken zahlreich und unsystematisch. Hintergrund der unterschiedlichen Schreibweisen oder fehlerhaften Erfassungen ist, dass die Eigentumseintragungen oder Umschreibungen durch unabhängig voneinander agierende grundbuchführende Stellen durchgeführt wurden.

Da die „Fehlerquellen“ zahlreich und unsystematisch sind, musste ein semiautomatisiertes Verfahren entwickelt werden. Hierbei wurden String-Variablen mit jeweils Kombinationen aus unterschiedlichen Merkmalen (z.B. Vorname, Name, ect. insgesamt Strings aus mind. drei Variablen) erzeugt. Die jeweils identifizierten doppelten Fälle wurden abgeglichen und die identischen Fälle wurden in einer eigenen Schlüsselvariablen „Eigentumsidentität“ gleichgesetzt. Insgesamt wurde mit diesem schrittweisen iterativen Abgleich von String-Kombinationen auf identische Fälle in einem Ausmaß Datenbereinigungen durchgeführt, die zwar weniger als 1% des in den ALB-Einträgen erfassten Gesamtbestandes an natürlichen und juristischen Personen betreffen. Eine Nichtbereinigung hätte aber zu einer bedeutsamen Überschätzung der Waldeigentümerzahlen (rd. 6%) und der Eigentumsstände (rd. 4,5%) geführt. Gibt es Algorithmen, die eine (beweisbar) hohe Sicherheit an „richtigen Zuordnungen“ herstellen können?

5.8 Friday, May 2nd, 2014: Afternoon Sessions

Energy grids - improving transportation models for transmission capacity expansion

Paul Stursberg	Department of Mathematics, Technische Universität München, Germany	
René Brandenberg	Department of Mathematics, Technische Universität München, Germany	
Michael Ritter	Department of Mathematics, Technische Universität München, Germany	

Day:	Fri, May 02
Time:	13:30
Room:	00.07.014

Investment planning models for the energy sector that take into account volatile renewable generation and storage facilities require both a long time horizon and high temporal and spacial resolution. Because of the resulting size of the optimisation problems, they typically have to compromise on technical details of the involved infrastructure, such as the power grid.

Our work explores the properties of one of the most widely used and computationally fastest representations of the power grid, the Transport Model. We investigate its representation of physical power flows and propose a modification that improves the representation without compromising the most important computational advantage.

Most existing approaches, especially for fixed infrastructures, use the Linearized Load Flow model as a basis for their power flow representation. While it does a decent job at representing active power distribution in a grid, it entirely ignores reactive power as well as transmission losses. And indeed, in recent years a number of different approaches have been proposed to alleviate these drawbacks: More and more advanced models of transmission losses in combination with reactive power flow approximations achieve results that come very close to exact AC power flow computations.

However, another major drawback of the Linearized Load Flow model remains almost untackled: If investments in infrastructure are to be optimised together with unit dispatch, one has to resort to computationally more expensive optimisation techniques such as nonlinear or mixed-integer programming. Therefore, for large scale investment problems, the very simple and inaccurate Transport Model remains the most widely used.

In this work, we explore the modelling domain between Transport and Linearized Load Flow models. We propose a new approach that improves the Transport Model towards a more accurate representation of physical power flows. Without compromising the computational advantage of the Transport Model in combined investment/dispatch models, our experiments indicate that in many cases, our model comes close to the accuracy of the Linearized Load Flow Model.

Modeling Thermal Start-up Costs in a Unit Commitment Problem

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Matthias Huber Technische Universität München, Germany

Day:	Fri, May 02
Time:	14:00
Room:	00.07.014

The ongoing development of intermittent renewable energy sources exposes the conventional power units to irregular load patterns with higher ramps. This leads to more frequent start-ups and irregular offline periods. Thus, accurate models of the cost associated with these start-ups gain importance.

For a thermal unit, the start-up cost consists of fixed operational costs and variable costs proportional to the temperature loss during the preceding offline period. We present a novel model of this thermal start-up cost, which extends a widely used MIP formulation of the Unit Commitment Problem.

By introducing new variables, our model is able to outperform the existing models in terms of theoretical properties, quality of the linear relaxation and computation times.

Servicing stationary objects in a linear working zone of a mobile processor: scheduling problem in the case of non-zero ready dates

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Day:	Fri, May 02
Time:	13:30
Room:	02.08.011

The model under study describes the systems in which a mobile processor must serve the set of the stationary objects located among a linear working zone. The processor performs two ways between the extreme points of the zone: forward way, where the part of the objects is served, and the backward way, where all other objects are served. Every object is associated with a number of characteristics, including individual penalty function that represents the losses depending on the servicing completion time. Unlike the model described in [1], we additionally consider the ready date for each stationary object, starting from which the servicing can be started. The arising one-criterion and bicriteria optimization problems are studied. The solving algorithms based on the dynamic programming approach are constructed. We prove that the problems under study are NP-hard in the case of non-zero ready dates. This result is opposed to the proved in [1] theorems stating that the corresponding problems are polynomially solvable in the case of zero ready dates.

On practice the given model describes the diesel oil supplies processes to the floating extraction facilities that mine gravel and gravel-sand mixture from the bottom of the rivers. According to the computational experiments, the usage of the proposed algorithms for optimization of these processes shows acceptable performance, in spite of the NP-hardness results. Therefore these algorithms can be recommended for the use on the water transport.

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Formulations for Minimizing Tour Duration of the Symmetric Traveling Salesman Problem with Time Windows

İmdat Kara Baskent University, Turkey
Tusan Derya Baskent University, Turkey

Day:	Fri, May 02
Time:	14:00
Room:	02.08.011

The Traveling Salesman Problem (TSP) lies at the heart of routing problems. It is one of the most attractive combinatorial optimization problems. TSP has many variants one of which is called as Traveling Salesman Problem with Time Windows (TSPTW). A time window for a city is an interval of time defined by earliest and latest time that this city can be visited. If the traveller arrives a node before the earliest time that this node can be served, it waits until the earliest time. TSPTW arises in distribution and logistics problems, such as school bus routing, transportation of perishables goods and etc.. Waiting times, during which some resources are used, directly affect the duration of the tour so the cost of the tour. The main objective functions expressed in the literature for TSPTW are concentrated on minimizing total distance travelled (or minimizing total travel time spent on the arcs, or minimizing total traveling cost). There exist a few formulations for minimizing just tour duration for symmetric case. As far as we are aware, there exists only one formulation for symmetric TSPTW which has nonlinear constraint set. In this paper we present two integer linear programming formulations for symmetric TSPTW for minimizing tour duration. The first model can be used just tour duration while the second formulation may be used for alternate objective functions, such as minimizing time spent on the arcs and/or minimizing total traveling cost. Our mathematical models have $O(n^2)$ binary variables and $O(n^2)$ constraints, where n is the number of the nodes of the underlying graph. In order to see the performance of the proposed formulations, a computational analysis is conducted and problems appearing in the literature are solved by using CPLEX 12.5 to optimality. The results show that our first formulation extremely faster than the second one. There exist benchmark instances up to 400 nodes. Our first formulation found optimal solutions of all the benchmark instances within seconds. We conclude that small and medium size real life problems may be solved to optimality by using our first formulation. For alternate objectives for TSPTW we propose our second formulation.

Cellular Manufacturing Layout Design in a Wheel Rim Manufacturing Industry : A Case Study

Feristah Ozcelik Eskisehir Osmangazi University, Turkey
Nidanur Eğercioğlu Eskisehir Osmangazi University, Turkey
Melike Gültekin Eskisehir Osmangazi University, Turkey

Day:	Fri, May 02
Time:	13:30
Room:	00.09.022

Cellular manufacturing (CM) is the physical division of the manufacturing facilities into production cells, representing the basis for advanced manufacturing systems such as just-in-time, flexible manufacturing system and computer integrated manufacturing. In CM, each cell is designed to produce a part family or families efficiently. The design for CM involves three stages: (1) forming cells by grouping parts into the part families and machines into the cells, (2) laying out the cells within the shop floor (i.e. inter-cell layout) and (3) laying out the machines within each cell (i.e. intra-cell layout). As problems in the three stages are NP-hard, a sequential heuristic approach has been proposed to tackle the cell formation, inter-cell and intra-cell layout problems for a wheel rim manufacturing company. The proposed layout is compared with the existing one. By using a cellular manufacturing layout, some reduction on materials' handling distances is gained.

Discovering functionally related genes by analyzing the topology of biological networks

Marek Blazewicz Poznan University of Technology, Poland
Klaus Ecker Clausthal University of Technology, Germany

Day:	Fri, May 02
Time:	14:00
Room:	00.09.022

The aim of the work was to create an algorithm capable of performing automatic identification and marking of functional modules of genes and proteins out of multiple datasets. The main motivation was to create a fast and reliable automatic tool to extract groups of functionally related genes and their products. The inclusion of multiple datasets allows minimizing the influence of the statistical noise in the results.

So far a lot of work has been done in the context of automatic clustering of similar genes with the use of both: single and multiple datasets, however to the best of our knowledge, little of the previous work has emphasized the topological similarities of the network structures induced by the investigated datasets.

As a particular methodology to determine the local network similarity, we have applied the idea of node graphlets, where the frequency of occurrences of small subnetworks of particular shape is captured. The actual similarity of two nodes (i.e., of genes or gene products) in the network is derived from comparing the frequencies of graphlets touching the nodes, in contrast to the usually considered shortest path distance of nodes. Though such an approach might generally be questionable, it has been proven to be an effective method for finding functionally related genes in biological networks (especially in PPI-structures).

In order to combine the analysis performed on different networks, we have utilized the recently proposed clustering method CLAIM. We were able to prove that enhancing CLAIM by including the graphlet approach has led to an improvement capability to identify gene groups. In particular, we have taken externally known groups of genes (pathways) and cross-validated the effectiveness of the new method by verifying the chance of detecting functionally related genes in the investigated networks.

In the presented work we have focused on the data derived from DNA/RNA microarrays and protein-protein interactions. As one of the particular biological problems, we have investigated Arabidopsis thaliana subjected to salt stress.

A fast and efficient algorithm for feature selection problem

Alkin Yurtkuran Uludag University, Turkey
Erdal Emel Uludag University, Turkey

Day:	Fri, May 02
Time:	13:30
Room:	02.04.011

Recently, feature selection problems in the area of data mining have been widely studied. Feature selection is the process of eliminating irrelevant features to improve classification accuracy. Since feature selection is an NP-Hard problem, researchers have analyzed various heuristic and meta-heuristic algorithms for feature selection problem. This study proposes an improved Electromagnetism-like algorithm (EMA) to solve feature selection problem. Electromagnetism-like Algorithm (EMA) is one of the recently introduced population based meta-heuristic which simulate the behavior of charged particles on an electrical field. The proposed algorithm is tested on several data sets and experimental results show that improved EMA obtains higher classification accuracies compared to other meta-heuristic algorithms.

A heuristic algorithm for a variant of student – project allocation problem with preferences

Alkin Yurtkuran Uludag University, Turkey
Erdal Emel Uludag University, Turkey

Day:	Fri, May 02
Time:	14:00
Room:	02.04.011

We propose a heuristic algorithm for solving a variant of a student-project allocation problem (SPA) where not only students express their preferences over projects but also project owners may have preferences over students based on their interviews. Each project has a specified capacity. Projects may require predefined knowledge and skills, which students in the group should collectively possess. Therefore, students with required specifications are always preferred over other students, even if a student may have a lower preference on the specified project. Moreover, to balance the overall capability of a project group among other groups, the deviation of the GPA of a group from the mean value of GPA of all the students taking a project has to be minimized. The proposed heuristic algorithm is applied to a real world case.

5.9 Saturday Plenary Talk

Interactive Multiobjective Optimization using Dominance-based Rough Set Approach

Day:	Sat, May 03
Time:	09:00
Room:	HS 3

Salvatore Greco
Portsmouth Business School, Operations & Systems Management, University of Portsmouth, UK
Department of Economics and Business, University of Catania, Italy

Benedetto Matarazzo
Department of Economics and Business, University of Catania, Italy

Roman Słowiński
Systems Research Institute, Polish Academy of Sciences, Warsaw, Poland
Institute of Computing Science, Poznań University of Technology, Poznań, Poland

Application of Dominance-based Rough Set Approach (DRSA) to preference modeling in Interactive Multiobjective Optimization (IMO) gave rise to a new method employing a logical preference model. The method is composed of two alternating stages: computation stage, and dialogue stage. In the computation stage, a sample of non-dominated solutions is generated and presented to the Decision Maker (DM). In the dialogue stage, the DM evaluates the proposed solutions by classifying them into preference ordered classes, such as "bad", "medium" and "good". This classification of the sampled solutions is an input preference information for DRSA. DRSA is using this information to induce a preference model expressed in terms of "if..., then ..." decision rules. The DM is then asked to select one or more decision rules considered as the most representative for her current preferences. These rules define new constraints to be added to the constraints of the multiobjective optimization problem from the last computation stage. The new constraints cut-off non-interesting solutions from the former set of feasible solutions. A new sample of non-dominated solutions is generated in the next computation stage from the newly constrained set of feasible solutions. The interaction continues until the DM finds a satisfactory solution. DRSA permits, moreover, to describe the Pareto frontier of the multiobjective optimization problem in both, the space of objectives and the space of decision variables, using "if..., then ..." association rules. We shall show how to apply IMO-DRSA in a multiobjective combinatorial optimization problem.

5.10 Saturday, May 3rd, 2014: Morning Sessions

Large scale nonlinear programming in practice

Zsolt Csizmadia FICO, United Kingdom

Day:	Sat, May 03
Time:	10:30
Room:	00.07.014

The talk will present common challenges arising in large scale nonlinear programming problems and propose strategies to address these. Practices against false stationary point solutions and balancing them against numerical considerations will be discussed on large blending problems. Challenges related to handling very large problem formulation data will be discussed on curve fitting problems, while convergence and stability considerations will be addressed using problems arising in financial applications.

Making optimization accessible

Oliver Bastert FICO, Germany

Day:	Sat, May 03
Time:	11:00
Room:	00.07.014

Well known challenges for delivering successful optimization projects are obtaining and cleaning customer data, building a suitable optimization model and solving the resulting optimization problem fast enough to meet the particular use case. In addition, we are regularly faced with the requirement of presenting the results in a very client specific way and making the solution accessible to non-expert users. Often the complexity is increased further due to specific client infrastructure and various restrictions imposed by IT.

In this talk we will present an overview of a number of projects and discuss the key challenges which we need to overcome to make optimization accessible to a wider audience. The examples we will discuss include marketing optimization, production planning, and energy pricing.

Convex Maximization for data segmentation

Andreas Brieden UniBw München, Germany
Peter Gritzmann Department of Mathematics, Technische Universität München, Germany

Day:	Sat, May 03
Time:	11:30
Room:	00.07.014

In general convex maximization problems are hard to solve, especially if side constraints are part of the problem definition. However, in case such problems arise in practical applications, they have to be "solved" efficiently. Hence polynomial-time approximation algorithms have to be developed that guarantee to deliver at least an approximate solution. In this talk we report on such problems, the approximation algorithm and the solutions.

Matroid optimisation problems with some non-linear monomials in the objective function

Anja Fischer	TU Dortmund, Germany	
Frank Fischer	University of Kassel, Germany	
Thomas McCormick	Sauder School of Business, University of British Columbia, Canada	

Day:	Sat, May 03
Time:	10:30
Room:	00.09.022

Motivated by recent results by Buchheim and Klein we consider general matroid optimisation problems with one additional monomial of arbitrary degree and with a set of nested monomials in the objective function. The monomials are linearised and we study the corresponding polytopes with the aim to better understand linearisations in general and to provide strengthened cutting planes as well as separation algorithms for linearisations of matroid optimisation problems with polynomial objective function. Extending results by Edmonds for the matroid polytope we present complete descriptions for the linearised polytopes. In the case of one additional monomial we fully characterise the facets of the associated polytope. Indeed, apart from the standard linearisation one needs appropriately strengthened rank inequalities fulfilling certain non-separability conditions. The separation problem of these rank inequalities reduces to a submodular function minimisation problem in both considered problem variants. Finally, we present possible extensions of our results.

On the diameter of (2,n)- and (3,n)-transportation polytopes

Steffen Borgwardt	Technische Universität München, Germany	
Jesus De Loera	University of California Davis, USA	
Elisabeth Finhold	Technische Universität München, Germany	

Day:	Sat, May 03
Time:	11:00
Room:	00.09.022

Repeated linear programming over transportation polytopes is an important tool in many algorithms. The diameter of these polytopes then is a useful indicator for the efficiency of such an approach, yet is still open whether the Hirsch conjecture holds for (m, n)-transportation polytopes with $m \geq 3$. It holds for $m = 2$ (De Loera, Kim); for $m \geq 3$, the best known bounds are linear (Brightwell, Heuvel, Stougie; Hurkens).

We prove the stronger monotone Hirsch conjecture and an even lower bound for the $(2, n)$-transportation polytopes by a constructive, graph-theoretical approach. Further, we improve the known bounds for $(3, n)$-transportation polytopes.

Optimal Gear Train Synthesis - A Combinatorial Model and a Mixed Integer Linear Approach

Peter Gritzmann	Department of Mathematics, Technische Universität München, Germany
Philipp Gwinner	Faculty of Mechanical Engineering, Technische Universität München, Germany
Bernd-Robert Höhn	Faculty of Mechanical Engineering, Technische Universität München, Germany
Fabian Klemm	Department of Mathematics, Technische Universität München, Germany
Patricia Rachinger	Department of Mathematics, Technische Universität München, Germany
Michael Ritter	Department of Mathematics, Technische Universität München, Germany
Karsten Stahl	Faculty of Mechanical Engineering, Technische Universität München, Germany

Day:	Sat, May 03
Time:	11:30
Room:	00.09.022

Efficient and high-performance gear trains are the essential part in any machine containing rotating elements. Hence, the search for new, superior gear trains is a permanent challenge in the field of mechanical engineering. However, the complexity of a gear train's structure grows rapidly with an increasing number of elements. For this reason new methods of gear train synthesis are required.

Although there have been some attempts to describe gear trains through graph models, there has not yet been a comprehensive optimization approach for an automated synthesis process. In particular, the existing models either fail to consider any optimality criteria or severely restrict the types of admissible gear trains. We present a combinatorial model for general gear trains extending some of the existing models, which covers all the essential aspects of a gear train such as speeds and torques. In particular, this model encompasses multispeed gear trains, which yields the possibility to optimize over gear trains for some pre-defined transmission series. Also, a first approach to use this model in a mixed integer linear programming approach is presented.

Power of Preemption on Uniform Parallel Machines

Alan James Soper	University of Greenwich, United Kingdom
Vitaly Strusevich	University of Greenwich, United Kingdom

Day:	Sat, May 03
Time:	10:30
Room:	02.04.011

For a scheduling problem on parallel machines, the power of preemption is defined as the ratio of the makespan of an optimal non-preemptive schedule over the makespan of an optimal preemptive schedule. We consider a scheduling problem on m uniform parallel machines and derive tight upper bounds on the power of preemption. In particular, we show that for any instance the power of preemption cannot be smaller than $2 - 1/m$.

Makespan minimization for parallel machines scheduling with resource constraints

Emine Akyol Anadolu University, Turkey
Tugba Sarac Eskisehir Osmangazi University, Turkey

Day:	Sat, May 03
Time:	11:00
Room:	02.04.011

This study proposes a mathematical model for identical parallel machine scheduling problem in which set up time of job depends on its sequence and each job can process on particular machines. Additionally, in this problem, each job requires a resource for processing and some resources are shared by particular jobs. There are multiple resource types and there is only a single instance of every resource type. The objective of the model is to minimize the makespan. We randomly generate instances in different sizes and solve them by the proposed mathematical model using GAMS/Cplex Solver. The obtained results are presented and discussed.

A genetic algorithm for identical parallel machine scheduling problem with shared resources

Tugba Sarac Eskisehir Osmangazi University, Turkey
Emine Akyol Anadolu University, Turkey

Day:	Sat, May 03
Time:	11:30
Room:	02.04.011

In recent years, various studies have been carried out to deal with identical parallel machine scheduling problems. However, resources are rarely considered in these studies although sharing resources in a parallel machine is an important aspect of this problem. In this study, an identical parallel machine scheduling problem with sequence dependent set up time, machine eligibility restrictions and shared resources is considered. A genetic algorithm is proposed for this problem. The performance of proposed algorithm is shown using randomly generated instances.

Minimum size extensible graph for (near) perfect matchings

Christophe Picouleau Laboratoire CEDRIC, France
Conservatoire National des Arts et Metiers, France
Marie-Christine Costa Laboratoire CEDRIC, France
Dominique de Werra Laboratoire CEDRIC, France

Day:	Sat, May 03
Time:	10:30
Room:	02.08.011

Let $G = (V, E)$ be a simple loopless finite undirected graph. We say that G is extensible if for any non-edge $uv \notin E$ it exists $F \subset E$ satisfying the following:

- F is a matching of G;

- $|F| = \lfloor |V|/2 \rfloor - 1$;
- $\forall xy \in F, \{x, y\} \cap \{u, v\} = \emptyset$.

In words: For every pair u, v of non adjacent vertices of G it is always possible to extend the non-edge uv to a perfect (or near perfect) matching using only edges of G that are not incident to u or v, i.e., when flipping uv to be an edge $F \cup \{uv\}$ is a perfect (or near perfect) matching.

The problem we are interested is the following: Given a positive integer n, the cardinality of the vertex set V, what is the minimum cardinality of E such that it exists $G = (V, E)$ which is extensible? This minimum number is denoted by $Ext(n)$.

For $n \geq 4$ we prove the following (the cases $n < 4$ being trivial):

- $Ext(4) = Ext(5) = 3$;
- $Ext(6) = Ext(7) = 6$;
- $Ext(n) = \frac{3}{2}n - 1$ for n even $n \geq 8$;
- $Ext(n) = n$ for n odd $n \geq 9$.

Additionally, we give a minimum size extensible graph for every order n.

J.A. Bondy, U. S. R. Murty, *Graphs Theory*, Springer, (2008).

R. Zenklusen, B. Ries, C. Picouleau, D. de Werra, M.-C. Costa, C. Bentz (2009), *Blockers and transversals*, Discrete Mathematics, 309 (13), 4306-4314.

The Shortest Path Game

Andreas Darmann University of Graz, Austria
Ulrich Pferschy University of Graz, Austria
Joachim Schauer University of Graz, Austria

Day:	Sat, May 03
Time:	11:00
Room:	02.08.011

We consider a game theoretic variant of the shortest path problem on a weighted graph with a designated starting vertex s and a destination vertex t. The aim of the game is to find a path from s to t in the following setting: The game is played by two players A and B who start in s and always move together along edges of the graph. In each vertex the players take turns at selecting the next vertex to be visited, with player A taking the first decision in s. The player deciding in the current vertex also has to pay the cost of the chosen edge. Each player wants to minimize the total edge costs it has to pay by choosing edges of low cost, while knowing that the other player is a selfish opponent that also tries to minimize its own costs. The game continues until the players reach the destination vertex t.

In this article we will consider optimal strategies in the sense of a game tree with complete information, where selfish decisions are taken by both players by moving backwards along all possible outcomes, i.e. anticipating all future reactions on a current move. We study this game on directed

as well as on undirected graphs. We will show that finding such an optimal strategy is polynomially solvable in acyclic graphs, whereas it becomes PSPACE-complete in directed and undirected graphs containing cycles, even on bipartite graphs. Note that the game is related to the well-known game Geography, but our result for undirected bipartite graphs exhibits a major difference between the two games.

Extending the treatment of special graph classes, we can show that on cactus graphs the optimal strategies can still be determined in polynomial time by a fairly involved algorithm. It is based on the decomposition of the graph into subgraphs on which the local optimal strategies can be found. These can be merged recursively into a global optimal solution. On the other hand, we can show that for slightly more general graphs, which also allow favorable decompositions, such as outerplanar graphs, the global solution may consist of suboptimal local solutions and the decomposition approach fails.

Contraction Blockers

Bernard Ries	University Paris-Dauphine, France
Daniel Paulusma	Durham University, UK
Christophe Picouleau	Laboratoire CEDRIC, France Conservatoire National des Arts et Metiers, France
Oznur Yasar	Kadir Has University, Turkey

Day:	Sat, May 03
Time:	11:30
Room:	02.08.011

Graph modification problems have been studied for many years. Given a graph G and a graph class B, these problems consist in modifying the graph G (deleting vertices and/or edges or adding vertices and/or edges, etc...) in order to obtain a graph G' belonging to the class B. Of course, the goal is to perform as few modifications as possible. Instead of being interested in a given graph class to which the resulting graph must belong, one may be interested in a given graph parameter, like for instance the stability number, the chromatic number or the clique number. Thus, given a graph G and an integer d>0, we want to modify the graph (with as few modifications as possible) such that the stability number (resp. the chromatic number or the clique number) of the resulting graph G' has decreased by at least d compared to G. In particular, we are interested in edge contractions as graph modification. A set of edges of minimum cardinality that need to be contracted in order to decrease by d the stability number (resp. the chromatic number or the clique number) of a given graph is called a minimum stability (resp. chromatic or clique) d-contraction blocker. Here we present results obtained by considering graphs G belonging to specific graph classes closed under edge contractions like split graphs, threshold graphs and interval graphs.

A Mixed Integer Programming Approach for Game Industry

Stefan Emet University of Turku, Finland

Day:	Sat, May 03
Time:	10:30
Room:	03.08.011

In the present paper the boolean satisfiability problem is considered. The satisfiability problem (SAT) is a decision problem, that appears in, for example, the design of many computer games. The mathematical question is: given the expression, is there some assignment of TRUE and FALSE values to the variables that will make the entire expression true? It is shown that the problem can be written in a linear form using Mixed Integer Linear Programming (MILP) techniques. Convexification techniques are applied, which guarantees global optimality of the solution. Special Ordered Sets (SOS) are included in the models in order to allow the use of a efficient type of branch-and-bound algorithm. Smaller instances of the Eternity II-puzzle is solved. The presented techniques can be applied on similar problems in various areas of computer science, game industry and artificial intelligence.

On the symmetries of MILP feasible sets

Gustavo Dias LIX, Ecole Polytechnique, Palaiseau, France
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Day:	Sat, May 03
Time:	11:00
Room:	03.08.011

Mathematical Programs (MP) may have symmetries in their solution set; as a consequence, Branch-and-Bound (BB) type algorithms may take even longer to terminate due to the exploration of symmetric subtrees. Among the strategies used to overcome this, a subgroup of these symmetries can be computed using formulation symmetries [1]: these symmetries are then "broken" either directly in the BB process or by adjoining some Symmetry-Breaking Constraints (SBC) to the formulation [2] (SBCs are derived from the action of the formulation group on the set of variable indices). Some problems, however, (e.g. sports tournaments and scheduling problems) have very symmetric feasible sets but non-symmetric objective functions. This makes the formulation non-symmetric; therefore, usual automatic symmetry computations methods [3] fail. On the other hand, the feasible set symmetries still enlarge the size of the BB tree. We aim to present a new method to generate SBCs that circumvents this issue and some preliminary computational experiments to support our proposal.

[1] - F. Margot. Symmetry in integer linear programming. In M. Junger, T. Liebling, D. Naddef, G. Nemhauser, W. Pulleyblank, G. Reinelt, G. Rinaldi, and L. Wolsey, editors, 50 Years of Integer Programming, page 647–681. Springer, Berlin, 2010.

[2] - L. Liberti. Symmetry in mathematical programming. In S. Leyffer and J. Lee, editors, Mixed Integer Nonlinear Programming, volume 154 of The IMA Volumes in Mathematics and its Applications, pages 263–286. Springer, New York, 2012.

[3] - L. Liberti. Reformulations in mathematical programming: Automatic symmetry detection and exploitation. Mathematical Programming, 131(1-2):273–304, 2012.

A trust region method for solving grey-box MINLP

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Day:	Sat, May 03
Time:	11:30
Room:	03.08.011

Trust region (TR) methods are used to solve various black-box optimization problems, especially when no derivative information is available. They have some similarities with traditional line-search methods, but in each iteration a step-size is selected before a descent direction. In this talk, we will consider an extension of trust region methods for mixed-integer nonlinear programming (MINLP). In particular, we solve an MINLP problem where the objective function is a grey-box, i.e it is the sum of a smooth function for which the closed form is given and a black-box. We use a local branching constraint to limit the number of flips in binary variable values, while maintaining TR boxes for continuous variables. We report on the convergence of the method and on early-stage computational results on real-life problems such as smart building design. The results suggest the potential use of the method for problems involving decision parameters (0-1) in complicated simulations.

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