Optima@ISMP

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Editorial

Dear ISMP participants!
We hope that you have already made yourself acquainted with some of Berlin's many facets. Today we highlight a major facet: the role of mathematics in Berlin. Leibniz, Euler, Dirichlet, Lagrange, Jacobi, Kronecker, von Neumann, Caratheodory, Weierstrass (all mathematical household names) and many others spent important parts of their academic life in Berlin. The historical lectures at ISMP and the book "Optimization Stories" tell you more. But Berlin is also full of modern optimization, bundled in the activities of Matheon. Berlin mathematicians have contributed to the time-table of Berlin's subway, the schedules of the BVG buses and their drivers, the layout of the telecom networks, and a lot more. These activities have generated successful start-up companies and attracted international companies such as our main sponsor TomTom, who has founded a lab to put car navigation on a new level with the help of mathematical programming (see session Wed.2.H 0104). We wish you a pleasant stay and hope you will also have time to spend a few hours to experience our great city.

Rolf Möhring and Martin Grötschel

Haus der Kulturen der Welt: Conference Dinner at 7 p.m. (Photo: Christoph Eyrich)

Today's Plenaries

- Christof Schütte: *Optimal control of molecular dynamics using Markov state models*, 09.00–09.50, H 0105
- Claudia Sagastizábal: *Divide to conquer: decomposition methods for energy optimization*, 17.00–17.50, H 0104
- Robert Weismantel: *Mixed Integer Convex Optimization*, 17.00–17.50, H 0105

Random Picks

- Testing total unimodularity of $0/1$-matrices with Klaus Truemper's algorithm becomes now a bit easier.
Matthias Walter: *A simple algorithm for testing total unimodularity of matrices*, 10.30–10.55, H 3005
- Transform discrete optimization problems into continuous ones, to solve the problems numerically with an interior-point algorithm.
Zelda Zabinsky: *Solving non-linear discrete optimization problems via continualization – an interior-point algorithm*, 10.30–10:55, H 2053
- How does the mathematical magic inside navigation devices work?
Heiko Schilling: *TomTom Navigation – How mathematics help getting through traffic faster*, 13.15–13.40, H 0104
- Time savings within two orders of magnitude are in fact more than one would normally expect!
Sara Lumbreras: *Efficient incorporation of contingency scenarios to stochastic optimization. Application to power systems*, 13.15–13.40, MA 550
- Optimization of the whole business rather than ordinary airline scheduling piece by piece.
Gary Froyland: *Robust airline schedule planning, aircraft routing and crew*, 15.15–15.40, H 0106
- Branch and fix coordination is used to solve large scale multi-stage stochastic mixed integer problems – and can be broken down into scenario groups with smaller subproblems. So why not parallelize computation?
Gerardo Perez Valdes: *Parallel computational implementation of a branch and fix coordination algorithm*, 15.15–15.40, MA 549

Optimal History

(al) Euler lived between 1741 and 1766 in Berlin at Behrenstraße 22/23 in modern Berlin Mitte, and he had a hard time there, since King Frederick II. (The Great), speaking mathematics not fluently (to say the least), disrespected his court mathematician and "cyclops".

Günter M. Ziegler picks three problems Euler did not tackle in his Berlin time: The seven bridges of Königsberg: How a problem of "Recreational Mathematics" led to the creation of Graph Theory.
The Basel problem: A healthy dose of serious numerical computing on the way to a $\zeta(2)$.
The polyhedron formula: Tracing the polyhedron formula from Stockholm to the Berne mountains.

Günter M. Ziegler is a Matheon professor for discrete and computational geometry at FU Berlin since 2011. He won several prizes and published several books, among others the *Book of Proofs* together with Martin Aigner.

Historical lecture on Wednesday:
- Günter M. Ziegler: *Leonhard Euler: Three strikes of a genius*, 17.00–17.50, H 1012

Today's Weather

08:00	☀	20°C / 68.0°F
11.00	⛅	22°C / 71.6°F
14:00	⛅	24°C / 75.2°F
17:00	⛅	24°C / 75.2°F
20:00	⛅	21°C / 69.8°F

60 Years of Turáns Question

(al) In October 1952, the number theorist Pál Turán came up with a problem from graph theory that many modern VLSI designers are familiar with: What is the crossing number of a bipartite or a complete graph? In other words: How many crossings are at least needed when you are drawing those graphs? Although many special cases have been solved in the last 60 years, the problem is in general still open. By the way and to be exact: 2012 is the 60th birthday of the publication of this problem, but Turàn came across it some years earlier in a labor camp near Budapest when thinking about the railway network for lorries in the brick factory there; for the history of this problem, see for instance the nice article of Beineke and Wilson in Math. Intelligencer 32 (2), 2010, pp. 41–48.

There have been many approaches to answer Turáns question. Among the most famous is an attempt from 1953/54 due to the topologist and Polish rocket pioneer Kazimierz Zarankiewicz who tried to prove that for a complete bipartite graph $K_{m,n}$, the minimal solution needs a *Zarankiewicz Number* of $\lfloor\frac{m-1}{2}\rfloor\lfloor\frac{m}{2}\rfloor\lfloor\frac{n-1}{2}\rfloor\lfloor\frac{n}{2}\rfloor$ crossings. For complete graphs K_m, it is conjectured that optimal drawings (that is: drawings with a minimal number of crossings) need $\frac{1}{4}\lfloor\frac{m}{2}\rfloor\lfloor\frac{m-1}{2}\rfloor\lfloor\frac{m-2}{2}\rfloor\lfloor\frac{m-3}{2}\rfloor\lfloor\frac{m-4}{2}\rfloor$ crossings. Although both conjectures seem highly reasonable, they are still open.

Up to now, the best lower bounds for the crossing number problem have been found by means of quadratic optimization for $K_{7,n}$ in 2008 by de Klerk et al..

Optimal Reading

(De Gruyter/al) The independent academic publishing house De Gruyter looks back on a history spanning over 260 years. Nowadays, they have a rather large portfolio in (functional) analysis, differential calculus and numerics – all the continuous stuff needed for optimization. Among the titles from 2012 which are presented at the De Gruyter booth, you can for instance find Peter Deuflhard's *Adaptive Numerical Solution of PDEs*. Peter Deuflhard is a well-known optimization pro from Zuse Institut in Berlin, and he focuses in his textbook on the numerical solution of PDEs with respect to adaptivity of discretizations in space and time. The emphasis lies on elliptic and parabolic systems; hyperbolic conservation laws are treated only on an elementary level excluding turbulence.

Another new textbook of De Gruyter is Matthias Gerdts' *Optimal Control of ODEs and DAEs*, addressing primarily master and PhD students as well as researchers in applied mathematics. Gerdts teaches at the University of the German Federal Armed Forces in Munich; his book provides the theoretical as well as the computational tools which are necessary to investigate and to solve optimal control problems with ordinary differential equations and differential-algebraic equations. An emphasis is placed on the interplay between the continuous optimal control problem and discrete optimal control problems.

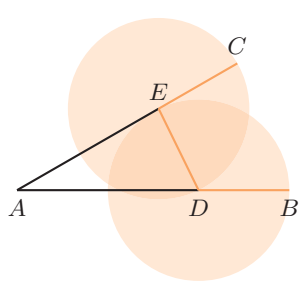
The De Gruyter Booth (Photo: Andreas Loos)

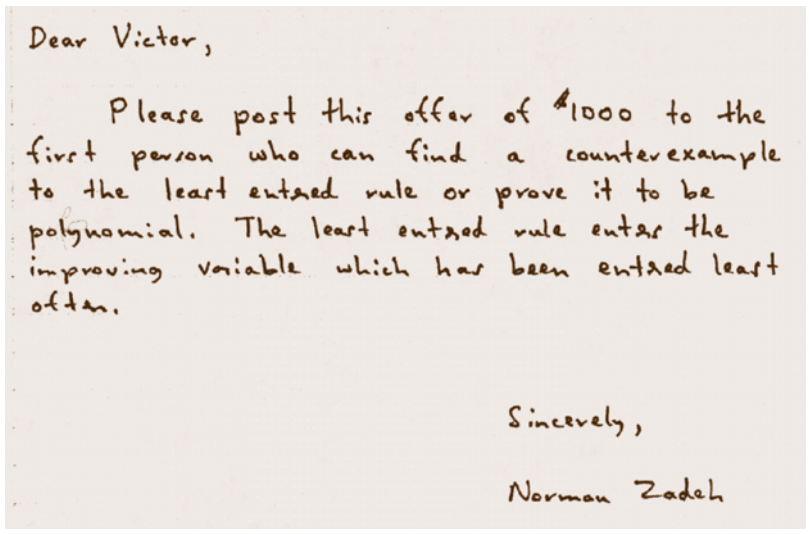
Last year, Matthias Gerdts published together with Frank Lempio also his book *Mathematische Optimierungsverfahren des Operations Research* (in German), an extensive presentation of mathematical optimization. Another book interesting for the (German speaking) optimization guild is Peter Kosmol's second edition of *Optimierung und Approximation* which appeared in 2010.

For more information and a full list of discounted ISMP titles (they are offering 20 % discount for english titles), please visit the De Gruyter booth in the Lichthof of the TU or check out www.degruyter.com

The Puzzle

(al) Dig out your rulers and compasses, here is a small puzzle from geometry: Given are arbitrary points A, B, and C. The task is to construct points D on AB and E on AC such that the lengths of CE, DE, and DB are all equal – and to do so only with ruler and compass.




Dear Victor,

Please post this offer of $1000 to the first person who can find a counterexample to the least entered rule or prove it to be polynomial. The least entered rule enter the improving variable which has been entered least often.

Sincerely,

Norman Zadeh

(Photo: Victor Klee/Günter M. Ziegler)

The Haus der Kulturen der Welt

(al) Today in the evening, it's the conference dinner at the Haus der Kulturen der Welt ("House of World Cultures") located in the *Tiergarten* park. If you sit there looking at the banks of the Spree river, then behind you rises the famous sweeping roof of the HDK. It is the reason why the house is also called "pregnant oyster" (schwangere Auster). (By the way: The German Chancellery nearby is commonly known as the "washing machine"; to find out why you should cross the Spree and look at it from the opposite bank.)

However, the pregnant oyster was not always as quiet as it is today: on May 21, 1980, at 10.56, the roof collapsed. One man died, five people where injured, and 600 tons of concrete chunks were the remains of the front part of the roof. The problem: The roof had rested on only two points and could therefore vibrate in the wind; corrosion and resonance were an evil mixture leading to the catastrophe. However, don't worry: The construction has been modified and the building is secure now.

Conference Dinner at 7 p.m.
Kongresshalle/Haus der Kulturen der Welt, John-Foster-Dulles-Allee 10, 10557 Berlin

During the whole evening, you can make a one-hour roundtrip by boat on the river *Spree*. The tour starts and ends directly at the *Haus der Kulturen der Welt*. To take part, you need a ticket (which is *free* for the participants of the ISMP). Tickets are available at the registration desk in the main building of the TU – and their number is limited!

Please note that the bus line 100 does not stop in front of the *Haus der Kulturen der Welt*, because of a building site there. Instead, you have to get off at a temporary bus stop called "Bellevue Allee" in "Straße des 17. Juni" and take a 10-minute-walk in northern direction through the *Tiergarten* park.


The view from the terrace: The Belltower next to the Haus der Kulturen der Welt (Photo: Christoph Eyrich)

"Linear Programming was just the cherry on the cake"

(al) Former Stanford Mathematician and current poker and porn millionaire Norm Zadeh couldn't remember at first: did he really, about 30 years ago, offer an award of 1000 $ to the mathematician who proved first that "Zadeh's pivot rule" doesn't make the Simplex algorithm run in polynomial time? The rule is easy: among all improving pivoting steps from the current basic feasible solution, take the one which has been entered least often.

Not only Zadeh had forgotten his prize – it had disappeared in a drawer of David Avis, a former postdoc student of Zadeh. But Avis digged it out in 2011, when Oliver Friedmann from the Ludwigs-Maximilians-Universität in Munich suprisingly proved a subexponential lower bound for Zadehs' Rule. Friedmann finally received the 1000 $ check from Zadeh – and now he won another 1000 $: He got the Tucker Prize for his thesis *Exponential Lower Bounds for Solving Infinitary Payoff Games and Linear Programs*. The committee for the Tucker Prize was excited: "The novelty of his approach is to show a connection between pivoting in linear programs and policy iteration for 2-player parity games, particularly Markov decision processes."

We met Oliver at the TU cafeteria to talk a bit about his work and his future.

optima@ismp: Visiting your website, one can find a lot of work in logics. Is logics where you come from?

Friedmann: Indeed, I started in logics. One could say this comes from my family: my daddy once studied philosophy, logics and science theory. And I focused for my diploma extensively on the connection between games and logics.

optima@ismp: But your thesis mainly found so much interest because it is building a bridge between Linear Programs and games.


Oliver Friedmann (Photo: Andreas Loos)

Friedmann: The Linear Programming was just the cherry on the cake. When translating problems from logic into games, I realized that the solvers did not perform well, so I focused on the current algorithms using policy iteration with improvement rules that decide on how to improve your strategy step by step. I constructed then a SAT formula depending on parameters n and i that could be satisfied if a game with n nodes could be improved to optimum in i steps, and then I solved it for small n and i – only to realize that only with large n one gets evil examples with long running time. Together with Uri Zwick and Thomas D. Hansen and some work of John Fearnley, I analyzed those evil examples to construct 2-player parity games that are difficult to improve, to translate them into 1-player Markov decision processes and to make them finally into LPs, where the improvement rules translate into pivoting rules for the Simplex. So we finally could also construct evil LPs for several pivot rules with our knowledge about games. We were simply lucky that it worked out!

optima@ismp: And now? Will you stay in research?

Friedmann: Actually, I am planning to create a startup together with some friends.

optima@ismp: So you will be the next maths millionaire?

Friedmann: (laughs) No, probably not. And in fact, I would also like to proceed with my research, doing the things I am interested in – not at the University, however. And I still have my blog to present my results.

optima@ismp: And Zadeh? Are there more prizes to win?

Friedmann: Norm Zadeh promised to spend one million dollars for mathematics if he won his lawsuit against Google – photos from his website could be found with the search engine for free. Unfortunately, I just learned: he lost his complaint. So perhaps, we have to wait for the next lawsuit.

There where two other Tucker finalists: *Amitabh Basu* from Carnegie Mellon University wrote a thesis on *Corner Polyhedra and Maximal Lattice-free Convex Sets: A Geometric Approach to Cutting Planes*. He studied cutting planes generated from several rows of the simplex tableau, in the context of solving mixed integer linear programs. The committee emphasized, this would "open the way to a new generation of computational advances in integer programming."

And Guanghui Lan from the Georgia Institute of Technology, Atlanta, was chosen for his 2009 thesis on *Convex Optimization under Inexact First-Order Information*. The thesis contains an optimal method for stochastic composite optimization which closes – according to the prize committee "the gap between the convergence rate of existing first-order methods and the theoretically optimal rate of convergence." "It represents the first universally optimal method which covers smooth, non-smooth and stochastic convex programming", the committee said.

Optimal Lunch Break

(al) In the mood for a conference break? Keen on photography? Then you could visit the Museum of Photography. At the moment, there are two exhibitions: One on Helmut Newton, a German-Australian fashion photographer (the Museum hosts his foundation and inheritance), and one on early portrait photography from India. These photographs come from the Ethnological Museum Berlin and are mainly from the second half of the 19th century – sepia brown images of nobles, tradesmen and poorer people.

The easiest way to get there is to walk (it's about 1.1 km). You leave the TU math building to the left until you reach the bridge over the *Landwehrkanal*. Do not cross the bridge, instead cross the broad *Straße des 17. Juni* and follow *Müller-Breslau-Straße* (by the way: at the end of this road, there is a nice small *Biergarten* called *Schleusenkrug*). However, we go left into *Fasanenstraße*. Behind the buildings to the right, there are some of the oldest parts of the TU from 1884, parts of a former heating plant and ruins of the arcades of the former *Borsig* factory that have been rebuilt there when the main factory in *Chausseestraße* was been given up in 1887 because it became too small. (If you are starting from the main building of TU, then you can essentially start your walk at this point by crossing the campus behind the main building.)

Take now the first street to the right (*Herzallee*) and walk right into *Jebensstraße* (at this corner, once the "Berlin Great Wheel" of 175 m height should have been built). You find the Museum to the right.

Museum for Photography, Jebensstraße 2, Admission 8€ (Student 4€). Tue–Sun 10.00–18.00 (Thu –22.00).


Arcades of the former *Borsig* factory on the TU Campus (Photo: Sabine Böck)

TomTom Competition: Deadline Today 12.00!

(al) In the documents you received at the registration, there was a sheet of paper with a quiz from TomTom – the *TomTom Competition*. Note that the deadline is today at 12.00, so if you want to take part – hurry up and bring the filled-out form to the large TomTom booth in the Lichthof in the TU main building. The quiz will be solved in the TomTom Session Wed.2 at H 0104 – and there you can also learn what mathematics is inside your navigation system!

Questions? Comments? Remarks? Just send us an E-Mail: andreas.loos@fu-berlin.de. More News? Visit us on the web: ismp2012.mathopt.org/en/news

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