MDS Statusworkshop 2014 schedule

Thursday, 16th October 2014.

15:00	Arrive/coffee
15:30 – 16:05	**Nimrod Talmon**—The complexity of degree anonymization by vertex addition
16:20 – 16:55	**Francesco Grande**—A sneak preview of 2-level matroids
17:10 – 17:25	Coffee
17:25 – 18:00	**Heuna Kim**—Congruence testing of two point sets in high dimensions
18:15 – 18:50	**Yannik Stein**—Approximating the Colorful Carathéodory Theorem
19:05 – 20:00	Dinner

Friday, 17th October 2014.

8:00 – 9:00	Breakfast
9:00 – 9:35	**Codruţ Grosu**—On Turán densities of hypergraphs
9:50 – 10:25	**Udo Hoffmann**—Slopes of segment intersection graphs
10:40 – 10:55	Coffee
10:55 – 11:30	**Tuan Tran**—A random version of Erdős-Ko-Rado theorem
11:45 – 12:20	**Moritz Firsching**—Solving system of polynomial equations with integer relation algorithms
12:35 – 13:40	Lunch
13:40 – 14:30	Free time
14:30 – 15:05	**Mohsen Rezapour**—On the integrality gap of the connected facility location with buy-at-bulk edge costs problem
15:20 – 15:55	**Veit Wiechert**—Order dimension and cover graphs
16:10 – 16:25	Coffee
16:25 – 17:00	**Kevin Schewior**—New results on online resource minimization
17:15 – 17:50	**Alexey Pokrovskiy**—Connectedness in tournaments
18:05 – 19:00	Dinner
19:00 – 20:00	Faculty meeting

Saturday, 18th October 2014.

8:00 – 9:00	Breakfast
9:00 – 9:35	**Katharina Jochemko**—Positivity and monotonicity of translation-invariant valuations
9:50 – 10:25	**Roman Rischke**—Scheduling with reservation cost
10:40 – 10:55	Coffee
10:55 – 11:30	**Ágnes Cseh** —Algorithmic results on the student-project allocation problem
11:45 – 12:20	**Philip Brinkmann**—Flag vector spaces of polytopes, spheres and Eulerian lattices
12:35 – 13:40	Lunch
13:40	Leave

Venue and transport details.

We will be staying in "Park Hotel, Trebbin" `http://www.parkhotel-trebbin.de/`.

Trains run hourly from Berlin. Here are two possible trains you could get on Thursday in order to arrive on time.

- 13:16 Hauptbahnhof (Südkreuz 13:24) – 13:45 Trebbin Bahnhof
- 14:16 Hauptbahnhof (Südkreuz 14:24) – 14:46 Trebbin Bahnhof

The cheapest possibility is buying a group ticket (2,70 EUR instead of 4,10 EUR per person, single). It is available at the ticket machine or the counter and can be bought directly before leaving. The minimum of the group is 5 persons. To get to the hotel from Trebbin Bahnhof, walk along Parkstraße for 5 minutes.

It can also be an option to cycle from Berlin if the weather is nice. Contact Ágnes Cseh if you are interested (`csagnes@msn.com`).

Talks will be 35 minutes each with a 15 minute period after each talk for questions and discussion.

Abstracts

Nimrod Talmon—The Complexity of Degree Anonymization by Vertex Addition.

Thursday, 15:30 – 16:05.
Motivated by applications in privacy-preserving data publishing, I will speak about the problem of making an undirected graph k-anonymous by adding few vertices (together with incident edges). That is, after adding these "dummy vertices", for every vertex degree d in the resulting graph, there shall be at least k vertices with degree d. We explore three variants of vertex addition (justified by real-world considerations) and study their (parameterized) computational complexity. We derive mostly (worst-case) intractability results, even for very restricted cases (including trees or bounded-degree graphs) but also obtain a few encouraging fixed-parameter tractability results.

Francesco Grande—A sneak preview of 2-level matroids.

Thursday, 16:20 – 16:55.
The Theta rank of a finite point configuration V is the maximal degree necessary for a sum-of-squares representation of a non-negative linear function on V. This is an important invariant for polynomial optimization that is in general hard to determine. I will consider a class of 0/1-point configurations arising from matroids and study their Theta rank by looking at the geometry of the configuration, more precisely its levelness. Indeed the matroids with (minimal) Theta rank= 1 are exactly the 2-level matroids, a generalization of the well-known series-parallel graphs. These matroids reveal other significant minimality properties: positive semidefinite rank, generation degree. Furthermore they have a very peculiar decomposition in uniform matroids that makes them particularly suitable for enumeration. In the talk I will present an overview on the many interesting aspects of 2-level matroids together with some derived results and possible developments. This is going to be a warm-up for what I will be talking about at the MDS colloquium on November 10th.

Heuna Kim—Congruence Testing of Two Point Sets in High Dimensions.

Thursday, 17:25 – 18:00.
The congruence testing problem for two point sets is the problem that decides if two point sets in the d-dimensional Euclidean space are the same up to rotations and translations. Although the problem is sensitive for numerical errors, since matching point sets within ε errors are shown to be NP-hard, we restrict our concerns to the exact case using Real Random-Access Machine(Real-RAM) model.

In general, the problem is shown to be $\Omega(n \log n)$ and, for two and three dimensional cases, there are known $O(n \log n)$ algorithms due to Manacher and Atkinson.

It has been conjectured that $O(n \log n)$ algorithms should exist for any dimensions and there have been a series of results for high-dimensional cases. The best known algorithm by Brass et al. achieves $O(n^{\lceil d/3 \rceil} \log n)$ in d-dimensional space. This bound is an improvement of Alt et al., whose complexity is $O(n^{d-2} \log n)$ and Matoušek, $O(n^{\lceil d/2 \rceil} \log n)$. We are working on improving the algorithmic complexity in 4-dimensional space.

This is joint work with Günter Rote.

Yannik Stein—Approximating the Colorful Carathéodory Theorem.

Thursday, 18:15 – 18:50.
Let $P_1, \ldots, P_{d+1} \subset \mathbb{R}^d$ be point sets whose convex hulls each contain the origin. Each set represents a color class. The *Colorful Carathéodory theorem* guarantees the existence of a *colorful choice*, i.e., a set that contains exactly one point from each color class, whose convex hull also contains the origin. So far, the computational complexity of computing such a colorful choice is unknown and thus approximation algorithms are of interest.

We consider a new notion of approximation: a set C' is called an *m-colorful choice* if it contains at most m points from each color class. We show that for all constant $\varepsilon > 0$, an $\lceil \varepsilon(d+1) \rceil$-colorful choice containing the origin in its convex hull can be found in polynomial time.

Joint work with W. Mulzer.

Codruţ Grosu—On Turán densities of hypergraphs.

Friday, 9:00 – 9:35.
The study of Turán densities of hypergraphs goes back to the original paper of Turán from 1941. Although much progress has been made, many basic questions remain open. In the case of graphs, it is a consequence of the Erdős-Stone-Simonovits theorem that any Turán density is of the form $1 - \frac{1}{r}, r \geq 1$. We will explain how this statement can be interpreted algebraically, and how in this form it generalizes to all hypergraphs.

Udo Hoffmann—Slopes of segment intersection graphs.

Friday, 9:50 – 10:25.
I will show that it is NP-hard to determine the minimal number of slopes that is required to draw a segment representation of a segment intersection graph. As a side product we obtain new proofs for the NP-hardness of the recognition of grid, segment and pseudosegment graphs. We show as well, that the minimal number of slopes of a segment graph can drop arbitrarily upon the removal of a single vertex.

Tuan Tran—A random version of Erdős-Ko-Rado theorem.

Friday, 10:55 – 11:30.

Given natural numbers n, k with $2 \leq k < n/2$. We write $\binom{[n]}{k}$ for the family of all subsets of size k of $[n] := \{1, 2, \ldots, n\}$. The Kneser graph $K(n, k)$ is the graph whose vertex set is $\binom{[n]}{k}$ where two k-sets $A, B \in \binom{[n]}{k}$ are adjacent if and only if $A \cap B = \emptyset$. The celebrated theorem of Erdos-Ko-Rado from 1961 says that every independent set in $K(n, k)$ has size at most $\binom{n-1}{k-1}$, and the only independent sets of this size are stars.

For $p = p(n) \in [0, 1]$, let $K_p(n, k)$ be the random subgraph of $K(n, k)$ obtained by retaining each edge of $K(n, k)$ independently with probability p. In this paper we are interested in the following question:

Given $2 \leq k = k(n) < n/2$, for what function $p = p(n) \in [0, 1]$ is $\alpha(K_p(n, k)) = \binom{n-1}{k-1}$ with high probability? Here $\alpha(K_p(n, k))$ denote the size of the largest independent set in $K_p(n, k)$. (Note that Erdős-Ko-Rado theorem corresponds to the case when $p = 1$.)

This question was investigated by Bollobás, Narayanan and Raigorodskii (2014). We extend their result showing the following statement.

Theorem 0.1. *There exists a constant $d > 0$ such that the following holds. Given a positive ε and let $k = k(n)$ be a natural number with $2 \leq k \leq dn$. Let $p_c = \frac{\log\left(n\binom{n-1}{k}\right)}{\binom{n-k-1}{k-1}}$, then*

$$\mathbb{P}\left(\alpha(K_p(n,k)) = \binom{n-1}{k-1}\right) \to \begin{cases} 1 & \text{if } p \geq (1+\varepsilon)p_c \\ 0 & \text{if } p \leq (1-\varepsilon)p_c. \end{cases}$$

Moreover, if $p \geq (1 + \varepsilon)p_c$ then the maximum independent sets are the stars.

This is a joint work with Shagnik Das.

Moritz Firsching—Solving system of polynomial equations with integer relation algorithms.

Friday, 11:45 – 12:20.

Many questions in Discrete Geometry can be phrased as a system of polynomial equations with integer coefficients. Sometimes one can obtain numerical approximations to a solutions of those system of equations. We present a method to find exact solutions given a numerical solution with very high precision. The method is a straightforward application of integer relation algorithms.

Mohsen Rezapour—On the Integrality Gap of the Connected Facility Location with Buy-at-Bulk Edge Costs Problem.

Friday, 14:30 – 15:05.

In the connected facility location with buy-at-bulk edge costs problem we are given a graph connecting clients and potential facilities, a core cable type of infinite capacity, and several access cable types with decreasing cost per capacity ratio. The task is to open some facilities, connect them by a Steiner tree of core cables, and build a forest network of access cables such that the edge capacities suffice to route all client demands to the open facilities. The objective is to minimize the total cost of opening facilities and installing core and access cables. This combined facility location network design problem arises widely, for example, in the planning of telecommunication networks. We present an IP formulation for this problem, and show that its integrality gap is constant, obtaining an $O(1)$-approximation algorithm for the problem.

This is joint work with Jose A. Soto.

Veit Wiechert—Order Dimension and Cover Graphs.

Friday, 15:20 – 15:55.

In this talk we give an introduction to the dimension of partial orders, that was first studied by Dushnik and Miller in 1941, and survey the most important results about dimension since then. Furthermore we focus on recent developments, which reveal relations between structural graph properties of a partial orders cover graph and its dimension. Own results are presented in the cases that the cover graph of a poset has tree-width 2 or path-width 2, respectively.

Kevin Schewior—New Results on Online Resource Minimization.

Friday, 16:25 – 17:00.

We consider the online resource minimization problem in which jobs with hard deadlines arrive online over time at their release date. The task is to determine a feasible schedule on a minimum number of machines. Apart from the analysis of some restricted cases, we present an $O(\log n)$-competitive algorithm for the preemptive online problem. This is the first improvement on a $O(\log(p_{max}/p_{min}))$-competitive algorithm that Phillips et al. (STOC 1997) gave for a semi-online variant in which the optimal number of machines is known in advance. Our algorithm maintains a dynamic partition of the job set and schedules each (temporal) subset individually on separate sets of machines.

The key is a characterization of how the decrease in the relative laxity of jobs influences the optimum number of machines. To achieve this we derive a compact expression of the optimum value, which might be of independent interest. We complement our main algorithmic result by showing lower bounds that rule out that other known algorithms may yield a similar performance guarantee. This is joint work with Lin Chen and Nicole Megow.

Alexey Pokrovskiy—Connectedness in Tournaments.

Friday, 17:15 – 17:50.
A (possibly directed) graph is k-linked if for any two disjoint sets of vertices $x_1, ..., x_k$ and $y_1, ..., y_k$ there are vertex disjoint paths $P_1, ..., P_k$ such that P_i goes from x_i to y_i. A theorem of Bollobás and Thomason says that every $22k$-connected (undirected) graph is k-linked. It is desirable to obtain analogues for directed graphs as well. Although Thomassen showed that the Bollobás-Thomason Theorem does not hold for general directed graphs, he proved an analogue of the theorem for tournaments - there is a function $f(k)$ such that every strongly $f(k)$-connected tournament is k-linked. The bound on $f(k)$ was reduced to $O(k \log k)$ by Kühn, Lapinskas, Osthus, and Patel, who also conjectured that a linear bound should hold. We'll talk about the ideas behind a proof of this conjecture, that every strongly 452k-connected tournament is k-linked.

Katharina Jochemko—Positivity and monotonicity of translation-invariant valuations.

Saturday, 9:00 – 9:35.
For a lattice polytope P and a natural number n the function counting lattice points in nP is given by a polynomial $Ehr(n)$ in n – the Ehrhart polynomial. Motivated by applications in algebra and combinatorics, the problem of characterizing Ehrhart polynomials has received considerable attention. A fundamental result in this direction was obtained by Stanley who showed with methods from commutative algebra that the entries of the Ehrhart h^*-vector are always positive integers and fulfill a monotonicity property. In this talk we will consider h^*-vectors for general translation-invariant valuations. We show that positivity and monotonicity are, in fact, equivalent and we give a simple characterization of valuations with these properties. For real-valued valuations, the h^*-nonnegative valuations form a convex cone. We discuss situations in which this cone is polyhedral. We further apply our results to solid-angle and Steiner polynomials. This is joint work with Raman Sanyal.

Roman Rischke—Scheduling with Reservation Cost.

Saturday, 9:50 – 10:25.
We consider a natural generalization of classical scheduling problems in which using a time slot on a machine for processing a job causes a certain time-dependent cost in addition to the standard scheduling cost. Such a model can be motivated by scheduling jobs in data centers with time-varying electricity costs or with time-varying spot-prices on resources. Adding the cost consideration to classical scheduling prob- lems increases the complexity significantly.

In the talk we will focus on preemptive single machine scheduling so as to minimize the sum of weighted completion times plus the total machine-reservation cost. We present a pseudo-polynomial time approximation scheme for this problem, which improves upon the currently best known 4-approximation algorithm.

This is joint work with Lin Chen, Nicole Megow, Leen Stougie, and José Verschae.

Ágnes Cseh —Algorithmic results on the student-project allocation problem.

Saturday, 10:55 – 11:30.
Abstract: Imagine a project-based university course, where our task is to assign students to projects they will enjoy to work on. In the student-project allocation problem, or shorter, SPA, each student submits a list of their acceptable projects, and likewise, each lecturer provides a set of acceptable students to each of their projects. Moreover, some projects are equipped with upper and lower quotas regarding the number of students assigned to them. The quota requirement is strict: projects not reaching their lower quotas must be closed entirely. The challenge is to find a b-matching assigning the highest number of students.

The heuristics investigated by Kwanashie, Irving, Manlove and Sng are already in use at the University of Glasgow. Our theoretical contribution is a joint work with Ashwin Arulselvan, David Manlove and Jannik Matuschke.

Philip Brinkmann—Flag Vector Spaces of Polytopes, Spheres and Eulerian Lattices.

Saturday, 11:45 – 12:20.
This seminar deals with open questions concerning the flag vector spaces of polytopes, strongly regular spheres and Eulerian lattices. These are natural generalizations of polytopes, since polytope boundaries are strongly regular spheres, and the faces of polytopes and spheres form Eulerian lattices. The open questions discussed concern characteristics and description of the flag vector spaces that belong to these objects. Especially the question will be raised, whether there is an Eulerian lattice that has a flag vector which is not the flag vector of a sphere; or whether there is a sphere with a flag vector which is not the flag vector of a polytope. Since these relations are known for lower dimensions, the focus of the talk will be on dimensions $d \geq 4$.