MDS Statusworkshop 2015

Friday, October 30 – Saturday, October 31

Venue and Transportation

The venue is the hotel Haus Chorin (`http://www.chorin.de`) situated in Chorin, a municipality located about 50 km north east from the center of Berlin and within a biosphere reserve. Besides coffee breaks, the hotel will also provide dinner on October 30 as well as breakfast and lunch on October 31. Beverages for dinner, at night, and for lunch are at your own expense.

The hotel is quite well accessible via public transport (15–20 minutes walk from the train station in Chorin). The proposed routes starting/ending at Berlin Central Station are:

- Berlin to Chorin on Friday, October 30: regional train leaving (presumably at platform 5) on 13:33pm and arriving on 14:16pm (`https://goo.gl/maps/vqbvnTHa2s62`).
- Chorin to Berlin on Saturday, October 31: regional train leaving on 14:44pm and arriving on 15:30pm (`https://goo.gl/maps/GehGBeA2PGH2`).

When using public transport, the cheapest option is separate single-ride tickets for every person, which are €8.40 each. This is independent of whether you have a semester ticket or not. The students can reimburse it the usual way via MDS (whereas the hotel will be paid directly by MDS).

Schedule

The workshop starts on October 30 after lunch and ends on October 31 after lunch. There will be ten talks, each taking 30 minutes. Additional 10 minutes per talk are reserved for questions. Apart from that, there will be two coffee breaks lasting 30 minutes each. At night, the room *"Der rote Salon"* is reserved for us.

Friday, October 30.

Time	Event
3:10pm	**Veit Wiechert.** *Sparsity and dimension.*
3:50pm	**Heuna Kim.** *Embedding of geometric structures.*
4:30pm	Coffee Break
5:00pm	**Julie Meißner.** *A randomized algorithm for MST with uncertainties.*
5:40pm	**Codruţ Grosu.** *The Towers of Hanoi puzzle with more pegs.*
6:20pm	**Nimrod Talmon.** *Manipulating elections in social networks.*
7:10pm	Dinner

Saturday, October 31.

Time	Event
8:00am	Breakfast and Check out (possible until 10am)
9:00am	**Kevin Schewior.** *Chasing convex bodies and functions.*
9:40am	**Philip Brinkmann.** *The first example of a sphere with a flag vector that is not the flag vector of a polytope.*
10:20am	**Tuan Tran.** *The number of colourings without monochromatic disjoint pairs.*
11:00am	Coffee Break
11:30am	**Jan Hofmann.** *The finiteness threshold width of lattice polytopes.*
12:10pm	**Yannik Stein.** *Time-space trade-offs for triangulations and Voronoi diagrams.*
1:00pm	Lunch

Abstracts

Veit Wiechert. *Sparsity and Dimension.*
Friday, 3:10pm–3:40pm

This talk is about connections between the dimension of a poset and structural graph properties of its cover graph. Specifically, we want to study the type of sparseness for cover graphs that imposes small dimension on posets.

A classic construction by Kelly shows that posets with planar cover graphs can have arbitrarily large dimension. However, in a series of positive results it was shown that posets have dimension bounded in terms of their height whenever their cover graph is planar, has bounded tree-width, or more generally excludes some fixed graph as a minor.

We generalize all these results and show that posets of bounded height whose cover graphs belong to a fixed class with bounded expansion have bounded dimension. Bounded expansion, introduced by Nešetřil and Ossona de Mendez as a model for sparsity in graphs, is a property that is naturally satisfied by a wide range of graph classes, from graph structure theory (graphs excluding a minor or a topological minor) to graph drawing (e.g. graphs with constant book thickness). We also show that the result is in a sense best possible, as it does not extend to nowhere dense classes; in fact, it already fails for cover graphs with locally bounded treewidth.

This is a joint work with Gwenaël Joret and Piotr Micek.

Heuna Kim. *Embedding of Geometric Structures.*
Friday, 3:50pm–4:20pm

This talk will provide a brief overview of new results related to the following (independent) questions:

1. Is it possible to embed a closed curve or a sphere in Euclidean space when some conditions on its orthogonal projection is given?
2. How many convex hulls do exist when a line arrangement is given and each vertex of the convex hulls should be embedded in each line from the line-arrangement?
3. Can we decide in polynomial time if we can disjointly embed the maximum number of line segments in some container only by translation when a collection of line segment is given?

Julie Meißner. *A Randomized Algorithm for MST with Uncertainties.*
Friday, 5:00pm–5:30pm

We study a network design model where uncertain data is given in the form of intervals and exact data can be explored at a cost. The goal is to find the optimal network minimizing the exploration cost. For the minimum spanning tree problem with uncertainties we will present the first randomized algorithm that improves upon the known 2-competitive deterministic algorithms that are tight. We achieve a competitive ratio of roughly 1.707 in expectation.

Codruţ Grosu. *The Towers of Hanoi Puzzle with more Pegs.*
Friday, 5:40pm–6:10pm

The *Towers of Hanoi* problem with p pegs is a well-known variation on the classic puzzle of É. Lucas with 3 pegs. The question of determining the minimum number of moves needed to solve the puzzle in general is a long-standing open problem. Only recently a complete solution of the case $p = 4$ has been obtained by Bousch.

In my talk I will describe an asymptotic improvement on the best known lower bound for the minimum number of moves needed when $p \geq 5$. My proof uses some of the ideas introduced by Bousch, which given time, I will try to explain.

Nimrod Talmon. *Manipulating Elections in Social Networks.*
Friday 6:20pm–6:50pm

I will discuss the computational complexity of several combinatorial problems which model the possibility of manipulating elections in the presence of social networks. For these problems an election is given, which is composed of a set of candidates and a collection of voters, and an external agent can perform operations in order to change the outcome of the election. According to social networks which connect either the candidates or the voters in the election, the external agent is able to change the set of voters or candidates which will participate in the election, or to change the way some voters vote. It turns out that these problems are NP-hard in general, thus several parameterizations and special cases are considered, sometimes allowing (exact and approximate) efficient algorithms.

Kevin Schewior. *Chasing Convex Bodies and Functions.*
Saturday, 9:00am–9:30am

This talk first deals with convex-body chasing. In this problem, the input is an online sequence of convex bodies in d-dimensional Euclidean space. The online algorithm starts in the origin and, in response to a body, it has to move to some destination point inside the body. The cost is the total distance moved.

The problem is trivial for $d = 1$. For $d = 2$, I first discuss the sub-problem where all convex bodies are lines. The first $\mathcal{O}(1)$-competitive algorithm is due to Friedman and Linial (1993). I present a simpler such algorithm along with an also simple analysis. For arbitrary but fixed d, this is then generalized to an $\mathcal{O}(1)$-competitive algorithm for chasing affine linear subspaces of any dimension. Friedman and Linial, on the other hand, generalized their algorithm to a general one for $d = 2$ (also 1993).

In the second part of the talk, I discuss the generalization of the above problem to convex functions over the whole space instead of convex bodies (i.e., convex functions mapping to $\{0, \infty\}$). As a response to a function, the algorithm can now respond by moving to an arbitrary position in the entire space but it additionally has to pay the function value at the destination point.

The latter problem is not trivial any more for $d = 1$. For this special case, I review known results such as the first $\mathcal{O}(1)$-competitive algorithm due to Lin et al. (2011). I then present a new improvement on the competitive ratio and a new best lower bound on it. Leveraging the above results and techniques for convex-body chasing, we obtain the first $\mathcal{O}(1)$-competitive algorithm for convex-function chasing with $d = 2$.

The results are from different papers and were obtained in collaboration with Antonios Antoniadis, Nikhil Bansal, Neal Barcelo, Anupam Gupta, Ravishankar Krishnaswamy, Michael Nugent, Kirk Pruhs, and Michele Scquizzato, and Cliff Stein.

Philip Brinkmann. *The First Example of a Sphere with a Flag Vector that is not the Flag Vector of a Polytope.*
Saturday, 9:40am–10:10am

This talk deals with the sets of flag vectors of convex 4-polytopes and 3-spheres. After a short introduction to the main concepts, we will show that these sets differ. In particular, we will examine a 3-sphere W_{12}^{40} with flag vector $(f_0, f_1, f_2, f_3; f_{02}) = (12, 40, 40, 12; 120)$: We will show its non-polytopality via oriented matroids and its uniqueness with the given flag vector via a complete enumeration of 2s2s 3-spheres with up to 12 vertices. To complete the picture, we will further examine other properties of this sphere.

This is joint work with G. M. Ziegler.

Tuan Tran. *The Number of Colourings without Monochromatic Disjoint Pairs.*
Saturday, 10:20am–10:50am

A family $\mathcal{F}$ is said to be *intersecting* if $F_1 \cap F_2 \neq \emptyset$ for every $F_1, F_2 \in \mathcal{F}$. The Erdős-Ko-Rado theorem states that if $n > 2k$ and $\mathcal{F} \subset \binom{[n]}{k}$ is intersecting, then $|\mathcal{F}| \leq \binom{n-1}{k-1}$. Taking all k-sets through a point (known as a *star*) shows that this bound is best possible. In this talk we consider an extension of the

Erdős-Ko-Rado theorem proposed by Hoppen, Kohayakawa and Lefmann.

Given a family $\mathcal{F} \subset \binom{[n]}{k}$, we denote by $c(\mathcal{F}, r)$ the number of colourings of sets in $\mathcal{F}$ with r colours such that each colour class forms an intersecting family. As observed by Hoppen, Kohayakawa and Lefmann, the Erdős-Ko-Rado theorem is equivalent to the following statement.

Statement. Suppose $n > 2k$, then $c(\mathcal{F}, 2) \leq 2^{\binom{n-1}{k-1}}$ for every family $\mathcal{F} \subset \binom{[n]}{k}$.

When colourings with three colours are considered, Hoppen, Kohayakawa and Lefmann (2012) proved the following theorem.

Theorem. Let n and k be positive integers with $n \geq Ck^3$ for sufficiently large C. Then $c(\mathcal{F}, 3) \leq 3^{\binom{n-1}{k-1}}$ for every $\mathcal{F} \subset \binom{[n]}{k}$. Moreover, the equality holds if and only if $\mathcal{F}$ is a star.

In the talk I will show that the same conclusion can be drawn in the case $n \geq 3k + 120 \ln k$. Since $c(\mathcal{F}, 3) = 3^{|\mathcal{F}|}$ for every intersecting family $\mathcal{F}$, our result implies Erdős-Ko-Rado Theorem in this range.

This is a joint work with Dennis Clemens and Shagnik Das.

Jan Hofmann. *The Finiteness Threshold Width of Lattice Polytopes.*
Saturday, 11:30am–noon

We prove that in each dimension d there is a certain width $w^\infty(d)$ such that for each $n \in \mathbb{N}$ all but at most finitely many d-polytopes of size n have width at most $w^\infty(d)$. We call $w^\infty(d)$ the finiteness threshold width and show $d - 3 \leq w^\infty(d) \leq O\left(d^{3/2}\right)$ and $w^\infty(4) = 2$. (Blanco and Santos already proved that $w^\infty(3) = 1$).

Our methods are based on looking closely at lifts of hollow $(d-1)$-polytopes, since the polytopes obtained in this way are the critical case to determine $w^\infty(d)$, by a result of Nill and Ziegler.

Yannik Stein. *Time-Space Trade-offs for Triangulations and Voronoi Diagrams.*
Saturday, 12:10am–12:40am

Let S be a planar n-point set. A *triangulation* for S is a maximal plane straight-line graph with vertex set S. The *Voronoi diagram* for S is the subdivision of the plane into cells such that each cell has the same nearest neighbors in S. Classically, both structures can be computed in $O(n \log n)$ time and $O(n)$ space. We study the situation when the available workspace is limited: given a parameter $s \in \{1, \ldots, n\}$, an s-workspace algorithm has read-only access to an input array with the points from S in arbitrary order, and it may use only $O(s)$ additional words of $\Theta(\log n)$ bits for reading and writing intermediate data. The output should then be written to a write-only structure. We describe a deterministic s-workspace algorithm for computing a triangulation of S in time $O(n^2/s + n \log n \log s)$ and a randomized s-workspace algorithm for finding the Voronoi diagram of S in expected time $O((n^2/s) \log s + n \log s \log^* s)$.

Joint work with Matias Korman, Wolfgang Mulzer, André van Renssen, Marcel Roeloffzen, and Paul Seiferth.