MDS Statusworkshop 2013

The *Methods for Discrete Structures* anual statusworkshop will start on the afternoon of *Thursday, January 24th, 2013* and it will end at noon of *Saturday, January 26th, 2013*. The seminar will take place at *Hotel Chorin* (`http://www.chorin.de`). For instructions on how to get there, see the following page `http://www.chorin.de/de/anreise-lage/anreise-lage.php`.

There will be 15 talks. Each talk will be 35 minutes long, followed by 15 minutes of questions and discussion. Breakfasts, lunches, coffee breaks and dinner will be provided by the hotel.

In the evenings, the group is welcome to use the *Bienenwiese* a room in the restaurant *Zur Immenstube* `http://www.hotel-haus-chorin.de/immenst.htm`. Drinks will be served.

Schedule

Thursday

15:30 – 16:00	**Coffee and Cake**
16:00 – 16:35	**Karim Adiprasito**. *Morse theories for stratified spaces and minimality of arrangements.*
16:50 – 17:25	**Moritz Firsching**. *Fair convex partitions: the state of the art.*
17:40 – 18:15	**Francesco Grande**. *Point configurations with low theta-rank.*
18:30 – 19:30	**Dinner**
19:30	**Faculty Meeting**

Friday

08:00 – 09:00	**Breakfast**
09:00 – 09:35	**Udo Hoffmann**. *Diagonal hook/stick graphs and paths in outerplanar graphs.*
09:50 – 10:25	**Konstantinos Stavropoulos**. *On a certain type of tree-decompositions.*
10:40 – 10:55	**Coffee Break**
10:55 – 11:30	**Lothar Narins**. *Extremal 3-graphs for Ryser's conjecture.*
11:45 – 12:20	**Hao Chen**. *On the ball-packability of graph joins.*
12:35 – 13:40	**Lunch**
13:40 – 14:15	**Mohsen Rezapour**. *Approximating connected facility location with buy-at-bulk edge costs via random sampling.*
14:30 – 15:05	**Philipp von Falkenhausen**. *Coarse correlated equilibria in atomic splittable routing.*
15:20 – 15:35	**Coffee Break**
15:35 – 16:10	**Ágnes Cseh**. *Stability in networks.*
16:25 – 17:00	**Kai-Simon Goetzmann**. *Theory and practice of multicriteria optimization.*
17:15 – 17:50	**José Soto**. *Constrained symmetric submodular function minimization.*
18:05 – 19:30	**Dinner**

Saturday

08:00 – 09:00	**Breakfast**
09:00 – 09:45	**Codrut Grosu**. *Higher inclusion matrices of hypergraphs.*
09:50 – 10:35	**Manh Tuan-Tran**. *Random graph polytopes.*
10:40 – 10:55	**Coffee Break**
10:55 – 11:30	**Katharina Jochemko**. *Counting lattice points in Minkowski-sums of polytopes – towards a multivariate Ehrhart-Macdonald reciprocity.*
11:45 – 12:00	**End**

Abstracts MODS Statusworkshop 2013

1. **Karim Adiprasito** (Student, FU-Berlin). *Morse Theories for Stratified Spaces and Minimality of Arrangements.*

   We prove that the complement of any affine 2-arrangement in $\mathbb{R}^d$ is minimal, that is, it is homotopy equivalent to a cell complex with as many i-cells as its i-th Betti number. To this end, we prove that the Björner–Ziegler complement complexes, induced by combinatorial stratifications of any essential 2-arrangement, admit perfect discrete Morse functions. Our results extend previous work by Falk, Dimca–Papadima, Hattori, Randell and Salvetti–Settepanella, among others.

2. **Moritz Firsching** (Student, FU-Berlin). *Fair Convex Partitions: the State of the Art.*

   There are many results about convex partitions of absolutely continuous probability measure in $\mathbb{R}^d$ into k convex pieces. The classical Ham Sandwich Theorem is one example: Any d such measures can be partitioned simultaneously into 2 convex pieces of equal size, i.e. cut by a hyperplane. This talk is an overview of what is known about (fair) convex partitions with a focus on topological methods and why some of these methods fail when the number of pieces is not a prime power. In this context we investigate how iterating the partitioning can help.

3. **Francesco Grande** (Student, FU-Berlin). *Point Configurations with Low Theta-rank.*

   In the context of linear optimization, I will consider the case in which the collection of extreme points of the feasible region is given by algebraic data. The approach I'm going to present is to transform the linear optimization problem into a semidefinite programming problem (SDP). The size and performance of the SDP-approach depend on the geometry of the point configuration (rather than the number of points). The theta-rank, which measures the performance, is difficult to determine even for "combinatorially nice" point configurations. I will introduce two matroid families whose associated ideal has small theta rank.

4. **Udo Hoffmann** (Student, TU-Berlin). *Diagonal Hook/Stick Graphs and Paths in Outerplanar Graphs.*

   Diagonal hook graphs are intersection graphs of rectangular axis aligned rectangles in the plane where the left upper corner is attached to a diagonal line. Considering horizontal and vertical line segments instead of boxes where one endpoint is attached to the diagonal defines diagonal stick graphs. This talk will introduce properties and characterisations as well as open problems of those graph classes. A characterisation of diagonal stick graphs gives a connection to intersection graphs of certain paths in outerplanar graphs. This leads to the problem of recognising intersection graphs of paths in outerplanar graphs in general.

5. **Konstantinos Stavropoulos** (Student, HU-Berlin). *On a Certain Type of Tree-Decompositions.*

   Treewidth has been a very important notion in both structural and algorithmic Graph Theory. We will discuss a certain type of tree-decompositions that have remarkable properties and add some perspective on treewidth in general.

6. **Lothar Narins** (Student, FU-Berlin). *Extremal 3-Graphs for Ryser's Conjecture.*

   Ryser's Conjecture states that any r-partite r-uniform hypergraph has a vertex cover of size at most $r-1$ times the size of the largest matching. For $r=2$, the conjecture is simply König's Theorem. It has also been proven for $r=3$ by Aharoni using topological methods. Our ambitious goal is to try to extend Aharoni's proof to $r=4$. We are currently still far from this goal, but we start by characterizing those hypergraphs which are tight for the conjecture for $r=3$. Our proof of this characterization is also based on topological machinery, particularly utilizing results on the (topological) connectedness of the independence complex of the line graph of a graph. Joint work with Penny Haxell and Tibor Szabó.

7. **Hao Chen** (Student, FU-Berlin). *On the Ball-packability of Graph Joins.*

   A graph is ball-packable if it can be realized as the tangency relations of a ball-packing in a given dimension. We study in this talk the ball-packability of some small graphs that can be written in the form of graph joins. This is then used to characterise the ball-packability of the 1-skeletons of stacked 4-polytopes.

8. **Mohsen Rezapour** (Student, TU-Berlin). *Approximating Connected Facility Location with Buy-at-Bulk Edge Costs via Random Sampling.*

   We consider a generalization of the connected facility location problem where the clients must be connected to the open facilities via shared capacitated (tree) networks instead of independent shortest paths. This problem arises in the planning of fiber optic telecommunication access networks, for example. Given a set of clients with positive demands, a set of potential facilities with facility opening costs, and available cable capacity types, one has to decide which facilities to open, how to interconnect them using a Steiner tree of infinite capacity, and which access cable types to install on which potential edges such that the installed capacities suffice to simultaneously route the entire demand of each client to an open facility via a single path. The objective is to minimize the total cost of opening facilities, building the core Steiner tree among them, and installing the access cables. In this talk, we present an improved approximation algorithm for this problem based on random sampling technique.

   This is joint work with Andreas Bley.

9. **Philipp von Falkenhausen** (Student, TU-Berlin). *Coarse Correlated Equilibria in Atomic Splittable Routing.*

   Algorithmic Game Theory employs a range of equilibrium concepts. Narrow concepts (pure, mixed Nash) have the drawback that they are hard to compute and may not exist in a particular game. Broader concepts – such as the coarse correlated equilibrium – don't have these drawbacks and incorporate more real-world characteristics, for example they can be 'learned' if each agent uses a learning algorithm to choose his strategy.

   In the first part of the talk, I give an introduction to such equilibria. Then, I analyze coarse correlated equilibria in atomic splittable routing games. I show an efficiency guarantee (POA = 3/2) that is as good as previously know tight guarantees for pure, mixed and correlated equilibria.

10. **Ágnes Cseh** (Associate Student, TU-Berlin). *Stability in Networks.*

    The well-known notion of stable matchings can be extended in several interesting ways, one of them operates with network flows. We talk about stability when there is no pair of vendors who mutually want to change the current flow. In this talk, we will see algorithms to find such flows and sketch problems related to max flows, flows over time and uncoordinated markets.

11. **Kai-Simon Goetzmann** (Student, TU-Berlin). *Theory and Practice of Multicriteria Optimization.*

    In the first two years of my PhD I have worked on the theoretical properties of compromise and reference point solutions in multicriteria optimization. From September till December last year I stayed with the DECYTEC group of Francisco Ruiz in Malaga to look at practical applications of these methods. In this talk I will present you some of the things I've done there and share my insights. In the first part, I will talk about the application of reference point methods to calculate synthetic sustainability indicators. The second part will be about the evaluation and comparison of genetic algorithms for multicriteria optimization by pictures, approximation factors and the hypervolume indicator.

12. **José Soto** (Postdoc, TU-Berlin). *Constrained Symmetric Submodular Function Minimization.*

    I will present a simple algorithm to find nonempty minimizers of a symmetric submodular function (SSF) over any family of sets that is closed under inclusion. Using this algorithm we can find, for instance the minimum of all cuts in a graph such that one of the two pieces is planar (or any hereditary property). More generally, given a value oracle for a SSF f and a membership oracle for an hereditary family $\mathcal{I}$, our algorithm reports all the inclusion-wise minimal nonempty minimizers of f in $\mathcal{I}$ using a cubic number of oracle calls. Our algorithm is based on Queyranne's pendent-pair technique for minimizing unconstrained SSF.

    This is joint work with Michel Goemans.

13. **Codrut Grosu** (Student, FU-Berlin). *Higher Inclusion Matrices of Hypergraphs.*

    Let $r \geq s \geq 0$ and G be an r-graph. The higher inclusion matrix $M_s^r(G)$ is a $\{0,1\}$-matrix with rows indexed by edges of G and columns indexed by subsets of $V(G)$ of size s: the entry corresponding to an edge e and a subset S is 1 if $S \subset e$ and 0 otherwise. In this talk I will start by discussing the problem of finding an algebraic analogue of the Kruskal-Katona theorem and how inclusion matrices fit into this picture. Motivated by a question of Frankl and Tokushige and a result of Peter Keevash, I will then define the rank-extremal function $\mathrm{rex}(n,t,r,s)$ as the maximum number of edges of an r-graph G having $\operatorname{rk} M_s^r(G) \leq \binom{n}{s} - t$. For t at most linear in n we have determined this function as well as the extremal r-graphs. I will explain how this result implies the Kruskal-Katona theorem for a certain (but rather modest) range of parameters and how the special case $t = 1$ answers a question of Peter Keevash. As time permits, I will give insights into the proof.

    This is joint work with Yury Person and Tibor Szabó.

14. **Manh Tuan-Tran** (Student, FU-Berlin). *Random Graph Polytopes.*

    Let G be a graph on the vertex set $V(G) = \{1, 2, \ldots, n\}$. The edge polytope $\mathcal{P}(G)$ of G is the polytope generated by all vectors $\mathbf{e}_i + \mathbf{e}_j$ such that i is adjacent to j, where $\mathbf{e}_i$ and $\mathbf{e}_j$ stand for the i-th and j-th unit vectors of $\mathbb{R}^n$. This family of polytopes includes the simplices and the second hypersimplices.

    In the talk we will discuss three topics:

    (1) A description of the low-dimensional faces of $\mathcal{P}(G)$.

    (2) Non-linear relations between the components of the f-vector of $\mathcal{P}(G)$.

    (3) The asymptotic growth rate of the maximum number of facets of d-dimensional edge polytopes.

    It is based on joint work with Günter M. Ziegler.

15. **Katharina Jochemko** (Associate Student, FU-Berlin). *Counting Lattice Points in Minkowski-sums of Polytopes – Towards a Multivariate Ehrhart-Macdonald Reciprocity.*

    Many combinatorial problems, such as counting graph colorings, can be transformed into the problem of counting lattice points in certain polytopes. It is due to Ehrhart that the function $f(n)$ counting lattice points in the n-th dilate of a lattice polytope agrees with a polynomial in n for all positive natural numbers n. More general, for lattice polytopes P and Q in $\mathbb{R}^d$ the function $f(m,n)$ counting lattice points in the Minkowski-sum $mP + nQ$ agrees with a multivariate polynomial in $m, n \geq 1$. By Ehrhart-Macdonald reciprocity $f(-m,-n)$ equals the number of points in the relative interior of $mP + nQ$. We aim at an interpretation for evaluating f at arbitrary points (m,n).