Program for MDS Status Workshop, 2012.

Friday. 10.2.2012.

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17:05 – 17:40	Cost Sharing Protocols for Matroid Congestion Games *Philipp von Falkenhausen*
17:40 – 18:15	Descriptive Complexity of Small Classes *Berit Grussien*
18:15 – 19:30	**Dinner.**
19:30 – 20:05	Models And Algorithms For The Survivable Hop Constrained Connected Facility Location Problem *Mohsen Rezapour*
20:05 – 20:40	Illuminating the space by floodlights *Rafel Jaume*
20:40 – 21:15	Erdös-Szekeres is NP-hard in 3 dimensions *Daniel Werner*

Saturday. 11.2.2012.

9:00 – 9:35	On upper bounds of treewidth that force a large grid minor *Konstantinos Stavropoulos*
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11:00 – 11:35	A weight set decomposition approach for multi-criteria linear programming *Sebastian Schenker*
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12:10 – 13:30	**Lunch.**

13:30 – 14:05	Subword complexes, cluster complexes, and generalized multi-associahedra *Cesar Ceballos*
14:05 – 14:40	The distance geometry for the kissing balls *Hao Chen*
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15:30 – 16:05	Hyperbolic Embeddings and Spanners *Rik Sarkar*

Friday, 10.2.2012.

Demand Allocation Games: Integrating Discrete and Continuous Strategy Spaces

Max Klimm
16:30 – 17:05

We introduce a class of games which we term demand allocation games that combines the characteristics of finite games such as congestion games and continuous games such as Cournot oligopolies. In a strategy profile each player may choose both an action out of a finite set and a non-negative demand out of a convex and compact interval. The utility of each player is assumed to depend solely on the action, the chosen demand, and the aggregated demand on the action chosen. We show that this general class of games possess a pure Nash equilibrium whenever the players' utility functions satisfy the assumptions negative externality, decreasing marginal returns and homogeneity. If one of the assumptions is violated, then a pure Nash equilibrium may fail to exist. We demonstrate the applicability of our results by giving several concrete examples of games that fit into our model. Joint work with Tobias Harks.

Cost Sharing Protocols for Matroid Congestion Games

Philipp von Falkenhausen
17:05 – 17:40

In this talk, we study matroid congestion games from a protocol design perspective. Such games feature a set of resources and a set of players that each choose a subset of the resources that forms the basis of matroid, for instance a spanning tree in a graph. Each resource has load dependent cost and this cost is shared among its users according to a cost sharing protocol. The design of the protocol crucially affects the games equilibrium states and the goal is to devise protocols with cheap outcomes, i.e. good price of anarchy and price of stability. We investigate three classes of protocols and find optimal protocols for two of them, while for the third we show that the price of anarchy is unbounded.

Descriptive Complexity of Small Classes

Berit Grussien
17:40 – 18:15

In descriptive complexity theory the goal is to find logical characterizations for complexity classes, that is, given a complexity class, we want to find a logic that defines exactly all properties of finite structures that are decidable in that complexity class. Most of the research in this area has been focused on the complexity class PTIME, as this approach might be a possible way to solve the well-known Millennium Prize Problem of whether PTIME is equal to NPTIME. For the smaller complexity class LOGSPACE almost nothing is known so far.

A major part of my talk will be to introduce the background and fundamental results in the area. Then I will explain a new logic for LOGSPACE and state some results regarding its expressive power.

Dinner 18:15 – 19:30.

Models And Algorithms For The Survivable Hop Constrained Connected Facility Location Problem

Mohsen Rezapour
19:30 – 20:05

We consider the problem of deploying a broadband telecommunication system field that lays optical fiber cable from a central office to a number of end-customers in a reliable manner. To model the problem, we generalize the Connected Facility Location problem to the case that considers simultaneously both survivability and hop-length constraints between the opened facilities. In this talk, we first present two flow based integer programming formulations for the problem using the layered representation. Afterwards, to solve the problem in practice, we project out the flow variables and generate Benders cuts within a Branch and Cut framework. Finally, we discuss computational results.

Illuminating the space by floodlights

Rafel Jaume
20:05 – 20:40

We consider the problem of given a polyhedral fan in $\mathbb{R}^2$ with n cells that collectively cover the space when placed with apices at the origin and n (different) points, find an assignment of cones to points such that the translated cones still cover the whole space. There is a theorem that guarantees we always can find such assignment and it can be computed in $O(n^3)$ time. For the bidimensional case, there is an optimal $O(nlogn)$ time algorithm. The algorithm can be used in higher dimensions ($\mathbb{R}^d$) if the fan is the projection of a convex cone in $\mathbb{R}^{d+1}$. But already in $\mathbb{R}^3$, not all polyhedral fans come from a polytope in $\mathbb{R}^4$. For instance, the "pinwheel fan" can not because it has a cycle in the in-front/behind relation and this is forbidden by the acycliclity theorem for cell complexes. We give a set of points such that there is no covering assignment. We state a necessary condition that an assignment should satisfy in order to cover the whole space and show that it has a convex cone representation in the space of the coordinates of the points. We show that this condition is not sufficient.

Erdös-Szekeres is NP-hard in 3 dimensions

Daniel Werner
20:40 – 21:15

We consider the computational problem of finding a maximal set of points in convex position among a given set of points. Since the 80s, it is known that in the plane this can be done in polynomial time, while the status of the higher dimensional variants of the problem remained completely unclear. In this talk, we show that already in $\mathbb{R}^3$ it cannot be solved in polynomial time, unless $P = NP$.

Saturday, 10.2.2012.

On upper bounds of treewidth that force a large grid minor

Konstantinos Stavropoulos

9:00 – 9:35

One of the most central concepts of Graph Minor Theory of Robertson and Seymour, which ultimately proves Wagners Conjecture about the structure of minor-closed graph properties, is the notion of treewidth. Treewidth has obtained immense attention ever since, especially because many NP-hard problems can be handled efficiently on graphs of bounded treewidth. In fact, all problems that can be defined in monadic second-order logic are solvable for graphs of bounded treewidth.

The min-max relation between the treewidth of a graph and its largest grid minor is a keystone of the Graph Minor Theory. A lot of algorithmic applications involve the use of a min-max relation of this kind, but the known bounds so far remain large. Besides of its independent interest as a problem, improving such a grid minor result leads to faster fixed-parameter algorithms for two families of graph problems, called minor-bidimensional and contraction-bidimensional parameters, which include feedback vertex set, vertex cover, minimum maximal matching, face cover, a series of vertex-removal parameters, dominating set, edge dominating set, R-dominating set, connected dominating set, connected edge dominating set, connected R-dominating set, and unweighted TSP tour.

On covering expander graphs by Hamilton cycles

Roman Glebov

9:35 – 10:10

The problem of packing Hamilton cycles in random and pseudorandom graphs has been studied extensively. In this paper, we look at the dual question of covering all edges of a graph by Hamilton cycles and prove that if a graph with maximum degree Δ satisfies some basic expansion properties and contains a family of $(1-o(1))\Delta/2$ edge disjoint Hamilton cycles, then there also exists a covering of its edges by $(1+o(1))\Delta/2$ Hamilton cycles. This implies that for every $\alpha 0$ and every $p \geq n^{\alpha-1}$ there exists a covering of all edges of $G(n,p)$ by $(1+o(1))np/2$ Hamilton cycles asymptotically almost surely, which is nearly optimal. Joint work with Michael Krivelevich and Tibor Szabó.

Transversals of bounded-degree graphs

Lothar Narins

10:10 – 10:45

A transversal of an r-partite graph is a choice of one vertex from each part. We are interested in the existence of transversals which induce a subgraph having certain graph properties, such as having connected components of at most a certain size, being forests, or being free of a particular subgraph. The existence of such transversals depends on the maximum degree of the graph, as well as the minimum size of the parts, and the aim is to understand the relationship between these parameters.

Coffee break 10:45 – 11:00.

A weight set decomposition approach for multi-criteria linear programming

Sebastian Schenker
11:00 – 11:35

Given several linear objectives subject to a linear constraint set, one can find so called Pareto optimal solutions (that cannot be improved in one objective without a loss in another objective) by scalarizing the objectives with positive weights. Although the number of Pareto optimal solutions can be exponential in the dimension of the decision space (in the worst case), one has to tackle the problem of finding all Pareto optimal solutions algorithmically. We will present an approach (based on a paper by Benson and Sun) that works in objective space and uses the one-to-one correspondence between a partition of the set of used weights and the extreme Pareto optimal solutions.

Compromise Solutions

Kai-Simon Goetzmann
11:35 – 12:10

In multicriteria optimization, a compromise solution is a feasible solution whose cost vector minimizes the distance to the ideal point w.r.t. a given norm. The coordinates of the ideal point are given by the optimal values for the single optimization problem for each criterion.

We show that the concept of compromise solutions fits nicely into the existing notion of Pareto optimality: For a huge class of norms, every compromise solution is Pareto optimal, and under certain conditions on the norm all Pareto optimal solutions are also a compromise solution, for an appropriate weighting of the criteria. Furthermore, under similar conditions on the norm, the existence of an FPTAS for compromise solutions guarantees the approximability of the Pareto set.

These general results are completed by applications to classical combinatorial optimization problems. In particular, we study approximation algorithms for the multicriteria shortest path problem and the multicriteria minimum spanning tree problem. On the one hand, we derive approximation schemes for both problems, on the other hand we show that for the latter problem simple approaches like local search and greedy techniques do not guarantee good approximation factors.

Lunch 12:10 – 13:30.

Subword complexes, cluster complexes, and generalized multi-associahedra

Cesar Ceballos
13:30 – 14:05

We present a new family of simplicial complexes called multi-cluster complexes. These complexes generalize the concept of cluster complexes, and extend the notion of multi-associahedra to arbitrary finite Coxeter groups. We present combinatorial and geometric properties of these objects, as well as open problems and conjectures. This is joint work with Jean-Philippe Labbé and Christian Stump.

The distance geometry for the kissing balls

Hao Chen
14:05 – 14:40

I will propose a distance function on the set of kissing balls, from which we can construct a matrix that plays a double role at the same time : the Distance matrix, and the Cayley-Menger matrix. This may be a powerful tool in the study of ball packings.

Starshaped embeddings of simplicial complexes

Karim Adiprasito
14:40 – 15:15

I will talk about two old questions of Chillingworth, Lickorish, Goodrick and Kirby. Furthermore, I will discuss applications to PL topology and enumerative combinatorics of the sphere.

Coffee break 15:15 – 15:30.

Hyperbolic Embeddings and Spanners

Rik Sarkar
15:30 – 16:05

We consider the problem of embedding trees into the hyperbolic plane. We show that any tree can be realized as the Delaunay graph of its embedded vertices. Particularly, a weighted tree can be embedded such that the weight on each edge is realized as the hyperbolic distance between its embedded vertices and the distance distortion between non adjacent vertices can be made arbitrarily small – less than a $(1 + \varepsilon)$ factor for any given ε. We will also discuss the question of building spanners for hyperbolic point sets.