

Abstracts of the Annual Workshop 2005

Monday, 09/26/05

1. 9:00-9:40, **Martin Aigner, FU Berlin**

Turning off the Light

2. 9:40-10:10, **Cornelia Dangelmayr, FU Berlin**

Intersection Graphs

Among other constructions with regard to the open question if planar graphs were intersection graphs of Jordan curves in the plane, I will have a look at non planar graphs and forbidden subgraphs of this class of intersection graphs.

3. 10:40-11:10, **Taral Guldahl Seierstad, HU Berlin**

The minimum degree graph process

We consider a random graph process, where edges are added at random in a way to ensure that the minimum degree grows quickly. In this graph process a phase transition occurs, similarly to the standard random graph model, where the largest component grows quickly in a short period of time. Earlier we have found the exact location of the phase transition. We now take a closer look at the phase transition, and consider other problems concerning the graph process, such as the threshold for having a perfect matching or a hamiltonian cycle.

4. 11:10-11:40, **Dirk Schlatter, HU Berlin**

The random planar graph process

We consider the following variant of $G_{n,m}$: Having chosen the next edge u.a.r., only insert it if the graph remains planar. As soon as the edge density is greater than 1, the graph is a.a.s. connected and contains linearly many copies of some fixed planar graph. The first property is in contrast and the second one in accordance with the uniformly random planar graph studied by Gerke, McDiarmid, Steger, and Weißl.

5. 15:30-16:00, **Hubert Chen, HU Berlin**

Beyond Hypertree Width: Decomposition Methods Without Decompositions

The general intractability of the constraint satisfaction problem has motivated the study of restrictions on this problem that permit polynomial-time solvability. One major line of work has focused on structural restrictions, which arise from restricting the interaction among constraint scopes. In this paper, we engage in a mathematical investigation of generalized hypertree width, a structural measure that has up to recently eluded study. We obtain a number of computational results, including a simple proof of the tractability of CSP instances having bounded generalized hypertree width. (Joint work with Victor Dalmau.)

6. 16:00-16:30, **Robert Berke, ETH Zürich**

Transversals on abstract graphs

Let G be a graph and let \mathcal{P} be a partition of $V(G)$ into sets V_1, \dots, V_m . A transversal of \mathcal{P} is a subset T of $V(G)$ for which $T \cap V_i \neq \emptyset$ for all $i \in [m]$. The number $p(d, r)$ denotes the smallest integer such that any d -regular graph with a partition into classes of size at least $p(d, r)$ has a transversal that spans connected components of order at most r . Tight results for $p(d, r)$ are only known if either $r = 1$ or $d = r = 2$.

In this talk I will introduce $\varphi(m, n)$, the smallest integer such that an m -partite graph with vertex-classes of size n exists that does not contain a matching transversal (a transversal spanning connected components of size at most two). Apparently, this number is closely related to $p(d, 2)$. Then I plan to show current results on $\varphi(4, n)$. (This is joint work with Penny Haxell and Tibor Szabó.)

7. 16:30-17:00, **Alantha Newman, TU Berlin**

Aggregating Inconsistent Information: Ranking and Clustering

A ranking of n web pages is to be chosen from outputs of k search engines. How do we choose one ranking minimizing the “disagreement” with the k rankings?

A clustering of n genes is to be chosen from outputs of k clustering algorithms. How do we choose one clustering minimizing the “disagreement” with the k clusterings?

These information aggregation problems date back to 1785, when the French philosophers Condorcet and Borda considered voting systems in which each voter specifies a full ranking of a set of candidates. Recently, their algorithmic and complexity aspects have been studied.

We obtain improved algorithms for both these problems using a remarkably simple principle. Our techniques also apply to related graph optimization problems such as the minimum feedback arc set problem on tournaments and the correlation clustering problem on complete graphs. Additionally, we show that the problem of finding a minimum feedback arc set on tournaments has no polynomial time algorithm, assuming NP is not contained in BPP. This almost settles a long-standing conjecture of Bang-Jensen and Thomassen, that the problem is NP-hard.

This is joint work with Nir Ailon and Moses Charikar (Princeton University).

8. 17:30-18:00, **Sarah Kappes, TU Berlin**

Non-generic Orthogonal Surfaces

Generic orthogonal surfaces are in relation with Scarf-Complexes and are rather well understood. In the non-generic case, when the generating vertices share coordinates, it is much harder to ensure that the complex has nice properties. We have to take care of degenerate situations before we can even determine the elements of the complex in a combinatorial way.

9. 18:00-18:30, **Florian Zickfeld, TU Berlin**

Orthogonal Surfaces - Rigidity and Coplanarity

We investigate the connections of 3-dimensional orthogonal surfaces and Schnyder Woods on 3-connected planar graphs.

A *rigid* orthogonal surface induces a unique planar graph and a Schnyder wood on this graph. Conversely, there is an orthogonal surface associated to every Schnyder wood. The generators of this surface are the face-count vectors of the vertices of the graph/Schnyder wood. The construction implies that all the generating points lie on a plane $x + y + z = \text{const}$. We call the corresponding surface *coplanar*.

We investigate rigid and coplanar orthogonal surfaces. We prove that every coplanar embedding can be obtained by (weighted) face counting. Furthermore we present an example of a Schnyder Wood S , such that a surface carrying S can not be both, coplanar and rigid, simultaneously.

10. 18:30-19:00, **Konstantinos Panagiotou**

New bounds and Models for Paging

The well-known paging problem deals with servicing a sequence of requests in a two-level memory system. One level of this system is the slow memory which stores a fixed set of pages; the other level is a fast memory which is able to store up to k distinct pages. Whenever a certain page is requested, it must be made available in fast memory. If a requested page is not in the fast memory, a page fault occurs and the requested page must be brought to it. The objective is to minimize the number of page faults.

In this talk, we present a new and very general lower bound for the minimum number of page faults needed to service a given request sequence. This bound depends on a parameter of the sequence which we call the characteristic vector. This parameter also enables us to prove a characterization of the number of faults incurred by the Least-Recently-Used (LRU) algorithm.

In addition, we introduce a new adversarial model which captures some notion of locality of reference and variable cache-size. This model enables us to compare the number of faults of a certain algorithm to the optimum number of faults, for any adversarial request sequence on the same cache-size. The performance of an algorithm is measured with the expected competitive ratio. In addition, we provide tight bounds for the performance of the LRU algorithm (up to a constant factor).

This is joint work with Alexander Souza.

Tuesday, 09/27/05

1. 9:00-9:40, **Günter M. Ziegler, TU Berlin**

Combinatorial surfaces, geometric surfaces

Constructions by Heffter (1891) and by Datta (2005) yield combinatorial schemes for closed polyhedral surfaces. However, it is a long way from the combinatorial description via topological classification to geometric realizations of such surfaces.

In this lecture, we will in particular present the (surprisingly simple and explicit) surfaces by Datta, ask lots of questions about them, and connect them to a number of challenging open problems about the maximal “complexity” of polyhedral surfaces in 3-space.

2. 9:40-10:10, **Stephan Hell, TU Berlin**

On the fractional Helly property

Helly’s theorem is a classical theorem in convex geometry: For every finite family F of convex sets in d -dimensional Euclidean space in which every d or fewer sets have a common point we have a point common to the whole family. The fractional Helly theorem for the family convex sets is a deep extension of Helly’s theorem. In my talk, I give an overview on fractional Helly theorems. Then I present a topological fractional Helly theorem, and discuss related problems.

3. 10:40-11:10, **Carsten Schultz, TU Berlin**

Complexes of graph colourings

To a graph G one can assign a cell complex $Hom(G, K_n)$ whose vertices are the n -colourings of G and whose cells correspond to multi-colourings assigning a non-empty set of colours to each vertex of G . These complexes are at the heart of the topological graph colourings theorems by Lovász and by Babson and Kozlov. They are also interesting complexes in their own right. For example Csorba and Lutz have shown that $Hom(C_5, K_4)$, where C_5 denotes the cyclic graph of length 5, is homeomorphic to projective 3-space. We will see that more generally $Hom(C_5, K_{n+2})$ is homeomorphic to the space of unit tangent vectors of the n -sphere as conjectured by Péter Csorba.

4. 11:10-11:40, **Jakob Jonsson, TU Berlin**

Grid Graphs with Periodic Boundary Conditions and Rhombus Tilings of the Plane

Let $T_{m,n}$ be the graph on the vertex set $\mathbb{Z}_m \times \mathbb{Z}_n$ with an edge between (a, b) and (c, d) if and only if either $(a, b) = (c, d \pm 1)$ or $(a, b) = (c \pm 1, d)$ modulo (m, n) . We consider the simplicial complex $\Sigma_{m,n}$ of independent sets in $T_{m,n}$ and present a formula for the Euler characteristic of $\Sigma_{m,n}$. In particular, we show that the unreduced Euler characteristic of $\Sigma_{m,n}$ vanishes whenever m and n are relatively prime, thereby settling a conjecture due to Fendley, Schoutens and van Eerten. For general m and n , we relate the Euler characteristic of $\Sigma_{m,n}$ to certain periodic rhombus tilings of the plane. Using this correspondence, we settle another conjecture due to Fendley et al. about a certain “transfer matrix” associated to $\{\Sigma_{m,n} : n \geq 1\}$.

5. 16:00-16:30, **Esther Moet, Utrecht University**

Combinatorial Complexities of Visibility Maps in 3D

It is generally known, especially in the world of computer graphics, that computations concerning visibility and the generation of shadows are important to obtain realistic images. The visibility or shadow map of a point in a 3D scene, i.e., a set of n triangles in \mathbb{R}^3 , has combinatorial complexity $\Theta(n^2)$ and has been studied extensively. We look at visibility maps of line segments and triangles in 3D; this introduces two new notions of visibility: strong (complete) and weak (partial) visibility. In this talk, I will give several upper and lower bounds on the combinatorial complexity of four different types of visibility maps.

6. 16:30-17:00, **Kevin Buchin, FU Berlin**

On Biased Randomized Incremental Construction

Randomized incremental algorithms construct a data structure by inserting objects one by one in a random order while maintaining the data structure. Biased randomized incremental construction assigns points randomly to rounds of insertion and allows to choose the order within a round freely. We consider biased randomized incremental construction in the context of constructing the Delaunay triangulation of a point set using the space-filling curve heuristic within rounds. In this talk we will focus on the performance on non-uniform point sets or on implementation issues.

7. 17:00-17:30, **Maike Buchin**

Frechet Distance of Curves and Surfaces

I will talk about problems concerning the Frechet distance of curves and surfaces. I will start by giving an overview of what is known and what is open. Then I will focus on two open problems I am interested in: the computability of the Frechet distance between surfaces and how to define an average Frechet distance between curves. I will sketch a proof of the semi-computability of the Frechet distance between surfaces and show the difficulties of defining an average Frechet distance that satisfies the triangle inequality.

8. 18:00-18:30, **Andreas Razen, ETH Zürich**

Counting Satisfying 2SAT Assignments

2SAT, the satisfiability problem of CNF formulas whose clauses contain at most two literals, is known to be solvable in polynomial time. However, its associated counting problem #2SAT of determining the number of satisfying assignments of a (≤ 2) -CNF formula is #P-complete.

We describe the method of “weighted assignments”, that allows improved running times of the form $O(2^{cn})$ with $c < 1$, suppressing polynomial factors, with the best current bound due to Frer and Kasiviswanathan.

Additionally, we give a subclass of #2SAT instances that is solvable in linear time $O(n)$.

9. 18:30-19:00, **Philipp Zumstein**

Pseudo-random graphs via eigenvalues

Pseudo-random graphs are graphs which behave like random graphs in some sense. We describe the concept of pseudo-random graphs via eigenvalues. There are two approaches to do that. One considers the spectrum of the adjacency matrix and the other the spectrum of the normalized Laplacian. The first approach is easier to apply but mostly applicable for d -regular graphs. In the talk we will present generalizations of some theorems about pseudo-random graphs to the non-regular case.

1. 9:00-9:40, **Michael Hoffmann, ETH Zürich**

Chordless Paths Through Three Vertices

Consider the following problem, which we call “Chordless Path through Three Vertices” or CP3V, for short: Given a simple undirected graph $G = (V, E)$, a positive integer k , and three distinct vertices s , t , and $v \in V$, is there a chordless path of length at most k from s via v to t in G ? In a chordless path, no two vertices are connected by an edge that is not in the path. Alternatively, one could say that the subgraph induced by the vertex set of the path in G is the path itself. The problem has arisen in the context of service deployment in communication networks. We resolve the parametric complexity of CP3V by proving it W[1]-complete with respect to its natural parameter k . Our reduction extends to a number of related problems about chordless paths and cycles. In particular, deciding on the existence of a single directed chordless (s, t) -path in a digraph is also W[1]-complete with respect to the length of the path.

2. 9:40-10:10, **Jan Remy, ETH Zürich**

Approximation Schemes for Node-Weighted Geometric Steiner Tree Problems

In this talk, we consider the following variant of the geometric Steiner tree problem. Every point u which is not included in the tree costs a penalty of $\pi(u)$ units. Furthermore, every Steiner point we use costs c_S units. The goal is to minimize the total length of the tree plus the penalties. We prove that the problem admits a polynomial time approximation scheme. Our PTAS uses a new technique which allows us to avoid the so-called Patching Lemma [Arora 98] or equivalents. It may thus open new possibilities to find approximation schemes for geometric optimization problems that include complicated topology. Furthermore the techniques we use provide a more general framework which can be applied to geometric optimization problems with more complex objective functions.

3. 10:40-11:10, **Alberto Ceselli, TU Berlin**

An optimization algorithm for the ordered open-end bin packing problem (A. Ceselli and G. Righini)

The ordered open-end bin packing problem is a variant of the well-known bin packing problem in which the items to be packed are sorted in a given order and the capacity of each bin can be exceeded by the last item packed into the bin. The problem was introduced in a recent paper by Yang and Leung [1]. The authors examined several algorithms for on-line and off-line approximation and studied their worst-case and average-case performance. In this talk, we first present combinatorial and linear programming lower bounds for the ordered open-end bin packing problem; then we describe a branch-and-price algorithm for its exact optimization. The pricing problem is a special variant of the binary knapsack problem, in which the items are ordered and the last one does not contribute to consume capacity: we devised a specialized optimization algorithm for this subproblem, which allows to effectively solve the pricing problem to optimality, exploiting suitable bounds and domination criteria. We also discuss implementation details of our branch-and-price approach and show computational results on datasets for packing problems presented in the literature.

[1] J. Yang, J. Y.-T., Leung, The ordered open-end bin-packing problem, Operations Research 51 (2003) 759-770.

Approximation Algorithms for the Monge-Kantorovich Distance Under Translation

In earlier talks I discussed approximation algorithms for the Earth Mover's Distance (EMD) under several classes of transformations. The EMD is a well known distance measure for weighted point sets with many applications and is a special case of the Monge-Kantorovich Distance (MKD). The history of the MKD goes back to 1781 and this distance measure can be defined on more general classes of subsets of \mathbb{R}^d than discrete sets of weighted points. But, it is still open how to compute this transportation distance efficiently, even under restrictions on different classes of subsets. I will present attempts to compute approximations on the distance and, using methods already introduced in earlier talks, get approximations on the the MKD under translations.