Abstracts of the Annual Workshop 2003

Monday, 09/29/03

1. 9:00-9:40, **Rolf H. Möhring, TU Berlin**

   Routing Traffic Flows in Networks with Congestion

   abstract TBA

2. 9:40-10:10, **Yoshio Okamoto, ETH Zürich**

   Fair Cost Allocations under Conflicts

   We study the cost allocation problem when the players are involved in a conflict situation from the game-theoretic point of view. More formally, we investigate some algorithmic aspects of a minimum coloring game introduced by Deng, Ibaraki and Nagamochi. In this talk, we will look at results by the speaker about the core, the tau-value, the nucleolus and the Shapley value on some classes of graphs.

3. 10:40-11:10, **Sai Anand, ETH Zürich**

   Pre-routed Call Admission Control

   Call admission control deals with accepting and routing decisions of call requests. In pre-routed call control a protocol or strategy fixes unique routes for calls. In this case, the call control algorithm has to make only acceptance and rejection decisions. The bandwidth constraints on links imply that the number of calls that are routed through an edge cannot exceed the capacity.The objective of call control is to maximize the number (or profits) of accepted call requests under the bandwidth limitation.

   In this talk we restrict the communication network to be a cycle. We present a simple 2-approximation algorithm for maximizing the profits of accepted calls. Discuss special cases for which the problem can be solved optimally. Finally, derive that our problem is as hard as the "exact matching problem", whose computational complexity has not been resolved to be in P or NP-hard. This derivation is an easy reworking of a recent result by Hochbaum et al. on cyclic scheduling.

4. 11:10-11:40, **Péter Csorba, ETH Zürich**

On the n-in-a-Row Game

In the $(a : b)$-biased n-in-a-row game two players, Maker and Breaker occupy the empty $\mathbb{Z} \times \mathbb{Z}$ lattice points in the plane. In one turn first Maker occupies a previously unoccupied points then Breaker occupies b. Maker wins if he can occupy a segment of n consecutive points horizontally, vertically or diagonally. Breaker wins, if he can prevent Maker to win. Since already in the (2:1)-version Maker has a winning strategy for arbitrary n, Jozsef Beck suggested to limit Maker's power by requiring him that the points he occupies within one turn are closeto each other. We will study this distance restricted version together with other variants.

5. 14:30-15:00, **Dieter Mitsche, ETH Zürich**

Spectral Clustering

The goal of k-clustering on a given graph G=(V,E), given by its adjacency matrix, is to find k disjoint subsets ('clusters') $V_i \subseteq V$, $V_i \cap V_j = 0, \forall\, i \neq j$, $\cup_{i=1}^{k} V_i =$ V, such that vertices in the same cluster are strongly connected whereas vertices between different clusters are loosely connected. It is well known that the exact solution of this problem is NP-hard, even for the case k=2. One method which has gained a lot of interest recently is to solve this problem is by looking at the spectrum of a matrix related to the graph (mostly the adjacency matrix or the Laplacian).

In this talk a maximum-spanning tree approach based on the spectrum of the Laplacian is presented, together with a bound on the error norm, up to which noise can be allowed so that the clusters are still perfectly reconstructed. Furthermore new conjectures about the k largest eigenvalues of the Laplacian resp. the k smallest eigenvalues of the adjacency matrix when adding some random noise to the clusters will be presented.

6. 15:00-15:30, **Manuel Bodirsky, HU Berlin**

Unrooting Planar Structures

Planar structures - for instance forests, outerplanar graphs, triangulations, k-connected planar graphs - are much easier to count if they are *rooted*, i.e. we count them up to isomorphisms that fix a certain vertex or a certain edge. We want to present a general approach how to derive counting formulas for their *unrooted* counterparts, given the counting formulas for rooted structures. This also yields *deterministic* polynomial time generation algorithms that generate these structures uniformly at random - up to now only expected polynomial time algorithms, or almost uniform sampling algorithms are known.

7. 15:30-16:00, **Dirk Schlatter, HU Berlin**

Triangulation processes

Let T_n be a labelled triangulation on n vertices, selected uniformly at random. Some recent results have been obtained by McDiarmid, Steger, and Welsh concerning random planar graphs, which imply in particular that T_n contains any planar graph of constant size with high probability. We will consider a greedy triangulation process instead, which uniformly chooses a permutation of $E(K_n)$, and then, starting with an empty graph, takes an edge if it does not destroy planarity. We conjecture that the two processes differ substantially, but properties similar to the one above also hold.

8. 16:30-17:00, **Mihyun Kang, HU Berlin**

How big is the largest component in a random planar graph?

Random graph theory has its origin in the series of seminal papers by Erdős and Rényi in the 1960s who investigated what a typical random graph looks like and how the properties of a random graph evolves as the edge density grows. We can think of a random graph as a process $\{G(n,M)\}_{0\leq M\leq\binom{n}{2}}$ which starts with an empty graph and attains a new random edge one by one until the graph becomes full. The structural properties of a random graph changes as the graph evolves from empty to full. At the beginning of the process the picture of evolution is quite simple: until $M << n$ asymptotically almost surely (abbeviated by a.a.s.) $G(n,M)$ is a forest which contains copies of all trees of size $o(\log n)$. When $M < n/2$ a.a.s. $G(n, M)$ still contains only trees and unicyclic components, whose size is at most $\Theta(\log n)$ and the size of components increase smoothly as new edges are added. But around $M = n/2$ the largest component of $G(n, M)$ rapidly grows from $\Theta(\log n)$ to $\Theta(n^{2/3})$ and then to $\Theta(n)$; a.a.s. $G(n, M)$ has no component larger than $O(\log n)$ when $M - n/2 << -n^{2/3}$, whereas it has the largest component of size $\Theta(n^{2/3})$ when $M = n/2$ and then it has the giant component of size $\Theta(n)$ when $M - n/2 >> n^{2/3}$.

However not much is known about the the evolution of a random planar graph $P(n, M)$, in particular how big the largest component in a random planar graph is? If $M < (1 - \epsilon)n/2$, $\epsilon > 0$, a random planar graph $P(n, M)$ and the classical random graph $G(n, M)$ will have the same typical properties since a.a.s. $G(n, M)$ is planar. But if $M > (1 + \epsilon)n/2$, the graphs $P(n, M)$ and $G(n, M)$ might behave fairly differently and $P(n, M)$ might have a phase transition at an earlier stage. Moreover $P(n, M)$ might contain a giant component smaller than that of $G(n, M)$. The largest component of a planar graph can be considered to be constructed by inserting vertices of degree two on the edges of an almost cubic planar graph and then inserting trees at vertices of a resulting graph in a similar way as $G(n, M)$. Thus the structural properties of a random cubic planar graph would give critical information on the largest component of a random planar graph. In this talk we discuss the properties of a random planar graph and a random cubic planar graph.

Tuesday, 09/30/03

1. 9:00-9:40, **Günter Rote, FU Berlin**

Planar Frameworks with Plane Reciprocals, and Pseudotriangulations

Every straight-line graph in the plane whose underlying graph is planar and which supports a self-stress (a set of forces on the edges which is in equilibrium at every vertex) has a reciprocal framework: an embedding of the dual graph whose edges are parallel to the corresponding edges of the original graph. We study necessary and sufficient conditions under which both frameworks are noncrossing: their faces must be pseudotriangles and pseudoquadrangles only, and the signs of the self-stress around every vertex and around every face can only follow a limited repertoire of patterns. A pseudotriangulation with a single non-pointed vertex always has a noncrossing reciprocal.

A self-stress also induces a Maxwell lifting: a surface in three dimensions which projects onto the given framework. The plane frameworks with plane reciprocals give rise to very special lifted surfaces: they have a single peak, and all other vertices are twisted simple saddles, having negative curvature in a some strong sense. These surfaces have certain properties which are analogous to properties of pseudotriangles in the plane.

2. 9:40-10:10, **Ares Ribó Mor, FU Berlin**

A Generalisation of the Maxwell-Cremona Theorem for Self-Touching Configurations

Given a planar configuration in $\mathbb{R}^2$, the classic Maxwell-Cremona theorem establishes a bijection (up to the addition of a linear function) between the set of equilibrium stresses and the set of three-dimensional polyhedral terrains that project onto it. We generalize this wonderful theorem to self-touching configurations, those configurations in which vertices and edges can be infinitessimally close, and edges can even lie along each other, but not properly cross. Our motivation are several open problems in the context of self-touching configurations which seem to be difficult to solve in the plane. The idea is to study at the properties of the lifted polyhedral terrain given by this new tool.

3. 10:40-11:10, **Oliver Klein, FU Berlin**

Lower Bounds for Shape Matching with Reference Points

Given two polygons $A, B \subset \mathbb{R}^2$, one is interested in how these resemble each other. One good measure for this resemblance is the minimal Hausdorff-Distance under translation.

Since the known exact algorithms to solve the problem are not very efficient, approximation algorithms based on reference points are used to get faster results. One possible reference point of a convex polygon is the Steiner point which is the weighted sum of the vertices. Due to Alt, Aichholzer and Rote is known, that the Steiner point is a reference point which induces an approximation algorithm with approximation ratio $\frac{4}{\pi}$ with respect to translations. Additionally, it is shown that any approximation algorithm using reference points cannot achieve a ratio better than $\frac{4}{\pi}$; this fact is shown even if only convex subsets of $\mathbb{R}^2$ are considered. However, the proof of the lower bound is not constructive. So far, examples showing good lower bounds are only known in the non-convex case and the bound given by these is not as strong as the true lower bound.

I will discuss our approach of finding better lower bounds in the convex case which is based on linear programming.

4. 11:10-11:40, **Maike Walther, FU Berlin**

On Computing the Frechet Distance of Curves and Surfaces

For the computation of the Frechet distance of two polygonal curves, Alt and Godau have given a polynomial-time algorithm. For higher dimensions, Godau has shown that the computation is NP-hard.

This talk is concerned with whether the Frechet distance of polygonal surfaces - i.e. triangular meshes - is computable. One idea to show the computability, is to approximate the Frechet distance by the discrete Frechet distance, which is defined using discrete instead of continous mappings on the parameter spaces.

I will show how this can be done for curves and discuss ideas on how this might be done for surfaces.

5. 14:30-15:00, **Kevin Buchin, FU Berlin**

Locality Properties of Discrete Space-Filling Curves

A discrete space-filling curve is a linear traversal, i.e. a one-dimensional indexing, of a finite set of points in a multidimensional space. A typical requirement of a discrete space-filling curve is that it preserves locality, either in the sense that nearby points in the multidimensional space have small index differences, or that points with small index differences are nearby in the space.

In this talk, two locality measures for points on a square grid are considered: the sum of index differences of neighboring points (possibly after application of some function) and the expected length of the traversal of a randomly chosen subset. Experimental results for these measures are presented and discussed.

6. 15:00-15:30, **Paweł Żyliński(*), University of Gdańsk**

Cooperative guards in grids

A *grid* P is a connected union of vertical and horizontal line segments. A point $x \in P$ can see a point $y \in P$ if the line segment $\overline{xy}$ is a subset of the grid. The visibility graph of a set $\mathcal{S}$ of points in P is the graph whose the vertex set is $\mathcal{S}$ and two vertices are adjacent if their corresponding points see each other.

Herein we investigate the cooperative guard problem for guards in grids. A set of points $\mathcal{S}$ in the grid P is a *cooperative guard* set for P provided that (i) for every point $x \in P$ there is a point $g \in \mathcal{S}$ such that g sees x; and (ii) the visibility graph of S is connected.

We show that the minimum cooperative guard problem (MCGP) can be solved in a polynomial time for both 2-dimensional and 3-dimensional grids. In the first case, the MCGP corresponds to the problem of finding a minimum spanning tree in the intersection graph of a grid, thus, a $O(n+k)$ time algorithm is obtained, where n is the number of segments and k is the number of intersections in the grid. In the latter case, an algorithm uses $O(kn^{2.5})$ time; the solution is obtained from a spanning set of a 2-polymatroid constructed from the intersection graph of the grid.

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7. 15:30-16:00, **Ingo Schurr, ETH Zürich**

Linear programming via Unique Sink Orientations of Cubes

Unique sink orientations in general are an abstraction from linear programming, but this was not clear for the special case of unique sink orientations of cubes. Recently Bernd Gärtner found a way of expressing linear programms as such orientations. In this talk I will present an easy transformation for linear programms in equality form.

8. 16:30-17:00, **Kaspar Fischer, ETH Zürich**

Unique Sink Orientations from Miniball-of-Balls

In the MINIBALL-OF-BALLS problem we want to find the smallest ball MB(S) which encloses a given set S of balls in R^d. Since it turns out that small instances ($|S| \leq d+1$, say) are the hard part of the problem, we focus on finding the minimal subset of the at most $d+1$ input balls which spans MB(S).

We present a reduction from this "MICROBALL problem" to the problem USO of finding the sink in a *unique sink orientation* of the (edge-oriented) $|S|$-dimensional cube. We can then apply existing USO - algorithms to find us the desired subset of S spanning MB(S). Our reduction is based on the geometric *inversion transform* and shows, as a by-product, how to compute the distance from a given point to the convex hull of a set of balls.

9. 17:00-17:30, **Martin Kutz, FU Berlin**

Angels With Broken Wings

We play a game with a chess king on an infinite checkers board. The king moves across the board according to the usual chess rules and we want to trap him by destroying squares of the board. Precisely, in each move the king steps onto an undamaged square adjacent to his current position and we in turn delete an arbitrary square from the board (except the one under the king, of course). Can you trap the king, that is, do you have a strategy such that at some point the king cannot move any more? Or is he able to run on forever?

Berlekamp showed that you can trap him. In fact, the strategy is not very complicated. But the problem gets amazingly difficult if you increase the power of the king. Conway defined a k-angel to be a "king" that can “fly” in one move to any untouched square at distance at most k from his current position. He then asked whether the opponent–whom he figuratively calls “the devil”–can catch any angel of arbitrary power. This problem remains unsolved for over two decades now.

After revisiting some well-known, yet rather counterintuitive facts about the game, we introduce a slight variant in which angels are only allowed to run, not to fly. Under these modified rules–which are asymptotically equivalent to the original setup–we are able to prove slight improvements upon Berlekamp’s devil result, revealing further peculiarities and possible fallacies of this “everlasting game”.

Wednesday, 10/01/03

1. 9:00-9:40, **Thomas Erlebach, ETH Zürich**

On the OVSF Code Assignment Problem

Orthogonal Variable-Spreading-Factor (OVSF) codes can be used to share the radio spectrum among several connections of possibly different bandwidth in a wireless network. The available codes can be represented as the nodes of a complete binary tree, and codes on different levels allow different transmission rates. A set of codes can be used simultaneously if and only if in the tree, no code is an ancestor of another code. When a user requests a code at a certain level, it may be necessary to reassign some of the codes that are currently in use in order to make space for the new code assignment. One is interested in minimizing the number of code reassignments. We discuss on-line and off-line variants of this optimization problem and present hardness results as well as algorithms.

This is joint work with Riko Jacob, Matus Mihalak, Marc Nunkesser, Gabor Szabo, and Peter Widmayer.

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

On Tverberg-type theorems and crossing numbers

First, we'll give a survey of the current state of proofs of the "Topological Tverberg Theorem", a statement on partitioning points in Euclidean Space. The general case is still open, so "Theorem" is a little bit misleading in this context. Then we'll show some relations to results of the same type. Especially, the question of drawing complete graphs in the plane will be involved.

3. 10:40-11:10, **Andreas Paffenholz, TU Berlin**

Construction and Shellability of Bier Spheres

In 1992, Thomas Bier descibed a very simple and nice construction for a large number of piecewise linear $(n-1)$-spheres with $2n$ vertices. Most of them are not realizable as polytopes. The construction starts with the Boolean lattice B_n and a proper ideal $I \subset B_n$. These spheres were subsequently studied in particular by Matoušek, Björner and Ziegler.

In my talk I want to show that his construction can be extended to any face lattice L of a piecewise linear CW sphere and any proper ideal $I \subset L$ to give new piecewise linear spheres. Furthermore I will show that all the spheres coming from the Boolean lattice and ideals therein are shellable. I will give an explicit shelling order for them.

4. 11:10-11:40, **Arnold Waßmer, TU Berlin**

The Homomorphism Complex

The chromatic number of a graph is a typical number in graph theory. Topology has a number that plays a similar role: the connectivity of a space. Laszlo Lovasz invented a method to join these two numbers. For a given graph he constructed a topological space such that its connectivity gives a lower bound for the chromatic number of the graph. This topological space, the neighborhood complex, was the mother of many other complexes: the so called Lovasz complex, the box complex, and all its brothers and sisters. I want to talk about the youngest child in this family – the homomorphism complex.

5. 11:40-12:10, **Axel Werner, TU Berlin**

Calculating 0/1-Polytopes

Oswin Aichholzer presented a method to provide representatives of all classes of 0/1-Polytopes with respect to 0/1-equivalence, which works in a reasonably efficient way up to dimension 5. I will briefly show how the system works, how it can be used - together with other programs - to check combinatorial equivalence of 0/1-Polytopes and what conclusions, more general conjectures as well as hints how they might be proved, can be extracted from these results.