Tuesday, August 30, 14:00, Room MA041

A Practical Linear Time Algorithm for Disjoint Paths in Graphs with Bounded Tree-width

Petra Scheffler, Technische Universität Berlin

The graphs with bounded tree-width have gotten much attention in the study of algorithms for NP-complete problems in recent years. The reason is that there are general methods that lead to linear time algorithms for large classes of problems when restricted to graphs with bounded tree-width. Indeed, these methods are given only in a theoretical setting up to now.

In our talk, we present an algorithm on graphs with bounded tree-width in a form that is relatively easy to implement. We solve the DISJOINT PATHS problem in linear time. The number of paths is **not** assumed to be fixed. We chose this problem for two reasons: On the one hand, it has many applications, for instance in VLSI-design. On the other hand, it does not fit into any of the known general concepts. The DISJOINT PATHS problem is stated as a decision problem as follows:

Instance: Graph $G = (V, E)$ and net-list $\mathcal{N} = \{N_1 = \{s_1, t_1\}, \ldots, N_k = \{s_k, t_k\}\}$.

Question: Do pairwise disjoint paths $\{P_i | P_i = s_i, \ldots, t_i, 1 \leq i \leq k\}$ exist in G?

Tuesday, August 30, 14:30, Room MA041

Bounds for the Edge-Disjoint Steiner Problem in Graphs

Frank Compagner, University of Amsterdam
C. Duin, University of Amsterdam
Anton Volgenant, University of Amsterdam

In a weighted graph G, the Steiner Problem is the problem of constructing a tree of minimum total weight spanning a certain subset S of the vertices of G. We consider a variation on this problem in which we require that the solution consists of two or more edge- disjoint trees spanning S. Deciding whether a feasible solution to this problem exists is a NP-complete problem. We consider two relaxations of the problem, the first one based on the (normal) Steiner Problem in Graphs and the second one based on the disjoint minimum spanning tree problem. By applying subgradient optimization to these relaxations we compute a lower bound to the problem. The results from the first optimization program is also used to calculate an upper bound. Computational results are given for graphs with up to 100 vertices and 4950 edges.

Tuesday, August 30, 15:00, Room MA041

The General Two-Path Problem in time $O(m \log n)$

Jens Gustedt, Technische Universität Berlin

The GENERAL TWO PATH PROBLEM is the problem of finding vertex disjoint paths between two pairs of terminals in an arbitrary graph G. We show that this problem is solvable in time $O(m \log n)$, where n and m are the numbers of vertices and edges of G resp.

Tuesday, August 30, 15:30, Room MA041

Complexity of the Inverse Shortest Path Problem

S'andor Fekete, ZPR Universität Köln
Winfried Hochstättler, ZPR Universität Köln
Stefan Kromberg, ZPR Universität Köln
Christoph Moll, ZPR Universität Köln

The calculation of distances in a graph with weights on the edges is a well known problem in combinatorial optimization. In our talk we consider the inverse problem. Given a graph and distances between some pairs of nodes, we want to calculate weights on the edges, that induce these distances. This problem arises in the estimation of transmission coefficients of networks. An application is the estimation of avarage speeds of streets, knowing the traffic network and the travel time between some towns.

In our talk we will indicate the relation of this problem to the multicommodity flow problem and the disjoint path problem. We will show that this problem remains NP-complete under several restrictions on the instances and give some cases solvable in polynomial time.

Semi-Plenary Lecture
Wednesday, August 31, 09:00, Room MA041

Edge-Coloring Algorithms

Takao Nishizeki, Graduate School of Information Sciences, Tohoku University

In an ordinary edge-coloring of a graph $G = (V, E)$, each color appears at each vertex $v \in V$ at most once. On the other hand, in generalized edge-colorings called f- and fg-colorings, each color appears at each vertex $v \in V$ at most $f(v)$ times, and furthermore each color appears at each set of multiple edges joining vertices v and w at most $g(vw)$ times in an fg-coloring. Such ordinary and generalized edge-colorings often appear in various scheduling problems like the file transfer problem on computer networks. This talk reviews old and new results on the edge-coloring problems. In particular we survey various upper bounds on the chromatic index, that is, the minimum number of colors required to edge-color graphs, and present ideas and techniques behind algorithms for edge-coloring graphs with a number of colors no more than the bounds. Furthermore we report efficient sequential and parallel algorithms for various classes of graphs such as bipartite graphs, planar graphs, and graphs of bounded tree-width, genus, arboricity, or degeneracy, etc.

Wednesday, August 31, 10:00, Room MA041

A Simple Min Cut Algorithm

Mechtild Stoer, Konrad-Zuse-Zentrum für Informationstechnik Berlin
Frank Wagner, Freie Universität Berlin

We present an algorithm for finding the minimum cut of an edge-weighted graph. It is simple in every respect. It has a short and compact description, is easy to implement and has a surprisingly simple proof of correctness. Its runtime matches that of the fastest algorithm known. The runtime analysis is straightforward. In contrast to nearly all approaches so far, the algorithm use no flow techniques. Roughly spoken the algorithm consists of about $|V|$ nearly identical phases each of which is formally similar to Prim's minimum spanning tree algorithm.

Wednesday, August 31, 10:30, Room MA041

Maximum Flows in Planar Networks

Karsten Weihe, Technische Universität Berlin

Let $G = (V, A)$ be a directed, planar graph, let $s, t \in V$, $s \neq t$, and let $c_a \geq 0$ be the *capacity* of an arc $a \in A$. The problem is to find a maximum flow from s to t in G subject to these capacities. The fastest algorithm known so far requires $\mathcal{O}(|V| \cdot \sqrt[3]{|V|} \cdot \log |V|)$ time, whereas the algorithm introduced in this talk requires only $\mathcal{O}(|V| \log |V|)$ time.

Wednesday, August 31, 14:00, Room MA041

Two Pursuers Against a Fugitive in a Graph

Valentin E. Brimkov, Bulgarian Academy of Sciences
Radan Mirjanov, University of Sofia

The paper deals with the problem for searching necessary or sufficient conditions for successful pursuit of two pursuers against a fugitive in a graph. The question we are trying to answer is: in what class of graphs two pursuers will be able to catch a fugitive, if all they have equal finite speed, and in what types of graphs this is not possible.

We consider models of two types of pursuit: (i) With priority of the pursuers - if at every fixed moment of time t the both pursuers have information about the future fugitive's behaviour in some interval of time after t, and (ii) With priority of the fugitive - if the fugitive knows the pursuers' behaviour in some interval of time after the current moment.

It is proven that there exists a successful strategy for the pursuers in some classes of graphs, and such strategy is presented for rectangular lattice. Some necessary conditions for the graph are obtained, and the essential difference between the two models of pursuit is revealed.

Wednesday, August 31, 14:30, Room MA041

A New Heuristic Layout Algorithm for DAGs

Stefan Dresbach, Universität zu Köln

Directed acyclic graphs (DAGs) are a common representation of hierarchical relationships and are widely used in software and information engineering, system theory, and others. The usefulness depends on a readable, understandable and easy to remember layout. The key problem of such a good layout is the reduction of numbers of arc crossings.

We focuse on the two layer problem and make a fresh attempt at a heuristic method of arc crossing reduction based on a stochastic approach. The "stochastic"heuristic is described in detail. The results of the approach are analyzed. A comparison of these results with the mostly used methods of barycentering and median-ordering is given. The "stochastic"heuristic is shown to be preferable in terms of WARFIELD's generating matrices.

Wednesday, August 31, 15:00, Room MA041

On the Domination Number

Cyriel van Nuffelen, University of Antwerpen

We consider simple graphs, i.e. finite, not directed, no multiple edges and no loops. In the adjacency matrix $A = [a_{ij}]$ the element $a_{ij} = 1$ if the edge (i, j) exists otherwise $a_{ij} = 0$. We calculate the rank of this adjacency matrix over different number fields like the real numbers, $GF(2)$, and so on. The rank of the adjacency matrix (in several number fields) is an upper bound for the domination number of the graph. The rank of the adjacency matrix of the complementary graph is an upper bound for the domination number of the original graph. On the other hand we establish an upper bound for the independence number in terms of the domination number of the graph. These bounds are "best possible" bounds and of interest because the calculation of the domination number and independence number is known to be $\mathcal{NP}$-complete.

Wednesday, August 31, 15:30, Room MA041

Linear Independences in Fuzzy Algebras

Jan Plavka, Technical University Kosice, Slovakia

no abstract received

Thursday, September 1, 09:00, Room MA041

A Catalogue of the Smallest Hard-to-Color Graphs

Marek Kubale, Technical University of Gdansk, Poland
Jaroslaw Pakulski, Technical University of Gdansk, Poland

For a given approximate vertex coloring a graph is said to be *slightly hard-to-color* if some implementation of the algorithm uses more colors than the minimum needed. Similarly, a graph is said to be *hard-to-color* if every implementation of the algorithm results in a non-optimal coloring. A (slightly) hard-to-color graph is said to be *smallest* if it has fewest edges among all (slightly) hard-to-color graphs with the minimum number of vertices. So far the smallest hard-to-color and slightly hard-to-color graphs have been known only for the following algorithms: greedy independent sets, largest-first, random sequential and connected sequential. In the paper we give such graphs for the following heuristics: smallest-last, saturation largest-first, largest-first with interchange, smallest-last with interchange, and coloring pairs. Some of the new results have been obtained by means of an exhaustive computational search.

Thursday, September 1, 09:30, Room MA041

Combinatorial Analysis of Gossiping and Broadcasting

Roger Labahn, Universität Rostock

We introduce two common models for communication and information dissemination in networks: *broadcasting* and *gossiping*. These have been studied in numerous different variations and modifications to the underlying graphs as well as to the particular way of information transmission. Some of the models investigated in the literature will be discussed.
The intention of this talk is to give a survey on the combinatorial aspects of the area: We present results for the extremal values of the main studied parameters in general graphs and special important networks, and structural results for extremal networks.
Finally, we will list open problems.

Thursday, September 1, 14:00, Room MA041

Using Network Flows for Mesh Generation and Density Control

Rolf H. Möhring, Technische Universität Berlin
Matthias Müller-Hannemann, Technische Universität Berlin
Karsten Weihe, Technische Universität Berlin

Network flow techniques are applied to a problem arising in the computer aided design of cars, planes, ships or components of them: Refine a coarse mesh of spheric polygons, which approximates the surface of a workpiece, such that the resulting mesh is suitable for a numerical analysis (in particular, we are asked to achieve a specified mesh density and to generate meshes consisting of quadrilaterals only). This comes out to be a difficult discrete problem (strongly $\mathcal{NP}$-hard). We show how to formulate it in terms of network flow theory. We obtain an *undirected* graph $G = (V, E)$ with upper and lower capacities on the edges and some additional node balance conditions. In that graph, a feasible flow is sought for, satisfying all these constraints. In our talk, we introduce a generic algorithm and discuss the encouraging results of a first implementation.

Thursday, September 1, 14:30, Room MA041

The Parametric Identification Problem for Water Supply System with Deficit

Ewa Szlachcic, The Technical University of Wroclaw, Poland

The parametric identification problem for nonlinear water supply network, when the system can not satisfy the needs of water consumers within their desire and deficit arrived, is presented in this paper. Identification of real network structure at deficit state with real demands and flows requires a special description of consumer points with the relation among the consumer demands and the possibility of satisfying the needs. It leads to the reduction model of nonlinear water distribution network with the optimization of total wastes of energy in the set of pipelines connected with their resistances.

The original simulation method with parametric decomposition technique for identification of water supply system with the minimization of deficit consequences, is proposed. The numerical results of the test confirm the usefulness of the presented parametric identification method.

Thursday, September 1, 15:00, Room MA041

A Parallel Branch & Bound Algorithm for the Travelling Salesman Problem

Ewa Dudek-Dyduch, Cracow University of Technology
Tadeusz Dyduch, Cracow University of Technology

The paper deals with parallelization of a branch & bound algorithm that is applied for the Travelling Salesman Problem. Two different conceptions of parallelization are presented and analysed. The main difference between the conceptions consists in different rule of choice the next node of decision tree. In the first conception the rule utilises the value of lower bound, i.e. the node with minimal value of the lower bound is chosen. Such an approach needs multi-user data base and storing all the generated and unsolved subproblems. In the second conception, the decision tree is analysed with use of back-track algorithm. In this conception all the sub- problems need not be stored. Apart of it, several solutions are computed simultaneously, which enables us to find the better upper bound.

Thursday, September 1, 15:30, Room MA041

An Efficient Branch-and-Bound Algorithm for the Maximum Cardinality Stable Set Problem

Jean-Marie Bourjolly, Universite de Montreal
Gilbert Laporte, Universite de Montreal
Helene Mercure, Universite de Montreal

We describe a branch-and-bound algorithm for the exact solution of the maximum cardinality stable set problem. Upper bounds are obtained by covering the nodes of the graph with edges, odd cycles, and odd homeomorphs of K4. Various heuristics are used to fix subsets of nodes and to trim the branch-and-bound tree. Computational tests on random graphs and on the DIMACS Challenge benchmark problems will be reported.

Friday, September 2, 10:30, Room MA041

Interval Packing and Covering in Partially Ordered Sets

Isma Bouchemakh, Technische Universität Algier,
Konrad Engel, Universität Rostock

We study the hypergraph $\mathcal{H}(\mathcal{P})$ whose vertices are the points of a finite poset P and whose edges are the maximal intervals in P (i.e. sets of the form $I = \{v \in P : p \le v \le q\}, p$ minimal, q maximal). We show that the problems of the determination of the independence number α, the point covering number τ, the matching number ν and the edge covering number ρ are NP-complete. For interval orders (points are represented as closed intervals on the real line, and two points are related if the corresponding intervals are disjoint) we describe polynomial primal-dual resp. parenthesization algorithms and prove the König property ($\nu = \tau$) and the dual König property ($\alpha = \rho$). Special interest is devoted to posets P with rank function r and to subposets induced by $P_{l,u} := \{p \in P : l \le r(p) \le u\}$. For the Boolean lattice $P = B_n$ Voigt and Wegener proved that $\alpha(P_{l,u}) = \rho(P_{l,u}) = \max\{\binom{n}{l}, \binom{n}{u}\}$, and they used this result for the construction of minimal polynomials for symmetric Boolean functions. We derive analogous results for posets which admit special symmetric chain partitions. The determination of the numbers ν and τ is more difficult. For $P = B_n$ we can prove (with $v := n - u$) e.g.

$$\binom{l+v+1}{l} \le \nu(P_{l,u}) \le \frac{(l+v)^{l+v}}{l^l v^v},$$

and this result is related to extremal set problems solved by Bollobás and Lovász.

Friday, September 2, 11:00, Room MA041

On the Use of Boolean Methods for the Computation of the Stability Number

Alain Hertz, Ecole Polytechnique Fédérale de Lausanne

In a graph G, a set S of vertices is stable (or independent) if no two vertices in S are linked by an edge. The maximum cardinality of a stable set in G is called the stability number of G.

We derive from Boolean methods transformations which, when applicable, build from a graph $G = (V, E)$ a new graph $G' = (V', E')$ with the same stability number and such that $|V'| = |V| - 1$.

We next describe classes of graphs for which such transformations lead to polynomial algorithms for the computation of the stability number.

Friday, September 2, 11:30, Room MA041

Recognizing Interval Digraphs and Bi-Interval Graphs in Polynomial Time

Haiko Müller, Friedrich-Schiller-Universität Jena

A finite directed graph (V, A) without parallel edges is an interval digraph if there exist two families $\{S_v : v \in V\}$ and $\{T_v : v \in V\}$ of intervals on the real line such that $(v, w) \in A \iff S_v \cap T_w \neq \emptyset$. A finite simple bipartite graph (X, Y, E) is a bi-interval graph if there exists a family $\{S_v : v \in X \cap Y\}$ of intervals on the real line such that $\{x, y\} \in E \iff x \in X \wedge y \in Y \wedge S_x \cap S_y \neq \emptyset$. We give polynomial time algorithms recognizing interval digraphs and bi-interval graphs, respectively.

Friday, September 2, 12:00, Room MA041

Versions of Morphological Clique Problem

Mark Sh. Levin, Moskow

Let $G = (\{B_j, j = 1, \ldots, m\}, E_c)$ be a morphograph, where B_j is a set of vertices (e.g., design choices A_s) in morphoclass j, $|B_i \cap B_j| = 0$, E_c is a set of arcs (compatibilities I_s) between A_s of different morphoclasses (symmetric binary relation). The problem is: to find a morphological clique (a composition S) of the best elements (one representative from each B_j) with taking into account possible I_s and/or numerical constraints.

Various approaches to measuring quality of components (e.g., A_s, I_s) may be used: value, ordinal estimate, ordinal interval, preference relation or vector; according functions are used for S. Thus, we consider versions of the problem above: (a) ordinal measurement of A_s, I_s, and S; (b) ordinal interval measurement of A_s, I_s, and S; (c) specific cases for generalized condensed I_s (chain, tree); (d) multi-choice problem with I_s or specific logical tree-like restriction, etc. Mainly, these versions are NP-complete/hard.

We investigate exact and approximate algorithms for solving the problem, for analysis (revealing bottlenecks), and for improvement of solutions. Applications to design, planning, and some combinatorial optimization problems are discussed.