10211 Abstracts Collection
Flexible Network Design
— Dagstuhl Seminar —

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Abstract. From Monday 24.05.2010—Friday 28.05.2010, the Dagstuhl Seminar 10211 "Flexible Network Design " was held in Schloss Dagstuhl – Leibniz Center for Informatics. During the seminar, several participants presented their current research, and ongoing work and open problems were discussed. Abstracts of the presentations given during the seminar as well as abstracts of seminar results and ideas are put together in this paper. The first section describes the seminar topics and goals in general. Links to extended abstracts or full papers are provided, if available.

Keywords. Network Design, Approximation Algorithms, Game Theory and Mechanism Design, Wireless Networks

10211 Summary – Flexible Network Design

Network design with its many variants is one of the most active research areas in theoretical computer science involving researchers from Algorithms and Complexity, Combinatorial Optimization, Distributed Computing and Algorithmic Game Theory. This area is fertile ground for new problems and the development of new techniques, since modern communication systems require a flexible and permanent adaptation of the network structure to highly dynamic access pattern especially in the context of mobile and adhoc networks. This brings many new aspects into network design such as flexible construction, dynamic scheduling of recources, adaptive bandwidth or spectrum assignment, and routing with respect to varying demands.

The goal of this seminar was to bring together experts from the several different communities above, and to give them the possibility to discuss recent advances, understand current trends, identify understudied areas, and formulate

new directions for further investigation in this area. The seminar focussed on emergent problems in the area of flexible network design like online and oblivious network design, network design with game theoretic approaches, positioning in wireless sensor networks, and scheduling interfering signals in wireless networks.

The seminar provided an opportunity for information sharing and collaborations, and to identify new problems and areas for future collaboration. Indeed, to facilitate the exchange of ideas, some of the participants were requested to give overview talks or surveys of subjects of cross-cutting interest; this was complemented by shorter talks by other participants on specific research results.

On the Efficiency of Restricted Tolls in Network Routing Games

Vincenzo Bonifaci (MPI für Informatik - Saarbrücken, DE)

One of the most effective means to reduce the price of anarchy in non-atomic network routing games is to impose tolls on the arcs of the network. It is a well-known fact that marginal cost tolls induce a Nash flow that corresponds to a minimum cost flow. However, despite their effectiveness, marginal cost tolls suffer from two major drawbacks, namely (i) that potentially every arc is tolled and (ii) that the imposed tolls might be arbitrarily large. In this paper, we consider the problem of computing (approximately) optimal tolls that are restricted to not exceed a predefined budget for every arc, or path. The main contribution of the paper is to prove an equivalence between the set of epsilon-Nash flows and the set of Nash flows that are inducible by tolls that do not increase the latency of any path by more than an epsilon-fraction. A consequence of our results is that the efficiency of the best Nash flow that is inducible via such tolls corresponds to the price of stability of epsilon-Nash flows.

Keywords: Network routing game, Wardrop equilibria, price of anarchy, price of stability, tolls

Joint work of: Bonifaci, Vincenzo; Salek, Mahyar; Schäfer, Guido

Diameter of Polyhedra: Limits of Abstraction

Friedrich Eisenbrand (EPFL - Lausanne, CH)

We investigate the diameter of a natural abstraction of the 1-skeleton of polyhedra. Even if this abstraction is more general than other abstractions previously studied in the literature, known upper bounds on the diameter of polyhedra continue to hold here. On the other hand, we show that this abstraction has its limits by providing an almost quadratic lower bound.

Keywords: Polyhedra, Graphs

Joint work of: Eisenbrand, Friedrich; Hähnle, Nicolai; Razborov, Alexander; Rothvoß, Thomas

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2010/2724

Economical Caching

Matthias Englert (University of Warwick, GB)

We study the management of buffers and storages in environments with unpredictably varying prices in a competitive analysis. In the economical caching problem, there is a storage with a certain capacity. For each time step, an online algorithm is given a price from the interval $[1, \alpha]$, a consumption, and possibly a buying limit. The online algorithm has to decide the amount to purchase from some commodity, knowing the parameter α but without knowing how the price evolves in the future. The algorithm can purchase at most the buying limit. If it purchases more than the current consumption, then the excess is stored in the storage; otherwise, the gap between consumption and purchase must be taken from the storage. The goal is to minimize the total cost. Interesting applications are, for example, stream caching on mobile devices with different classes of service, battery management in micro hybrid cars, and the efficient purchase of resources. First we consider the simple but natural class of algorithms that can informally be described as memoryless. We show that these algorithms cannot achieve a competitive ratio below $\sqrt{\alpha}$. Then we present a more sophisticated deterministic algorithm achieving a competitive ratio of

$$\frac{1}{W\left(\frac{1-\alpha}{e\alpha}\right)+1} \in \left[\frac{\sqrt{\alpha}}{\sqrt{2}}, \frac{\sqrt{\alpha}+1}{\sqrt{2}}\right] \ ,$$

where W denotes the Lambert W function. We prove that this algorithm is optimal and that not even randomized online algorithms can achieve a better competitive ratio. On the other hand, we show how to achieve a constant competitive ratio if the storage capacity of the online algorithm exceeds the storage capacity of an optimal offline algorithm by a factor of $\log \alpha$.

Keywords: Online algorithms, Competitive analysis, Storage management

Joint work of: Englert, Matthias; Röglin, Heiko; Spönemann, Jacob; Vöcking, Berthold

Full Paper:
http://drops.dagstuhl.de/opus/volltexte/2009/1826/

See also: In Proc. of the 26th STACS (Freiburg, Germany, 2009). Pages 385-396.

Distributed Vision with Smart Pixels

Sándor Fekete (TU Braunschweig, DE)

We study a problem related to computer vision: How can a field of sensors compute higher-level properties of observed objects deterministically in sublinear time, without accessing a central authority? This issue is not only important for real-time processing of images, but lies at the very heart of understanding how a brain may be able to function.

In particular, we consider a quadratic field of n "smart pixels" on a video chip that observe a B/W image. Each pixel can exchange low-level information with its immediate neighbors. We show that it is possible to compute the centers of gravity along with a principal component analysis of all connected components of the black grid graph in time $O(\sqrt{n})$, by developing appropriate distributed protocols that are modeled after sweepline methods.

Our method is not only interesting from a philosophical and theoretical point of view, it is also useful for actual applications for controling a robot arm that has to seize objects on a moving belt. We describe details of an implementation on an FPGA; the code has also been turned into a hardware design for an application-specific integrated circuit (ASIC).

Keywords: Distributed vision, distributed algorithms, sublinear algorithms, principal component analysis, sweepline algorithms

Joint work of: Fekete, Sándor; Kröller, Alexander; Schmidt, Christiane

Full Paper:
http://portal.acm.org/citation.cfm?id=1542410&dl=ACM

See also: Proceedings of the 25th annual ACM Symposium on Computational geometry (SoCG 2009), pp. 257-266

Envy Free Mechanisms

Amos Fiat (Tel Aviv University, IL)

This talk covers several recent papers concerning Envy Free Mechanisms. We give an envy free mechanism for makespan minimization, that is within a factor of $\log n$ of the minimal makespan. We also give a lower bound of $\log n / \log \log n$. We give envy free and incentive compatible mechanisms for allocation problems with homogeneous agent capacities and show that with heterogeneous capacities one cannot insist upon no positive payments. We give a characterization of mechanisms that are simultaneously envy free and incentive compatible, and show tradeoffs between these two concepts.

Joint work with Edith Cohen, Michal Feldman, Haim Kaplan, Svetlana Olonetsky, and Amiram Wingarten

Keywords: Mechanism Design, Incentive Compatible, Envy Free, Walrasian Pricing

An Improved LP-based Approximation for Steiner Tree

Fabrizio Grandoni (Università di Roma II, IT)

The Steiner tree problem is one of the most fundamental NP-hard problems: given a weighted undirected graph and a subset of terminal nodes, find a minimum-cost tree spanning the terminals. In a sequence of papers, the approximation ratio for this problem was improved from 2 to the current best 1.55 [Robins,Zelikovsky-'05]. All these algorithms are purely combinatorial. A long-standing open problem is whether there is an LP-relaxation for Steiner tree with integrality gap smaller than 2 [Vazirani,Rajagopalan-'99].

In this work we improve the approximation factor for Steiner tree, developing an LP-based approximation algorithm. Our algorithm is based on a, seemingly novel, iterative randomized rounding technique. We consider a directed-component cut relaxation for the k-restricted Steiner tree problem. We sample one of these components with probability proportional to the value of the associated variable in the optimal fractional solution and contract it. We iterate this process for a proper number of times and finally output the sampled components together with a minimum-cost terminal spanning tree in the remaining graph. Our algorithm delivers a solution of cost at most ln(4) times the cost of an optimal k-restricted Steiner tree. This directly implies a ln(4)+eps<1.39 approximation for Steiner tree.

As a byproduct of our analysis, we show that the integrality gap of our LP is at most 1.55, hence answering to the mentioned open question. This might have consequences for a number of related problems.

Keywords: Approximation algorithms, Network design, Steiner tree

Joint work of: Byrka, J. and Grandoni, F. and Rothvoss, T. and Sanità

Full Paper:
http://www.disp.uniroma2.it/users/grandoni/Pubblicazioni/BGRS10stoc.pdf

See also: An improved LP-based approximation for Steiner tree. J. Byrka, F. Grandoni, T. Rothvoss, and L. Sanità. In ACM Symposium on Theory of Computing (STOC), 2010. Best Paper Award. To appear.

Recent progress on wireless scheduling in the SINR model

Magnus M. Halldorsson (Reykjavik University, IS)

This talk will be a survey of recent work on performance guarantees for the physical (SINR) model for wireless communication. We outline the essential properties of the model and ways of ameliorating the difficult features, and examine relations between different variants based on power assignment (fixed, oblivious, arbitrary) and distance metrics (Euclidean, doubling, bidirectional, arbitrary). We finally survey results on centralized and distributed algorithms.

Keywords: Wireless computing, capacity, scheduling, power control

Combinatorial Auctions for Secondary Spectrum Markets

Martin Hoefer (RWTH Aachen, DE)

Consider the following combinatorial auction problem with conflict graph: There is a set of k communication channels that should be allocated to n » k bidders. Bidders have arbitrary valuations for bundles of channels. A channel can be assigned to multiple bidders unless there is a conflict between two bidders sharing the same channel.

Conflicts are described in terms of a graph in which the nodes represent the bidders and the edges represent conflicts. This problem generalizes combinatorial auctions and maximum weight independent set.

To motivate our study, we show that problem formulations for secondary spectrum auctions in well established models for wireless communication can be reduced to the combinatorial auction problem with different variants of conflict graphs. We prove that for the conflict graphs obtained in our reductions the so-called inductive independence number ρ can be bounded by a constant or a logarithmic function for many prominent communication models. This allows us to construct efficient approximation algorithms with approximation factors based on ρ and k for the combinatorial auction problem with conflict graph – thereby bypassing strong lower bounds for independent set problems. Our approximation ratios are close to best possible in both ρ and k. The algorithms can be used to derive incentive-compatible mechanisms using the LP-based framework of Lavi and Swamy for general bidders with demand oracles. The obtained mechanisms are truthful in expectation.

Keywords: Spectrum Auctions, SINR, Interference Scheduling, Combinatorial Auctions

Joint work of: Hoefer, Martin; Kesselheim, Thomas; Vöcking, Berthold

Distributed Contention Resolution in Wireless Networks

Thomas Kesselheim (RWTH Aachen, DE)

We present and analyze simple distributed contention resolution protocols for wireless networks. In our setting, one is given n pairs of senders and receivers located in a metric space. Each sender wants to transmit a signal to its receiver at a prespecified power level, e. g., all senders use the same, uniform power level as it is typically implemented in practice. Our analysis is based on the physical model in which the success of a transmission depends on the Signal-to-Interference-plus-Noise-Ratio (SINR). The objective is to minimize the number of time slots until all signals are successfully transmitted.

Our main technical contribution is the introduction of a measure called maximum average affectance enabling us to analyze random contention-resolution

algorithms in which each packet is transmitted in each step with a fixed probability depending on the maximum average affectance. We prove that the schedule generated this way is only an $O(\log^2 n)$ factor longer than the optimal one, provided that the prespecified power levels satisfy natural monontonicity properties. By modifying the algorithm, senders need not to know the maximum average affectance in advance but only static information about the network. In addition, we extend our approach to multi-hop communication achieving the same appoximation factor.

Keywords: Wireless Network, Interference, Physical Model, SINR, Distributed Scheduling

Joint work of: Kesselheim, Thomas; Vöcking, Berthold

Approximating Generalized Covering Integer Programs

Jochen Koenemann (University of Waterloo, CA)

Many network design problems are naturally cast as 0,1 (set-) covering integer programs, where connectivity requirements are expressed through cut-covering constraints; e.g., a set of edges is feasible if each edge-cut is covered by a sufficient number of edges. In this talk we focus on capacitated covering problems, where the coverage supplied by a set for the elements it contains is an arbitrary non-negative number. Such problems are naturally modeled by so called column-restricted covering IPs (CCIPs).

For a given CCIP, we define two related 0,1 covering problems: the underlying 0,1 problems, and a second, priority covering problem.

Our main result shows that the given CCIP has an O(1)-approximation if the natural LP formulations for two induced 0,1 problems have O(1) LP/IP gap.

Keywords: Approximation algorithms, LP/IP relaxations, covering integer programs

Joint work of: Chakrabarty, Deeparnab; Grant, Elyot; Koenemann, Jochen

Full Paper:
http://arxiv.org/abs/1003.2977

Constant Factor Approximation for the Steiner Forest Problem

Amit Kumar (Indian Inst. of Technology - New Dehli, IN)

We consider the stochastic Steiner forest problem: suppose we were given a collection of Steiner forest instances, and were guaranteed that a random one of these instances would appear tomorrow; moreover, the cost of edges tomorrow will be lambda times the cost of edges today.

Which edges should we buy today so that we can extend it to a solution for the instance arriving tomorrow, to minimize the expected total cost? We shall describe a constant factor approximation algorithm for this problem. We show connections of this problem with rent-or-buy network design and connected facility location problems.

We use this connection to come up with a novel LP relaxation for this problem. This is joint work with Anupam Gupta.

Decentralised Graph Colouring & Wireless Networks

Douglas Leith (Nat. University of Ireland, IE)

We propose a new class of decentralised graph colouring algorithms that are simple, robust and require no communication between graph vertices.

Keywords: Graph colouring, decentralised algorithms, wireless networks

Full Paper:
http://www.hamilton.ie/net/cfl/

Regret Minimization and Job Scheduling

Yishay Mansour (Tel Aviv University, IL)

Regret minimization has proven to be a very powerful tool in both computational learning theory and online algorithms.

Regret minimization algorithms can guarantee, for a single decision maker, a near optimal behavior under fairly adversarial assumptions.

In the talk I will discuss a recent extensions of the classical regret minimization model, which enable to handle many different settings related to job scheduling, and guarantee the near optimal online behavior.

Energy-efficient local strategies for robotic formations

Friedhelm Meyer auf der Heide (Universität Paderborn, DE)

Assume a scenario with a set of autonomous mobile robots having initial positions in the plane.

Their goal is to move in such a way that they eventually reach a prescribed formation. Such a formation may be a straight line between two given endpoints (short communication chain), a circle or any other geometric pattern, or just one point (gathering problem). In this talk, I consider simple local strategies for such robotic formation problems: the robots are limited to see only robots within a bounded radius; their decisions where to move next are solely based on the relative positions of robots within the bounded radius.

I survey recent results on local strategies for short communication chains and gathering. Our strategies are the first that come with upper and lower bounds on the number of rounds needed. The main new contributions are variants of these strategies that also yield bounds on the distance travelled by the robots, the main source for energy consumption. Finally we present a new continuous local strategy for short communication chains, and present a bound for the "price of locality": for every collection of initial robot positions, the maximum distance travelled by the robots is at most by a logarithmic (in the number of robots) factor away from the maximum distance of the initial robot positions to the straight line.

This talk surveys joint results with Bastian Degener, Barbara Kempkes, Peter Kling, and Jaroslaw Kutylowski.

Keywords: Local distributed algorithms, robotic formations

Approximation Algorithms for Weakly Coupled Stochastic Systems

Kamesh Munagala (Duke University, US)

Several problems in sequential decision theory have the property that they are composed of many independent decision sub-problems coupled together by a few constraints. We present several examples of such problems from diverse application areas such as wireless communication, design of experiments, mechanism design, and budgeted allocations. We present unifying solution techniques based on linear programming and duality, and show connections to well-known heuristics used in practice. The talk is self-contained.

Keywords: Multi-armed bandits; approximation algorithms; decision theory

Joint work of: Munagala, Kamesh; Guha, Sudipto; Shi, Peng

Full Paper:
http://arxiv.org/abs/0711.3861

Covering Crossing Biset-Families by Digraphs

Zeev Nutov (The Open Univ. of Israel - Raanan, IL)

A biset is an ordered pair of sets such that the first set contains the second set.

We consider the problem of covering a crossing biset-family by a minimum-cost set of directed edges.

While for intersecting family a standard primal-dual algorithm computes an optimal solution, the approximability of the case of crossing family is not yet understood, as it includes several NP-hard problems, for which a poly-logarithmic approximation was discovered only recently or not known.

We give an logarithmic approximation algorithm for crossing family and an almost constant approximation algorithm for some particular case that arise from the problem of increasing the connectivity of a graph by 1 at minimum cost.

Online Set Packing and Competitive Scheduling of Multi-Part Tasks

Boaz Patt-Shamir (Tel Aviv University, IL)

We consider a scenario where large data frames are broken into a few packets and transmitted over the network. Our focus is on a bottleneck router: the model assumes that in each time step, a set

of packets (a burst) arrives, from which only one packet can be served, and all other packets are lost. A data frame is considered useful only if none of its constituent packets is lost, and otherwise it is worthless. We abstract the problem as a new type of *online set packing*, present a randomized distributed algorithm and a matching lower bound on the competitive ratio for any randomized online algorithm. Our bounds are expressed in terms of the maximal burst size and the maximal number of packets per frame. We also present refined bounds that depend on the uniformity of these parameters.

Keywords: Online set packing, competitive analysis, packet fragmentation, multi-packet frames

Joint work of: Emek, Yuval; Halldorsson, Magnus; Mansour, Yishay; Patt-Shamir, Boaz; Radhakrishnan, Jaikumar; Rawitz, Dror

See also: To appear in Proc. ACM PODC 2010.

Approximation Algorithms for Domatic Partitions of Unit Disk Graphs

Sriram V. Pemmaraju (University of Iowa - Iowa City, US)

We prove a new structural property regarding the "skyline" of uniform radius disks and use this to derive a number of new sequential and distributed approximation algorithms for well-known optimization problems on unit disk graphs (UDGs). Specifically, the paper presents new approximation algorithms for two problems: *domatic partition* and *weighted minimum dominating set (WMDS)* on UDGs, both of which are of significant interest to the distributed computing community because of applications to energy conservation in wireless networks. Using the aforementioned skyline property, we derive the first constant-factor approximation algorithm for the domatic partition problem on UDGs. Prior to our work, the best approximation factor for this problem was $O(\log n)$, obtained by

simply using the approximation algorithm for general graphs. From the domatic partition algorithm, we derive a new and simpler constant-factor approximation for WMDS on UDGs.

Because of "locality" properties that our algorithms possess, both algorithms have relatively simple *constant-round* distributed implmentations in the $\mathcal{LOCAL}$ model, where there is no bound on the message size. In addition, we obtain $O(\log^2 n)$-round distributed implementations of these algorithms in the $\mathcal{CONGEST}$ model, where message sizes are bounded above by $O(\log n)$ bits per message.

Keywords: Approximation algorithms, domatic partitions, unit disk graphs

Joint work of: Pandit, Saurav; Pemmaraju, Sriram V.; Varadarajan, Kasturi R.;

Full Paper:
http://www.springerlink.com/content/up5467774l11n2w0/

See also: Approximation Algorithms for Domatic Partitions of Unit Disk Graphs, APPROX-RANDOM (2009), pp. 312–325

Oblivious Routing in the Lp-norm

Harald Raecke (University of Warwick, GB)

Gupta et al. introduced a very general multi-commodity flow problem in which the cost of a given flow solution on a graph $G = (V, E)$ is calculated by first computing the link loads via a load-function l, that describes the load of a link as a function of the flow traversing the link, and then aggregating the individual link loads into a single number via an aggregation function.

We show the existence of an oblivious routing scheme with competitive ratio $O(logn)$ and a lower bound of $\Omega(\log n/\log\log n)$ for this model when the aggregation function agg is an L_p-norm.

Our results can also be viewed as a generalization of the work on approximating metrics by a distribution over dominating tree metrics and the work on minimum congestion oblivious. We provide a convex combination of trees such that routing according to the tree distribution approximately minimizes the Lp-norm of the link loads. The embedding techniques of Bartal and Fakcharoenphol et al. can be viewed as solving this problem in the L_1-norm while the result on congestion minmizing oblivious routing solves it for L_∞. We give a single proof that shows the existence of a good tree-based oblivious routing for any L_p-norm.

Uncoordinated Two-Sided Matching Markets

Heiko Roeglin (Maastricht University, NL)

Various economic interactions can be modeled as two-sided markets. A central solution concept to these markets are stable matchings, introduced by Gale and Shapley.

It is well known that stable matchings can be computed in polynomial time, but many real-life markets lack a central authority to match agents. In those markets, matchings are formed by actions of self-interested agents. Knuth introduced uncoordinated two-sided markets and showed that the uncoordinated better response dynamics may cycle. However, Roth and Vande Vate showed that the random better response dynamics converges to a stable matching with probability one, but did not address the question of convergence time.

In this paper, we give an exponential lower bound for the convergence time of the random better response dynamics in two-sided markets. We also extend the results for the better response dynamics to the best response dynamics, i.e., we present a cycle of best responses, and prove that the random best response dynamics converges to a stable matching with probability one, but its convergence time is exponential. Additionally, we identify the special class of correlated matroid two-sided markets with real-life applications for which we prove that the random best response dynamics converges in expected polynomial time.

Keywords: Stable Marriage Problem, Convergence Time, Random Dynamics

Joint work of: Ackermann, Heiner; Goldberg, Paul; Mirrokni, Vahab; Röglin, Heiko; Vöcking, Berthold

Full Paper:
http://www.roeglin.org/publications/EC08.pdf

See also: In Proc. of the 9th ACM Conference on Electronic Commerce (EC), pp. 256-263, 2008.

A PTAS for the Highway Problem

Thomas Rothvoss (EPFL - Lausanne, CH)

In the highway problem, we are given an n-edge line graph (the highway), and a set of paths (the drivers), each one with its own budget.

For a given assignment of edge weights (the tolls), the highway owner collects from each driver the weight of the associated path, when it does not exceed the budget of the driver, and zero otherwise. The goal is choosing weights so as to maximize the profit.

A lot of research has been devoted to this apparently simple problem. The highway problem was shown to be strongly NP-hard only recently [Elbassioni, Raman,Ray-'09].

The best-known approximation is $O(\log n/\log\log n)$ [Gamzu,Segev-'10], which improves on the previous-best $O(\log n)$ approximation [Balcan,Blum-'06].

Finding a constant (or better!) approximation algorithm is a well-known open problem in network design. Better approximations are known only for a number of special cases.

In this work we present a PTAS for the highway problem, hence closing the complexity status of the problem. Our result is based on a novel randomized

dissection approach, which has some points in common with Arora's quadtree dissection for Euclidean network design [Arora-'98]. The basic idea is enclosing the highway in a bounding path, such that both the size of the bounding path and the position of the highway in it are random variables. Then we consider a recursive $O(1)$-ary dissection of the bounding path, in subpaths of uniform optimal weight. Since the optimal weights are unknown, we construct the dissection in a bottom-up fashion via dynamic programming, while computing the approximate solution at the same time. Our algorithm can be easily derandomized.

Joint work of: Grandoni, Fabrizio; Rothvoss, Thomas

Full Paper:
http://arxiv.org/abs/1004.3051

Min st-Cut Oracle for Planar Graphs with Near-Linear Preprocessing Time

Piotr Sankowski (University of Rome "La Sapienza", IT)

For an undirected n-vertex planar graph G with non-negative edge-weights, we consider the following type of query: given two vertices s and t in G, what is the weight of a min st-cut in G? We show how to answer such queries in constant time with $O(n \log^5 n)$ preprocessing time and $O(n \log n)$ space. We use a Gomory-Hu tree to represent all the pairwise min cuts implicitly. Previously, no subquadratic time algorithm was known for this problem. Since all-pairs min cut and the minimum cycle basis are dual problems in planar graphs, we also obtain an implicit representation of a minimum cycle basis in $O(n \log^5 n)$ time and $O(n \log n)$ space and an explicit representation with additional $O(C)$ time and space where C is the size of the basis.

These results require that shortest paths be unique. We deterministically remove this assumption with an additional $\log^2 n$ factor in the running time.

Joint work with Glencora Borradaile and Christian Wulff-Nilsen

Full Paper:
http://arxiv.org/abs/1003.1320

Jamming-resistant MAC Protocols for Wireless Networks

Christian Scheideler (Universität Paderborn, DE)

In this talk I consider the problem of designing medium access control (MAC) protocols for wireless networks that are provably robust against adaptive adversarial jamming. In the simple single-hop case, the wireless network consists of a set of honest and reliable nodes that are within the transmission range of each

other. In addition to these nodes there is an adversary. The adversary may know the protocol and its entire history and use this knowledge to jam the wireless channel at will at any time. It is allowed to jam a $(1-\epsilon)$-fraction of the time steps, for an arbitrary constant $\epsilon > 0$, but it has to make a jamming decision before it knows the actions of the nodes at the current step (we also call such a jammer a non-reactive jammer). The nodes cannot distinguish between the adversarial jamming or a collision of two or more messages that are sent at the same time. We demonstrate that there is a local-control MAC protocol requiring only very limited knowledge about the adversary and the network that achieves a constant throughput for the non-jammed time steps under any adversarial strategy above. We also show how to extend this protocol to the case of a reactive jammer that can distinguish between no transmission at all or at least one transmission at the current time step. Finally, we also consider an extension for multi-hop networks that can be modeled as unit disk graphs.

Keywords: Wireless networks, MAC protocols, jamming

Iterative Rounding and Relaxation

Mohit Singh (McGill University - Montreal, CA)

In this talk we will demonstrate iterative rounding and relaxation as a general technique to analyze linear programming formulations of network design problems. We will focus on degree bounded network design problems where the task is to minimize the cost of the network and also satisfy given degree bounds on nodes. The most studied problem in this class is the Minimum Bounded Degree Spanning Tree problem. We present a polynomial time algorithm that returns a spanning tree of optimal cost while exceeding the degree bound of any vertex by at most an additive one. This is the best possible result for this problem and settles a 15-year-old conjecture of Goemans affirmatively.

We will also discuss extensions to degree constrained versions of more general network design problems and give first additive approximation algorithms using the iterative method. These results add to a rather small list of combinatorial optimization problems which have an additive approximation algorithm.

Keywords: Network Design, Degree Constrained Spanning Tree

Full Paper:
http://www.cs.mcgill.ca/~mohit/publications/mbdst.pdf

See also: Approximating Minimum Bounded Degree Spanning Trees to within One of Optimal. Mohit Singh and Lap Chi Lau, In Proceedings of 39th ACM Symposium on Theory of Computing, STOC 2007: 661-670.

Power Efficient Scheduling in Wireless Networks

Markus Voelker (KIT - Karlsruhe Institute of Technology, DE)

We consider the problem of computing power efficient schedules with high throughput. First, we answer the open question concerning the complexity of scheduling with power control in the SINR_G model of interference for the case that maximum and minimum transmission powers are known. Based on a novel scheme for dynamic computation of optimum transmission powers in feasible schedules, we introduce a new and efficient heuristic for finding good schedules along the tradeoff between throughput and energy efficiency in the physical SINR model. Since our algorithms do not rely on simplistic assumptions about path loss, they are suited for realistic scenarios with attenuation and shadowing effects. We compare our approach to a broad selection of state-of-the-art approaches in indoor and outdoor scenarios. In all situations, our approach outperforms the existing approaches with respect to schedule length and power consumption.

Joint work of: Katz, Bastian; Völker, Markus; Wagner, Dorothea