09511 Abstracts Collection
Parameterized complexity and approximation algorithms
— Dagstuhl Seminar —

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Abstract. From 14. 12. 2009 to 17. 12. 2009., the Dagstuhl Seminar 09511 "Parameterized complexity and approximation algorithms " 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. Parameterized complexity, Approximation algorithms

09511 Executive Summary – Parameterized complexity and approximation algorithms

Many of the computational problems that arise in practice are optimization problems: the task is to find a solution where the cost, quality, size, profit, or some other measure is as large or small as possible. The NP-hardness of an optimization problem implies that, unless P = NP, there is no polynomial-time algorithm that finds the exact value of the optimum. Various approaches have been proposed in the literature to cope with NP-hard problems. When designing approximation algorithms, we relax the requirement that the algorithm produces an optimum solution, and our aim is to devise a polynomial-time algorithm such that the solution it produces is not necessarily optimal, but there is some worst-case bound on the solution quality.

Keywords: Parameterized complexity, Approximation algorithms

Joint work of: Demaine, Erik D.; Hajiaghayi, MohammadTaghi; Marx, Dániel

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2010/2501

09511 Open Problems – Parameterized complexity and approximation algorithms

The paper contains a list of the problems presented on Monday, December 14, 2009 at the open problem session of the Seminar on Parameterized Complexity and Approximation Algorithms, held at Schloss Dagstuhl in Wadern, Germany.

Keywords: Parameterized complexity, approximation algorithms, open problems

Joint work of: Demaine, Erik D.; Hajiaghayi, MohammadTaghi; Marx, Dániel

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2010/2499

Tree-width for first order formulas

Isolde Adler (Goethe-Universität Frankfurt am Main, DE)

We introduce the notion of tree-width for first order formulas, fotw, and we show that model checking of first order logic of bounded fotw is fixed-parameter tractable (where the parameter is the length of the formula).

Keywords: Tree-width, first order logic, model checking

Joint work of: Adler, Isolde; Weyer, Mark

Full Paper:
http://www.springerlink.com/content/c521717292717857/

Metakernelization: a piece of the proof

Hans L. Bodlaender (Utrecht University, NL)

In this talk, a method to obtain kernelization algorithms for a large class of problems on surfaces is discussed. In particular, the talk focusses on the result that all problems that look for a minimum set fulfilling a compactness property and a property stated in MSOL have a quadratic kernel on planar graph. The main ingredients of the proof are discussed.

Joint work of: Bodlaender, Hans L.; Fomin, Fedor V.; Lokshtanov, Daniel; Penninkx, Eelko; Saurabh, Saket; Thilikos, Dimitrios M.

Satisfiability Allows No Nontrivial Sparsification Unless The Polynomial-Time Hierarchy Collapses

Holger Dell (HU Berlin, DE)

Consider the following two-player communication process to decide a language L: The first player holds the entire input x but is polynomially bounded; the second player is computationally unbounded but does not know any part of x; their goal is to cooperatively decide whether x belongs to L at small cost, where the cost measure is the number of bits of communication from the first player to the second player.

For any integer $d \geq 3$ and positive real ϵ we show that if satisfiability for n-variable d-CNF formulas has a protocol of cost $O(n^{d-\epsilon})$ then coNP is in NP/poly, which implies that the polynomial-time hierarchy collapses to its third level. The result even holds for conondeterministic protocols, and is tight as there exists a trivial deterministic protocol for $\epsilon = 0$. Under the hypothesis that coNP is not in NP/poly, our result implies tight lower bounds for parameters of interest in several areas, namely sparsification, kernelization in parameterized complexity, lossy compression, and probabilistically checkable proofs.

By reduction, similar results hold for other NP-complete problems.

For the vertex cover problem on n-vertex d-uniform hypergraphs, the above statement holds for any integer $d \geq 2$. The case $d = 2$ implies that no NP-hard vertex deletion problem based on a graph property that is inherited by subgraphs can have kernels consisting of $O(k^{2-\epsilon})$ edges unless coNP is in NP/poly, where k denotes the size of the deletion set. Kernels consisting of $O(k^2)$ edges are known for several problems in the class, including vertex cover, feedback vertex set, and bounded-degree deletion.

Keywords: Sparsification, Kernelization, Probabilistically Checkable Proofs, Lower Bounds

Joint work of: Dell, Holger; van Melkebeek, Dieter

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2010/2504

Overview of Bidimensionality

Erik Demaine (MIT - Cambridge, US)

Bidimensionality theory is an approach to algorithmic graph minor theory. This theory provides general tools for designing fast (constructive, often subexponential) fixed-parameter algorithms, and approximation algorithms (often PTASs), for a wide variety of NP-hard graph problems in graphs excluding a fixed minor.

For example, some of the most general algorithms for feedback vertex set and connected dominating set are based on bidimensionality. Another approach is “deletion and contraction decompositions”, which split any graph excluding a fixed minor into a bounded number of small-treewidth graphs. For example, this approach has led to some of the most general algorithms for graph coloring and the Traveling Salesman Problem on graphs. I will describe these and other approaches to efficient algorithms through graph minors.

Planar subgraph isomorphism

Frederic Dorn (University of Bergen, NO)

In this talk, we will give an insight on the exact computation of subgraph isomorphism and of variations of subgraph isomorphism on planar graphs.

The problem of Subgraph Isomorphism is defined as follows: Given a *pattern* H on k vertices and a *host graph* G on n vertices, does G contain a subgraph that is isomorphic to H? Subgraph Isomorphism generalizes many important graph problems, such as Hamiltonicity, Longest Path, and Clique. It is known to be NP-complete, even when restricted to planar graphs. Until now, the best known algorithm to solve Subgraph Isomorphism is the naïve exhaustive search algorithm with running time $O(n^k)$. If H is a simple path, we have the k-Longest Path problem, and the elegant Color-coding technique of Alon et al [J'ACM 95] provides an FPT-algorithm of running time $2^{O(k)} \cdot O(n^2)$.

We study Planar Subgraph Isomorphism when both pattern and host graph are restricted to planar graphs and the order k of the pattern is our parameter. We introduce an algorithmic technique, called “embedded dynamic programming", exploiting the topology of the underlying graph embeddings. The basic idea behind this technique is, on a suitably structured graph decomposition, to exploit the topology of the possible embeddings of the subgraph pattern (rather than of the host graph). We give an upper bound on the number of partial solutions in each dynamic programming step as a function of pattern size—as it turns out, for Planar Subgraph Isomorphism, that function is single exponential in the number of vertices in the pattern. Whereas the previously fastest algorithm (Eppstein's FPT-algorithm [SODA 95, J'GAA 99]) runs in time $k^{O(k)}n$, our algorithm has the running time $2^{O(k)}n$, that is, single exponential in k while keeping the term in n linear.

Next to deciding subgraph isomorphism, we can construct a solution and count all solutions in the same asymptotic running time. We may enumerate w subgraphs within an additive term $O(wn)$ in the running time of our algorithm.

Keywords: Subgraph Isomorphism, FPT-algorithms, Planar graphs, Dynamic programming

Combining two worlds: parameterized approximation algorithms for vertex cover

Henning Fernau (Universität Trier, DE)

This talk describes work-in-progress that shows how ideas from parameterized algorithmics can be used to obtain approximation algorithms for vertex cover that not only yield approximation factors smaller than 2 that are usually not believed to be obtainable by polynomial time algorithms, but also yield run times far better than direct applications of known parameterized algorithms in this setting.

To this end, new kinds of approximation-preserving reduction rules are devised that might be interesting in their own right, and new kind of branching strategies are shown that are inherently different from what is usually done in parameterized exact algorithms.

Keywords: Vertex cover, approximation, parameterized algorithm

Joint work of: Brankovic, Ljiljana; Fernau, Henning

Problems Parameterized Above Tight Lower Bounds

Gregory Z. Gutin (RHUL - London, GB)

Mahajan and Raman (1999) were the first to formally consider problems parameterized above tight lower bounds (PATLB). They and few others proved that some such problems are FPT. Mahajan, Raman and Sikdar (2009) obtained more results on the topic and stated several open questions.

I'll consider recent progress in determining parameterized complexity of problems PATLB stated by Mahajan, Raman and Sikdar, by Benny Chor, etc. and methods involved in proving results in the area. In particular, I'll consider a powerful combination of probabilistic and harmonic analysis inequalities in proving that some of the problems PATLB are FPT and admit polynomial-size kernels.

Keywords: FPT, kernelization, lower bound, probabilistic method, Fourier Analysis

Minimizing Movement: Approximability and Fixed Parameter Tractability

MohammadTaghi Hajiaghayi (AT&T Research - Florham Park, US)

We study an extensive class of movement minimization problems which arise from many practical scenarios but so far have little theoretical study.

In general, these problems involve planning the coordinated motion of a collection of agents (representing robots, people, map labels, network messages, etc.) to achieve a global property in the network while minimizing the maximum or average movement (expended energy). The only previous theoretical results about this class of problems are about approximation, and mainly negative: many movement problems of interest have polynomial inapproximability. Given that the number of mobile agents is typically much smaller than the complexity of the environment, we turn to fixed-parameter tractability. We characterize the boundary between tractable and intractable movement problems in a very general set up: it turns out the complexity of the problem fundamentally depends on the treewidth of the minimal configurations. Thus the complexity of a particular problem can be determined by answering a purely combinatorial question. Using our general tools, we determine the complexity of several concrete problems and fortunately show that many movement problems of interest can be solved efficiently. On the other hand, we give approximation algorithms and inapproximability results for a class of movement problems. This general family of movement problems encompass an intriguing range of graph and geometric algorithms, with several real-world applications and a surprising range of approximability. In some cases, we obtain tight approximation and inapproximability results using direct techniques (without use of PCP), assuming just that P $\neq$ NP.

Keywords: Graph Algorithms, FPT, Approximation, Algorithm

Full Paper:
http://www-math.mit.edu/~hajiagha/FPTMovement.pdf

Efficient Parameterized Algorithms for Protein Structure Prediction and Applications

Xiuzhen Huang (Arkansas State University - Jonesboro, US)

The immediate need for knowing proteins structure intensifies as the applications of engineered proteins for drugs, carriers, enzymatic activities, receptors, vaccines, antibodies, biomaterials and nanotechnology, in vitro synthesis, and detection systems grow. Due to the high cost of experimental determination of protein structures, there is tremendous demand for efficient and accurate computational predictions of protein structures from primary sequence data and inference of protein functions from structure for rational protein or drug design. However, current computational approaches provide limited accuracy, often cannot handle large proteins, and require significant computational time. We developed a novel parameterized algorithm for structure-sequence alignment, which is the highly challenging computational part for protein structure prediction based on threading. The algorithm incorporates a graph theoretic model, parameterized computation and tree decomposition techniques. Experimental results demonstrate a successful application of the algorithm to non-coding RNA structure search in genomes. Methods based on this algorithm provide analogous increases in efficiency and accuracy in response to the protein structure prediction challenges. Through collaborative research with biologists and biomedical researchers, we are applying these methods to structure-function studies on proteins (like RTB and UGTs) with direct significant medical applications.

A fast approximation scheme for the multiple knapsack problem

Klaus Jansen (Universität Kiel, DE)

In this talk we propose an improved efficient approximation scheme for the multiple knapsack problem (MKP). Given a set $\mathcal{A}$ of n items and set $\mathcal{B}$ of m bins with possibly different capacities, the goal is to find a subset $S \subseteq \mathcal{A}$ of maximum total profit that can be packed into $\mathcal{B}$ without exceeding the capacities of the bins. Kellerer gave a polynomial time approximation scheme (PTAS) for MKP with identical capacities and Chekuri and Khanna presented a PTAS for MKP with arbitrary capacities with running time $n^{O(1/\epsilon^8 \log(1/\epsilon))}$. Recently we found an efficient polynomial time approximation scheme (EPTAS) for MKP with running time $2^{O(1/\epsilon^5 \log(1/\epsilon))} poly(n)$.

Here we present an improved EPTAS with running time $2^{O(1/\epsilon \log(1/\epsilon)^4)} + poly(n)$. If the modified round-up property for bin packing with different sizes is true, the running time can be improved to $2^{O(1/\epsilon \log(1/\epsilon)^2)} + poly(n)$.

Keywords: Knapsack problem, approximation scheme

A survey of connectivity approximation via a survey of techniques

Guy Kortsarz (Rutgers University-Camden, US)

We survey approximation algorithms of connectivity problems. The survey presented describing various techniques. In the talk the following techniques and results are presented.

1)Outconnectivity: Its well known that there exists a polynomial time algorithm to solve the problems of finding an edge k-outconnected subgraph from r [Edmonds] and a vertex k-outconnectivity subgraph from r [Frank-Tardos]. We show how to use this to obtain a ratio 2 approximation for the min cost edge k-connectivity problem.

2)The critical cycle theorem of Mader: We state a fundamental theorem of Mader and use it to provide a $1 + (k-1)/n$ ratio approximation for the min cost vertex k-connected subgraph, in the metric case. We also show results for the min power vertex k-connected problem using this lemma. We show that the min power is equivalent to the min-cost case with respect to approximation.

3)Laminarity and uncrossing: We use the well known laminarity of a BFS solution and show a simple new proof due to Ravi et al for Jain's 2-approximation for Steiner network.

Keywords: Connectivity, laminar, uncrossing, Mader's Theorem, power problems

Joint work of: Kortsarz, Guy; Nutov, Zeev

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2010/2497

Full Paper:
http://crab.rutgers.edu/~guyk/pub/book/nabs.pdf

See also: G. Kortsarz and Z. Nutov, Approximating min-cost connectivity problems, Survey Chapter in handbook on approximation, 2006.

Algorithmic Properties of Nowhere Dense Classes of Graphs

Stephan Kreutzer (University of Oxford, GB)

Nowhere Dense classes of graphs is a new concept of graphs recently introduced by Nesetril and Ossona de Mendez to capture sparse graph classes.

Nowhere dense graph classes strictly generalise classes excluding a fixed minor, or of bounded local tree-width or which locally exclude a minor.

In this talk we will present several algorithmic techniques to obtain parameterised algorithms for a range of problems such as variations of the dominating set problem on nowhere dense classes. We will also show that every problem definable in first-order logic (in a parameterized sense) can be decided in almost parmeterized linear time on any such class and illustrate the proof technique for this which is based on the idea of low tree-depth colouring studied by Nesetril and Ossona de Mendez.

As it turns out, this result can be generalised even further to a new concept of graph classes which are "colourable over some class C with the type representation property". Such classes include all classes of bounded clique-width and also all classes which are nowhere dense and hence all classes excluding a minor. Hence applying this technique allows one to obtain algorithms which work on very dense graph classes having bounded clique-width but alsoon sparse classes which are nowhere dense.

Keywords: Parameterized complexity, parameterized algorithms, algorithmic meta-theorems, finite model theory

Introduction to Kernel Lower Bounds

Daniel Lokshtanov (University of Bergen, NO)

Kernelization is a mathematical framework for studying polynomial time preprocessing. In this talk i will survey recent results showing when efficient kernelization is infeasible.

Keywords: Kernelization, Pre-proessing

Survey of connections between approximation algorithms and parameterized complexity

Dániel Marx (Tel Aviv University, IL)

In my talk, I overview the ways approximation can be introduced into the framework of parameterized complexity, survey results in this direction, and show how parameterized hardness theory can be used to give lower bounds on the efficiency of approximation schemes.

Keywords: Approximation, parameterized complexity

A Win/Win Strategy for TSP and Minimum Hamiltonian Paths

Tobias Moemke (ETH Zürich, CH)

We consider variants of the traveling salesman problem with precedence constraints.

We characterize hard input instances for Christofides' algorithm and Hoogeveen's algorithm by relating the two underlying problems, i. e., the traveling salesman problem and the problem of finding a minimum-weight Hamiltonian path between two prespecified vertices.

We show that the sets of metric worst-case instances for both algorithms are disjoint in the following sense. There is an algorithm that, for any input instance, either finds a Hamiltonian tour that is significantly better than 1.5-approximative or a set of Hamiltonian paths between all pairs of endpoints, all of which are significantly better than 5/3-approximative.

Keywords: TSP, Hamiltonian path, structural properties

Algorithms for rank-width

Sang-il Oum (KAIST - Daejeon, KR)

Rank-width is a width parameter of graphs, developed to be a better replacement of clique-width.

Most algorithmic applications of clique-width require a decomposition tree of clique-width to be given as an input but it is still open whether for fixed $k > 3$, there is a polynomial-time algorithm to decide whether clique-width of an input graph is at most k.

Rank-width is a tool to bypass this difficulty by providing an approximate but good decomposition for clique-width.

I will give an overview on algorithms related to finding a good decomposition for rank-width and clique-width.

Keywords: Rank-width, clique-width

Some lower bounds from the complexity of SAT

Mihai Patrascu (AT&T Research - Florham Park, US)

We describe reductions from the problem of determining the satisfiability of Boolean CNF formulas (CNF-SAT) to several natural algorithmic problems. We show that attaining any of the following bounds would improve the state of the art in algorithms for SAT:

- an $O(n^{k-\varepsilon})$ algorithm for k-Dominating Set, for any $k \geq 3$;
- a (computationally efficient) protocol for 3-party set disjointness with $o(m)$ bits of communication;
- an $n^{o(d)}$ algorithm for d-SUM;
- an $O(n^{2-\varepsilon})$ algorithm for 2-SAT with $m = n^{1+o(1)}$ clauses, where two clauses may have unrestricted length;
- an $O((n+m)^{k-\varepsilon})$ algorithm for HornSat with k unrestricted length clauses.

One may interpret our reductions as new attacks on the complexity of SAT, or sharp lower bounds conditional on exponential hardness of SAT.

Joint work of: Patrascu, Mihai; Williams, Ryan

Full Paper:
http://people.csail.mit.edu/mip/papers/sat-lbs/paper.pdf

See also: 21st ACM/SIAM Symposium on Discrete Algorithms (SODA 2010).

Kernels for Feedback Arc Set In Tournaments

Christophe Paul (CNRS, Université Montpellier II, FR)

A tournament $T = (V, A)$ is a directed graph in which there is exactly one arc between every pair of distinct vertices.

Given a digraph on n vertices and an integer parameter k, the Feedback Arc Set problem asks whether the given digraph has a set of k arcs whose removal results in an acyclic digraph. The Feedback Arc Set problem restricted to tournaments is known as the k-Feedback Arc Set in Tournaments (k-FAST) problem. In this paper we obtain a linear vertex kernel for k-FAST. That is, we give a polynomial time algorithm which given an input instance T to k-FAST obtains an equivalent instance T' on $O(k)$ vertices. In fact, given any fixed $\epsilon > 0$, the kernelized instance has at most $(2 + \epsilon)k$ vertices. Our result improves the previous known bound of $O(k^2)$ on the kernel size for k-FAST. Our kernelization algorithm solves the problem on a subclass of tournaments in polynomial time and uses a known polynomial time approximation scheme for k-FAST.

Keywords: Kernel, tournament, feedback arc set

Joint work of: Bessy, Fomin, Gaspers, Paul, Perez, Saurabh, Thomassé

FPT Algorithms using Iterative Localization

Saket Saurabh (University of Bergen, NO)

Given a permutation π of $\{1, \dots, n\}$ and a positive integer k, we give an algorithm with running time $2^{O(k^2 \log k)} n^3$ that decides whether π can be partitioned into at most k increasing or decreasing subsequences.

Thus we resolve affirmatively the open question of whether the problem is fixed parameter tractable. This NP-complete problem is equivalent to deciding whether the cochromatic number (the minimum number of cliques or independent sets that the vertices can be partitioned into) of a given permutation graph on n vertices is at most k. In fact, we give a more general result: within running time $2^{O(k^2 \log k)} n^{O(1)}$, we can decide whether the cochromatic number of a given perfect graph on n vertices is at most k.

To obtain our result we combine in a new way two well-known techniques within parameterized algorithms: greedy localization and iterative compression.

We further demonstrate the power of this combination by giving a $2^{O(k^2 \log k)} n^{O(1)}$ time algorithm for deciding whether a given set of n non-overlapping axis-parallel rectangles can be stabbed by at most k of a given set of horizontal and vertical lines. Existence of such an algorithm was posed as an open question in several papers

Keywords: Iterative localization, co-coloring, rectangle stabbing

Joint work of: Heggernes, Pinar; Kratsch, Dieter; Lokshtanov, Daniel; Raman, Venkatesh; Saurabh, Saket

Parameterized Algorithms for String Correction Problems

Ulrike Stege (University of Victoria, CA)

String correction problems model genome rearrangement problems as well as text-correction problems in areas such as computational biology, data mining, and information retrieval. The common question considered is for two given strings x and y and a set of operations, how many (if at all possible) of the permitted operations are necessary to change y into x. Although many such problems have seen a lot of attention in the literature, by far not all relevant ones are studied or sufficiently solved.ă We consider here the parameterized complexity of the problems Sorting by Reversals, Sorting by Transpositions (both FPT) and of another problem belonging to this family that has not received much attention in the past years, namely the String-to-String Correction problem (S2Sc), listed in Garey-Johnson's catalogue of NP-complete problems. In S2Sc, we are given two strings x and y and a positive integer k, and are asked whether it is possible to transform y into x with at most k single character deletions and adjacent character exchanges. We present a first simple fixed-parameter algorithm for String-to-String Correction that runs in $O^*(2^k)$ and thus show that the problem is a member of the class FPT. Moreover, we present a search-tree algorithm that exhibits a novel technique of bookkeeping, charging, which leads to an improved $O^*(1.62^k)$ algorithm.

Joint work of: Stege, Ulrike; Abu-Khzam, Faisal; Fernau, Henning; Langston, Michael; Lee-Culture, Serena; Dehne, Frank

Differentially Private Combinatorial Optimization

Kunal Talwar (Microsoft Research - Mountain View, US)

Consider the following problem: given a metric space, some of whose points are "clients," select a set of at most k facility locations to minimize the average distance from the clients to their nearest facility. This is just the well-studied k-median problem, for which many approximation algorithms and hardness results are known. Note that the objective function encourages opening facilities in areas where there are many clients, and given a solution, it is often possible to get a good idea of where the clients are located. This raises the following quandary: what if the locations of the clients are sensitive information that we would like to keep private? *Is it even possible to design good algorithms for this problem that preserve the privacy of the clients?*

In this paper, we initiate a systematic study of algorithms for discrete optimization problems in the framework of differential privacy (which formalizes the idea of protecting the privacy of individual input elements). We show that many such problems indeed have good approximation algorithms that preserve differential privacy; this is even in cases where it is impossible to preserve cryptographic definitions of privacy while computing any non-trivial approximation to even the *value* of an optimal solution, let alone the entire solution.

Apart from the k-median problem, we consider the problems of vertex and set cover, min-cut, facility location, and Steiner tree, and give approximation algorithms and lower bounds for these problems. We also consider the recently introduced submodular maximization problem, "Combinatorial Public Projects" (CPP), shown by Papadimitriou et al. to be inapproximable to subpolynomial multiplicative factors by any efficient and *truthful* algorithm. We give a differentially private (and hence approximately truthful) algorithm that achieves a logarithmic additive approximation.

Joint work with Anupam Gupta, Katrina Ligett, Frank McSherry and Aaron Roth.

Keywords: Differential Privacy, Approximation Algorithms

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2010/2498

Faster Approximation Schemes and Parameterized Algorithms on H-Minor-Free Graphs

Siamak Tazari (HU Berlin, DE)

One of the most prominent techniques to derive approximation algorithms and schemes on proper minor-closed graph classes is the method commonly known as Baker's approach (1994). Grohe (2003) and Demaine et al. (2005) generalized Baker's idea from planar graphs to all H-minor-free graphs by basically proving a certain partitioning theorem for these graph classes. Our first main result is a significantly faster version of this algorithm: we improve the running time from $O(n^{f(|H|)})$ to $O(f(|H|)n^{O(1)})$ showing the fixed-parameter tractability of this problem with parameter $|H|$. As a consequence, we improve all the numerous implications of this result obtaining e.g. the first 2-approximation for coloring and PTASes for various problems, such as independent set, dominating set, and max-cut running in FPT-time with respect to $|H|$ on H-minor-free graphs.

In the second main part of our work, we introduce a new technique to derive (sub-exponential) parameterized algorithms on H-minor-free graphs. We provide a uniform algorithm running in time $\inf_{0<\varepsilon<=1} O((1+\varepsilon)^k + n^{O(1/\varepsilon)})$, where n is the size of the input and k is the number of vertices or edges in the solution, defining a new parameterized complexity class SUBEPT$^+$. Our technique applies, in particular, to problems such as Steiner tree, (directed) sub-graph with a property, (directed) longest path, (connected/independent) dominating set, vertex cover and independent set on some or all proper minor-closed graph classes, many of which were previously not even known to admit an algorithm with running time better than $O(2^k n^O(1))$. We obtain as a corollary that all problems with a minor-monotone sub-exponential kernel and amenable to our technique can be solved in sub-exponential FPT-time on H-minor free graphs. This results in a general methodology for sub-exponential parameterized algorithms outside the framework of bidimensionality.

Keywords: Subexponential Parameterized Algorithms, Kernels, Graph Minors, PTAS

Contraction Bidimensionality: the Accurate Picture

Dimitrios M. Thilikos (National and Kapodistrian University of Athens, GR)

We provide new combinatorial theorems on the structure of graphs that are contained as contractions in graphs of large treewidth. As a consequence of our combinatorial results we unify and significantly simplify contraction bidimensionality theory: the meta algorithmic framework to design efficient parameterized and approximation algorithms for contraction closed parameters.

Keywords: Paramerterized Algorithms, Bidimensionality, Graph Minors

Joint work of: Fomin, Fedor V.; Golovach, Petr; Thilikos, Dimitrios M.

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2010/2500

Full Paper:
http://users.uoa.gr/∼sedthilk/papers/bidim.pdf

See also: ESA 2009: pages 706-717.

Structure of Polynomial-Time Approximation

Erik Jan van Leeuwen (TU Eindhoven, NL)

Approximation schemes are commonly classified as being either a polynomial-time approximation scheme (ptas) or a fully polynomial-time approximation scheme (fptas). To properly differentiate between approximation schemes for concrete problems, several subclasses have been identified: (optimum-)asymptotic schemes (ptas$^{\infty}$, fptas$^{\infty}$), efficient schemes (eptas), and size-asymptotic schemes. We explore the structure of these subclasses, their mutual relationships, and their connection to the classic approximation classes. Using notions from fixed-parameter complexity theory, we also provide new characterizations of when problems have a ptas or fptas.