Parameterized Complexity News
Newsletter of the PC Community July 2011

Welcome

Frances Rosamond, Editor
Congratulations to Dániel Marx, Cristina Bazgan and Iyad Kanj for awards, and to others on new positions. This newsletter includes two excellent articles, new results, positions, conferences, and call for papers. Please keep the Table of Races updated with your latest results at our community wiki **www.fpt.wikidot.com**.

Dániel Marx awarded an ERC

Congratulations to **Dániel Marx** awarded a prestigious European Research Council Starting Grant. Dániel's 1.15M EUR, 5-year project will start January 2012 in Budapest, Hungary. The project is "PARAMTIGHT: Parameterized complexity and the search for tight complexity results".

Figure 1: Dániel Marx

Dániel Marx received his Ph.D. in CS at Budapest Univ. of Technology and Economics. He has held postdoc positions at Berlin, Budapest, and Tel Aviv, and now holds a Humboldt Research Fellowship for Experienced Researchers at Humboldt-University, Berlin. Marx is often an invited speaker, including WG2011 with "Important separators and parameterized algorithms".

Researchers in parameterized complexity have been successful in obtaining ERC grants. *Fedor Fomin* received an ERC Advanced Grant 2010 for the project "Rigorous Theory of Preprocessing," and *Stefan Szeider* received an ERC Starting Grant 2009 for "The Parameterized Complexity of Reasoning Problems." The ERC has offered the awards since 2007. They are highly competitive, among top scientists in all fields, aiming to support innovative ideas at the frontiers of knowledge.

Cristina Bazgan awarded an IUF

Congratulations to **Cristina Bazgan** awarded a Junior Institute Universitaire de France. The highly competitive IUF distinguishes a small number of teacher-researchers

Figure 2: Cristina Bazgan

for their research excellence. Prof Bazgan is LAM-

Contents of this issue:

SADE researcher and Co-Director of the Grad School: Decision, Computer Science, Mathematics and Organization at Univ. Dauphine. The IUF aims to give its winners freedom to pursue their research by providing significant teaching relief and project support for five years. The IUF is an "organization without walls" whose members remain in their own universities.

Iyad Kanj awarded *Spirit of Inquiry*

Figure 3: Iyad Kanj

Congratulations to **Iyad Kanj** who has received the *Spirit of Inquiry Award* from DePaul University in recognition for his research in theoretical computer science, especially in the area of parameterized complexity. Iyad was nominated by his faculty, and then honoured by the University Research Council. The competition was with all other fields. Iyad is Associate Professor at DePaul Univ, Chicago. His Ph.D. in computer science comes from Texas A and M.

Breakthrough Poly(k) Kernelization: Odd Cycle Transversal!

by Michael Fellows, Charles Darwin University, Australia

In a paper posted to arXiv on 15 July 2011 with the title, "*Compression via Matroids: A Randomized Polynomial Kernel for Odd Cycle Transversal*" Stefan Kratsch and Magnus Wahlström have achieved a major breakthrough: the problem of deleting k vertices to make graph bipartite, has a polynomial kernelization. Bart Jansen and others have previously noted this as one of the most prominent concrete open problems in the rapidly developing theory of polynomial-time kernelization, along with the still open questions in this regard concerning Chordal Deletion, Planar Deletion and Directed Feedback Vertex Set. Bart conjectures (this is an interpretation of a recent email) that all of these problems *do* have polynomial-sized kernels: "... polynomial, but really involved, kernels." This paper settles affirmatively, by very interesting new methods, one of the four most prominent concrete open problems in kernelization, and perhaps lends support to Bart's conjecture that all four admit polynomial kernelization. Encoding the relevant information about a problem compactly into a language different than that of the original problem seems like an interesting direction for kernelization, and a direct, combinatorial kernel remains a very interesting problem.

FPT papers in Conferences

Here is a great resource that will help us quickly find recent FPT papers. This is the "List of FPT papers in Conferences" page located at `http://fpt.wikidot.com/fpt-papers-in-conferences`. Or, go to the wiki at `http://fpt.wikidot.com` and choose from the menu on the left column. Many thanks to Bart Jansen for this useful resource.

Solving MSO-definable problems

by Alexander Langer, Felix Reidl, Peter Rossmanith, Somnath Sikdar, RWTH Aachen University, Germany

Several real-world optimization problems can be modeled by graphs with small treewidth. Interesting examples include optimization problems for train and road networks when the underlying network has low treewidth. In practice, however, LP or ILP solvers that are oblivious to the treewidth are usually used when the problems admit an (I)LP formulation. Another option is to develop tailor-made algorithms, but it is not clear whether these algorithms will be faster than general ILP solvers. Moreover, they take considerable time and energy to develop.

The fundamental theorem of Courcelle [1] states that every problem definable in Monadic Second-Order Logic (MSO) is solvable in linear time on graphs of bounded treewidth. However, it turns out that even for trivial problems like testing connectivity, the straightforward approach of constructing a tree automaton is infeasible in practice [10, 4, 5, 7, 8]. Recently, there have been a couple of approaches to avoid the problematic power set construction [7, 8, 4, 3, 2]. We use a new approach [9] that essentially combines the simple PSPACE-algorithm for MSO model-checking with dynamic programming on the tree decomposition.

We implemented this approach in C++ and ran experiments for the Minimum Dominating Set and Minimum Connected Dominating Set problems on grid-like graphs of dimension $k \times 1000$, where $1 \leq k \leq 8$, which have treewidth at most k. It turns out that for certain instances of low treewidth our tool can compete and even outperform CPLEX [6]. Of course, CPLEX does much better on other instances which is to be expected from a

highly optimized commercial ILP-solver. With time, we plan to add in more functionality to make our software a practical tool for many purposes.

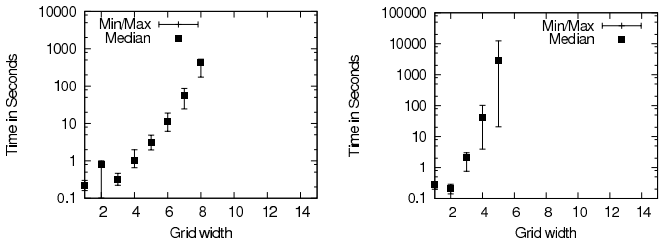

Figure 4: Running time of our MSO solver for Minimum Dominating Set and Minimum Connected Dominating Set on subgraphs of $k \times 1000$-grids.

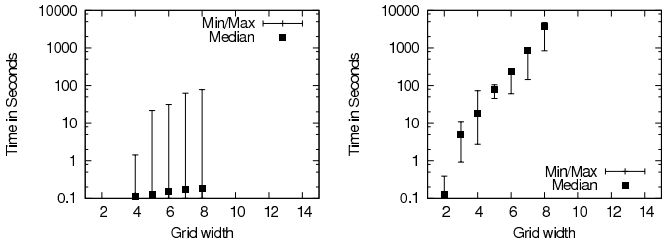

Figure 5: Running time of CPLEX for Minimum Dominating Set on subgraphs of grids (edge probability $p < 0.9$ and $p \geq 0.9$, respectively). The problem becomes significantly harder on denser instances.

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Constraint Satisfaction Problems Parameterized Above or Below Tight Bounds

by Anders Yeo, Royal Holloway, London

We will give a short survey of some results and open problems in a new area of parameterized complexity where the parameter denotes how much better than a given bound we can do. Probably the best known problem in this area is MaxSat, where for a given CNF formula F with m clauses, we are asked to determine the maximum number of clauses of F that can be satisfied by a truth assignment, which will be denoted by $\text{sat}(H)$.

It is well-known that there exists a truth assignment to the variables of F which satisfies at least $m/2$ clauses (as every clause has probability at least $1/2$ of being satisfied by a truth assignment where every variable is assigned *true* or *false* independently with probability $1/2$). The lower bound $\text{sat}(F) \geq m/2$ is tight as we have $\text{sat}(H) = m/2$ if $H = (x_1) \wedge (\bar{x}_1) \wedge \cdots \wedge (x_n) \wedge (\bar{x}_n)$.

The standard parameterization of MaxSat is as follows: decide whether there is a truth assignment which satisfies at least k clauses of F, where k is the parameter. It is very easy to see that MaxSat has a kernel with a linear number of variables. Indeed, consider an instance I of MaxSat. If $k \leq m/2$ then I is a Yes-instance. Otherwise, we have $k > m/2$ and $m \leq 2k - 1$. In fact, even a better bound for the kernel size, say $1.01k$ would be of little interest, as the answer is YES unless $k > m/2$ in which case the bound is at least $0.505m$, which is clearly huge! Thus, such a kernel is not *small* as a first glance might suggest.

To the best of our knowledge, [8] was the first paper on problems parameterized above or below tight bounds and it contained the following problem: Can we decide if a CNF formula satisfies at least $m/2 + k$ clauses in FPT time, where k is the parameter. The authors then showed that the answer is *yes* as it has a kernel with at most $6k+3$ variables and $10k$ clauses. This was later improved to $4k$ variables and $8.474k$ clauses in [3]. A more difficult problem is the following:

MaxSat-AA
Instance: A CNF formula F (clauses may appear several times in F) and a nonnegative integer k.
Parameter: k.
Question: Is $\text{sat}(F) \geq Avg(F) + k$, where $Avg(F)$ denotes the average number of clauses satisfied by a random truth assignment where all variables are assigned true or false with probability 1/2 independently?

It is still unknown whether this problem is FPT or not. However if we bound the size of the clauses by some constant r then it is shown in [1] that there exists an $O(k^2)$ kernel. The main idea of the proof in [1] is to reduce Max-r-SAT-AA to Max-r-Lin2-AA (which will be defined below) and use results on Max-r-Lin2-AA.

This result solves an open question from [9] not only for Max-r-Sat-AA but also for the more general problem Max-r-CSP-AA (which is a more general problem where we consider arbitrary Boolean functions rather than clauses). The kernel for Max-r-CSP-AA is of polynomial size, but the degree of the polynomial is not determined.

It is also interesting to parameterize below tight upper bounds. For example m is clearly an upper bound on the number of clauses that can be satisfied in 2-SAT, so a natural question would be if we can satisfy $m-k$ clauses where k is the parameter. In [11] it was shown that the problem has a kernel with at most $15^k k$ clauses. This was further improved to $O(9^k(km)^{O(1)})$ and $O(4^k(km)^{O(1)})$ in [10] and [4], respectively.

The problems Max-Lin2-AA and Max-r-Lin2-AA are defined as follows. In Max-Lin2-AA we are given a system of linear equations over $\mathbb{F}_2$ in which each equation has a positive integral weight and we need to decide whether there is an assignment to the variables that satisfies equations of total weight at least $W/2+k$, where W is the total weight of all equations. Max-r-Lin2-AA is the same as MaxLin2-AA except each equation has at most r variables, where r is a constant. These problems have received a lot of attention recently both due to the importance of the problems themselves as well as their connection to constraint satisfaction problems. After several partial results were published it was finally proved in [2] that Max-Lin2-AA has a kernel with at most $O(k^2 \log k)$ variables. The question whether Max-Lin2-AA admits a polynomial kernel (in the number of equations as well as variables) is still open.

Another area which has been extensively studied is *Ordering CSPs* which are defined as follows. Linear Order-r is the problem of finding a global ordering (permutation) of a set of variables V, such that the maximum number of constraints are satisfied, where a constraint is defined as follows. A constraint contains a given ordering of a set of r variables in V and is said to be satisfied if the ordering in the constraint matches the global ordering (the same set of r variables may appear in several constraints). Linear Order-2 is equivalent to the problem Acyclic ordering in a digraph (that is, find an acyclic subdigraph with the maximum number of arcs). Well known problems such as Betweenness and Circular Ordering can easily be reduced to Linear Order-3 and can therefore be considered as special cases of Linear Order-3. When parameterizing above the average (which is a tight lower bound) a quadratic kernel for Linear Order-2 was obtained in [6] and for Linear Order-3 in [5]. These have recently been improved to kernels with a linear number of variables in [7]. It is still unknown if Linear Order-r is FPT for $r \geq 4$.

Among the tools that are currently being developed/used in this area are probabilistic approaches and linear-algebraic and harmonic analysis methods/tools.

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Not-About-Graphs! Darwin

Parameterized Complexity: Not About Graphs! 5-8 August 2011 for Workshop at Charles Darwin Univ, Australia, plus 9-13 August for Problem-Solving/touring in the remote outback. The one-time-only workshop will produce a small book, published by CDU Press, that celebrates key open problems in unexplored areas. The workshop aim is to identify important problems in new directions (control theory, automata, number theory, robotics, game theory, computational physics, etc.) to investigate within the parameterized framework. We expect the discussions and presentations at the workshop to be rich with possibilities for further development of entire research areas, and programmatic themes that can be developed into future research proposals. See `www.cdu.edu.au/parameterized-nag` or the FPT wiki at www.fpt.wikidot.com. Email `Michael.Fellows@cdu.edu.au` for more information.

WorKer 2011 Sept in Vienna

The Third Workshop on Kernelization, WorKer 2011, will take place on September 2–4, 2011, in Vienna, Austria. Research on theory and applications of kernelization is a vibrant and rapidly developing area in algorithm design and complexity. After successful workshops in Bergen 2009 and Leiden 2010, this third workshop aims at consolidating the results achieved in recent years and discussing future research directions.

A special aspect this year is to take a closer look at related work from different research areas, in particular from Practical Preprocessing, Property Testing, and Knowledge Compilation. Therefore, leading researchers from these three areas will provide keynote talks.

The workshop will feature invited keynote talks as well as several invited and contributed talks with surveys and new technical results. The workshop will also provide opportunities for all participants to engage in joint research and discussions on open problems and future directions.

This year's keynote speakers are the following.

- Armin Biere, Johannes Kepler Univ., Linz, Austria
- Sourav Chakraborty, Chennai Mathematical Institute, India
- Michael R. Fellows, Charles Darwin Univ., Australia
- Fedor V. Fomin, Univ. of Bergen, Norway
- Bart Jansen, Utrecht Univ., the Netherlands
- Daniel Lokshtanov, Univ. of California, San Diego, USA
- Pierre Marquis, Univ. d'Artois & CRIL-CNRS, France
- Anders Yeo, Royal Holloway, Univ. of London, UK

The workshop is organized by Serge Gaspers, Sebastian Ordyniak, and Stefan Szeider. They are supported by an advisory board consisting of Sourav Chakraborty, Fedor V. Fomin, and Daniel Lokshtanov.

See `http://www.kr.tuwien.ac.at/drm/worker2011`

IPEC 2011 Sept in Saarbrucken

The 6th International Symposium on Parameterized and Exact Computation will be part of ALGO 2011, which also hosts ESA, WABI, WAOA, ATMOS, and ALGOSENSORS. ALGO 2011 will take place September 5-9, 2011 in Saarbrucken, Germany. IPEC covers research in all aspects of parameterized and exact algorithms and complexity. The Program co-chairs are Dániel Marx and Peter Rossmanith. The Invited speaker is Martin Grohe.

Accepted papers and program are at `http://tcs.rwth-aachen.de/IPEC2011/`.

Algorithmic and game-theoretic aspects of social choice in Auckland

The Centre for Mathematical Social Science (CMSS) at The University of Auckland, issues a Call for Participation at its 3rd Summer Workshop: 20-21 February, 2012. Confirmed speakers from overseas include:

- Jerome Lang (Universit Paris Dauphine)
- Toby Walsh (University of NSW and NICTA)
- Piotr Faliszewski (AGH Institute of Technology, Krakow)
- Edith Elkind (NTU, Singapore)

Formal presentations will be accompanied by research collaborations in small groups with participation from visitors and local researchers, including PhD students. The proposed topics for these small group sessions are to be discussed but will certainly include voting procedures and voting equilibria, manipulation of voting procedures, simple games and power indices. Contact: Arkadii Slinko. Email: `a.slinko@auckland.ac.nz`, Dept Mathematics, Univ. Auckland, Centre for Mathematics in Social Sciences.

Call for Papers for TCS Special Issue

Manuscripts are solicited for a Special Issue on "Exact and Parameterized Computation Moderately Exponential and Parameterized Approximation" in the journal *Theoretical Computer Science*.

Moderately Exponential and Parameterized Approximation has been developed quite recently as a research programme aiming at bringing together Exact Computation and Polynomial Approximation and at remedying to the numerous inapproximability results, the Polynomial Approximation paradigm suffers.

With this Special Issue, we wish to foster research in the areas of Exact Computation and Moderately Exponential Approximation as well as to their intersection by exposing new results and directions for further research and to contribute to the development of further scientific links between them.

Potential topics include (but are not limited to) the following:

- Moderately exponential algorithms for NP-hard problems
- Parameterized algorithms
- New tools for exact computation
- Hardness in fixed parameter computation
- Moderately exponential and/or parameterized approximation algorithms for NP-hard problems
- Structure in moderately exponential and/or parameterized approximation
- New tools for exponential or parameterized approximation
- Relations between polynomial approximation and parameterized computation
- Probabilistic techniques in exponential approximation

Submissions before Dec 31, 2011. Contact Guest Ed Vangelis Th. Paschos, LAMSADE, CNRS and Université Paris-Dauphine, Institut Universitaire de France.

Call for Papers–Journal of Clinical Bioinformatics

Interest is in technologies of biomarker profiling, bioinformatics, biostatistics, computational biology and networks, database, mathematical medicine and biology, meta analysis on clinical trials, and medical informatics. Contact Prof. Pablo Moscato, Priority Research Centre for Bioinformatics, Biomarker Discovery and Information-based Medicine, Univ. Newcastle, Au, `pablo.moscato@newcastle.edu.au`.

Tenure-track assistant professorship at LAMSADE-Paris

Tenure-track assistant professorship with associated CNRS Chair at LAMSADE, University Paris-Dauphine in The Laboratoire d'Analyse et Modelisation de Systemes pour l'Aide a la Decision (Director Prof. Paschos).

The successful candidate will join the project, *Efficient solution of hard Combinatorial Optimization problems: new models concepts and tools*, and work mainly on "Exact computation with provably time complexity upper bounds" on "Moderately exponential time approximation algorithms" and on "Parameterized algorithms".

Other themes where outstanding applications will also be considered are: Polynomial approximation, On-line computation, Reoptimization, Algorithmic games.

Applications are due by February 2012. Please contact Prof. Vangelis Th. Paschos (`paschos@lamsade.dauphine.fr`) or Prof. Cristina Bazgan (`bazgan@lamsade.dauphine.fr`).

Professor of Computer Science, University of Adelaide

Professor of Computer Science, available immediately, is being sought by the School of Computer Science, University of Adelaide. The successful candidate will be an outstanding computer scientist who will provide discipline leadership ensuring the School of Computer Science remains at the leading edge of international research and teaching. The successful applicant will have a track record of high impact research. This tenurable full time position is available immediately at 147,603AUD per annum plus an employer superannuation contribution of 17 percent. The department is friendly to parameterized complexity.

Contact Prof. David Suter, Ph: (08) 8313 3661 or `dsuter@cs.adelaide.edu.au`. Job Reference: 16854. See website `http://www.unijobs.com.au`.

CONGRATULATIONS ON POSITIONS

Congratulations on these exciting new positions.

Frederic Dorn has accepted a researcher position at SINTEF Energy Research, in production planning for renewable energy (in particular water power)in Trondheim, Norway. His position will contain both research and development. The SINTEF Group is the largest

independent research organization in Scandinavia with approximately 2000 employees.

Gabor Erdelyi has accepted a Junior professor (equivalent to an Assistant Professor) position at the University of Siegen, Germany. Gabor currently holds a post-doc position at Nanyang Technological University, Singapore.

Eun Jung Kim has accepted a CNRS Researcher position at the University Daulphine, Paris. She will be coming from a post-doc position at University Montpellier. Eun Jung received her PhD in summer 2010 with advisor Gregory Gutin.

Michael Lampis has accepted a position with Johan Hastad in KTH, Stockholm starting in October. He will defend his dissertation in September.

Luke Mathieson has accepted a position as Research Fellow at Macquarie University in Sydney, Australia.

Stephan Thomasse has moved to the Department of Mathematics and Computer Science, Ecole Normale Supérieure de Lyon - ENS, Lyon, France. Stephan's new email is `stephan.thomasse@ens-lyon.fr`.

CONGRATULATIONS New PhD

Holger Dell. *Sparse Instances of Hard Problems*, Humboldt-Universität zu Berlin. Advisor: Martin Grohe. Congratulations, Dr. Dell.

Very Special

A joyful welcome to Johannes Eberhard Dorn, firstborn of Marianna Betti and Frederic Dorn.

Figure 6: Frederic Dorn and baby Johannes

The past Parameterized Complexity Newsletters are archived at the wiki at `http://fpt.wikidot.com`