Always Parameterize!

Parameterized Complexity News

Newsletter of the PC Community August 2012

IPEC 2012 Ljubljana, Slovenia

Welcome

Frances Rosamond, Editor

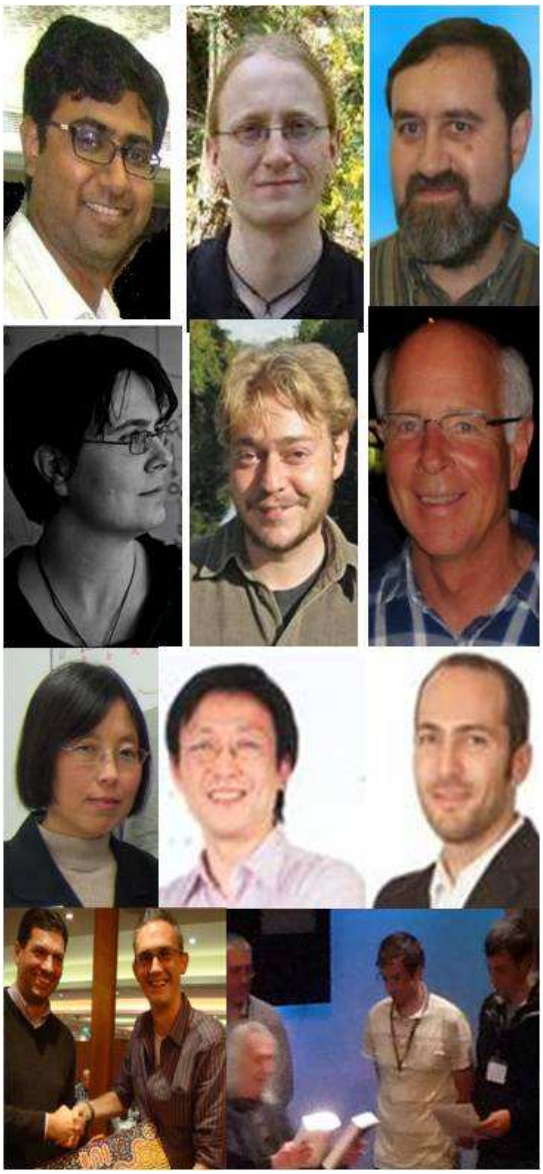
Congratulations on awards, new positions, and publications—including 15 at ICALP! We appreciate Bart Jansen for posting on (`http://fpt.wikidot.com/recent-papers`). Sepp Hartung and André Nichterlein present a summary of their CiE award winning paper. Mike Fellows contributes an APAC Opinion Piece. Please keep (`http://fpt.wikidot.com`) updated with your results, publications & job offers.

IPEC 2012

7th International Symposium on Parameterized and Exact Computation colocated with ALGO in Ljubljana, Slovenia. `http://ipec2012.isoftcloud.gr/`
Symposium: September 12-14, 2012
Invited Speakers: Dániel Marx (Computer and Automation Research Inst, Hungarian Academy of Sciences (MTA SZTAKI)), Andreas Björklund (Lund Univ).
Workshop: Saket Saurabh: Subexponential Parameterised Algorithms.

Winners All

Pictured from top left are Saket Saurabh, Stefan Kratsch, Gregory Gutin, Iris van Rooij, Johan Kwisthout, Michael Fellows, Xiuzhen Huang, Jiong Guo, Tobias Friedrich, Joachim Gudmundsson awarding Pim van 't Hof et al., Barry Cooper awarding Sepp Hartung and André Nichterlein. Stories inside.



Contents of this issue:

Saket Saurabh

Congratulations to **Saket Saurabh**, IMSc Chennai, for a European Research Council Executive Agency (ERCEA) award of 1.690k Euro, for his project, *Parameterized Approximation*.

Stefan Kratsch

Congratulations to **Stefan Kratsch**, Utretch, who has been accepted into the Emmy Noether program. He will move to Berlin in November, spending September and October at MPI in Saarbruecken.

Gregory Gutin

Congratulations to **Gregory Gutin**, Royal Holloway, Univ of London who is principle investigator on a large EPSRC (UK) grant of 772K pounds = 990K Euro for *Parameterized Algorithmics for the Analysis and Verification of Constrained Workflow Systems*. His co-investigators are Jason Crampton (Information Security Group, RHUL) and Dave Cohen (CompSci, RHUL, an expert in constraint satisfaction), and Anders Yeo is one of the collaborators. Comments by one of the reviewers is instructive. One reviewer wrote: If the project is successful, it will fulfill two very important research goals. 1) The proposal will help fixed-parameterized algorithms to establish themselves as a really successful methodology of solving practical problems. The potential of this methodology has been widely recognized. However, this potential is currently very far from being completely explored. Existing practical algorithms are rather ad-hoc and there is no 'industry' of designing software based on practical fixed-parameter algorithms similar to what we see in the area of Satisfiability. In this situation, the methodology needs a boost, a concentrated effort directed towards *one* particular application that would establish the status of fixed-parameter algorithm as a *really* (rather than potentially) practical methodology. This proposal looks a perfect fit to be such a much needed effort. 2) The application considered by the proposal is strong in the sense that it is relevant in a number of important industrial contexts (e.g. information security and verification of business plans) and fixed-parameter algorithms look completely relevant for solving the related computational problems.The novelty of this proposal is that, being mainly theoretical, it is completely application-driven. The proposers, established researchers in algorithms and complexity, will look at the problems exactly as they appear in the applied context without intention of trimming them so that they become more compact, more standard-mathematical, more academic if you like. In presence of the current gap between theoretical and applied algorithmics it is a commendable and ambitious effort.

Tobias Friedrich and Jiong Guo

Congratulations to **Tobias Friedrich**, Univ Jena and **Jiong Guo**, Head of the Junior Research Group Efficient Algorithms for Hard Problems at Univ Saarlandes, for a DFG award of 350k Euro for their project, *Average-Case Analysis of Parameterized Problems and Algorithms*. Tobias has accepted the Chair of Theoretical Computer Science at Friedrich Schiller University Jena, previously held by Rolf Niedermeier before he moved to TU Berlin.

Michael Fellows

Congratulations to **Michael Fellows**, Charles Darwin Univ, Australia, who has been awarded (with Tim Bell and Ian Witten) the ETH Zurich International Medal of Honor for Computer Science Education, for *Computer Science Unplugged!* (`www.csunplugged.org`)

Iris van Rooij and Johan Kwisthout

Congratulations to **Iris van Rooij**, Radboud Univ Nijmegen, Donders Institute for Brain, Cognition and Behaviour and Johan Kwisthout, Leiden Univ, Leiden Inst of Advanced Computer Science. Their paper *Bridging the Gap between Theory and Practice of Approximate Bayesian Inference* was invited to the "Best of ICCM-2012" Special Issue of Cognitive Systems Research.

Xiuzhen Huang

Congratulations to **Xiuzhen Huang**, Arkansas State Univ and **Gail McClure**,Arkansas Science Authority for a NSF award of $99,999 USD for a national *Workshop in Bioinformatics to Foster Collaborative Research* to be held in Little Rock, 3–5 March 2013. The goal is to foster research collaborations between bioinformatists and life science researchers. Open to the public.

Rémy Belmonte, Pinar Heggernes, Pim van 't Hof, Reza Saei

Congratulations to **Rémy Belmonte, Pinar Heggernes, Pim van 't Hof and Reza Saei**, Dept Informatics, Univ Bergen, for winning the Best Paper Award at COCOON 2012 with *Ramsey Numbers for Line Graphs and Perfect Graphs*.

Sepp Hartung, André Nichterlein

Congratulations to **Sepp Hartung and André Nichterlein**, Ph.D. students at TU Berlin for winning the CiE 2012 Best Student Paper Award with *NP-Hardness and Fixed-Parameter Tractability of Realizing*

Degree Sequences with Directed Acyclic Graphs. They also came in second over ALL the papers in Citeseer. This is an big accomplishment especially considering that an unprecedented 240 presentations were accepted for Turing Centenary Conference in Cambridge.

Scott Aaronson

Congratulations to **Scott Aaronson**, MIT, recipient of the 2012 Alan T. Waterman Award of the NSF for work in quantum computing (not parameterized). The annual prize is a medal and US$1 million to be used over five years given to researchers under age 35 in any field of science or engineering.

AMS Special Session on PC, San Diego

Special Session *Parameterized Complexity and Incrementalization* at the American Mathematical Society Annual Meeting in San Diego, 11/12 January 2013. Presenters include Moshe Vardi, Neil Immerman, Dan Willard, Fritz Henglein, Annie Liu, Shmuel Onn, Yiannis Koutis, Ulrike Stege, Holger Dell, Ryan Williams, Petr Hlineny, V. Arvind, Rod Downey, Mike Fellows, Anil Nerode. Contact: Frances Rosamond.

FPT & Algorithms Engineering in Oman

Workshop on *FPT and Algorithm Engineering* will take place at the German Univ Technology (GUTech) in Muscat, Oman (`www.gutech.edu.om`), 18-22 Feb 2013. Organizers:
–Mike Fellows, Charles Darwin Univ
–Rudolf Fleischer, GUtech
–Kurt Mehlhorn, MPI, Saarbruecken
–Saket Saurabh, IMSc, Chennai

The goal is to explore new research directions in FPT algorithms with a focus on algorithm engineering, and continues the theme of the "Not-About-Graphs!" 2011 workshop at Charles Darwin Univ (`www.cdu.edu.au/parameterized-nag/`). We will start with talks and discussion at GUtech on the first 2 days, followed by 3 days of research at some desert camp near Muscat.

Shonan PC, Japan

Shonan Computer Conference Center will host *Parameterized Complexity and the Understanding, Design and Analysis of Heuristics*, May 5-11, 2013. Contact: Gregory Gutin.

Dagstuhl Birthday Party, Mike Fellows

The 2012 WorKer (Kernelization) held at Dagstuhl (filled to overflowing) was brilliant, inspiring, warm, lovingfabulous! Many thanks to organizers and everyone who came and to those who wanted to come but couldn't. Thursday talks celebrated Mike Fellows' birthday, describing the early history of the field and many future directions. Fran Rosamond described Mike's outreach of *Computer Science Unplugged!* and his *Mathematical Passion Plays*. Rod Downey presented a mysterious pile under a white cloth. The Festschrift, "The Multivariate Algorithmic Revolution and Beyond" (Springer LNCS 7370) was revealed when Mike pulled aside the cloth. Mike is 'walking on air' very happy!! Very appreciative.

Figure 1: Mike with Festschrift authors

APAC Workshop at ICALP–An Appreciation

by Michael Fellows, Charles Darwin Univ

The *Workshop on Applications of Parameterized Algorithms and Complexity* (APAC 2012) was held at Univ Warwick prior to ICALP. It was organized by Gregory Gutin. There were eight invited talks. See `http://www.cs.rhul.ac.uk/apac/` for abstracts, slides and photos.

There were 15 papers on parameterized algorithmics at ICALP, including two entire sessions. Approximately 4.1 million euro-equivalent in fresh multi-year funding has been announced in the last two months (writing this on 1 August 2012).

The primary impulse of APAC was to highlight the opportunities that can come from applications. There are many conference series and funding sources where *applications of parameterized algorithms and complexity* have barely been explored. Wherever NP-completeness has gone (very far indeed), parameterization must surely

follow. I found three of the talks particularly thought-provoking.

• Mike Langston began the workshop with a vigorous overview of what it means to do *applied computer science*. Roughly based on the official guidelines for USA National Science Foundation proposals, Mike offered a three-level typology of applications engagement. There are very big differences between these three levels of engagement, and this was rhetorically emphasized by discussing them in the order 1, 3, and then 2.

Level 1. You talk about applications, but your own main interest is in proving nice mathematical theorems, and publishing them in the usual venues of TCS.

Level 3. Domain science. Domain scientists have data and may hack at it, but they have no mathematical science agenda. You may think that mathematical science is the center of the intellectual universe; they don't.

Level 2. Described by Mike Langston as the *sweet spot* in this 1-2-3 spectrum. Here you have mathematical ideas and new algorithms that can beat the hackers at level 3, and if you can get established, research funding is plentiful. But key to success at this level, you must:

– seriously work with domain scientists, and learn a lot about their fields and their datasets
– expect to publish in conferences and journals that you have never heard of before
– expect to have lots of coauthors in large interdisciplinary teams
– be excited about doing real stuff that matters to science and the world

This was a great talk, rich with detail of specific applications, and with sophisticated reflection of how and why to *do* applied parameterized algorithmics. The following speakers at APAC made constant reference to Mike's three levels of applied science engagement.

• Faisal Abu-Khazam gave a fascinating talk — with what seems to me a possibly profound programmatic message. The basic issue is this: we have been relatively shy about aggregate parameterizations, partly because we have not been tremendously engaged with real datasets, and want to keep our target parameterized problems mathematically elegant, and partly perhaps because of a fear that complicated aggregate parameterization, i.e., *the parameter is* $(k, r, t, d, w, 1/\epsilon)$, might be too awkward to deal with. Faisal reported two things:
– such complex aggregate parameterizations can lead to mathematically powerful and elegant kernelization algorithms
– these perform well both in terms of theory (worst-case analysis), and in terms of implementations on real datasets

So basically he was reporting on a big *win/win*: with aggressive aggregate parameterization, you get both:
– greater data realism
– better performing FPT algorithms

A surprising thing about Faisal's results was that while the the aggregate parameterization looks intrinsically messy, the algorithm distilled from it had a lot of elegance.

• Norbert Zeh (Dalhousie Univ., Canada) reported on a breakthrough FPT algorithm in Phylogenetics, with implementation data. It is a tricky problem, open for quite awhile, for which they worked out an FPT algorithm and implemented it and compared it to established packages. They didn't algorithms-engineer it, didn't put it on a supercomputer, etc. — they simply implemented it. The hard part was finding the FPT algorithm. According to Norbert, this bare-bones FPT implementation simply beat the pants off the standard packages.

These were the main highlights for this commentator. There were other very nice talks!

Anders Yeo reported on (see the above report on Gutin's grant; Anders is one of the collaborators) a foray into the parameterized complexity of designing and analyzing security access protocols — a great example perhaps of Langston's Level 2 — joint work with Jason Crampton, the application domain expert. Such research partnerships seem to be the key.

I think the workshop was a great success, and gave a pretty good current account of what it set out to do. I look forward to the next APAC, wherever that may be.

NP-Hardness and Fixed-Parameter Tractability of Realizing Degree Sequences with Directed Acyclic Graphs

by Sepp Hartung and André Nichterlein, TU Berlin

Given a degree sequence (that is, a multiset of positive integers) graph realization problems ask to decide whether there is a graph whose vertex degrees match the given sequence. The realization problem is known to be polynomial-time solvable when the graph is directed or undirected [Erdős and Gallai (1960), Havel (1955), Kleitman and Wang (1973)]. In contrast, we show NP-completeness for the problem of realizing a given sequence with a *directed acyclic graph* (DAG), answering an open question of [Berger and Müller-Hannemann (2011)]. Furthermore, we classify the problem as fixed-parameter tractable with respect to the parameter "maximum degree".

Formally, we consider DAG Realization where one is given a multiset $\mathcal{S} = \left\{\binom{a_1}{b_1}, \ldots, \binom{a_n}{b_n}\right\}$ of positive integer pairs and one has to decide whether there is a so-called *realizing DAG*, that is, a DAG without multi-arcs that admits a labeling of its vertex set $\{v_1, \ldots, v_n\}$ such that for all $v_i \in V$ the indegree is a_i and the outdegree is b_i.

To prove that DAG Realization is NP-complete,

we reduce from the strongly NP-hard 3-Partition problem. Towards an FPT-algorithm with respect to the maximum degree parameter $\Delta := \max\{a_1, b_1, \ldots, a_n, b_n\}$ we view the problem as the task of finding an ordering of $\mathcal{S}$ that corresponds to a topological ordering of a realizing DAG for $\mathcal{S}$. (Given an ordering of $\mathcal{S}$ it is polynomial-time decidable whether there is such a corresponding DAG [Berger and Müller-Hannemann (2012)].) Now, suppose we already fixed the first i positions in the ordering of $\mathcal{S}$. Clearly, at position $i+1$ we can only place elements whose indegree is at most the "remaining outdegree" (sum over the outdegrees minus the indegrees) of the first i elements. Our algorithm now distinguishes two main cases: First, the remaining outdegree is at least Δ^2, a so-called *high potential*. By some reordering arguments, one can show that the first (and last) high potential position can be assumed to be at most $\Delta^{2\Delta}$ positions apart from start (and end). Thus the start and the end parts of the ordering can be found by brute-force. Since a high potential position guarantees that we can place an arbitrary element on the next position, the order of the remaining elements between start and end can be greedily found by first placing the elements whose indegree is at most their outdegree.

In the second case, we try to find an ordering where at each position the remaining outdegree is less than Δ^2. Because of this upper bound on the remaining outdegree any ordering of a "huge" multiset $\mathcal{S}$ that corresponds to the topological ordering of a realizing DAG contains subsequences that repeat quite often. By similar reordering arguments as in the high potential case, one can assume that these repetitions are subsequent in the ordering. We then show that the length of the ordering without repetitions is bounded by some function in Δ and thus can be found by brute-force. In a final step, we reinsert the repetitions by using an ILP (integer linear program), leading to the desired solution, if existing.

The running time of our algorithm is $\Delta^{\Delta^{\Delta^{O(\Delta)}}} \cdot n$ and, thus, is of classification nature only. If m denotes the number of arcs in a realizing DAG, in ongoing work we proved fixed-parameter tractability for the parameter k where $k = m - n$. Furthermore, we showed for each constant $c > 1$ that DAG Realization remains NP-complete when $m = n \cdot c$. Finally, we mention that it is open whether the parameter "number of different tuples in $\mathcal{S}$", which is a smaller parameter than the maximum degree Δ, admits an FPT-algorithm. As an intermediate step one may first consider the parameter $\min\{\max\{a_1, \ldots, a_n\}, \max\{b_1, \ldots, b_n\}\}$.

[Berger and Müller-Hannemann (2011)] A. Berger and M. Müller-Hannemann. Dag realizations of directed degree sequences. In *Proc. 18th FCT*, volume 6914 of *LNCS*, pages 264–275. Springer, 2011.

[Berger and Müller-Hannemann (2012)] A. Berger and M. Müller-Hannemann. How to attack the NP-complete dag realization problem in practice. In *Proc. 11th SEA*, volume 7276 of *LNCS*, pages 51–62. Springer, 2012.

[Erdős and Gallai (1960)] P. Erdős and T. Gallai. Graphs with prescribed degrees of vertices (in Hungarian). *Math. Lapok*, 11:264–274, 1960.

[Havel (1955)] V. Havel. A remark on the existence of finite graphs. *Casopis Pest. Mat.*, 80:477–480, 1955.

[Kleitman and Wang (1973)] D. Kleitman and D. Wang. Algorithms for constructing graphs and digraphs with given valences and factors. *SIAM J. Discrete Math.*, 6(1):79–88, 1973.

CALL FOR PAPERS

"Graph Algorithms" – A special issue of Algorithms (ISSN 1999-4893) devoted to the design and analysis of algorithms for solving combinatorial problems of a theoretical or practical nature involving graphs, with a focus on computational complexity. Contact: Jesper Jansson, Kyoto University, Guest Editor

Keywords: * computational complexity * approximation algorithms * fixed-parameter tractability and more Submit by 31 October 2012.

Moving Around

Congratulations to all on these positions.
Marek Cygan, **Marcin Pilipczuk**, and **Marcin Kaminski** have tenure-track positions at the Univ Warsaw starting October. (Watch out, Warsaw! ;-))

Martin Grohe will move to the Dept. of Computer Science at RWTH Aachen this fall.

Danny Hermelin has accepted a Senior Researcher position at the Department of Industrial Management and Engineering in Ben Gurion University, Beer-Sheva.

Chunmei Liu has accomplished successful early tenure and is now Associate Professor at Howard Univ.

Neeldhara Misra is now a post-doc in the Dept of Computer Science and Automation, Indian Institute of Science, Bangalore.
Barnaby Martin will join the Dept. Computer Science at Middlesex Univ, London as Lecturer.

Yinglei Song is now Assistant Professor of CS at Univ. Maryland, Eastern Shore.

Ondra Suchy will join the Czech Technical University in Prague starting September as an Assistant Professor.