Parameterized Complexity News

Newsletter of the Parameterized Complexity Community

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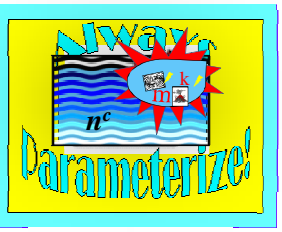

Welcome

Frances Rosamond, Editor, Charles Darwin University
Welcome to the *Parameterized Complexity Newsletter*. Congratulations to many award-winners, graduates and new job holders. We sadly announce the death of Professor Ed Blum, mathematician and computer scientist. Ed always had confidence in Parameterized Complexity, and was pleased at PC submissions to the *JCSS* journal.

EDWARD BLUM - in Memoriam

Professor Edward Blum, Managing Editor of JCSS since its inception in 1967, passed away in February. Ed played a vital role in the success of the journal, and we are truly indebted by his dedication to the authors and readers the journal serves. He will be greatly missed.

Toby Walsh - Humboldt Research Award

Congratulations to **Toby Walsh**, UNSW, NICTA for the Humboldt Research Award, recognizing past and future cutting-edge research impact. Toby visits Torsten Schaub, U. Potsdam and Rolf Niedermeier, TU Berlin.

Michael Fellows - EATCS Fellow

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Congratulations to Prof. **Michael Fellows**, Charles Darwin University, conferred in 2014 as one of the ten inaugural EATCS Fellows for "his role in founding the field of parameterized complexity theory ... and for being a leader in computer science education." Mike thanks everyone for their support. He feels tremendously honoured personally, and for all of the field.

EATCS-IPEC NERODE PRIZE

The 2014 EATCS-IPEC Nerode Prize for a series of papers on how to establish lower bounds on kernelization will be awarded during IPEC. The two papers and prize winners are: *On problems without polynomial kernels*, **Hans Bodlaender, Rodney Downey, Michael Fellows, Danny Hermelin**. Journal of Computer and System Sciences 2009. *Infeasibility of instance compression and succinct PCPs for NP*, **Lance Fortnow, Rahul Santhanam**, same journal 2011. **Hans L. Bodlaender** will give an invited talk at IPEC 2014. Congratulations, all! `http://eatcs.org/images/awards/nerode.pdf`

Katrin Casel - DAAD Award

Congratulations to **Katrin Casel** for winning a DAAD grant to visit Dr. Ljiljana Brankovic, U. Newcastle, AU. Katrin is a PhD student of Henning Fernau, U. Trier. Katrin is also holding a PhD grant awarded by the state of Rhineland-Palatinate.

Gabor Erdelyi - DFG Award

Congratulations to **Gabor Erdelyi**, U. Siegen, who has received a 167K Euros, two-year DFG award for the project that includes *parameterized and average-case complexity of decision-making problems*.

Piotr Faliszewski - DFG Mercator Guest Professorship

Congratulations to **Piotr Faliszewski**, AGH U. Krakow.

Piotr has received a DFG Mercator Guest Professorship to work with the group of Rolf Niedermeier, TU Berlin on *Parameterized Algorithmics for Voting Problems*.

Fabrizio Grandoni - ERC Starting Grant

Congratulations to **Fabrizio Grandoni**, Algorithms and Complexity Group of IDSIA, U. Lugano for the ERC Starting Grant *New Approaches to Network Design*.

Danny Hermelin - Marie Curie Award

Congratulations to **Danny Hermelin**, Ben-Gurion U. of the Negev, who has received an EU Marie Curie Career Integration Grant of 100K Euros for a period of 4 years for *MetaKer - New Directions in Meta-Kernelization*.

Casel, Erdelyi, Grandoni, and Hermelin

Matthias Mnich–DFG Award

Congratulations to **Matthias Mnich**, University of Bonn, for a DFG award for the project, *Big Data Kernelization*. The award is for 231K Euros for three years. Apply for a PhD position to work on the project by contacting `mmnich@uni-bonn.de`. Well done, Matthias.

Michal Pilipczuk - Meltzer Prize

Congratulations to **Michal Pilipczuk**, U. Bergen, for the 2014 Meltzer Prize for Young Researchers. Michal received his PhD in 2013 from U. Bergen. He holds masters degrees in both Mathematics and Informatics from the U. of Warsaw. The committee says: "What makes Michal's work exceptional is not the short time it took him to get his PhD degree (in two years, with teaching duties), but the depth and the diversity of his research. His contributions to research within theoretical computer science is

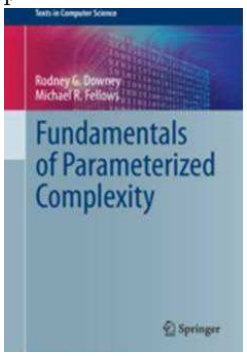
equivalent to several PhD degrees. The number of exceptional results that he has contributed to is outstanding not only for a young researcher but it is exceptional even for internationally acknowledged professors in their most productive years."

Michael Fellows - ETH-ABZ Honor in Computer Science Outreach

Congratulations to **Michael Fellows**, Charles Darwin U., for the *2014 ABZ International Medal of Honor for Fundamental Contributions to Computer Science Education*, presented at ETH-Zurich. The award was given to *Computer Science Unplugged!* `www.csunplugged.org` co-authors Tim Bell, U. Canterbury and Ian Witten, Otago U. Activities are used in CS4HS (sponsored by Google), codeweek.eu, and translated into 19 languages– a global grass-roots movement.

Rod Downey and Mike Fellows - New Book

Congratulations to **Rodney Downey**, Victoria U. Wellington and **Michael Fellows**, Charles Darwin U. for their new book, *Fundamentals of Parameterized Complexity*, Springer, 2013. This 763–pager is an update to the 1999 monograph.



New Ideas in Multivariate Algorithmics

by Michael Fellows, Charles Darwin University

Here are 3 new ideas that I would like to share that have been central to our recent grant proposals in Australia.

1) Banish Real Numbers. To make a problem definition which legislates real numbers to measure something is daft and should be banned, despite having been common practice for thirty years. In the context of asymptotic complexity analysis, one would have to believe that things can be measured to arbitrary accuracy. Au contraire! There are probably quantum mechanical reasons why *nothing* can be measured to fifty decimal places of accuracy. Hardness results for problems involving real numbers are unsurprising, and meaningless. All need to be revisited, as do all problems where hardness results exploit numbers in binary. For example, all hardness results in computational game theory. Given the errors and uncertainties in the data, realistic problem legislation should probably stick to k different numbers in unary.

2) Move Approximation Into the Modeling. Related to the above point, it is reasonable to try to move approximation issues into the modeling and problem legislation: for example, by replacing arithmetic issues with real numbers, with problem legislation based on relevant ultrafinite arithmetic, and parameterizing on the size of that arithmetic. For a nice example concerning the Heat-Sensitive Scheduling problem, see Fellows, Gaspers, and Rosamond, *Parameterizing on the Number of Numbers*, ToCS 50(4): (2012) 675-693.

3) FPT-Turbocharging Greedy Heuristics. Most work to date in algorithms and complexity, including parameterized complexity, can be characterized as *top down*. One legislates a computational problem that captures all concerns, tries for a tractability result, and hopes the result is useful on practical datasets - of which we usually have limited understanding. An alternate approach would be to work *bottom up*. Start from a heuristic H of some proven success. Evidently the heuristic has somehow implicitly captured *some* understanding of the natural datasets. Try to identify a subroutine for which an FPT result might contribute to an improved heuristic *H'*. A nice example which seems to generalize well the project of FPT-turbocharging greedy heuristics can be found in the important paper of Hartung and Niedermeier, *Incremental List Coloring of Graphs, Parameterized by Conservation*, TCS, 494:86-98, 2013.

Algorithms - Special Issue

There will be a special issue on "Parameterized Algorithms - Challenges from Real-World Applications" in the open-access journal *Algorithms* published by MDPI, edited by **Christian Komusiewicz, Stefan Kratsch**, and **Rolf Niedermeier**. Submission deadline is 31 May 2014, but slight delays of two weeks or so may be possible. Please send a short abstract to `algorithms@mdpi.com`. See `http://www.mdpi.com/si/algorithms/Parameterized_Algorithmics`.

New Results in Multivariate Algorithmics

Keep up-to-date on new results and papers by looking on `www.fpt.wikidot.com` at *FPT papers in Conferences* and *FPT papers On-Line* by Bart Jansen.
For example, the wonderful result that *graph isomorphism*

parameterized by treewidth is FPT has been shown by Daniel Lokshtanov, Marcin Pilipczuk, Michal Pilipczuk, and Saket Saurabh. The ArXiv paper is *Fixed-parameter tractable canonization and isomorphism test for graphs of bounded treewidth.*

A Polynomial-time Algorithm for Outerplanar Diameter Improvement

by Nathann Cohen (LRI Orsay), Eun Jung Kim (LAMSADE Paris), Daniel Gonçalves, Christophe Paul, Ignasi Sau, Dimitrios M. Thilikos, and Mathias Weller (all LIRMM Montpellier).

Introduction. Given a planar graph G and an integer D, Planar Diameter Improvement (PDI) asks whether G can be turned into a planar graph of diameter at most D by adding (arbitrarily many) edges to G. Although PDI was first mentioned by Dejter and Fellows [2] in 1993, the computational complexity of PDI is still open. While the question whether it is NP-complete is puzzling, Planar Diameter Improvement *is known* to be FPT since its yes-instances are closed under taking minors.

We report on our studies of the Outerplanar Diameter Improvement problem (OPDI) which, given an outerplanar graph $G = (V, E)$ and an integer D, asks to add edges G so that the resulting graph, while staying outerplanar, has diameter at most D. We show that Outerplanar Diameter Improvement is polynomial-time solvable by a dynamic programming based algorithm, even when the input graph may be disconnected. We believe that this approach might be interesting for generalizations or variations of the OPDI problem, such as the one where we demand that the completed graph has fixed outerplanarity or is series-parallel.

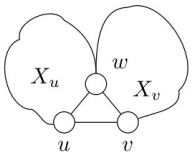
Settling the computational complexity of PDI remains the main challenge in this area. An explicit FPT (or even an XP) algorithm would also be significant.

In the following, applying the $\leq$-relation on pairs means element-wise comparison, that is $(a, b) \leq (x, y) \iff a \leq x \wedge b \leq y$. Likewise, for two sets of pairs A and X, we define $A \leq X \iff \forall_{(a,b)\in A}\forall_{(x,y)\in X}(a, b) \leq (x, y)$. Furthermore, for an outerplanar graph H, we denote by $\mathcal{C}(H)$ the set of completions of H whose diameter is at most D .

First, assume that our input graph G is 2-connected. For each vertex v, we are going to compute a diameter-D outerplanar completion of G that minimizes the eccentricity of v (that is, the maximum over all vertices $x \in V$ of $\mathrm{dist}(v, x)$). We refer to this eccentricity by $\mathrm{ecc}^*_G(v)$.

Let uv be an edge that is incident with v and lies on the outer face of G and let $X \subseteq V$. Then, for each $H \in \mathcal{C}(G[X])$, there is a set of pairs $\max_{x\in X}\{(\mathrm{dist}_H(u, x), \mathrm{dist}_H(v, x))\}$ denoting the maximal distances of any vertex in X to u and v, respectively. We call this set $\mathrm{ecc}(uv, H)$. Then, the set $\min_{H\in\mathcal{C}(G[X])} \mathrm{ecc}(uv, H)$ is the set of at most two sets of pairs representing the best possible diameter-D outerplanar completions of $G[X]$. We call this set $\mathrm{ecc}^*_X(uv)$.

To compute $\mathrm{ecc}^*_X(uv)$, we first guess a vertex $w \in X$ such that an optimal diameter-D outerplanar completion contains uw and vw. This gives rise to vertex sets X_u and X_v with $u \in X_u$, $v \in X_v$ and $w \in X_u \cap X_v$ (See figure).



Then, $\mathrm{ecc}^*_X(uv)$ can be computed recursively. To this end, for all $S_u \in \mathrm{ecc}^*_{X_u}(uw)$ and all $S_v \in \mathrm{ecc}^*_{X_v}(vw)$, compute

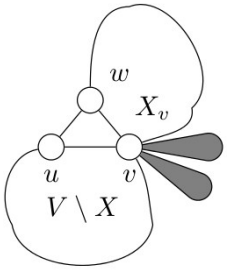
$$Z_{S_u} := \{(d_u, \min\{d_u, d_w\} + 1) \mid (d_u, d_w) \in S_u\}$$
$$Z_{S_v} := \{(\min\{d_v, d_w\} + 1, d_v) \mid (d_v, d_w) \in S_v\}.$$

Then, compute

$$\mathrm{ecc}^*_X(uv) = \min_{S_u\in\mathrm{ecc}^*_{X_u}(uw)} \min_{S_v\in\mathrm{ecc}^*_{X_v}(vw)} \max(Z_{S_u} \cup Z_{S_v}).$$

Since solutions for X_u and X_v are independent, the recursion can be turned into a dynamic program running in $O(n^4)$ time. Then, $\mathrm{ecc}^*_G(v)$ equals $\min_{uv\in E} \max_{(d_u,d_v)\in\mathrm{ecc}^*_V(uv)} d_v$ where uv is on the outer face of G.

Separator Vertices. If G is connected, but not 2-connected, then the dynamic programming is deficient if v (or u) is a separator because it is not clear whether a connected component of $G - v$ should be in X_v or not (see figure).



To overcome this, we include a set $\mathcal{Y}$ of connected components of $G - \{u, v\}$ into the query of the dynamic program: $\mathrm{ecc}_{\mathcal{Y}}(uv)$ is then defined as the maximal elements of $\{\mathrm{dist}_{G'}(u, x), \mathrm{dist}_{G'}(v, x) \mid x \in V'\}$, where $G' = (V', E')$ is a diameter-D outerplanar completion of $G[\bigcup\mathcal{Y}]$ that minimizes $\mathrm{ecc}_{V'}(uv)$. The resulting dynamic programming, however, may exceed polynomial time since there are exponentially many choices for $\mathcal{Y}$. To take care of this, we employ a preprocessing routine that removes all but 8 connected components of $G - v$.

Reduction Rule 1 *Let G be an outerplanar graph with a separator v. Let $C_1, C_2, \ldots$ be the vertex sets of the connected components of $G-v$ such that, with $B_i := C_i \cup \{v\}$,*

the B_i are sorted by $\mathrm{ecc}^*_{G[B_i]}(v)$ in descending order. Then, remove $C_9, C_{10}, \ldots$ from G.

Connected Components. Finally, if the input is disconnected, we can use the previously described algorithm to decide whether its connected components can be combined in a way that allows a diameter-D outerplanar completion. To this end, for each connected component C, we compute a value that we call *escalated eccentricity* $r^+(C)$. It denotes the minimum over all $u \in C$ of $\mathrm{ecc}^*_{G[C\cup\{v\}]}(v)$, where v is a new degree-one vertex attached to u. Using a lower bound on the radius of diameter-D outerplanar completions by Dankelmann et al.[1], we can then discard connected components whose escalated radius is small, since they can be attached to a center vertex of any solution. Finally, we show that connected components with a large escalated radius have to be adjacent to each other in any solution. Thus, by outerplanarity, there can only be 3 of them. Thus, we can guess 2 edges (of the optimal solution) connecting the graph.

All in all, the algorithm solves OPDI in $O(n^9)$ time.

References.

[1] P. Dankelmann, D.J. Erwin, W. Goddard, S. Mukwembi and H.C. Swart, A characterisation of eccentric sequences of maximal outerplanar graphs, *The Australasian Journal of Combinatorics*, 58(3):376–391, 2014.

[2] Italo J. Dejter and Michael Fellows, Improving the Diameter of a Planar Graph, *Computer Science Dept., U. Victoria, BC, Ca.*, 1993.

IPEC 2014 - September

The 9th IPEC 2014 will be part of ALGO, also hosting ESA and other workshops. Dates: 10–12 Sept, Wroclaw, Poland. ALGO is 8 –12 Sept. (`http://algo2014.ii.uni.wroc.pl/ipec`)

Excellent Student Paper Award: Authors have not been awarded a PhD before submission deadline.

Poster Session: anyone can present a poster. The intention is to make it easier for those without an accepted paper to attend IPEC and disseminate their results.

Algorithmica: Selected papers will be invited for a special issue.

Invited Talk by Hans Bodlaender, Utrecht U., EATCS-IPEC Nerode Prize winner.

Invited Tutorial by Stefan Szeider, Vienna U. Technology.

Abstract Submission: June 19

Paper Submission: June 21

Notification of Acceptance: July 18

Poster submission: July 20

Program Committee Co-Chairs: Pinar Heggernes, U. Bergen and Marek Cygan, U. Warsaw

Lorentz Workshop - Perspectives on Human Probabilistic Inference

Perspectives on Human Probabilistic Inference, Lorentz Center, 12 –16 May. This interdisciplinary workshop brings together neuroscientists, philosophers, computer scientists, and cognitive scientists to foster new interdisciplinary perspectives on the role of probabilistic inference in three themes. Several of the organizers are keen to apply multivariate algorithmics (FPT) in this context:

1) unifying conceptions of brain functioning,

2) mechanisms of phenomenological experience,

3) the computational realization of cognition.

Scientific organizers are Andy Clark (Edinburgh), Johan Kwisthout (Nijmegen), Bill Phillips (Stirling), Iris van Rooij (Nijmegen), Anil Seth (Brighton). Contact Iris van Rooij (`i.vanrooij@me.com`).

Bertinoro - Parameterized Complexity and Approximation

The workshop *Frontiers and Connections between Parametrization and Approximation* takes place 25–30 May at the Bertinoro Center for Informatics.

Scientific organizing committee: Michael Fellows, Charles Darwin U., Klaus Jansen, U. of Kiel, Vangelis Paschos, U. Paris-Dauphine, and Hadas Shachnai, Technion.

L to R: Naomi Nishimura (Waterloo), Anand Srivastav (Kiel), Ljiljana Brankovic (Newcastle, AU), Jan Arne Telle (Bergen), Hans-Joachim Böckenhauer (ETH-Zurich, behind Henning), Henning Fernau (Trier), Hadas Shachnai (Technion).

FUN with Algorithms - July

Conference 1–3 July , Lipari Island, Sicily, Italy. Conference Chairs: Alfredo Ferro and Fabrizio Luccio; PC Chair: Peter Widmayer. See the cool logo by E. Demaine `www.di.unipi.it/fun14`.

FLoC Conference and Workshops - July

The Sixth Federated Logic Conference (FLoC 2014) will be part of the Vienna Summer of Logic, the *largest logic event in history*, with 2500 participants expected. FLoC

2014 will host eight conferences (CAV, CSF, ICLP, IJCAR, ITP, CSL-LICS, RTA-TLCA, SAT) and many workshops. **Stefan Szeider** is FLoC Workshop Chair. (`http://vsl2014.at/floc-ws/`)

PCCR 2014: 2nd Workshop on the Parameterized Complexity of Computational Reasoning, 17–18 July, FLoC organized by Mike Fellows, Serge Gaspers, and Toby Walsh. Invited speakers include Georg Gottlob, Dániel Marx, and Stefan Szeider.

Dagstuhl Cognitive Science - August

Dagstuhl Seminar 14341: *Resource-bounded Problem Solving*, 17–22 August. Applications of parameterized complexity in cognitive modeling is a major theme of the workshop. Organizers are Yll Haxhimusa (TU Wien), Iris van Rooij (Radboud Univ.), Sashank Varma (U. Minnesota, USA), Todd Wareham (Memorial U., Canada).

School Bedlewo, Poland - August

School of Parameterized Algorithms and Complexity from Monday–Friday, 18– 22 August 2014 at the Conf. Center in Bedlewo, Poland. CONTENTS: Basic introductory as well as very recent developments, including exercises and open problems. Master or grad students, young researchers, and even more experienced participants will find the presentations interesting and fruitful. Fee around 250 Euros covers accommodation and full board. We expect to support researchers with funding difficulties. The workshop is supported by ERC grants "Rigorous Theory of Preprocessing" (no. 267959) and "Parameterized Approximation" (no. 306992), and by Warsaw Center of Mathematics and Computer Science. See `http://fptschool.mimuw.edu.pl`. Contact: `fptschool@mimuw.edu.pl`.

Algorithmic Social Choice - Eisenhardt Castle - October

Workshop on Challenges in Algorithmic Social Choice (CASC 2014) Eisenhardt Castle, Bad Belzig (near Berlin), Germany, 8-11 October, 2014. Invited speakers are Edith Elkind (U. Oxford), Ariel Procaccia (Carnegie Mellon U.), Clemens Puppe (KIT), Arkadii Slinko (U. Auckland), Toby Walsh (NICTA and UNSW) Gerhard J Woeginger (Eindhoven U. of Technology).

Workshop chairs: Piotr Faliszewski (AGH U. of Science and Technology, Krakow) and Rolf Niedermeier (TU Berlin). `www.akt.tu-berlin.de/nenue/casc14`.

Dagstuhl Optimality - November

Dagstuhl Seminar 14451: *Optimality and tight results in parameterized complexity* takes place 2–7 November. Organizers are Stefan Kratsch (TU Berlin), Daniel Lokshtanov (U. Bergen), Daniel Marx (Hungarian Academy of Sciences), Peter Rossmanith (RWTH Aachen).

LAW Cliques - Brazil - November

The *Sixth Latin-American Workshop on Cliques in Graphs* will take place 9–12 November in Pirenopolis, Brazil. Invited speakers are Marcia Cerioli (Federal U. of Rio de Janeiro), Mike Fellows and Frances Rosamond (Charles Darwin U.), Vadim Lozin (U. Warwick), and Claudio Lucchesi (U. Campinas).

Creative Mathematical Sciences Communication - Chennai - December

Second Int'l Conf. on Creative Mathematical Sciences Communication takes place 9–12 December at IMSC, Chennai, and is co-located with FST-TCS. Email `Jam@imsc.res.in` or check the site (`www.CSMaths.org`). The first conf. was a huge success and this one will be even better! `www.cdu.edu.au/conference/csmaths`.

Multivariate Algorithmics and Approximation - Banff - Nov 2015

Mark your calendar for Banff, November 2015.

New Resource - www.CSMaths.org

New blog (`www.CSMaths.org`) with new *CS Unplugged* activities, and research into computer science outreach. It is an outcome of the **Creative Mathematical Sciences Communication Conference**. Moderator `Frances.Rosamond@cdu.edu.au`.

Parameterized Complexity Blog

by Neeldhara Misra, IIS, Bangalore, BLOG Editor

Enjoy the FPT blog at `http://fptnews.org`. Sign up at `http://www.fptnews.org/contribute`. The blog offers open problems, event announcements, expositions, reports, and so forth. Post your overviews, anecdotes, pictures, updates, and announcements. Help keep the blog an up-to-date, active resource.

Moving Around – Congratulations to ALL.

Yixin Cao will join Department of Computing, Hong Kong Polytechnic University as a research assistant professor starting May. PhD and/or Postdoc positions will be available soon. Inquiries are welcome at `yixin@sztaki.hu`.

Yijia Chen has moved to Fudan University in Shanghai.

Morgan Chopin is now a postdoc at the Institute of Optimization and Operations Research at University of Ulm.

Michael Lampis has been promoted to Assistant Professor in the Dept. of Maths and Computer Science Lab LAMSADE at University Paris-Dauphine.

Chunmei Liu has been promoted to Professor in the Department of Computer Science, Howard University. Congratulations, Chunmei!

Jesper Nederlof is a postdoc with the Operations Research Group in Maastricht, Netherlands `jespernederlof@hotmail.com`.

Mahdi Parsa is now Research Associate in the Business School at the University of Strathclyde.

Sonia Toubaline is now Postdoc at Ecole Polytechnique.

CONGRATULATIONS New PhDs

Sepp Hartung, *Exploring Parameter Space in Coping with Computational Intractability*, 2013, University TU Berlin, Supervisor: Prof. Dr. Rolf Niedermeier. Dr. Hartung has accepted a DFG-funded post-doctoral position at the U. British Columbia with Prof Holger H. Hoos. Congratulations, Dr. Hartung.

Valia Mitsou, *The computational complexity of some games and puzzles with theoretical applications*, 2014, City University of New York, Supervisor: Prof. Amotz Bar-Noy. Valia will be joining the ERATO project in Hokkaido U., Japan as a postdoc with Prof. Minato.