

PARAMETERIZED COMPLEXITY/MULTIVARIATE ALGORITHMICS

Summary to 2015

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OVERVIEW

Parameterized Complexity is a recent branch of computational complexity theory that provides a framework for a fine-grained analysis of hard algorithmic problems. It takes into account problem structure by addressing “secondary” measurements (parameters), apart from the primary measurement of overall input size, that significantly affect problem computational complexity. The central notion of fixed parameter tractability (FPT) is a generalization of polynomial-time based on confining any non-polynomial (typically exponential) complexity costs to a function only of these secondary measurements. The name is gradually changing from “Parameterized” to “Multivariate” with connections to heuristics, and the multivariate approach allows more realistic modelling of real-world input distributions. The field is strongly interdisciplinary, with applications in massive parallel processing of huge data sets, bioinformatics, AI, social choice, and other disciplines.

ONLINE RESOURCES

<http://www.fpt.wikidot.com> The Parameterized Complexity Wiki has a tremendous amount of information, including the *Table of Races* for FPT running time and kernel size.

The Parameterized Complexity Newsletter keeping the community informed about breakthrough news. (<http://fpt.wikidot.com/fpt-news:the-parameterized-complexity-newsletter>)

FPT Papers in Conferences and arXiv are collected by Bart Jansen. Excellent up-to-date resource. (<http://fpt.wikidot.com/fpt-papers-in-conferences>) (<http://fpt.wikidot.com/fpt-papers-on-arxiv>)

Blog at <http://fptnews.org/> moderated by Neeldhara Misra.

MONOGRAPHS

1. *Parameterized Algorithms*, M. Cygan, F. Fomin, Ł. Kowalik, D. Lokshtanov, D. Marx, M. Pilipczuk, M. Pilipczuk, and S. Saurabh. A comprehensive textbook for teaching parameterized complexity. Springer, 2015.
2. *Foundations of Parameterized Complexity*, R. Downey, M. Fellows. Springer-Verlag, 2013.
3. *The Multivariate Algorithmic Revolution and Beyond, Essays Dedicated to Michael R. Fellows on the Occasion of His 60th Birthday*. Springer, LNCS 7370, 2012.
4. *Parameterized Complexity Theory*, J. Flum, M. Grohe. Springer-Verlag, 2006.
5. *Invitation to Fixed-Parameter Algorithms*, R. Niedermeier. Oxford University Press, 2006.
6. *Parameterized Complexity*, R. G. Downey, M. R. Fellows. Springer-Verlag, 1999.

SOME RECENT DEVELOPMENTS and SOME OF THE IMPORTANT PAPERS

✓ Reductions that use the Strong Exponential Time Hypothesis to argue about the optimality of algorithms for polynomial-time solvable problems. The fine-grained point of view and the SETH conjecture originating from parameterized analysis made this possible.

- Amir Abboud, Arturs Backurs, Virginia Vassilevska Williams. *Quadratic-Time Hardness of LCS and other Sequence Similarity Measures*. (<http://arxiv.org/abs/1501.07053>).
- Karl Bringmann. *Why Walking the Dog Takes Time: Frechet Distance Has No Strongly Subquadratic Algorithms Unless SETH Fails*. FOCS 2014: 661-670.
- Amir Abboud, Fabrizio Grandoni, Virginia Vassilevska Williams. *Subcubic Equivalences Between Graph Centrality Problems, APSP and Diameter*. SODA 2015, 1681-1697.
- Amir Abboud, Virginia Vassilevska Williams. *Popular Conjectures Imply Strong Lower Bounds for Dynamic Problems*. FOCS 2014: 434-443.

- ✓ Adaptive Turing kernels.
 - Bart M. P. Jansen. *Turing Kernelization for Finding Long Paths and Cycles in Restricted Graph Classes*. ESA 2014: 579-591.
 - Stéphan Thomassé, Nicolas Trotignon, Kristina Vuskovic. *A Polynomial Turing-Kernel for Weighted Independent Set in Bull-Free Graphs*. WG 2014: 408-419.
- ✓ Kernelization in a streaming input setting.
 - Stefan Fafianie, Stefan Kratsch. *Streaming Kernelization*. MFCS (2) 2014: 275-286.
 - Rajesh Chitnis, Graham Cormode, MohammadTaghi Hajiaghayi, Morteza Monemizadeh. *Parameterized Streaming: Maximal Matching and Vertex Cover*. SODA 2015: 1234-1251.
- ✓ Analyzing preprocessing for integer linear programming.
 - Stefan Kratsch, Vuong Anh Quyen. *On Kernels for Covering and Packing ILPs with Small Coefficients*. IPEC 2014: 307-318.
 - Stefan Kratsch. *On Polynomial Kernels for Integer Linear Programs: Covering, Packing and Feasibility*. ESA 2013: 647-658.
 - Stefan Kratsch. *On Polynomial Kernels for Sparse Integer Linear Programs*. STACS 2013: 80-91.
- ✓ Dynamic Turbocharging
 - Faisal Abu-Khzam, Peter Shaw, Michael Fellows, Frances Rosamond, Judith Egan. *On the Parameterized Complexity of Dynamic Problems with Connectivity Constraints*, (COCOA 2014) LNCS 2014, Volume 8881, 625-636.
 - Rodney G. Downey, Judith Egan, Michael R. Fellows, Frances A. Rosamond, and Peter Shaw. *Dynamic Dominating Set and Turbo-Charging Greedy Heuristics*. Tsinghua Journal of Science and Technology, 19(4): (2014) 329–337.
 - Sepp Hartung, Rolf Niedermeier. *Incremental list coloring of graphs, parameterized by conservation*. Theor. Comput. Sci. 494: 86-98 (2013)
- ✓ Using matroid-based representative sets for fast computations and kernelization.
 - Hans Bodlaender, Marek Cygan, Stefan Kratsch, Jesper Nederlof. *Deterministic Single Exponential Time Algorithms for Connectivity Problems Parameterized by Treewidth*. ICALP (1) 2013: 196-207.
 - Stefan Kratsch, Magnus Wahlström. *Representative Sets and Irrelevant Vertices: New Tools for Kernelization*. FOCS 2012: 450-459.
 - Fedor V. Fomin, Daniel Lokshtanov, Fahad Panolan, Saket Saurabh. *Representative Sets of Product Families*. ESA 2014: 443-454.
 - Fedor V. Fomin, Daniel Lokshtanov, Saket Saurabh. *Efficient Computation of Representative Sets with Applications in Parameterized and Exact Algorithms*. SODA 2014: 142-151.
 - Ariel Gabizon, Daniel Lokshtanov, Michał Pilipczuk. *Representative sets for multisets*. CoRR abs/1411.6756 (2014).
 - Hadas Shachnai, Meirav Zehavi. *Representative Families: A Unified Tradeoff-Based Approach*. ESA 2014: 786-797.
- ✓ Backdoors for Satisfiability and CSP.
 - Fedor V. Fomin, Daniel Lokshtanov, Neeldhara Misra, M. S. Ramanujan, Saket Saurabh. *Solving d -SAT via Backdoors to Small Treewidth*. SODA 2015: 630-641.
 - Serge Gaspers, Neeldhara Misra, Sebastian Ordyniak, Stefan Szeider, Stanislav Zivny. *Backdoors into Heterogeneous Classes of SAT and CSP*. AAI 2014: 2652-2658.
 - Christian Bessiere, Clément Carbonnel, Emmanuel Hebrard, George Katsirelos, Toby Walsh. *Detecting and Exploiting Subproblem Tractability*. IJCAI 2013.
 - Serge Gaspers, Stefan Szeider. *Strong Backdoors to Bounded Treewidth SAT*. FOCS 2013: 489-498.
- ✓ Parameterized Combinatorial Optimization often uses parameters different from those usually used in PC on graphs and CSP. Methods from both PC and Combinatorial Optimization are used.

- René van Bevern, Rolf Niedermeier, Manuel Sorge, and Mathias Weller. *Complexity of Arc Rooting Problems*. Chapter 2 in A. Corberán and G. Laporte (eds.), *Arc Routing: Problems, Methods and Applications*, SIAM, Phil., in press.
- Frederic Dorn, Hannes Moser, Rolf Niedermeier, and Mathias Weller. *Efficient algorithms for Eulerian extension*. *SIAM J. Discrete Math.* 27(1):75--94, 2013.
- Gregory Gutin, Mark Jones, and Bin Sheng, *Parameterized complexity of the k -arc Chinese postman problem*. *ESA 2014*, 530--541.
- Gregory Gutin, Magnus Wahlström and Anders Yeo. *Rural Postman Parameterized by the Number of Components of Required Edges*. To appear in *JCSS*.
- Gregory Gutin, Mark Jones, Bin Sheng, Magnus Wahlström. *Parameterized Directed k -Chinese Postman Problem and k -Arc-Disjoint Cycles Problem on Euler Digraphs*. *WG 2014*, 1--13.
- ✓ Workflow Satisfiability Problems: applications of PC in information security and new notions in information access control. Successes are in both theoretical results and algorithm engineering.
 - Q. Wang and N. Li. *Satisfiability and resiliency in workflow authorization systems*. *ACM Trans. Inf. Syst. Secur.* 13(4), article 40 (2010).
 - J. Crampton, Gregory Gutin, Anders Yeo. *On the parameterized complexity and kernelization of the workflow satisfiability problem*. *ACM Trans. Inf. Syst. Secur.* 16(1), article 4 (2013).
 - D. Cohen, J. Crampton, A. Gagarin, Gregory Gutin, Mark Jones. *Iterative Plan Construction for the Workflow Satisfiability Problem*. *J. Artif. Intel. Res.* 51 (2014), 555--577.
 - Gregory Gutin, Stefan Kratsch, and Magnus Wahlström. *Polynomial Kernels and User Reductions for the Workflow Satisfiability Problem*. *IPEC 2014*, 208-220.
- ✓ Using shadowless solutions to solve graph separation problems.
 - Dániel Marx, Igor Razgon. *Fixed-Parameter Tractability of Multicut Parameterized by the Size of the Cutset*. *SIAM J. Comput.* 43(2): 355-388 (2014)
 - Rajesh Hemant Chitnis, MohammadTaghi Hajiaghayi, Dániel Marx. *Fixed-Parameter Tractability of Directed Multiway Cut Parameterized by the Size of the Cutset*. *SIAM J. Comput.* 42(4): 1674-1696 (2013)
 - Rajesh Hemant Chitnis, László Egri, Dániel Marx, *List H -Coloring a Graph by Removing Few Vertices*. *ESA 2013*: 313-324
 - Stefan Kratsch, Marcin Pilipczuk, Michal Pilipczuk, Magnus Wahlström. *Fixed-Parameter Tractability of Multicut in Directed Acyclic Graphs*. *ICALP (1) 2012*: 581-593
 - Daniel Lokshtanov, M. S. Ramanujan. *Parameterized Tractability of Multiway Cut with Parity Constraints*. *ICALP (1) 2012*: 750-761
 - Rajesh Hemant Chitnis, Marek Cygan, Mohammad Taghi Hajiaghayi, Dániel Marx. *Directed Subset Feedback Vertex Set Is Fixed-Parameter Tractable*. *ICALP (1) 2012*: 230-241
- ✓ Geometric problems. For example, $W[1]$ -hardness for a well known geometric problem:
 - Panos Giannopoulos, Christian Knauer and Daniel Werner. *On the computational complexity of Erdős-Szekeres and related problems in R^3* . *ESA 2013*: 541-552.
- ✓ FPT reductions to SAT.
 - Ulle Endriss, Ronald de Haan, Stefan Szeider. *Parameterized Complexity Results for Agenda Safety in Judgment Aggregation*, *AAMAS 2015/ACM*.
Ronald de Haan, Stefan Szeider. *Machine Characterizations for Parameterized Complexity Classes Beyond Para-NP*. *SOFSEM 2015: LNCS (8939) 2015*: 217-229.
 - R. de Haan, S. Szeider. *The Parameterized Complexity of Reasoning Problems Beyond NP*. *Principles of Knowledge Representation and Reasoning: KR 2014*, AAAI Press, 2014.
 - Ronald de Haan, Stefan Szeider. *Fixed-Parameter Tractable Reductions to SAT*. *SAT 2014*, LNCS (8561) 2014: 85-102.

✓ Parameterized Proof Complexity.

- Stefan S. Dantchev, Barnaby Martin, Stefan Szeider. *Parameterized Proof Complexity*. Computational Complexity 20(1): 51-85, 2011 (full version of a FOCS 2007 paper).
- Olaf Beyersdorff, Nicola Galesi, Massimo Lauria, Alexander A. Razborov. *Parameterized Bounded-Depth Frege Is not Optimal*. ACM Trans on Computation Theory 4(3):7, 2012.
- Olaf Beyersdorff, Nicola Galesi, Massimo Lauria. *Parameterized Complexity of DPLL Search Procedures*. ACM Trans. Comput. Log. 14(3):20, 2013.

SPECIAL ISSUES AND SURVEYS

Recent Developments in Kernelization: A Survey. Stefan Kratsch, *Bulletin of the EATCS* 113 (2014) <http://eatcs.org/beatcs/index.php/beatcs/article/view/285>.

Special Issue on Parameterized Complexity, Guest Eds: Frances Rosamond, Liming Cai, and Iyad Kanj, *Tsinghua Journal of Science and Technology*, 19(4): (2014).

Special Issue on Exact and Parameterized Computation – Moderately Exponential & Parameterized Approximation, Guest Ed: Vangelis Th. Paschos, *Theoretical Computer Science*, (511) (2013).

Special Issue on Parameterized and Exact Computation, Part I and Part II, Guest Eds: Venkatesh Raman and Saket Saurabh, *Algorithmica* 64(1) (2012) and 65(4), (2013).

Towards Fully Multivariate Algorithmics: Parameter Ecology and the Deconstruction of Computational Complexity, Michael R. Fellows, Bart M. P. Jansen, Frances A. Rosamond, *Eur. J. Comb.* 34(3): 541-566 (2013).

Multivariate Complexity Theory, by Michael Fellows, Serge Gaspers, and Frances Rosamond, in the book *Computer Science: The Hardware, Software and Heart of It*, Eds: E. K. Blum and A. V. Aho, Springer, (ISBN 9781-4614-1167-3) 269—294 (2011).

Lower Bounds Based on the Exponential Time Hypothesis, Daniel Lokshantov, Dániel Marx and Saket Saurabh, *EATCS Bulletin*, No. 105, 41–71 (2011).

Confronting Intractability via Parameters, Rodney G. Downey and Dimitrios M. Thilikos, *Computer Science Review* 5(4): 279-317 (2011).

Special Issue on Parameterized Complexity of Discrete Optimization, Guest Eds: Michael Fellows, Fedor V. Fomin and Gregory Gutin, *Journal of Discrete Optimization*, 8(1):1 (2011).

Fixed-Parameter Tractability and Parameterized Complexity Applied to Problems From Computational Social Choice, C. Lindner and J. Rothe. *Supplement in Mathematical Programming Glossary (A. Holder, Ed) INFORMS Computing Society* (2008).

Special double issue on Parameterized Complexity, Guest Eds: Michael Fellows, Rod Downey and Michael Langston, *The Computer Journal*, Vol 1 and Vol 3, (2008) Two-volume special issue with 17 survey papers, book reviews, and a preface by Mike Fellows.

Special Issue on Exact and Parameterized Computation, Guest Ed: Jianer Chen, *Algorithmica* (2008).

Invitation to data reduction and problem kernelization, Jiong Guo and Rolf Niedermeier, *ACM SIGACT News*, 38(1):31-45 (2007).

INTERNATIONAL CONFERENCE/WORKSHOPS SERIES

(1) The premier conference series is the *International Symposium on Parameterized and Exact Computation* (IPEC) (formerly IWPEC), celebrating its 10th year in 2015, collocated with ALGO in Patras, Greece. See <http://fpt.wikidot.com/ipec> for IPEC History, Steering Committee, Awards, etc.

(2) *Workshop on Kernelization (WorKer)* was first held in 2009. The 7th workshop, WorKer 2015 takes place at the Sophus Lie Conference Center, Norway.

(3) *Approximation, Parameterized and Exact Algorithms (APEX)* is supported by the French National Agency for Research (ANR). Chaired by Vangelis Paschos, co-located STACS 2012, 2013.

(4) *Workshop on Graph Classes, Optimization, and Width Parameters (GROW)*. GROW 2015 will be the 7th workshop, Chair: Christophe Paul, France, October 2015.

(5) *Parameterized Complexity Not-About-Graphs*. IMSC, Chennai Dec 2014, chaired by Michael Fellows and Saket Saurabh. Darwin, Australia 2011 and 2013, chaired by Michael Fellows. German Technical University, Oman 2013, chaired by Rudolf Fleischer & Michael Fellows.

(6) *Parameterized Complexity of Reasoning Problems*. The 1st was a Satellite Workshop of MFCS & CSL 2010. Organized: Stefan Szeider and Stefan Woltran. Brno, Czech Republic, Aug 2010. The 2nd was part of FLoC 2014. Organizers: Michael Fellows, Serge Gaspers, Toby Walsh, Vienna July 2014.

Dagstuhl is the world premier venue for informatics. *Dagstuhl Seminars* related to PC include:

- 2015 15171: Theory and Practice of SAT Solving
- 15301: The Constraint Satisfaction Problem: Complexity and Approximability
- 2014 14451: Optimality and tight results in parameterized complexity
- 14372: Analysis of Algorithms Beyond the Worst Case
- 14341: Resource-bounded Problem Solving
- 14071: Graph Modification Problems
- 2013 13331: Exponential Algorithms: Algorithms and Complexity Beyond Polynomial Time
- 13121: Bidimensional Structures: Algorithms, Combinatorics and Logic
- 2012 12451: The Constraint Satisfaction Problem: Complexity and Approximability
- 12241: Data Reduction and Problem Kernels. Dedicated to the occasion of the 60th birthday of Michael Fellows. Takes the place of WorKer 2012
- 2011 11182: Exploiting graph structure to cope with hard problems
- 2010 10441: Exact Complexity of NP-hard Problems
- 2009 09511: Parameterized complexity and approximation algorithms
- 09441: The Constraint Satisfaction Problem: Complexity and Approximability
- 09171: Adaptive, Output Sensitive, Online and Parameterized Algorithms
- 2008 08431: Moderately Exponential Time Algorithms
- 2007 07281: Structure Theory and FPT Algorithmics for Graphs, Digraphs and Hypergraphs
- 07211: Exact, Approximative, Robust and Certifying Algorithms on Particular Graph Classes
- 2006 06401: Complexity of Constraints
- 2005 05301: Exact Algorithms and Fixed-Parameter Tractability
- 2004 04221: Robust and Approximative Algorithms on Particular Graph Classes
- 2003 03311: Fixed Parameter Algorithms
- 2001 01311: Parameterized Complexity

Shonan Workshops:

Toward the Ground Truth, Exact Algorithms for Bioinformatics Research, 2014.
Parameterized Complexity and the Understanding, Design, and Analysis of Heuristics, 2013.

Bertinoro Workshops:

Frontiers and Connections between Parametrization and Approximation May 2014

3rd Bertinoro Workshop on Algorithms and Graphs, 2013.

Enumeration Algorithms, Exact Methods for Exponential Problems in Computational Biology, 2012.

BIRS Institute Banff:

15w5118: Approximation Algorithms and Parameterized Complexity, Organizers: M. Fellows, H. Shachnai, K. Jansen, R. Solis-Oba.

13w5091: Geometric and topological graph theory, Organizers: Sergio Cabello, Zdenek Dvorák

Other Related and Occasional Workshops

Simons Institute, Berkeley from August 2015 is supporting a semester-long program on “Fine-Grained Complexity and Algorithm Design”. Fine-grained complexity analysis is a codeword for parameterized/multivariate algorithmics that seems to have been first used in the Foreword to the *Computer Journal* double special issue on parameterized complexity (2008) which also first articulated the FPT-optimality and XP-optimality programs, generalizing early results of Cai and Juedes, and later Chen et al. (later articulated by Dániel Marx into a successful ERC Starting Grant proposal.) The optimality programs will be the subject of a workshop during the semester. Organizers R. Paturi (Chair), R. Impagliazzo, D. Marx, V. Williams, and R. Williams.

ELC/B01 Workshop on Parameterized Algorithms, Chair: Rémy Belmonte, University of Electro-communication, Chofu, Japan, 2015.

Symposium on New Frontiers in Knowledge Compilation, Chairs: Pierre Marquis, CRIL-CNRS/Univ d'Artois, and Stefan Szeider, Vienna University of Technology, Vienna Austria, June 4-6, 2015.

Games and Cognition Workshop @SMARTCogSci Amsterdam, March 2015.

Workshop on Challenges in Algorithmic Social Choice, Eisenhardt Castle, Bad Belzig (near Berlin), Germany October 8-11, 2014.

First Symposium on Structure in Hard Combinatorial Problems, Chairs: Bart Selman, Cornell University and Stefan Szeider, Vienna Univ Technology, May 2014.

Using Parameterized Complexity Analysis in Cognitive Science, Tutorial at the 35th Annual Mtg of the Cognitive Science Society CogSci2013, Berlin. Lecturers: Iris van Rooij, Johan Kwisthout, Mark Blokpoel, Radboud University Nijmegen, Donders Institute for Brain, Cognition and Behaviour, Todd Wareham University of Newfoundland, July 2014.

AMS Special Session: *Mathematical Underpinnings of Multivariate Complexity Theory and Algorithm Design, and Its Frontiers and the Field of Incrementalization*, Organizers: Rodney Downey, Victoria University of Wellington, New Zealand, Michael Fellows, Charles Darwin University, Australia, Anil Nerode, Cornell University, Frances Rosamond, Charles Darwin University, Australia, San Diego, January 2013.

13th Haifa Workshop on Interdisciplinary Applications of Graph Theory, Combinatorics, and Algorithms, Haifa, Israel, May 19, 2013.

Parameterized Complexity - Multivariate Complexity Analysis Tutorial at the Computing: Australasian Theory Symposium: CATS (ACSW Week), Chair: Michael Fellows. Melbourne 2012.

1st Workshop on Applications of Parameterized Algorithms and Complexity (APAC). Organized by Gregory Gutin, co-located with ICALP 2012.

Bergen Treewidth Workshop May 19-20, 2011.

Graph Decomposition: Theoretical, Algorithmic and Logical Aspects, CIRM, Luminy, supported by French ANR projects GRAAL and AGAPE, 2010.

Workshop on Parameterized Complexity, Chair: Michael Fellows, Univ Newcastle, Au, March 2010.

Mathematical and Computational Methods in the Social Sciences. Workshop at the Univ. Auckland Centre for Algorithmic Aspects of Game Theory and Social Choice, a joint Centre between Economics, Mathematics and Computer Science, Arkadii Slinko, Director, 2010.

Introduction to Graph and Geometric Algorithms workshop held at IISc Bangalore, 2009.

Graph Decompositions and Algorithms (GRAAL), Chair: Christophe Paul, Montpellier, 2009.

Parameterized Complexity Seminar Series, Chinese University of Hong Kong, Leizhen Cai, 2009.

Parameterized Complexity Lecture Series, Rolf Niedermeier and Peter Rossmanith. National Chung Cheng U., National Tsing Hua U., National Dong Hwa U., Academia Sinica, Taipei, 2008.

Parameterized Complexity Workshop Satellite event to International Summer School in Formal Languages and Applications, organized by Prof. Joerg Flum (Freiburg) 2008.

Intractability and Cognitive Modelling: Formalization of Analogical Structure Mapping, organized by Moritz Muller, Iris van Rooij and Todd Wareham, 2008.

SCHOOLS

- Parameterized Algorithms and Complexity, Organizers: Marek Cygan, Fedor Fomin, Daniel Lokshtanov, Dániel Marx, Marcin Pilipczuk, Michał Pilipczuk, and Saket Saurabh. Będlewo, Poland, August 2014.
- Max Planck summer school ADFOCS (Advanced Course on the Foundations of Computer Science) Speakers: Łukasz Kowalik, Dániel Marx, Saket Saurabh, Aug 2013.
- Introduction to Parameterized Complexity, Winter School KAIST, S. Korea. Sang-II Oum, 2010.
- AGAPE Spring School on Parameterized and Exact Complexity, Corsica, May 2009.
- International Summer School on Fixed Parameter Algorithms, Fudan University, Shanghai, Satellite event to AAIM'08. Organized by Prof. Rudolf Fleischer, 2008.

AWARDS/PRIZES received in 2014 (about 3 million Euro for the field over 3-4 years)

Hans Bodlaender, Rodney Downey, Michael Fellows, Danny Hermelin *2014 Nerode Prize awarded by EATCS and IPEC* for “On problems without polynomial kernels” *JCSS* 2009, and Lance Fortnow, Rahul Santhanam for “Infeasibility of instance compression and succinct PCPs for NP”, *JCSS* 2011.

Katrin Casel, a DAAD grant to visit Dr. Ljiljana Brankovic, U. Newcastle, AU. Katrin is a PhD student of Henning Fernau, U. Trier. Katrin also holds a PhD grant awarded by Rhineland-Palatinate.

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

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

Michael Fellows *Honorary Fellow of the Royal Society of New Zealand*. Honorary Fellows include Albert Einstein, Marie Curie, Charles Darwin, Sir Arthur Eddington, Sir Alexander Fleming, Priestley, Richter, Rutherford, Bohr; altogether 230 since 1870.)

Michael Fellows *One of the ten inaugural EATCS Fellows* for “his role in founding the field of parameterized complexity theory ... for being a leader in computer science education.”

Michael Fellows, Charles Darwin U., for the *2014 ABZ International Gold Medal of Honor for Fundamental Contributions to Computer Science Education*, presented by ETH-Zurich.

Michael Fellows *Australian Prime Minister of Science Award*, Short-listed.

Henning Fernau, U. Trier, for a three-year DFG grant of 326K Euro for *Parameterized approximation - new concepts and new applications*.

Serge Gaspers, UNSW and NICTA for an Australian Research Council Future Fellowship for the project, *Algorithms for hard graph problems based on auxiliary data*, about 500k Euro over 4 years.

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

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

Danny Hermelin, an Israel Science Foundation (ISF) grant for *New Directions in Meta-Kernelization*. It is for 500k shekels (roughly 100K Euro) over four years.

Bart Jansen for a VENI for *Frontiers in Parameterized Preprocessing* of 234k Euro over three years.

Bart Jansen *Christiaan Huygens Prize* awarded once every 5 years in the area of ICT for a PhD thesis that contributes significantly to science and has clear relevance to society. The prize consists of 10,000 Euros and a bronze statue of the Dutch scientist Christiaan Huygens.

Matthias Mnich, U. Bonn, a DFG award for *Big Data Kernelization*, 231k Euro for three years.

Jesper Nederlof for a VENI (Netherlands Organization for Scientific Research) for *Reducing small instances of complex tasks to large instances of simple ones*, 231k Euro over three years.

Frank Neumann, U. Adelaide and Tobias Freidrich, Friedrich Schiller U.–Jena awarded a 300k ARC Award for *Parameterised Analysis of Bioinspired Computing*, 2014–2016.

Michał Pilipczuk, U. Bergen, for the *2014 Meltzer Prize for Young Researchers*.

Michał Pilipczuk for *Optimality in Parameterized Complexity*, funded by the Polish National Science Center starting October for three years.

Stefan Szeider, Vienna U. of Technology a 3-year Austrian Science Fund Award for Eur 340k on the topic of *Exploiting New Types of Structure for Fixed Parameter Tractability*.

Toby Walsh, UNSW, NICTA, *Humboldt Research Prize* which provides 60k EURO for visiting German researchers for up to one year. Toby visits Torsten Schaub, U. Potsdam and Rolf Niedermeier, TU Berlin.

AWARDS/PRIZES received in 2013 (about 1.5 million Euro for the field over 3-4-5 years)
Chris Calabro, Russell Impagliazzo, Valentine Kabanets, Ramamohan Paturi, Francis Zane *2013 Nerode Prize* awarded by EATCS and IPEC.

Rajesh Chitnis, a CS third-year Ph.D. student advised by Assoc. Prof. Mohammad Hajiaghayi at U.Maryland. Rajesh awarded \$48,000 by Simons Foundation for *New Techniques and Applications of Parameterized Complexity*, a two-year grant for graduate students in TCS.

Gregory Gutin, Royal Holloway, London *Royal Society Wolfson Research Merit Award for Parameterised Combinatorial Optimisation Problems*, provides a salary supplement for 5 years.

Falk Huffner, TU Berlin received a DFG award for his two-year project *Algorithm Engineering for NP-hard Problems: Parameterized Algorithms versus Established Techniques*. 174k EURO.

Klaus Jansen for a three-year DFG award for the project, *Lower Bounds on the running time for scheduling and packing problems under the exponential time hypothesis*. About 200,000 EURO.

Petteri Kaski, Aalto Univ School of Science received a 1.1 million Euro ERC Starting Grant for the project "Theory and Practice of Advanced Search and Enumeration".

George Mertzios, Durham U. for an EPSRC Award, the UK research funding body, for *Algorithmic Aspects of Intersection Graph Models*.

Neeldhara Misra, Innovation in Science Pursuit for Inspired Research Award for *Parameterized Methods in Bioinformatics*. Provides equivalent of 5 years IIT Assistant Professor position, which Neeldhara will avail at the Indian Institute of Science, Bangalore.

Reinhard Pichler and the Data-Base and Artificial Intelligence Group at TU Wien awarded three FWF Austrian Science Fund awards. (1) *Fixed-Parameter Tractability in Artificial Intelligence and Reasoning (FAIR)* studies the parameterized complexity of logic based problems such as answer-set programming and description logics. 350k EUR. (2) *Extending the Answer-Set Programming Paradigm to Decomposed Problem Solving* combines tree decomposition techniques with the declarative language "answer-set programming". 280k EUR. (3) *Fragment-Driven Belief Change* studies belief revision, update, and merging, subareas of Artificial Intelligence that deal with incorporating new information into existing knowledge bases. Part of the project is devoted to a parameterized complexity analysis of these problems. Awarded 350k EUR.

Stefan Szeider, Vienna U. of Technology a 3-year Austrian Science Fund Award for Eur 340k on the topic of *Parameterized Compilation*.

Gerhard J. Woeginger, TU Eindhoven received a *2013 Humboldt Research Prize*, which provides 60k EURO for visiting German researchers for up to one year. Gerhard visits Rolf Niedermeier.

AWARDS/PRIZES 2012 (about 8 million Euro for the field over 3-4-5 years)

Morgan Chopin awarded a 2012 DAAD Fellowship to visit Rolf Niedermeier at Technical U. Berlin. Morgan is the student of Cristina Bazgan, U. Dauphine, Paris.

Erik Demaine and MohammadTaghi Hajiaghayi, in the past three months, have been awarded two very competitive grants. The first from DARPA with 1 million each and the second NSF midsize (400K Erik and 200K MohammadTaghi) on *Fixed Parameter algorithms for graph problems and its connection to other fields*. So in total, just in the past three months, they have been awarded 2.6 million USD for parameterized complexity related projects.

Tobias Friedrich, U. Jena and Jiong Guo, Head of the Junior Research Group Efficient Algorithms for Hard Problems at U. Saarlandes, for a 2012 DFG award of 350k Euro for their project, *Average-Case Analysis of Parameterized Problems and Algorithms*.

Gregory Gutin, Royal Holloway, U. London, EPSRC (UK) of about 900k Euro for *Parameterized Algorithmics for the Analysis and Verification of Constrained Workflow Systems*.

Stefan Kratsch, Utrecht, has been accepted into the 2012 Emmy Noether program. He will move to Berlin in November, spending September and October at MPI in Saarbruecken.

Yiannis Koutis, U. Puerto Rico awarded prestigious 2012 NSF CAREER AWARD for spectral graph theory and linear time algorithms. He will be managing about 600k over the next 5 years.

Dániel Marx awarded a 2012 European Research Council Starting Grant for *PARAMTIGHT: Parameterized complexity and the search for tight complexity results*. The 1.15M Euro, 5-year project will start January 2012.

Pablo Moscato, U. Newcastle, AU was keynote speaker at the 2012 IX Congress of the Chilean Inst of Operations Research. Pablo is Co-Director of the Priority Research Centre for Bioinformatics, Biomarker Discovery and Information-based Medicine. At the Congress, Pablo gave a Tutorial on Memetic Algorithms, including links to parameterized complexity related to the design of local search and recombination operators. Pablo's group has big results in Alzheimer's Disease.

Saket Saurabh, IMSc Chennai, for a 2012 European Research Council Executive Agency (ERCEA) award of 1.690k Euro, for the project, *Parameterized Approximation*.

Xiuzhen Huang, Arkansas State U. and Gail McClure, Arkansas Science Authority for a 2012 NSF award of about \$100,000 USD to create a national *Workshop in Bioinformatics to Foster Collaborative Research* to be held in Little Rock, 3–5 March 2013.

AWARDS/PRIZES 2011 (about 2 million Euro for the field over 3-4 years)

Cristina Bazgan, LAMSADE, U. Dauphine awarded *2011 Junior Institute Universitaire de France*.

Vlad Estivil-Castro (Griffith U.), Mike Fellows and Frances Rosamond. (Charles Darwin U., AU) awarded 2011 Australian Research Council Discovery for *Algorithmic engineering and complexity analysis of protocols for consensus*, 250,000 AUD over 2011-2013.

Serge Gaspers, Vienna Univ of Technology awarded a 2011 Australian Research Council Discovery Early Career Researcher Award (DECRA) and *also* the U. New South Wales (UNSW) Vice-Chancellor Award. He had to choose only one, chose the DECRA for 375,000 AUD for his project, *Solving intractable problems: from practice to theory and back*.

MohammadTaghi Hajiaghayi awarded the 2011 Office of Naval Research Young Investigator Award, an NSF CAREER Award, and a Google Faculty Research Award (twice), U. of Maryland Research and Scholarship Award (RASA), AT&T Research Labs with total more than 1M dollars.

Petr Hlineny (Masaryk Univ) awarded 3-year *Czech Republic Science Research Award*.

Iyad Kanj, DePaul Univ, Chicago awarded *2011 Spirit of Inquiry Award* in recognition of his research in theoretical computer science, especially in the area of parameterized complexity.

Klaus Jansen, Christian-Albrechts-University award 2011-2013 for *Efficient Polynomial Time Approximation Schemes for Scheduling and Related Optimization Problems*, approx 400,000 Euro.

AWARDS/PRIZES 2010 (about 8 million Euro for the field over 3-4 years)

Fedor Fomin, European Research Council Starting Grant for *Rigorous Theory of Preprocessing*, about 2.2 million Euro.

Michael Fellows, Australian Professorial Award, five year research-only academic position.

Pinar Heggernes, Research Council of Norway award for *SCOPE - Exploiting Structure to Cope with Hard Problems*, about 12M NOK or 1.36 million Euro.

Daniel Lokshantov, Bergen Research Foundation award of 12.5 million NOK over 4 years including a tenure track position at the Univ of Bergen. Daniel also received a 2-year Simons Foundation Postdoc at UCSD, San Diego, CA.

Dániel Marx, Humboldt Fellowship for Experienced Researchers. He will be in Berlin for 18 months, following a postdoc in Tel Aviv.

Matthias Mnich, *Philips Prize of the Royal Mathematical Society in the Netherlands*, for the best PhD research project. Award given to, Advisor: Gerhard Weoginger, Mathematics and Computer Science, Eindhoven Univ of Technology. Matthias accepted a postdoc with Richard Karp, Berkeley, funded through a DAAD Fellowship.

Igor Razgon, President of Ireland Young Researcher Award for *Parameterized Complexity of Multiway Cut*, about 700K Euro over 4 years. The project succeeded against an interdisciplinary competition that included researchers from Biology, Medical, and other Sciences.

Saket Sarabh, Microsoft Research Travel Grant 2010-2015, MSRI, Chennai.

Stefan Szeider, European Research Council Starting Grant for *The Parameterized Complexity of Reasoning Problems*, 2010-2014, about 1.4M Euro.

Todd Wareham, NSERC grant renewed as of April 2010; about 11,000 Euro/year for 5 years for the project, *Parameterized complexity analysis in cognitive science*.

AWARDS/PRIZES 2009

Fred Havet. Project Leader, Local Leaders D. Kratsch, I.Todinca, S. Thomassé, C. Paul. Agence Nationale de la Recherche, Programme Blanc Grant for the AGAPE Project, *Research in Fixed-Parameter and Exact Algorithmics*. Approx 700k Euros for 4 years.

Chunmei Liu, Howard University, Washington, DC NSF CAREER award for *A Complete System for Protein Identification with Computational Approaches*. The project uses parameterized complexity and tree decomposition.

CITATION STATISTICS by Mike Fellows, Charles Darwin Univ., in *Parameterized Complexity Newsletter*, April 2013. (www.fpt.wikidot.com/fpt-news:the-parameterized-complexity-newsletter) Statistics for JCSS. The data was gathered using *Publish-or-Perish*.

Period I: all papers published in JCSS in the years 2003-2013 (11 years), average number of cites per paper: 19.5 (788 papers).

Period I: same, but restricted to papers in my area (45 papers), average cites/paper: 29.1.

Period II (more recent) 2008-2013: average number of cites over all papers published in JCSS in this period is 9.9.

Over the PC area (27 papers) published in JCSS in this period, the average cites/paper is 23.2.

Similar statistics were found for *TALG*.

2006–April 2013 (all papers): average cites/paper: 15.7.

2006–April 2013 (papers in Parameterized Complexity) average cites/paper: 20.7.

2009–April 2013 (all papers): average cites/paper: 8.4.

2009–April 2013 (papers in PC) average cites/paper: 16.1.

BEST PAPER AWARDS

SODA 2015 PC gives both the Best Paper Award *and* the Best Student Paper Award to the *biclique* paper by Bingkai Lin. <http://www.siam.org/meetings/da15/paper.php>

IPEC 2013 Excellent Student Paper Awards to:

-Mateus de Oliveira Oliveira, KTH, Stockholm for *Subgraphs Satisfying MSO Properties on z -Topologically Orderable Digraphs*

-Lukas Mach, U. Warwick and Tomas Toufar, Charles U., Prague for *Amalgam Width of Matroids*

-Bart M.P. Jansen, U. Bergen for *On Sparsification for Computing Treewidth*

IPEC 2012 Excellent Student Paper Awards to: Ivan Bliznets and Alexander Golovnev, both of St. Petersburg University of the Russian Academy of Sciences for their paper, *A New Algorithm for Parameterized MAX-SAT*.

SWAT 2012 Marek Cygan, Univ of Warsaw *Deterministic Parameterized Connected Vertex Cover*

WG 2012 Marek Cygan, Univ of Warsaw, Marcin Pilipczuk and Michał Pilipczuk, both of Univ. Bergen: *On Group Feedback Vertex Set Parameterized by the Size of the Cutset*.

CiE 2012 Sepp Hartung and André Nichterlein, TU Berlin *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.

COCOON 2012 Rémy Belmonte, Pinar Heggernes, Pim van 't Hof and Reza Saei, Dept Informatics, Univ Bergen, for *Ramsey Numbers for Line Graphs and Perfect Graphs*.

Best of ICCM-2012 Special Issue of Cognitive Systems Research. Iris van Rooij, Radboud Univ Nijmegen, Donders Institute for Brain, Cognition and Behaviour and Johan Kwisthout, Leiden Univ,

Leiden Inst of Advanced Computer Science for *Bridging the Gap between Theory and Practice of Approximate Bayesian Inference*.

WG 2011 Rémy Belmonte, Martin Vatshelle, Univ Bergen: *Graph Classes with Structured Neighborhoods and Algorithmic Applications*.

IPEC 2011 Yoichi Iwata Excellent Student Paper Award for *A Faster Algorithm for Dominating Set Analyzed by the Potential Method*.

IPEC 2010 Excellent Student Paper Awards to:

-M. Praveen, IMSc, for *Small Vertex Cover Makes Petri Net Coverability and Boundedness Easier* -

-Jesper Nederlof and Johan M. M. van Rooij, Univ. Bergen for *Inclusion/Exclusion Branching for Partial Dominating Set Set Splitting*.

RESEARCH TEAMS ACTIVE IN PARAMETERIZED COMPLEXITY

Africa Tanzania. Egbert Mujuni

Australia Charles Darwin U.: Michael Fellows, Frances Rosamond, Peter Shaw, Judith Egan. U. Newcastle: Pablo Moscato, Ljiljana Brankovic. Griffith U.: Vladimir Estivill-Castro. U. New South Wales: Toby Walsh, Serge Gaspers. U. Sydney: Joachim Gudmundsson, Julian Mestre. U. Queensland: Benjamin A. Burton, Jonathan Spreer. U. Adelaide: Frank Neumann.

Austria Vienna U. Technology: Stefan Szeider, Reinhard Pichler. Univ Vienna: Moritz Muller

Brazil Federal U. Rio de Janeiro: Jayme Szwarcfiter, Fábio Protti, Uéverton dos Santos Souza, Maise Dantas da Silva

Canada Carleton: Frank Dehne. Dalhousie U.: Norbert Zeh, McGill U.: Michael Hallett, Memorial U. Newfoundland: Todd Wareham. New Brunswick: Patricia Evans. U. Victoria: Sue Whitesides, Ulrike Stege. Waterloo: Naomi Nishimura, Prabhakar Ragde

Czech Republic Masaryk U.: Petr Hliněný. Charles U. Prague: Jan Kratochvíl. Czech Technical U. Prague: Ondrej Suchý.

Chile Universidad de Chile: Juan Andres Montoya

China Central South: Changsha. Jianxin Wang, Zhibiao Yang. Shanghai Jiaotong Univ: Yijia Chen. Shandong U. Jian: Jiong Guo

Hong Kong City U. Hong Kong: Leizhen Cai. Hong Kong Polytechnic: Yixin Cai

Denmark Copenhagen: Thore Husfeldt

Finland Helsinki: Mikko Koivisto

France CIRM Luminy and Montpellier: Christophe Paul, Ignasi Sau. LAMSADE and Univ. Dauphine: Vangelis Paschos, Cristina Bazgan, Michael Lampis, Eunjung Kim. Lyon: Stephane Thomassé. Metz: Dieter Kratsch

Germany RWTH Aachen: Martin Grohe, Arie Koster, Roman Rabinovich, Peter Rossmanith. Technische University-Berlin: Stefan Kreutzer, Rolf Niedermeier. Dusseldorf: Jorg Rothe, Felix Brandt. Freiburg: Jorg Flum. Karlsruhe: Detlef Seese. Christian Albrechts U.: Klaus Jansen. Frankfurt: Isolde Adler. Luebeck: Rudiger Reischuk. Max Planck Research Institute, Saarbrücken: Kurt Mehlhorn, Philip Geevarghese, Erik Jan van Leeuwen. Univ. Saarlands, Saarbrücken: Holger Dell. Trier: Henning Fernau. Bonn: Marek Karpinski, Stefan Kratsch, Mattias Mnich. Jena: Tobias Friedrich, Sebastian Böcker.

Greece Athens. Dimitrios M. Thilikos

Hungary Budapest. Dániel Marx

India Institute for Mathematical Sciences, Chennai: Venkatesh Raman, Saket Saurabh, V. Arvind. Indian Institute of Science-Bangalore: Neeldhara Misra

Ireland Cork: Barry O'Sullivan

Israel Haifa Technion: Hadas Shachnai. Tel Aviv. Noga Alon, Benny Chor, Ron Shamir

Italy U.Rome Tor Vergata: Marco Cesati. U. Rome La Sapienza: Paul Wollan. U. Lugano: Fabrizio Grandoni.

Japan Tokyo: Ken-Ichi Kawarabayashi, Yusuke Kobayashi, Osamu Watanabe, Bingkai Lin. U. Electro-communication, Chofu: Remy Belmonte. Tohoku: Kei Uchizawa, Takanori Aoki, Takehiro Ito, Xiao Zhou

Lebanon Lebanese American U.: Faisal Abu-Khzam

Netherlands Utrecht: Hans Bodlaender. Eindhoven: Gerhard Woeginger. Radboud, Nijmegen: Iris van Rooij, Bart Jansen. Leiden: Johan Kwisthout

New Zealand Auckland: Arkady Slinko. Massey: Catherine McCartin. Wellington: Rodney Downey

Norway Bergen: Fedor Fomin, Pinar Heggernes, Jan Arne Telle, Petr Golovach, Daniel Lokshantov,

Oman German Technical U. of Oman: Rudolf Fleischer

Poland Warsaw: Marek Cygan, Michał Pilipczuk, Marcin Kaminski, Łukasz Kowalik

Slovenia Ljubljana: Sergio Cabello

South Korea KAIST: Sang-Il Oum

Sweden Lund: Thore Husfeldt, Peter Damaschke

UK Oxford. Georg Gottlob. Durham: George Mertzios, Paul Bonsma, Daniel Paulusma. U. London Birbeck: Igor Razgon. Royal Holloway, U. of London: David Cohen, Jason Crampton, Gregory Gutin, Mark Jones, Magnus Wahlstrom. U. of Strathclyde: Mahdi Parsa. U. Edinburgh: Andrew Drucker. U. Warwick: Daniel Kral', Marcin Pilipczuk.

United States Arkansas: Xiuzhen Huang. Buffalo: Kenneth W. Regan. Central Florida: Ron Dutton. U. of Chicago: Marcus Schafer. DePaul Univ: Iyad Kanj. U. Georgia: Liming Cai. U. of Maryland: MohammadTaghi Hajiaghayi. MIT; Erik D. Demaine. U. Ohio: David Juedes. U. Oregon: Andrzej Proskurowski. Puerto Rico: Yiannis Koutis. Stanford: Ryan Williams, Vanessa Williams, Amir Abboud, Arturs Backurs. U. Tennessee and Oak Ridge National Labs: Michael Langston. Texas A&M: Jianer Chen. Lafayette College: Ge Xia. Montana State: Binhai Zhu