17th International Symposium on Parameterized and Exact Computation

IPEC 2022, September 7–9, 2022, Potsdam, Germany

Edited by
Holger Dell
Jesper Nederlof
LIPIcs – Leibniz International Proceedings in Informatics

LIPIcs is a series of high-quality conference proceedings across all fields in informatics. LIPIcs volumes are published according to the principle of Open Access, i.e., they are available online and free of charge.

Editorial Board
- Luca Aceto (Chair, Reykjavik University, IS and Gran Sasso Science Institute, IT)
- Christel Baier (TU Dresden, DE)
- Mikolaj Bojanczyk (University of Warsaw, PL)
- Roberto Di Cosmo (Inria and Université de Paris, FR)
- Faith Ellen (University of Toronto, CA)
- Javier Esparza (TU München, DE)
- Daniel Král’ (Masaryk University - Brno, CZ)
- Meena Mahajan (Institute of Mathematical Sciences, Chennai, IN)
- Anca Muscholl (University of Bordeaux, FR)
- Chih-Hao Luke Ong (University of Oxford, GB)
- Phillip Rogaway (University of California, Davis, US)
- Eva Rotenberg (Technical University of Denmark, Lyngby, DK)
- Raimund Seidel (Universität des Saarlandes, Saarbrücken, DE and Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Wadern, DE)

ISSN 1868-8969

https://www.dagstuhl.de/lipics
Contents

Preface
   Holger Dell and Jesper Nederlof .......................................................... 0:ix

Program Committees .................................................................................. 0:xi

List of External Reviewers .......................................................................... 0:xiii

List of Authors ............................................................................................ 0:xv

Regular Papers

A Finite Algorithm for the Realizability of a Delaunay Triangulation
   Akanksha Agrawal, Saket Saurabh, and Meirav Zehavi .......................... 1:1–1:16

Parameterized Complexity of Perfectly Matched Sets
   Akanksha Agrawal, Sutanay Bhattacharjee, Satyabrata Jana,
   and Abhishek Sahu ........................................................................... 2:1–2:13

On the Hardness of Generalized Domination Problems Parameterized by
Mim-Width
   Brage I. K. Bakkane and Lars Jaffke .................................................... 3:1–3:19

FPT Approximation for Fair Minimum-Load Clustering
   Sayan Bandyapadhyay, Fedor V. Fomin, Petr A. Golovach, Nidhi Purohit,
   and Kirill Simonov ........................................................................... 4:1–4:14

On Sparse Hitting Sets: From Fair Vertex Cover to Highway Dimension
   Johannes Blum, Yann Disser, Andreas Emil Feldmann, Siddharth Gupta,
   and Anna Zych-Pawlewicz .................................................................. 5:1–5:23

On the Complexity of Problems on Tree-Structured Graphs
   Hans L. Bodlaender, Carla Groenland, Hugo Jacob, Marcin Pilipczuk,
   and Michal Pilipczuk ......................................................................... 6:1–6:17

On the Parameterized Complexity of Computing Tree-Partitions
   Hans L. Bodlaender, Carla Groenland, and Hugo Jacob ..................... 7:1–7:20

XNLP-Completeness for Parameterized Problems on Graphs with a Linear
Structure
   Hans L. Bodlaender, Carla Groenland, Hugo Jacob, Lars Jaffke,
   and Paloma T. Lima ........................................................................... 8:1–8:18

Twin-Width VIII: Delineation and Win-Wins
   Édouard Bonnet, Dibyayan Chakraborty, Eun Jung Kim, Noleen Köhler,
   Raul Lopes, and Stéphan Thomassé ................................................... 9:1–9:18

Obstructions to Faster Diameter Computation: Asteroidal Sets
   Guillaume Ducoffe .............................................................................. 10:1–10:24
<table>
<thead>
<tr>
<th>Title</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>On the Parameterized Complexity of Symmetric Directed Multicut</td>
<td>11:1–11:17</td>
</tr>
<tr>
<td>Eduard Eiben, Clément Rambaud, and Magnus Wahlström</td>
<td></td>
</tr>
<tr>
<td>Computing Generalized Convolutions Faster Than Brute Force</td>
<td>12:1–12:22</td>
</tr>
<tr>
<td>Barış Can Esmer, Ariel Kulik, Dániel Marx, Philipp Schepper,</td>
<td></td>
</tr>
<tr>
<td>and Karol Węgrzycki</td>
<td></td>
</tr>
<tr>
<td>Exact Exponential Algorithms for Clustering Problems</td>
<td>13:1–13:14</td>
</tr>
<tr>
<td>Fedor V. Fomin, Petr A. Golovach, Tanmay Inamdar, Nidhi Purohit,</td>
<td></td>
</tr>
<tr>
<td>and Saket Saurabh</td>
<td></td>
</tr>
<tr>
<td>Domination and Cut Problems on Chordal Graphs with Bounded Leafage</td>
<td>14:1–14:24</td>
</tr>
<tr>
<td>Esther Galby, Dániel Marx, Philipp Schepper, Roohani Sharma,</td>
<td></td>
</tr>
<tr>
<td>and Prafullkumar Tale</td>
<td></td>
</tr>
<tr>
<td>Slim Tree-Cut Width</td>
<td>15:1–15:18</td>
</tr>
<tr>
<td>Robert Ganian and Viktoriia Korchemna</td>
<td></td>
</tr>
<tr>
<td>A Fixed-Parameter Algorithm for the Schrijver Problem</td>
<td>16:1–16:16</td>
</tr>
<tr>
<td>Ishay Haviv</td>
<td></td>
</tr>
<tr>
<td>Towards Exact Structural Thresholds for Parameterized Complexity</td>
<td>17:1–17:20</td>
</tr>
<tr>
<td>Falko Hegerfeld and Stefan Kratsch</td>
<td></td>
</tr>
<tr>
<td>Hardness of Interval Scheduling on Unrelated Machines</td>
<td>18:1–18:16</td>
</tr>
<tr>
<td>Danny Hermelin, Yuval Itzhaki, Hendrik Molter, and Deir Shabtay</td>
<td></td>
</tr>
<tr>
<td>Vertex Cover and Feedback Vertex Set Above and Below Structural Guarantees</td>
<td>19:1–19:14</td>
</tr>
<tr>
<td>Leon Kellerhals, Tomohiro Koana, and Pascal Kunz</td>
<td></td>
</tr>
<tr>
<td>Parameterized Local Search for Vertex Cover: When Only the Search Radius Is Crucial</td>
<td>20:1–20:18</td>
</tr>
<tr>
<td>Christian Komusiewicz and Nils Morawietz</td>
<td></td>
</tr>
<tr>
<td>Parameterized Complexity of a Parallel Machine Scheduling Problem</td>
<td>21:1–21:21</td>
</tr>
<tr>
<td>Maher Mallem, Claire Hanen, and Alix Munier-Kordon</td>
<td></td>
</tr>
<tr>
<td>Dániel Marx, Govind S. Sankar, and Philipp Schepper</td>
<td></td>
</tr>
<tr>
<td>Parameterized Complexity of Maximum Happy Set and Densest k-Subgraph</td>
<td>23:1–23:18</td>
</tr>
<tr>
<td>Yosuke Mizutani and Blair D. Sullivan</td>
<td></td>
</tr>
<tr>
<td>Parameterized Complexity of Streaming Diameter and Connectivity Problems</td>
<td>24:1–24:16</td>
</tr>
<tr>
<td>Jelle J. Oostveen and Erik Jan van Leeuwen</td>
<td></td>
</tr>
<tr>
<td>Applying a Cut-Based Data Reduction Rule for Weighted Cluster Editing in Polynomial Time</td>
<td>25:1–25:14</td>
</tr>
<tr>
<td>Hjalmar Schulz, André Nichterlein, Rolf Niedermeier, and Christopher Weyand</td>
<td></td>
</tr>
</tbody>
</table>
PACE Solver Descriptions

The PACE 2022 Parameterized Algorithms and Computational Experiments Challenge: Directed Feedback Vertex Set

*Ernestine Großmann, Tobias Heuer, Christian Schulz, and Darren Strash* 26:1–26:18

PACE Solver Description: DiVerSeS – A Heuristic Solver for the Directed Feedback Vertex Set Problem

*Sylwester Swat* 27:1–27:3

PACE Solver Description: Mount Doom – An Exact Solver for Directed Feedback Vertex Set


PACE Solver Description: Hust-Solver – A Heuristic Algorithm of Directed Feedback Vertex Set Problem

*YuMing Du, QingYun Zhang, JunZhou Xu, ShunGen Zhang, Chao Liao, ZhiHuai Chen, ZhiBo Sun, ZhouXing Su, JunWen Ding, Chen Wu, PinYan Lu, and ZhiPeng Lv* 29:1–29:3

PACE Solver Description: GraPA-JAVA

*Moritz Bergenthal, Jona Dirks, Thorben Freese, Jakob Gahde, Enna Gerhard, Mario Grobler, and Sebastian Siebertz* 30:1–30:4

PACE Solver Description: DreyFVS

*Gabriel Bathie, Gaétan Berthe, Yoann Coudert–Osmont, David Desobry, Amadeus Reinald, and Mathis Rocton* 31:1–31:4

PACE Solver Description: DAGer – Cutting out Cycles with MaxSAT

*Rafael Kiesel and André Schidler* 32:1–32:4

IPEC 2022
The International Symposium on Parameterized and Exact Computation (IPEC, formerly IWPEC) is a series of international symposia covering research in all aspects of parameterized and exact algorithms and complexity. Started in 2004 as a biennial workshop, it became an annual event in 2009. Previous iterations of the symposium were:

- 2004 Bergen, Norway
- 2006 Zürich, Switzerland
- 2008 Victoria, Canada
- 2009 Copenhagen, Denmark
- 2010 Chennai, India
- 2011 Saarbrücken, Germany
- 2012 Lubljana, Slovenia
- 2013 Sophia Antipolis, France
- 2014 Wrocław, Poland
- 2015 Patras, Greece
- 2016 Aarhus, Denmark
- 2017 Vienna, Austria
- 2018 Helsinki, Finland
- 2019 Munich, Germany
- 2020 Hong Kong, China
- 2021 virtual / Lisbon, Portugal

This volume contains the papers presented at IPEC 2022: the 17th International Symposium on Parameterized and Exact Computation. IPEC 2022 was held on September 7–9. It was a part of the ALGO 2022 congress, and took place in Potsdam, Germany. In response to the call for papers, 47 extended abstracts were submitted and 25 of them were ultimately selected for presentation at the conference and inclusion in these proceeding. Each considered submission received at least 3 reviews. The reviews were performed in a double-blind fashion by the 16 regular members of the program committee and by 19 external reviewers, together contributing 141 full reviews.

The Best Paper Award was given to Hans L. Bodlaender (Utrecht University), Carla Groenland (Utrecht University), Hugo Jacob (ENS Paris-Saclay), Lars Jaffke (University of Bergen) and Paloma de Lima (IT University of Copenhagen) for their paper “XNLP-completeness for Parameterized Problems on Graphs with a Linear Structure.”

The Best Student Paper Award was given to Jelle Oostveen (Utrecht University) and Erik Jan van Leeuwen (Utrecht University) for their paper “Parameterized Complexity of Streaming Diameter and Connectivity Problems”.

The EATCS-IPEC Nerode Prize was given to Bruno Courcelle for his papers “The Monadic Second-Order Logic of Graphs. I. Recognizable Sets of Finite Graphs” and “The Monadic Second-Order Logic of Graphs III: Tree-Decompositions, Minors and Complexity Issues”. IPEC 2022 hosted an award ceremony with a plenary talk given by Bruno Courcelle. The Nerode Prize committee consisted of Anuj Dawar (University of Cambridge), Fedor Fomin (University of Bergen), and Thore Husfeldt (IT University of Copenhagen).

Eun Jung Kim (Université Paris-Dauphine, PSL Research University, CNRS) presented an invited tutorial on “Directed Flow-augmentation”. Finally, IPEC 2022 hosted the award ceremony of the seventh Parameterized Algorithms and Computational Experiments (PACE) challenge. These proceedings contain a report on the PACE 2022 challenge and brief communications of the winners about their solvers.

We thank the program committee and the external reviewers for their commitment in the paper selection process. We also thank all the authors who submitted their work. We are grateful to the local organizers of ALGO 2022 for the local arrangements.

Holger Dell and Jesper Nederlof
Frankfurt and Utrecht, October 2022
Program Committees

IPEC 2022 Program Committee

- Christian Komusiewicz (Marburg University)
- Christophe Paul (Laboratoire d’Informatique Robotique et Microélectronique de Montpellier)
- Cornelius Brand (Technische Universität Wien)
- Édouard Bonnet (ENS Lyon)
- Holger Dell (Goethe University Frankfurt, ITU Copenhagen, and BARC, co-chair)
- Jesper Nederlof (Utrecht University, co-chair)
- Karol Węgrzycki (Saarland University and Max Planck Institute for Informatics)
- M.S. Ramanujan (University of Warwick)
- Marvin Künnemann (TU Kaiserslautern)
- Michael Lampis (Paris Dauphine University)
- Neeldhara Misra (IIT Gandhinagar)
- Pawel Rzążewski (Warsaw University of Technology and University of Warsaw)
- Radu Curticapean (ITU Copenhagen and BARC)
- René van Bevern (Huawei Cloud Technologies Co., Ltd.)
- Robert Ganian (Technische Universität Wien)
- Roohani Sharma (Max Planck Institute for Informatics)
- Sándor Kisfaludi-Bak (Aalto University)
- Valia Mitsou (Research Institute on the Foundations of Computer Science (IRIF) and Paris Diderot University)

IPEC 2022 Steering Committee

- Dániel Marx (2020 – 2023)
- Eun Jung Kim (2019 – 2022)
- Fedor Fomin (2021 – 2024)
- Holger Dell (2021 – 2024)
- Jesper Nederlof (2021 – 2024)
- Marcin Pilipczuk (2019 – 2022, chair)
- Meirav Zehavi (2020 – 2023)
- Petr Golovach (2020 – 2023)
- Yixin Cao (2019 – 2022)

PACE 2022 Program Committee

- Christian Schulz (chair) (Universität Heidelberg)
- Ernesteine Großmann (Universität Heidelberg)
- Tobias Heuer (Karlsruher Institut für Technologie)
- Darren Strash (Hamilton College)
List of External Reviewers

- Ararat Harutyunyan
- Archontia Giannopoulou
- Evangelos Protopapas
- Frank Sommer
- Giannos Stamoulis
- Kirill Simonov
- Laure Morelle
- Liana Khazaliya
- Mamadou Moustapha Kanté
- Manuel Lafond
- Mathias Weller
- Mathis Rocton
- Peter Rossmanith
- Philipp Schepper
- Rémy Belmonte
- Sebastian Ordyniak
- Stefan Mengel
- Thekla Hamm
- Viktoriia Korchenna
<table>
<thead>
<tr>
<th>List of Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akanksha Agrawal  (1, 2)                                                                                     Indian Institute of Technology Madras, Chennai, India</td>
</tr>
<tr>
<td>Sebastian Angrick  (28)                                                                                      Hasso Plattner Institut, Universität Potsdam, Germany</td>
</tr>
<tr>
<td>Brage I. K. Bakkane  (3)                                                                                     University of Bergen, Norway</td>
</tr>
<tr>
<td>Ben Bals  (28)                                                                                                 Hasso Plattner Institut, Universität Potsdam, Germany</td>
</tr>
<tr>
<td>Sayan Bandyapadhyay  (4)                                                                                      Department of Informatics, University of Bergen, Norway</td>
</tr>
<tr>
<td>Gabriel Bathie  (31)                                                                                           École Normale Supérieure de Lyon, France</td>
</tr>
<tr>
<td>Moritz Bergenthal  (30)                                                                                       Universität Bremen, Germany</td>
</tr>
<tr>
<td>Gaétan Berthe  (31)                                                                                           École Normale Supérieure de Lyon, France</td>
</tr>
<tr>
<td>Sutanay Bhattacharjee  (2)                                                                                     Indian Institute of Technology Madras, Chennai, India</td>
</tr>
<tr>
<td>Johannes Blum  (5)                                                                                             Universität Konstanz, Germany</td>
</tr>
<tr>
<td>Hans L. Bodlaender  (6, 7, 8)                                                                                  Department of Information and Computing Sciences, Utrecht University, The Netherlands</td>
</tr>
<tr>
<td>Édouard Bonnet  (9)                                                                                           Univ Lyon, CNRS, ENS de Lyon, Université Claude Bernard Lyon 1, LIP UMR5668, France</td>
</tr>
<tr>
<td>Katrin Casel  (28)                                                                                             Hasso Plattner Institut, Universität Potsdam, Germany</td>
</tr>
<tr>
<td>Dibyayan Chakraborty  (9)                                                                                     Univ Lyon, CNRS, ENS de Lyon, Université Claude Bernard Lyon 1, LIP UMR5668, France</td>
</tr>
<tr>
<td>ZhiHuai Chen  (29)                                                                                            Huawei TCS Lab Shanghai, China</td>
</tr>
<tr>
<td>Sarel Cohen  (28)                                                                                               The Academic College of Tel Aviv-Yaffo, Israel</td>
</tr>
<tr>
<td>Yoann Coudert-Osmont  (31)                                                                                    Université de Lorraine, CNRS, Inria, LORIA, Nancy, France</td>
</tr>
<tr>
<td>David Desobry  (31)                                                                                            Université de Lorraine, CNRS, Inria, LORIA, Nancy, France</td>
</tr>
<tr>
<td>JunWen Ding  (29)                                                                                            School of Computer Science and Technology, Huazhong University of Science &amp; Technology, China</td>
</tr>
<tr>
<td>Jona Dirks  (30)                                                                                            Universität Bremen, Germany</td>
</tr>
<tr>
<td>Yann Disser  (5)                                                                                            Technische Universität Darmstadt, Germany</td>
</tr>
<tr>
<td>YuMing Du  (29)                                                                                            School of Computer Science and Technology, Huazhong University of Science &amp; Technology, China</td>
</tr>
<tr>
<td>Guillaume Ducoste  (10)                                                                                       National Institute of Research and Development in Informatics, Bucharest, Romania; University of Bucharest, Romania</td>
</tr>
<tr>
<td>Eduard Eiben  (11)                                                                                            Department of Computer Science, Royal Holloway, University of London, Egham, UK</td>
</tr>
<tr>
<td>Barış Can Esmer  (12)                                                                                         CISPA Helmholtz Center for Information Security, Saarbrücken, Germany</td>
</tr>
<tr>
<td>Andreas Emil Feldmann  (5)                                                                                     Charles University, Prague, Czechia</td>
</tr>
<tr>
<td>Fedor V. Fomin  (4, 13)                                                                                       Department of Informatics, University of Bergen, Norway</td>
</tr>
<tr>
<td>Thorben Freese  (30)                                                                                           Universität Bremen, Germany</td>
</tr>
<tr>
<td>Tobias Friedrich  (28)                                                                                        Hasso Plattner Institut, Universität Potsdam, Germany</td>
</tr>
<tr>
<td>Jakob Gahde  (30)                                                                                            Universität Bremen, Germany</td>
</tr>
<tr>
<td>Esther Galby  (14)                                                                                            TU Hamburg, Germany</td>
</tr>
</tbody>
</table>

Robert Ganian (15)
Algorithms and Complexity Group,
TU Wien, Austria

Enna Gerhard (30)
Universität Bremen, Germany

Petr A. Golovach (4, 13)
Department of Informatics,
University of Bergen, Norway

Mario Grobler (30)
Universität Bremen, Germany

Carla Groenland (6, 7, 8)
Department of Information and Computing
Sciences, Utrecht University, The Netherlands

Siddharth Gupta (5)
University of Warwick, Coventry, UK

Claire Hanen (21)
Sorbonne Université, CNRS, LIP6,
F-75005 Paris, France;
Université Paris Nanterre, UPL,
92000 Nanterre, France

Niko Hastrich (28)
Hasso Plattner Institut,
Universität Potsdam, Germany

Ishay Haviv (16)
School of Computer Science, The Academic
College of Tel Aviv-Yaffo, Israel

Falko Hegerfeld (17)
Humboldt-Universität zu Berlin, Germany

Danny Hermelin (18)
Department of Industrial Engineering and
Management, Ben-Gurion University of the
Negev, Beer-Sheva, Israel

Tobias Heuer (26)
Karlsruhe Institute of Technology, Germany

Theresa Hradilak (28)
Hasso Plattner Institut,
Universität Potsdam, Germany

Yuval Itzhaki (18)
Department of Industrial Engineering and
Management, Ben-Gurion University of the
Negev, Beer-Sheva, Israel

Hugo Jacob (6, 7, 8)
ENS Paris-Saclay, France

Lars Jaffke (3, 8)
University of Bergen, Norway

Satyabrata Jana (2)
The Institute of Mathematical Sciences, HBNI,
Chennai, India

Leon Kellerhals (19)
Faculty IV, Institute of Software Engineering
and Theoretical Computer Science, Algorithmics
and Computational Complexity,
Technische Universität Berlin, Germany

Rafael Kiesel (32)
TU Wien, Austria

Eun Jung Kim (9)
Université Paris-Dauphine, PSL University,
CNRS UMR7243, LAMSADE, Paris, France

Otto Käßig (28)
Hasso Plattner Institut,
Universität Potsdam, Germany

Tomohiro Koana (19)
Faculty IV, Institute of Software Engineering
and Theoretical Computer Science, Algorithmics
and Computational Complexity,
Technische Universität Berlin, Germany

Christian Komusiewicz (20)
Fachbereich Mathematik und Informatik,
Philipps-Universität Marburg, Germany

Viktoriia Korchemna (15)
Algorithms and Complexity Group,
TU Wien, Austria

Stefan Kratsch (17)
Humboldt-Universität zu Berlin, Germany

Ariel Kulik (12)
CISPA Helmholtz Center for Information
Security, Saarbrücken, Germany

Pascal Kunz (19)
Faculty IV, Institute of Software Engineering
and Theoretical Computer Science, Algorithmics
and Computational Complexity,
Technische Universität Berlin, Germany