

28th Annual European Symposium on Algorithms

ESA 2020, September 7–9, 2020, Pisa, Italy (Virtual Conference)

Edited by

Fabrizio Grandoni

Grzegorz Herman

Peter Sanders



Editors

Fabrizio Grandoni 

IDSIA, USI-SUPSI, Manno, Switzerland
fabrizio@idsia.ch

Grzegorz Herman 

Jagiellonian University, Kraków, Poland
gherman@tcs.uj.edu.pl

Peter Sanders 

Karlsruhe Institute of Technology, Germany
sanders@kit.edu

ACM Classification 2012

Applied computing → Transportation; Theory of computation → Facility location and clustering; Computing methodologies → Agent / discrete models; Computing methodologies → Algebraic algorithms; Computing methodologies → Combinatorial algorithms; Human-centered computing → Graph drawings; Mathematics of computing → Approximation algorithms; Mathematics of computing → Combinatorial algorithms; Mathematics of computing → Graph algorithms; Mathematics of computing → Graph coloring; Mathematics of computing → Graphs and surfaces; Mathematics of computing → Graph theory; Mathematics of computing → Hypergraphs; Mathematics of computing → Information theory; Mathematics of computing → Network flows; Mathematics of computing → Paths and connectivity problems; Mathematics of computing → Probabilistic algorithms; Mathematics of computing → Random graphs; Mathematics of computing → Solvers; Mathematics of computing → Trees; Networks → Network algorithms; Theory of computation → Algorithmic game theory and mechanism design; Theory of computation → Approximation algorithms analysis; Theory of computation → Computational geometry; Theory of computation → Data structures design and analysis; Theory of computation → Design and analysis of algorithms; Theory of computation → Online algorithms; Theory of computation → Distributed algorithms; Theory of computation → Dynamic graph algorithms; Theory of computation → Facility location and clustering; Theory of computation → Fixed parameter tractability; Theory of computation → Graph algorithms analysis; Theory of computation → Network flows; Theory of computation → Online algorithms; Theory of computation → Packing and covering problems; Theory of computation → Parallel algorithms; Theory of computation → Parallel computing models; Theory of computation → Parameterized complexity and exact algorithms; Theory of computation → Pattern matching; Theory of computation → Problems, reductions and completeness; Theory of computation → Randomness, geometry and discrete structures; Theory of computation → Random network models; Theory of computation → Routing and network design problems; Theory of computation → Scheduling algorithms; Theory of computation → Shared memory algorithms; Theory of computation → Shortest paths; Theory of computation → Sorting and searching; Theory of computation → Stochastic approximation

ISBN 978-3-95977-162-7*Published online and open access by*

Schloss Dagstuhl – Leibniz-Zentrum für Informatik GmbH, Dagstuhl Publishing, Saarbrücken/Wadern, Germany. Online available at <https://www.dagstuhl.de/dagpub/978-3-95977-162-7>.

Publication date

August, 2020

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <https://portal.dnb.de>.

License

This work is licensed under a Creative Commons Attribution 3.0 Unported license (CC-BY 3.0):
<https://creativecommons.org/licenses/by/3.0/legalcode>.

In brief, this license authorizes each and everybody to share (to copy, distribute and transmit) the work under the following conditions, without impairing or restricting the authors' moral rights:

- Attribution: The work must be attributed to its authors.



The copyright is retained by the corresponding authors.

Digital Object Identifier: 10.4230/LIPIcs.ESA.2020.0

ISBN 978-3-95977-162-7

ISSN 1868-8969

<https://www.dagstuhl.de/lipics>

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*, Gran Sasso Science Institute and Reykjavik University)
- Christel Baier (TU Dresden)
- Mikolaj Bojanczyk (University of Warsaw)
- Roberto Di Cosmo (INRIA and University Paris Diderot)
- Javier Esparza (TU München)
- Meena Mahajan (Institute of Mathematical Sciences)
- Dieter van Melkebeek (University of Wisconsin-Madison)
- Anca Muscholl (University Bordeaux)
- Luke Ong (University of Oxford)
- Catuscia Palamidessi (INRIA)
- Thomas Schwentick (TU Dortmund)
- Raimund Seidel (Saarland University and Schloss Dagstuhl – Leibniz-Zentrum für Informatik)

ISSN 1868-8969

<https://www.dagstuhl.de/lipics>

■ Contents

Preface	
<i>Fabrizio Grandoni, Grzegorz Herman, and Peter Sanders</i>	0:xi
Planar Bichromatic Bottleneck Spanning Trees	
<i>A. Karim Abu-Affash, Sujoy Bhore, Paz Carmi, and Joseph S. B. Mitchell</i>	1:1–1:16
Parallel Batch-Dynamic Trees via Change Propagation	
<i>Umut A. Acar, Daniel Anderson, Guy E. Blelloch, Laxman Dhulipala, and Sam Westrick</i>	2:1–2:22
Reconstructing Biological and Digital Phylogenetic Trees in Parallel	
<i>Ramtin Afshar, Michael T. Goodrich, Pedro Matias, and Martha C. Osegueda</i> ...	3:1–3:24
Kruskal-Based Approximation Algorithm for the Multi-Level Steiner Tree Problem	
<i>Reyan Ahmed, Faryad Darabi Sahneh, Keaton Hamm, Stephen Kobourov, and Richard Spence</i>	4:1–4:21
Analysis of the Period Recovery Error Bound	
<i>Amihod Amir, Itai Boneh, Michael Itzhaki, and Eitan Konratovsky</i>	5:1–5:21
Approximation of the Diagonal of a Laplacian’s Pseudoinverse for Complex Network Analysis	
<i>Eugenio Angriman, Maria Predari, Alexander van der Grinten, and Henning Meyerhenke</i>	6:1–6:24
Cutting Polygons into Small Pieces with Chords: Laser-Based Localization	
<i>Esther M. Arkin, Rathish Das, Jie Gao, Mayank Goswami, Joseph S. B. Mitchell, Valentin Polishchuk, and Csaba D. Tóth</i>	7:1–7:23
Set Cover with Delay – Clairvoyance Is Not Required	
<i>Yossi Azar, Ashish Chiplunkar, Shay Kutten, and Noam Touitou</i>	8:1–8:21
Improved Bounds for Metric Capacitated Covering Problems	
<i>Sayan Bandyopadhyay</i>	9:1–9:17
Minimum Neighboring Degree Realization in Graphs and Trees	
<i>Amotz Bar-Noy, Keerti Choudhary, Avi Cohen, David Peleg, and Dror Rawitz</i> ...	10:1–10:15
Tight Approximation Algorithms for p -Mean Welfare Under Subadditive Valuations	
<i>Siddharth Barman, Umang Bhaskar, Anand Krishna, and Ranjani G. Sundaram</i> .	11:1–11:17
Mincut Sensitivity Data Structures for the Insertion of an Edge	
<i>Surender Baswana, Shiv Gupta, and Till Knollmann</i>	12:1–12:14
Linear Time LexDFS on Chordal Graphs	
<i>Jesse Beisegel, Ekkehard Köhler, Robert Scheffler, and Martin Strehler</i>	13:1–13:13
Grundy Distinguishes Treewidth from Pathwidth	
<i>Rémy Belmonte, Eun Jung Kim, Michael Lampis, Valia Mitsou, and Yota Otachi</i>	14:1–14:19



On the Complexity of BWT-Runs Minimization via Alphabet Reordering <i>Jason W. Bentley, Daniel Gibney, and Sharma V. Thankachan</i>	15:1–15:13
Simulating Population Protocols in Sub-Constant Time per Interaction <i>Petra Berenbrink, David Hammer, Dominik Kaaser, Ulrich Meyer, Manuel Penschuck, and Hung Tran</i>	16:1–16:22
An Optimal Decentralized $(\Delta + 1)$ -Coloring Algorithm <i>Daniel Bertschinger, Johannes Lengler, Anders Martinsson, Robert Meier, Angelika Steger, Miloš Trujić, and Emo Welzl</i>	17:1–17:12
Noisy, Greedy and Not so Greedy k -Means++ <i>Anup Bhattacharya, Jan Eube, Heiko Röglin, and Melanie Schmidt</i>	18:1–18:21
An Algorithmic Study of Fully Dynamic Independent Sets for Map Labeling <i>Sujoy Bhore, Guangping Li, and Martin Nöllenburg</i>	19:1–19:24
Lower Bounds and Approximation Algorithms for Search Space Sizes in Contraction Hierarchies <i>Johannes Blum and Sabine Storandt</i>	20:1–20:14
The Minimization of Random Hypergraphs <i>Thomas Bläsius, Tobias Friedrich, and Martin Schirneck</i>	21:1–21:15
Acyclic, Star and Injective Colouring: A Complexity Picture for H -Free Graphs <i>Jan Bok, Nikola Jedličková, Barnaby Martin, Daniël Paulusma, and Siani Smith</i> .	22:1–22:22
An Algorithmic Weakening of the Erdős-Hajnal Conjecture <i>Édouard Bonnet, Stéphan Thomassé, Xuan Thang Tran, and Rémi Watrigant</i>	23:1–23:18
Reconfiguration of Spanning Trees with Many or Few Leaves <i>Nicolas Bousquet, Takehiro Ito, Yusuke Kobayashi, Haruka Mizuta, Paul Ouvrard, Akira Suzuki, and Kunihiko Wasa</i>	24:1–24:15
When Lipschitz Walks Your Dog: Algorithm Engineering of the Discrete Fréchet Distance Under Translation <i>Karl Bringmann, Marvin Künnemann, and André Nusser</i>	25:1–25:17
Improved Algorithms for Alternating Matrix Space Isometry: From Theory to Practice <i>Peter A. Brooksbank, Yinan Li, Youming Qiao, and James B. Wilson</i>	26:1–26:15
Sometimes Reliable Spanners of Almost Linear Size <i>Kevin Buchin, Sarel Har-Peled, and Dániel Oláh</i>	27:1–27:15
New Binary Search Tree Bounds via Geometric Inversions <i>Parinya Chalermsook and Wanchote Po Jiamjitrak</i>	28:1–28:16
More on Change-Making and Related Problems <i>Timothy M. Chan and Qizheng He</i>	29:1–29:14
The Maximum Binary Tree Problem <i>Karthekeyan Chandrasekaran, Elena Grigorescu, Gabriel Istrate, Shubhang Kulkarni, Young-San Lin, and Minshen Zhu</i>	30:1–30:22
Single-Source Shortest Paths and Strong Connectivity in Dynamic Planar Graphs <i>Panagiotis Charalampopoulos and Adam Karczmarz</i>	31:1–31:23

The Number of Repetitions in 2D-Strings <i>Panagiotis Charalampopoulos, Jakub Radoszewski, Wojciech Rytter, Tomasz Waleń, and Wiktor Zuba</i>	32:1–32:18
New Bounds on Augmenting Steps of Block-Structured Integer Programs <i>Lin Chen, Martin Koutecký, Lei Xu, and Weidong Shi</i>	33:1–33:19
Distance Bounds for High Dimensional Consistent Digital Rays and 2-D Partially-Consistent Digital Rays <i>Man-Kwun Chiu, Matias Korman, Martin Suderland, and Takeshi Tokuyama</i>	34:1–34:22
Finding Large H -Colorable Subgraphs in Hereditary Graph Classes <i>Maria Chudnovsky, Jason King, Michał Pilipczuk, Paweł Rzążewski, and Sophie Spirkl</i>	35:1–35:17
Compact Oblivious Routing in Weighted Graphs <i>Philipp Czerner and Harald Räcke</i>	36:1–36:23
Approximation Algorithms for Clustering with Dynamic Points <i>Shichuan Deng, Jian Li, and Yuval Rabani</i>	37:1–37:15
A Sub-Linear Time Framework for Geometric Optimization with Outliers in High Dimensions <i>Hu Ding</i>	38:1–38:21
Practical Performance of Space Efficient Data Structures for Longest Common Extensions <i>Patrick Dinklage, Johannes Fischer, Alexander Hertel, Tomasz Kociumaka, and Florian Kurpicz</i>	39:1–39:20
First-Order Model-Checking in Random Graphs and Complex Networks <i>Jan Dreier, Philipp Künke, and Peter Rossmanith</i>	40:1–40:23
Optimally Handling Commitment Issues in Online Throughput Maximization <i>Franziska Eberle, Nicole Megow, and Kevin Schewior</i>	41:1–41:15
A Polynomial Kernel for Line Graph Deletion <i>Eduard Eiben and William Lochet</i>	42:1–42:15
Approximate CVP_p in Time $2^{0.802n}$ <i>Friedrich Eisenbrand and Moritz Venzin</i>	43:1–43:15
A $(1 - e^{-1} - \varepsilon)$ -Approximation for the Monotone Submodular Multiple Knapsack Problem <i>Yaron Fairstein, Ariel Kulik, Joseph (Seffi) Naor, Danny Raz, and Hadas Shachnai</i>	44:1–44:19
Linear Expected Complexity for Directional and Multiplicative Voronoi Diagrams <i>Chenglin Fan and Benjamin Raichel</i>	45:1–45:18
Polynomial Time Approximation Schemes for Clustering in Low Highway Dimension Graphs <i>Andreas Emil Feldmann and David Saulpic</i>	46:1–46:22
Coresets for the Nearest-Neighbor Rule <i>Alejandro Flores-Velazco and David M. Mount</i>	47:1–47:19
Kernelization of Whitney Switches <i>Fedor V. Fomin and Petr A. Golovach</i>	48:1–48:19

Subexponential Parameterized Algorithms and Kernelization on Almost Chordal Graphs <i>Fedor V. Fomin and Petr A. Golovach</i>	49:1–49:17
On the Complexity of Recovering Incidence Matrices <i>Fedor V. Fomin, Petr Golovach, Pranabendu Misra, and M. S. Ramanujan</i>	50:1–50:13
An Algorithmic Meta-Theorem for Graph Modification to Planarity and FOL <i>Fedor V. Fomin, Petr A. Golovach, Giannos Stamoulis, and Dimitrios M. Thilikos</i>	51:1–51:17
A Constant-Factor Approximation for Directed Latency in Quasi-Polynomial Time <i>Zachary Friggstad and Chaitanya Swamy</i>	52:1–52:20
On Compact RAC Drawings <i>Henry Förster and Michael Kaufmann</i>	53:1–53:21
Fast Preprocessing for Optimal Orthogonal Range Reporting and Range Successor with Applications to Text Indexing <i>Younan Gao, Meng He, and Yakov Nekrich</i>	54:1–54:18
Dual Half-Integrality for Uncrossable Cut Cover and Its Application to Maximum Half-Integral Flow <i>Naveen Garg and Nikhil Kumar</i>	55:1–55:13
An Efficient, Practical Algorithm and Implementation for Computing Multiplicatively Weighted Voronoi Diagrams <i>Martin Held and Stefan de Lorenzo</i>	56:1–56:15
Fully-Dynamic Coresets <i>Monika Henzinger and Sagar Kale</i>	57:1–57:21
Dynamic Matching Algorithms in Practice <i>Monika Henzinger, Shahbaz Khan, Richard Paul, and Christian Schulz</i>	58:1–58:20
Finding All Global Minimum Cuts in Practice <i>Monika Henzinger, Alexander Noe, Christian Schulz, and Darren Strash</i>	59:1–59:20
Approximate Turing Kernelization for Problems Parameterized by Treewidth <i>Eva-Maria C. Hols, Stefan Kratsch, and Astrid Pieterse</i>	60:1–60:23
The Fine-Grained Complexity of Median and Center String Problems Under Edit Distance <i>Gary Hoppenworth, Jason W. Bentley, Daniel Gibney, and Sharma V. Thankachan</i>	61:1–61:19
Capacitated Sum-Of-Radii Clustering: An FPT Approximation <i>Tanmay Inamdar and Kasturi Varadarajan</i>	62:1–62:17
Optimal Polynomial-Time Compression for Boolean Max CSP <i>Bart M. P. Jansen and Michał Włodarczyk</i>	63:1–63:19
A Linear Fixed Parameter Tractable Algorithm for Connected Pathwidth <i>Mamadou Moustapha Kanté, Christophe Paul, and Dimitrios M. Thilikos</i>	64:1–64:16
Exploiting c -Closure in Kernelization Algorithms for Graph Problems <i>Tomohiro Koana, Christian Komusiewicz, and Frank Sommer</i>	65:1–65:17

Many Visits TSP Revisited <i>Łukasz Kowalik, Shaohua Li, Wojciech Nadara, Marcin Smulewicz, and Magnus Wahlström</i>	66:1–66:22
Light Euclidean Spanners with Steiner Points <i>Hung Le and Shay Solomon</i>	67:1–67:22
Settling the Relationship Between Wilber’s Bounds for Dynamic Optimality <i>Victor Lecomte and Omri Weinstein</i>	68:1–68:21
On the Computational Complexity of Linear Discrepancy <i>Lily Li and Aleksandar Nikolov</i>	69:1–69:16
Augmenting the Algebraic Connectivity of Graphs <i>Bogdan-Adrian Manghiuc, Pan Peng, and He Sun</i>	70:1–70:22
Chordless Cycle Packing Is Fixed-Parameter Tractable <i>Dániel Marx</i>	71:1–71:19
Incompressibility of H -Free Edge Modification Problems: Towards a Dichotomy <i>Dániel Marx and R. B. Sandeep</i>	72:1–72:25
Approximating k -Connected m -Dominating Sets <i>Zeev Nutov</i>	73:1–73:14
Full Complexity Classification of the List Homomorphism Problem for Bounded-Treewidth Graphs <i>Karolina Okrasa, Marta Piecyk, and Paweł Rzążewski</i>	74:1–74:24
Generalizing CGAL Periodic Delaunay Triangulations <i>Georg Osang, Mael Rouxel-Labbé, and Monique Teillaud</i>	75:1–75:17
Engineering Fast Almost Optimal Algorithms for Bipartite Graph Matching <i>Ioannis Panagiotas and Bora Uçar</i>	76:1–76:23
Efficient Computation of 2-Covers of a String <i>Jakub Radoszewski and Juliusz Straszypiński</i>	77:1–77:17
Improved Approximation Algorithm for Set Multicover with Non-Piercing Regions <i>Rajiv Raman and Saurabh Ray</i>	78:1–78:16
Improved Distance Sensitivity Oracles with Subcubic Preprocessing Time <i>Hanlin Ren</i>	79:1–79:13
Fine-Grained Complexity of Regular Expression Pattern Matching and Membership <i>Philipp Schepper</i>	80:1–80:20
Space-Efficient, Fast and Exact Routing in Time-Dependent Road Networks <i>Ben Strasser, Dorothea Wagner, and Tim Zeitz</i>	81:1–81:14
Improved Prophet Inequalities for Combinatorial Welfare Maximization with (Approximately) Subadditive Agents <i>Hanrui Zhang</i>	82:1–82:17
On the Approximation Ratio of the k -Opt and Lin-Kernighan Algorithm for Metric and Graph TSP <i>Xianghui Zhong</i>	83:1–83:13

■ Preface

This volume contains the extended abstracts selected for presentation at ESA 2020, the 28th European Symposium on Algorithms. Due to the COVID-19 pandemic, the symposium was organized as a virtual meeting during September 7–9 by the University of Pisa, Italy as part of ALGO 2020. Performing the switch from physical to virtual meeting was accompanied by many discussions about how to handle this situation. However, eventually, the scientific quality of the program as well as the process of selecting contributions was surprisingly little affected. In particular, the number of submissions as well as the acceptance rate was similar to previous years. The PC-chairs gave an exceptional five-day deadline extension to mitigate potential difficulties of authors in handling the situation. This proved an effective means of achieving a high turnout of good submissions.

The scope of ESA includes original, high-quality, theoretical and applied research on algorithms and data structures. Since 2002, it has had two tracks: the Design and Analysis Track (Track A), intended for papers on the design and mathematical analysis of algorithms, and the Engineering and Applications Track (Track B), for submissions that also address real-world applications, engineering, and experimental analysis of algorithms. Information on past symposia, including locations and proceedings, is maintained at <http://esa-symposium.org>.

In response to the call for papers for ESA 2020, 313 papers were submitted, 262 for Track A and 51 for Track B (these are the counts after the removal of papers with invalid format and after withdrawals). Paper selection was based on originality, technical quality, exposition quality, and relevance. Each paper received at least three reviews. The program committees selected 83 papers for inclusion in the program, 70 from track A and 13 from track B, yielding an acceptance rate of about 1/4.

The European Association for Theoretical Computer Science (EATCS) sponsored a best paper award and a best student paper award. A submission was eligible for the best student paper award if all authors were doctoral, master, or bachelor students at the time of submission. The best student paper award for track A was given to Hanrui Zhang for the paper *Improved Prophet Inequalities for Combinatorial Welfare Maximization with (Approximately) Subadditive Agents*. The best paper award for track A was given to Moritz Venzin and Friedrich Eisenbrand for the paper *Approximate CVP_p in time $2^{0.802n}$* . The best paper award for track B was given to Georg Osang, Mael Rouxel-Labbé and Monique Teillaud for the paper *Generalizing CGAL Periodic Delaunay Triangulations*. No best student paper award has been given this year for track B.

We wish to thank all the authors who submitted papers for consideration, the invited speakers, the members of the program committees for their hard work, and all the external reviewers who assisted the program committees in the evaluation process. Special thanks go to the organizing committee, who helped us with the organization of the conference. All of these people did a great job in keeping ESA a hoard of excellence in a difficult situation.



■ Program Committees

Track A (Design and Analysis) Program Committee

- Amir Abboud, IBM Almaden Research Center
- Greg Bodwin, Georgia Tech
- Karl Bringmann, Saarland University and Max Planck Institute for Informatics
- Deeparnab Chakrabarty, Dartmouth College
- Daniel Dadush, Vrije Universiteit Amsterdam
- Michael Elkin, Ben-Gurion University of the Negev
- Leah Epstein, University of Haifa
- Manuela Fischer, ETH Zurich
- Fabrizio Frati, Roma Tre University
- Fabrizio Grandoni, IDSIA (PC Chair)
- Kasper Green Larsen, Aarhus University
- Jacob Holm, University of Copenhagen
- Michael Kapralov, Ecole Polytechnique Fédérale de Lausanne
- Petteri Kaski, Aalto University
- Telikepalli Kavitha, Tata Institute of Fundamental Research
- Tomasz Kociumaka, Bar-Ilan University
- Moshe Lewenstein, Bar-Ilan University
- Shi Li, University at Buffalo
- Yury Makarychev, Toyota Technological Institute at Chicago
- Krzysztof Onak, IBM T.J. Watson Research Center
- Seth Pettie, University of Michigan
- Marcin Pilipczuk, University of Warsaw
- Thomas Rothvoss, University of Washington
- Laura Sanità, Eindhoven University of Technology
- Saket Saurabh, The Institute of Mathematical Sciences
- Chris Schwiegelshohn, TU Dortmund
- Vera Traub, University of Bonn
- Carmine Ventre, King's College London
- David Wajc, Carnegie Mellon University
- Andreas Wiese, Universidad de Chile
- David P. Woodruff, Carnegie Mellon University
- Meirav Zehavi, Ben-Gurion University of the Negev



Track B (Engineering and Applications) Program Committee

- Armin Biere, Johannes Kepler University Linz
- Maïke Buchin, Ruhr Universität Bochum
- Markus Chimani, Osnabrück University
- Irene Finocchi, LUISS Guido Carli University Rome
- Travis Gagie, Dalhousie University Halifax
- Rolf Niedermeier, TU Berlin
- Kunihiko Sadakane, The University of Tokyo
- Peter Sanders, Karlsruhe Institute of Technology (PC Chair)
- Yihan Sun, Carnegie Mellon University
- Sivan Toledo, Tel-Aviv University
- Jesper Träff, Vienna University of Technology
- Renato Werneck, Amazon

■ List of External Reviewers

Anders Aamand
Andreas Abels
Mikkel Abrahamsen
Marek Adamczyk
Peyman Afshani
Akanksha Agrawal
Hugo Akitaya
Carlos Alegría
Josh Alman
Georgios Amanatidis
Daniel Anderson
Haris Angelidakis
Patrizio Angelini
Spyros Angelopoulos
Antonios Antoniadis
Lars Arge
Boris Aronov
Sepehr Assadi
Gennadiy Averkov
Pranjal Awasthi
Kyriakos Axiotis
Michael Axtmann
Yossi Azar
Arturs Backurs
Ainesh Bakshi
Eric Balkanski
Nikhil Bansal
Leonid Barenboim
Michael Barrus
Luca Becchetti
Soheil Behnezhad
Xiaohui Bei
Robert Benkoczi
Matthias Bentert
Kristóf Bérczi
Benjamin Bergougnoux
Giulia Bernardini
Aaron Bernstein
Aditya Bhaskara
Anup Bhattacharya
Sayan Bhattacharya
Sujoy Bhore
Therese Biedl
Armin Biere
Philip Bille
Georgios Birmpas
Thomas Bläsius
Guy Blelloch
Niclas Boehmer
Fritz Bökler
Manuel Borrazzo
Vladimir Braverman
Nick Brettell
Gerth Stølting Brodal
Brian Brubach
Niv Buchbinder
Valentin Buchhold
Kevin Buchin
Maike Buchin
Andrei Bulatov
Sergio Cabello
Tiziana Calamoneri
Pilar Cano
Yixin Cao
Nofar Carmeli
Diptarka Chakraborty
Sankardeep Chakraborty
Parinya Chalermsook
T-H. Hubert Chan
Timothy M. Chan
Hsien-Chih Chang
Panagiotis Charalampopoulos
Abhranil Chatterjee
Shiri Chechik
Ho-Lin Chen
Wei Chen
Victor Chepoi
Markus Chimani
Rajesh Chitnis
Eden Chlamtac
Janka Chlebikova
Philip Chodrow
Davin Choo
Keerti Choudhary
Raphael Clifford
Christian Coester
Ilan Cohen
Sarel Cohen
Vincent Cohen-Addad
Emilio Cruciani

28th Annual European Symposium on Algorithms (ESA 2020).

Editors: Fabrizio Grandoni, Grzegorz Herman, and Peter Sanders



Leibniz International Proceedings in Informatics

Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Dagstuhl Publishing, Germany

0:xvi List of External Reviewers

Giordano Da Lozzo
Konrad K. Dąbrowski
Ovidiu Daescu
Shantanu Das
Argyrios Deligkas
Holger Dell
Dariusz Dereniowski
Karen Devine
Laxman Dhulipala
Emilio Di Giacomo
Hu Ding
Michael Dinitz
Yann Disser
Anne Driemel
Andre Droschinsky
Ran Duan
Bartłomiej Dudek
Thomas Dybdahl Ahle
Eduard Eiben
Marek Elias
Alina Ene
David Eppstein
Jeff Erickson
Hossein Esfandiari
Yuri Faenza
Piotr Faliszewski
Dan Feldman
Moran Feldman
Zhili Feng
Henning Fernau
Diodato Ferraioli
Yuval Filmus
Arnold Filtser
Irene Finocchi
Johannes Fischer
Noah Fleming
Till Fluschnik
Efi Fogel
Fedor Fomin
Kyle Fox
Daniel Freund
Zachary Friggstad
Hu Fu
Takuro Fukunaga
Radoslav Fulek
Mitsuru Funakoshi
Stefan Funke
Federico Fusco
Travis Gagie
Jakub Gajarský
Arun Ganesh
Robert Ganian
Jie Gao
Naveen Garg
Bernd Gärtner
Cyril Gavoille
Pawel Gawrychowski
Burkay Genc
Michele Gentili
Arijit Ghosh
Prantar Ghosh
Archontia Giannopoulou
Daniel Gibney
Alexander Göke
Petr Golovach
Alexander Golovnev
Adrián Gómez Brandón
Gramoz Goranci
Mayank Goswami
Sander Gribling
Luca Grilli
Martin Grohe
Martin Gronemann
Allan Grønlund
Yan Gu
Luciano Gualà
Joachim Gudmundsson
Siddharth Gupta
Sushmita Gupta
Guru Guruganesh
Michel Habib
Torben Hagerup
Thekla Hamm
Sariel Har-Peled
David Harris
Avinatan Hassidim
Ishay Haviv
Meng He
Qizheng He
Klaus Heeger
Marc Hellmuth
Danny Hermelin
Tobias Heuer
Michael Horton
Chien-Chung Huang
Zhiyi Huang

Sophie Huiberts
 Christoph Hunkenschroder
 Thore Husfeldt
 John Iacono
 Sharat Ibrahimpur
 Max Bernhard Ilsen
 Shunsuke Inenaga
 Gabor Ivanyos
 Yoichi Iwata
 Taisuke Izumi
 Samin Jamalabadi
 Bart M. P. Jansen
 Klaus Jansen
 Rajesh Jayaram
 Łukasz Jeż
 Dawei Jiang
 Matthew Johnson
 Gwenaël Joret
 Praneeth Kacham
 Naonori Kakimura
 Sagar Kale
 John Kallaughar
 Naoyuki Kamiyama
 Lior Kamma
 Frank Kammer
 Daniel Kane
 Haim Kaplan
 Adam Karczmarz
 Charles Karney
 Andreas Karrenbauer
 Matthew Katz
 Yasushi Kawase
 Leon Kellerhals
 Dominik Kempa
 Eun Jung Kim
 Evangelos Kipouridis
 Sándor Kisfaludi-Bak
 Aleks Kissinger
 Kim-Manuel Klein
 Peter Kling
 Dušan Knop
 Tomohiro Koana
 Jochen Koenemann
 Alexander Kononov
 Christian Konrad
 Tsvi Kopelowitz
 Dominik Köppl
 Evgenios Kornaropoulos
 Guy Kortsarz
 Dmitry Kosolobov
 Martin Koutecky
 Ioannis Koutis
 Laszlo Kozma
 Evangelos Kranakis
 Ravishankar Krishnaswamy
 Amer Krivosija
 Dominik Krupke
 Janardhan Kulkarni
 Gunjan Kumar
 Marvin Künnemann
 O-Joung Kwon
 Maria Kyropoulou
 Arnaud Labourel
 Jakub Łącki
 Leon Ladewig
 Bundit Laekhanukit
 Victor Lagerkvist
 John Lapinskas
 Dolores Lara
 Kim S. Larsen
 Philip Lazos
 Hung Le
 Francois Le Gall
 Euiwoong Lee
 Johannes Lengler
 Stefano Leucci
 Asaf Levin
 Roie Levin
 Avivit Levy
 Caleb Levy
 Moshe Lewenstein
 Jason Li
 Jian Li
 Yingyu Liang
 William Lochet
 Maarten Löffler
 Brendan Lucier
 Junjie Luo
 Jayakrishnan Madathil
 Sepideh Mahabadi
 Arvind Mahankali
 Konstantin Makarychev
 Frederik Mallmann-Trenn
 David Manlove
 Fredrik Manne
 Giovanni Manzini

0:xviii List of External Reviewers

Alberto Marchetti-Spaccamela
Mathieu Mari
Shaked Matar
Jannik Matuschke
Giancarlo Mauri
Samuel McCauley
Moti Medina
Arianne Meijer
Henk Meijer
Reshef Meir
George Mertzios
David L. Millman
Majid Mirzanezhad
Neeldhara Misra
Pranabendu Misra
Matthias Mnich
Hendrik Molter
Tobias Mömke
Rafaella Mosca
Benjamin Moseley
Amer Mouawad
Noela Müller
Wolfgang Mulzer
Alexander Munteanu
Christopher Musco
Wojciech Nadara
Viswanath Nagarajan
Yuto Nakashima
Seffi Naor
Jesper Nederlof
Maryam Negahbani
Ofar Neiman
Yakov Nekrich
Alantha Newman
Huy Nguyen
André Nichterlein
Aleksandar Nikolov
Naomi Nishimura
Martin Nöllenburg
Navid Nouri
Alexander Nover
Krzysztof Nowicki
André Nusser
Timm Oertel
Karolina Okrasa
Neil Olver
Shmuel Onn
Joel Ouaknine
Andrea Pacifici
Rasmus Pagh
Dömötör Pálvölgyi
Fahad Panolan
Evanthia Papadopoulou
Irene Parada
Kunsoo Park
Nikos Parotsidis
Merav Parter
Alice Paul
Andrzej Pelc
Richard Peng
Martin Pergel
Jeff Phillips
Michał Pilipczuk
Solon Pissis
Adam Polak
Ely Porat
Julian Portmann
Nicola Prezza
Maximilian Probst Gutenberg
Kirk Pruhs
Manish Purohit
Yuval Rabani
Jakub Radoszewski
Akbar Rafey
Saladi Rahul
Benjamin Raichel
Cyrus Rashtchian
Nidhi Rathi
R Ravi
Saurabh Ray
Bhaskar Ray Chaudhury
Ilya Razenshteyn
Igor Razgon
Rebecca Reiffenhäuser
Malte Renken
Thomas Robinson
Liam Roditty
Dennis Rohde
Lars Rohwedder
Massimiliano Rossi
Benjamin Rossman
Eva Rotenberg
Alan Roytman
Natan Rubin
Aviad Rubinfeld
Paweł Rzażewski

Guy Saar
Kunihiko Sadakane
Mohammad Salavatipour
R.B. Sandeep
Peter Sanders
Piotr Sankowski
Ramprasad Saptharishi
Thatchaphol Saranurak
Srinivasa Rao Satti
Ignasi Sau
David Saulpic
Saket Saurabh
Nitin Saxena
Melanie Schmidt
Ulrike Schmidt-Kraepelin
Oded Schwartz
Uwe Schwiegelshohn
Andras Sebo
Saeed Seddighin
Paolo Serafino
Alkmini Sgouritsa
Roohani Sharma
Bruce Shepherd
Abhishek Shetty
Anastasios Sidiropoulos
Sebastian Siebertz
Ana Silva
Francesco Silvestri
Genevieve Simonet
Sahil Singla
Nodari Sitchinava
Benjamin Smith
Marcin Smulewicz
Dina Sokol
Shay Solomon
Frank Sommer
Rishi Sonthalia
Manuel Sorge
Krzysztof Sornat
José A. Soto
Sophie Spirkl
Ramanujan M. Sridharan
Piyush Srivastava
Frank Staals
Tatiana Starikovskaya
Barak Steindl
Teresa Anna Steiner
Noah Stephens-Davidowitz
Ben Strasser
Vijay Subramanya
He Sun
Kevin Sun
Yihan Sun
Subhash Suri
Svend Christian Svendsen
Zoya Svitkina
Alexander Svozil
Prafullkumar Tale
Jakub Tarnawski
Jan Arne Telle
Sharma V. Thankachan
Clayton Thomas
Mikkel Thorup
Daniel Ting
Sivan Toledo
Noam Touitou
Ohad Trabelsi
Jesper Träff
Nicolas Tremblay
Thorben Tröbst
Niklas Troost
Tom Tseng
Marc Uetz
Przemysław Uznański
Ali Vakilian
Greg Van Buskirk
Yann Vaxès
José Verschae
Aravindan Vijayaraghavan
Marc Vinyals
Ellen Vitercik
Magnus Wahlström
Erik Waingarten
Tomasz Walen
Haitao Wang
Hung-Lung Wang
Yipu Wang
Yiqiu Wang
Justin Ward
Karol Węgrzycki
Yuanhao Wei
Oren Weimann
Nicole Wein
Omri Weinstein
Renato Werneck
Chris Whidden

0:xx **List of External Reviewers**

Daniel Wiebking
Tilo Wiedera
Sebastian Wiederrecht
Mathijs Wintraecken
Sascha Witt
Michal Włodarczyk
Prudence Wong
Sampson Wong
Marcin Wrochna
Christian Wulff-Nilsen
Yinzhan Xu
Sheng Yang
Jonathan Yaniv
Taisuke Yasuda
Shangdi Yu
Lydia Zakyntinou

Viktor Zamaraev
Or Zamir
Rico Zenklusen
Ruizhe Zhang
Zhao Zhang
Samson Zhou
Philipp Zschoche
Wiktor Zuba
Mark de Berg
Bart de Keijzer
Erik Jan van Leeuwen
André van Renssen
Rob van Stee
Marieke van der Wegen
Tom van der Zanden