

# **27th International Symposium on Algorithms and Computation**

**ISAAC 2016, December 12–14, 2016, Sydney, Australia**

Edited by

**Seok-Hee Hong**



*Editors*

Seok-Hee Hong  
School of Information Technology  
University of Sydney, Australia  
[seokhee.hong@sydney.edu.au](mailto:seokhee.hong@sydney.edu.au)

*ACM Classification 1998*

E.1 Data Structures, F.2.2 Nonnumerical Algorithms and Problems, G.1.6 Optimization, G.2 Discrete Mathematics, G.4 Mathematical Software, I.1.2 Algorithms, I.2.8 Problem Solving, Control Methods, and Search, I.3.5 Computational Geometry and Object Modeling

**ISBN 978-3-95977-026-2**

*Published online and open access by*

Schloss Dagstuhl – Leibniz-Zentrum für Informatik GmbH, Dagstuhl Publishing, Saarbrücken/Wadern, Germany. Online available at <http://www.dagstuhl.de/dagpub/978-3-95977-026-2>.

*Publication date*

December 2016, 2016

*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 <http://dnb.d-nb.de>.

*License*

This work is licensed under a Creative Commons Attribution 3.0 Unported license (CC-BY 3.0): <http://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.ISAAC.2016.0

**ISBN 978-3-95977-026-2**

**ISSN 1868-8969**

**<http://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*

- Susanne Albers (TU München)
- Chris Hankin (Imperial College London)
- Deepak Kapur (University of New Mexico)
- Michael Mitzenmacher (Harvard University)
- Madhavan Mukund (Chennai Mathematical Institute)
- Catuscia Palamidessi (INRIA)
- Wolfgang Thomas (*Chair*, RWTH Aachen)
- Pascal Weil (CNRS and University Bordeaux)
- Reinhard Wilhelm (Saarland University)

**ISSN 1868-8969**

**<http://www.dagstuhl.de/lipics>**



# Contents

Preface <i>Seok-Hee Hong</i> .....	0:ix
---------------------------------------	------

## Invited Talks

Towards Processing of Big Graphs: from Theory, Algorithm to System <i>Xuemin Lin</i> .....	1:1–1:1
Compressed and Searchable Indexes for Highly Similar Strings <i>Kunsoo Park</i> .....	2:1–2:1

## Regular Papers

Streaming Verification of Graph Properties <i>Amirali Abdullah, Samira Daruki, Chitradeep Dutta Roy, and Suresh Venkatasubramanian</i> .....	3:1–3:14
Building Clusters with Lower-Bounded Sizes <i>Faisal Abu-Khzam, Cristina Bazgan, Katrin Casel, and Henning Fernau</i> .....	4:1–4:13
Simultaneous Feedback Edge Set: A Parameterized Perspective <i>Akanksha Agrawal, Fahad Panolan, Saket Saurabh, and Meirav Zehavi</i> .....	5:1–5:13
Kernels for Deletion to Classes of Acyclic Digraphs <i>Akanksha Agrawal, Saket Saurabh, Roohani Sharma, and Meirav Zehavi</i> .....	6:1–6:12
An Efficient Algorithm for Placing Electric Vehicle Charging Stations <i>Pankaj K. Agarwal, Jiangwei Pan, and Will Victor</i> .....	7:1–7:12
Finding $k$ Simple Shortest Paths and Cycles <i>Udit Agarwal and Vijaya Ramachandran</i> .....	8:1–8:12
Packing Short Plane Spanning Trees in Complete Geometric Graphs <i>Oswin Aichholzer, Thomas Hackl, Matias Korman, Alexander Pilz, Günter Rote, André van Renssen, Marcel Roeloffzen, and Birgit Vogtenhuber</i> .....	9:1–9:12
Reconstruction of Weakly Simple Polygons from their Edges <i>Hugo A. Akitaya and Csaba D. Tóth</i> .....	10:1–10:13
Approximating Smallest Containers for Packing Three-Dimensional Convex Objects <i>Helmut Alt and Nadja Scharf</i> .....	11:1–11:14
Mind the Gap: Essentially Optimal Algorithms for Online Dictionary Matching with One Gap <i>Amihood Amir, Tsvi Kopelowitz, Avivit Levy, Seth Pettie, Ely Porat, and B. Riva Shalom</i> .....	12:1–12:12
Clustered Planarity with Pipes <i>Patrizio Angelini and Giordano Da Lozzo</i> .....	13:1–13:13

27th International Symposium on Algorithms and Computation (ISAAC 2016).  
Editor: Seok-Hee Hong



Leibniz International Proceedings in Informatics  
Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Dagstuhl Publishing, Germany

<i>L<sub>1</sub></i> Geodesic Farthest Neighbors in a Simple Polygon and Related Problems <i>Sang Won Bae</i> .....	14:1–14:12
Approximate Clustering via Metric Partitioning <i>Sayan Bandyapadhyay and Kasturi Varadarajan</i> .....	15:1–15:13
Hard Communication Channels for Steganography <i>Sebastian Berndt and Maciej Liśkiewicz</i> .....	16:1–16:13
On <i>r</i> -Guarding Thin Orthogonal Polygons <i>Therese Biedl and Saeed Mehrabi</i> .....	17:1–17:13
Dynamic Relative Compression, Dynamic Partial Sums, and Substring Concatenation <i>Philip Bille, Patrick Hagge Cording, Inge Li Gørtz, Frederik Rye Skjoldjensen, Hjalte Wedel Vildhøj, and Søren Vind</i> .....	18:1–18:13
Towards Plane Spanners of Degree 3 <i>Ahmad Biniaz, Prosenjit Bose, Jean-Lou De Carufel, Cyril Gavoille, Anil Maheshwari, and Michiel Smid</i> .....	19:1–19:14
Degree-Constrained Orientation of Maximum Satisfaction: Graph Classes and Parameterized Complexity <i>Hans L. Bodlaender, Hirotaka Ono, and Yota Otachi</i> .....	20:1–20:12
Online Packet Scheduling with Bounded Delay and Lookahead <i>Martin Böhm, Marek Chrobak, Łukasz Jeż, Fei Li, Jiří Sgall, and Pavel Veselý</i> ...	21:1–21:13
Biconnectivity, Chain Decomposition and <i>st</i> -Numbering Using $O(n)$ Bits <i>Sankardeep Chakraborty, Venkatesh Raman, and Srinivasa Rao Satti</i> .....	22:1–22:13
On $(1,\epsilon)$ -Restricted Max-Min Fair Allocation Problem <i>T.-H. Hubert Chan, Zhihao Gavin Tang, and Xiaowei Wu</i> .....	23:1–23:13
All-Pairs Shortest Paths in Unit-Disk Graphs in Slightly Subquadratic Time <i>Timothy M. Chan and Dimitrios Skrepetos</i> .....	24:1–24:13
Sink Evacuation on Trees with Dynamic Confluent Flows <i>Di Chen and Mordecai Golin</i> .....	25:1–25:13
Adaptivity vs. Postselection, and Hardness Amplification for Polynomial Approximation <i>Lijie Chen</i> .....	26:1–26:12
Search on a Line by Byzantine Robots <i>Jurek Czyzowicz, Konstantinos Georgiou, Evangelos Kranakis, Danny Krizanc, Lata Narayanan, Jaroslav Opatrný, and Sunil Shende</i> .....	27:1–27:12
Bipartite Matching with Linear Edge Weights <i>Nevzat Onur Domanıç, Chi-Kit Lam, and C. Gregory Plaxton</i> .....	28:1–28:13
Raising Permutations to Powers in Place <i>Hicham El-Zein, J. Ian Munro, and Matthew Robertson</i> .....	29:1–29:12
Space-Efficient Plane-Sweep Algorithms <i>Amr Elmasry and Frank Kammer</i> .....	30:1–30:13

Linear Kernels and Linear-Time Algorithms for Finding Large Cuts <i>Michael Etscheid and Matthias Mnich</i>	31:1–31:13
Universal Guard Problems <i>Sándor P. Fekete, Qian Li, Joseph S. B. Mitchell, and Christian Scheffer</i>	32:1–32:13
Fast Approximation Algorithms for the Generalized Survivable Network Design Problem <i>Andreas Emil Feldmann, Jochen Könemann, Kanstantsin Pashkovich, and Laura Sanità</i>	33:1–33:12
Space-Time Trade-Offs for the Shortest Unique Substring Problem <i>Arnab Ganguly, Wing-Kai Hon, Rahul Shah, and Sharma V. Thankachan</i>	34:1–34:13
The Subset Assignment Problem for Data Placement in Caches <i>Shahram Ghandeharizadeh, Sandy Irani, and Jenny Lam</i>	35:1–35:12
A Gap Trichotomy for Boolean Constraint Problems: Extending Schaefer’s Theorem <i>Lucy Ham</i>	36:1–36:12
Sliding Tokens on a Cactus <i>Duc A. Hoang and Ryuhei Uehara</i>	37:1–37:26
Complexity of Distributions and Average-Case Hardness <i>Dmitry Itsykson, Alexander Knop, and Dmitry Sokolov</i>	38:1–38:12
Computing the Pattern Waiting Time: A Revisit of the Intuitive Approach <i>Kai Jin</i>	39:1–39:12
$O(f)$ Bi-Approximation for Capacitated Covering with Hard Capacities <i>Mong-Jen Kao, Hai-Lun Tu, and D. T. Lee</i>	40:1–40:12
Surrogate Optimization for $p$ -Norms <i>Yasushi Kawase and Kazuhisa Makino</i>	41:1–41:13
Optimal Composition Ordering Problems for Piecewise Linear Functions <i>Yasushi Kawase, Kazuhisa Makino, and Kento Seimi</i>	42:1–42:13
Additive Approximation Algorithms for Modularity Maximization <i>Yasushi Kawase, Tomomi Matsui, and Atsushi Miyauchi</i>	43:1–43:13
The Densest Subgraph Problem with a Convex/Concave Size Function <i>Yasushi Kawase and Atsushi Miyauchi</i>	44:1–44:12
On the Classes of Interval Graphs of Limited Nesting and Count of Lengths <i>Pavel Klavík, Yota Otachi, and Jiří Šejnoha</i>	45:1–45:13
Pattern Matching and Consensus Problems on Weighted Sequences and Profiles <i>Tomasz Kociumaka, Solon P. Pissis, and Jakub Radoszewski</i>	46:1–46:12
Hierarchical Time-Dependent Oracles <i>Spyros Kontogiannis, Dorothea Wagner, and Christos Zaroliagis</i>	47:1–47:13
A Refined Definition for Groups of Moving Entities and its Computation <i>Marc van Kreveld, Maarten Löffler, Frank Staals, and Lionov Wiratma</i>	48:1–48:12

A Sidetrack-Based Algorithm for Finding the $k$ Shortest Simple Paths in a Directed Graph <i>Denis Kurz and Petra Mutzel</i> .....	49:1–49:13
On the Complexity of Matching Cut in Graphs of Fixed Diameter <i>Hoang-Oanh Le and Van Bang Le</i> .....	50:1–50:12
On the Optimality of Tape Merge of Two Lists with Similar Size <i>Qian Li, Xiaoming Sun, and Jialin Zhang</i> .....	51:1–51:17
Dispersing Points on Intervals <i>Shimin Li and Haitao Wang</i> .....	52:1–52:12
Optimal Nonpreemptive Scheduling in a Smart Grid Model <i>Fu-Hong Liu, Hsiang-Hsuan Liu, and Prudence W. H. Wong</i> .....	53:1–53:13
Distributed and Robust Support Vector Machine <i>Yangwei Liu, Hu Ding, Ziyun Huang, and Jinhui Xu</i> .....	54:1–54:13
Single Machine Scheduling with Job-Dependent Machine Deterioration <i>Wenchang Luo, Yao Xu, Weitian Tong, and Guohui Lin</i> .....	55:1–55:13
Approximation Algorithms for Capacitated $k$ -Travelling Repairmen Problems <i>Christopher S. Martin and Mohammad R. Salavatipour</i> .....	56:1–56:12
Scaling and Proximity Properties of Integrally Convex Functions <i>Satoko Moriguchi, Kazuo Murota, Akihisa Tamura, and Fabio Tardella</i> .....	57:1–57:13
Assigning Weights to Minimize the Covering Radius in the Plane <i>Eunjin Oh and Hee-Kap Ahn</i> .....	58:1–58:12
A Near-Optimal Algorithm for Finding an Optimal Shortcut of a Tree <i>Eunjin Oh and Hee-Kap Ahn</i> .....	59:1–59:12
Approximate Shortest Distances Among Smooth Obstacles in 3D <i>Christian Scheffer and Jan Vahrenhold</i> .....	60:1–60:13
An Improved Tax Scheme for Selfish Routing <i>Te-Li Wang, Chih-Kuan Yeh, and Ho-Lin Chen</i> .....	61:1–61:12
A Linear-Time Algorithm for Integral Multiterminal Flows in Trees <i>Mingyu Xiao and Hiroshi Nagamochi</i> .....	62:1–62:12
Shortest Disjoint $\mathcal{S}$ -Paths Via Weighted Linear Matroid Parity <i>Yutaro Yamaguchi</i> .....	63:1–63:13
The (1 1)-Centroid Problem on the Plane Concerning Distance Constraints <i>Hung-I Yu, Tien-Ching Lin, and Der-Tsai Lee</i> .....	64:1–64:12

## Preface

This volume contains the proceedings of the 27th International Symposium on Algorithms and Computation (ISAAC 2016), held in Sydney, Australia, December 12–14, 2016. ISAAC is an annual international symposium that covers the very wide range of topics in the field of algorithms and computation. The main purpose of the symposium is to provide a forum for researchers working in algorithms and theory of computation from all over the world.

In response to our call for papers, we received 155 submissions from 36 countries. Each submission was reviewed by at least three Program Committee members, possibly with the assistance of external reviewers. After an extremely rigorous review process and extensive discussion, the Program Committee selected 62 papers. Two special issues of Algorithmica and International Journal of Computational Geometry and Applications will publish selected papers from ISAAC 2016.

The best paper award was given to “Optimal Composition Ordering Problems for Piecewise Linear Functions” by Yasushi Kawase, Kazuhisa Makino and Kento Seimi. Selected from submissions authored by students only, the best student paper award was given to “Adaptivity vs. Postselection, and Hardness Amplification in Polynomial Approximation” by Lijie Chen.

In addition to selected papers, the program also included invited talks by two prominent invited speakers, Xuemin Lin, University of NSW, Australia, and Kunsoo Park, Seoul National University, Korea.

We thank all the Program Committee members and external reviewers for their professional service and volunteering their time to review the submissions under time constraints. We also thank all authors who submitted papers for consideration, thereby contributing to the high quality of the conference. We would like also to acknowledge our supporting organizations for their assistance and support, in particular the University of Sydney and the NSW Department of Industry, through the NSW Office of Science and Research. Finally, we are deeply indebted to the Organizing Committee members, Peter Eades and Amyra Meidiana, whose excellent effort and professional service to the community made the conference an unparalleled success.

December 2016

Seok-Hee Hong





## ■ Program Committee

Seok-Hee Hong (chair)	University of Sydney, Australia
Ulrik Brandes	University of Konstanz, Germany
Xiaotie Deng	Shanghai Jiao Tong University, China
Thomas Erlebach	University of Leicester, UK
William Evans	UBC, Canada
Rudolf Fleischer	GUtech, Oman
Fabrizio Frati	Roma Tre University, Italy
Takuro Fukunaga	National Institute of Informatics, Japan
Serge Gaspers	UNSW Australia and Data61, CSIRO, Australia
Michael Goodrich	University of California, Irvine, USA
Hiroshi Imai	University of Tokyo, Japan
Toshimasa Ishii	Hokkaido University, Japan
Giuseppe F. Italiano	University of Rome "Tor Vergata", Italy
Takehiro Ito	Tohoku University, Japan
Ming-Yang Kao	Northwestern University, USA
Michael Kaufmann	Tübingen University, Germany
Jan Kratochvil	Charles University, Czech Republic
Minming Li	City University of Hong Kong, Hong Kong
Giuseppe Liotta	University of Perugia, Italy
Hsueh-I Lu	National Taiwan University, Taiwan
Bernard Mans	Macquarie University, Australia
Sang-Il Oum	KAIST, South Korea
Evanthia Papadopoulou	University of Lugano (USI), Switzerland
Kunsoo Park	Seoul National University, South Korea
Md. Saidur Rahman	Bangladesh University of Engineering and Technology, Bangladesh
Ignaz Rutter	Karlsruhe Institute of Technology (KIT), Germany
Kunihiro Sadakane	The University of Tokyo, Japan
Pascal Schweitzer	RWTH Aachen University, Germany
Shin-Ichi Tanigawa	Kyoto University, Japan
Takeshi Tokuyama	Tohoku University, Japan
Takeaki Uno	National Institute of Informatics, Japan
Yushi Uno	Osaka Prefecture University, Japan
Osamu Watanabe	Tokyo Institute of Technology, Japan
Anthony Wirth	The University of Melbourne, Australia
Hsu-Chun Yen	National Taiwan University, Taiwan



## External Reviewers

Abboud, Amir  
Adnan, Muhammad Abdullah  
Agrawal, Akanksha  
Angelini, Patrizio  
Angelopoulos, Spyros  
Auletta, Vincenzo  
Banik, Aritra  
Barba, Luis  
Bei, Xiaohui  
Bekos, Michael  
Belmonte, Rémy  
Bhaskara, Aditya  
Binucci, Carla  
Bläsius, Thomas  
Chang, Yi-Jun  
Chau, Vincent  
Chen, Ruiwen  
Chen, Hao  
Chen, Ho-Lin  
Chen, Li  
Chiu, Man Kwun  
Das, Shantanu  
Datta, Samir  
Dehghani, Sina  
Didimo, Walter  
Donato, Valentino Di  
Donoso, Yago Diez  
Durocher, Stephane  
Engels, Christian  
Fagerberg, Rolf  
Franciosa, Paolo  
Fujiwara, Hiroshi  
Gajarský, Jakub  
Georgiadis, Loukas  
Giacomo, Emilio Di  
Göös, Mika  
Grilli, Luca  
Han, Xin  
Haraguchi, Kazuya  
Hasunuma, Toru  
Hatanaka, Tatsuhiko  
Heinsohn, Niklas  
Higashikawa, Yuya  
Hirahara, Shuichi  
Hon, Wing-Kai  
Huang, Shenwei  
Huang, Shang-En  
Jones, Mark  
Kakimura, Naonori  
Kawachi, Akinori  
Kawamura, Yasuyuki  
Kawase, Yasushi  
Keil, Mark  
Kijima, Shuji  
Kiyomi, Masashi  
Koabayashi, Yusuke  
Kobayashi, Yusuke  
Koike, Atsushi  
Korman, Matias  
Koshiba, Takeshi  
Krieger, Nils  
Kürvík, Zbyněk  
Kucera, Petr  
Kumar, Nirman  
Lai, Kai-Yuan  
Lampis, Michael  
Liao, Chung-Shou  
Liu, Chih-Hung  
Loitzenbauer, Veronika  
Lozzo, Giordano Da  
Mathieson, Luke  
McCauley, Samuel  
Mchedlidze, Tamara  
Mehta, Aranyak  
Meijer, Henk  
Misra, Neeldhara  
Mnich, Matthias  
Mondal, Debajyoti  
Montecchiani, Fabrizio  
Moriyama, Sonoko  
Mouawad, Amer  
Mulzer, Wolfgang  
Naamad, Yonatan  
Näher, Stefan  
Najeebullah, Kamran  
Nguyen, Trung Thanh  
Niedermann, Benjamin  
Nilsson, Bengt J.  
Nishat, Rahnuma Islam  
Okamoto, Yoshio

Ono, Hirotaka  
Onodera, Taku  
Otachi, Yota  
Ozeki, Kenta  
Palios, Leonidas  
Parotsidis, Nikos  
Pasquale, Francesco  
Poon, Sheung-Hung  
Radermacher, Marcel  
Rahman, Atif  
Roeloffzen, Marcel  
Saitoh, Toshiki  
Satti, Srinivasa Rao  
Sauerhoff, Martin  
Schnoor, Henning  
Sedeño-Noda, Antonio  
Shen, Liang-Hsin  
Shibuya, Tetsuo  
Shioura, Akiyoshi  
Shurbevski, Aleksandar  
Silveira, Rodrigo  
Singh, Shikha  
Strash, Darren  
Su, Hsin-Hao  
Suzuki, Akira  
Takazawa, Kenjiro  
Talebanfard, Navid  
Tamaki, Suguru  
Teague, Vanessa  
Thaler, Justin  
Thankachan, Sharma V.  
Thierauf, Thomas  
van Bevern, René  
van Leeuwen, Erik Jan  
van Renssen, André  
Varadarajan, Kasturi  
Wang, Haitao  
Wang, Bow-Yaw  
Wasa, Kunihiro  
Watson, Thomas  
Wilmes, John  
Wismath, Steve  
Wu, Weiwei  
Yamanaka, Katsuhisa  
Yasunaga, Kenji  
Zhang, Jialin  
Zhang, Lele  
Zhao, Yingchao  
Zündorf, Tobias