

# 38th IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science

FSTTCS 2018, December 11–13, 2018, Ahmedabad, India

Edited by

Sumit Ganguly  
Paritosh Pandya



#### *Editors*

Sumit Ganguly  
Department of Computer Science and Engineering  
Indian Institute of Technology, Kanpur, India  
sganguly@cse.iitk.ac.in

Paritosh Pandya  
Tata Institute of Fundamental Research  
Mumbai, India  
pandya@tifr.res.in

*ACM Classification 2012*  
Theory of Computation

**ISBN 978-3-95977-093-4**

#### *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/978-3-95977-093-4>.

#### *Publication date*

December, 2018

#### *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.FSTTCS.2018.0

ISBN 978-3-95977-093-4

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*

- Luca Aceto (*Chair*, Gran Sasso Science Institute and Reykjavik University)
- Susanne Albers (TU München)
- Christel Baier (TU Dresden)
- Javier Esparza (TU München)
- Michael Mitzenmacher (Harvard University)
- Madhavan Mukund (Chennai Mathematical Institute)
- Anca Muscholl (University Bordeaux)
- Catuscia Palamidessi (INRIA)
- Raimund Seidel (Saarland University and Schloss Dagstuhl – Leibniz-Zentrum für Informatik)
- Thomas Schwentick (TU Dortmund)
- Reinhard Wilhelm (Saarland University)

**ISSN 1868-8969**

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



## ■ Contents

Preface	
<i>Sumit Ganguly and Paritosh Pandya</i> .....	0:ix

### Invited Papers

Random Testing for Distributed Systems with Theoretical Guarantees	
<i>Rupak Majumdar</i> .....	1:1–1:1
Model Checking Randomized Security Protocols	
<i>A. Prasad Sistla</i> .....	2:1–2:1
Algorithms for the Asymmetric Traveling Salesman Problem	
<i>Ola Svensson</i> .....	3:1–3:1
Continuous Algorithms	
<i>Santosh Vempala</i> .....	4:1–4:1

### Regular Papers

On the Probabilistic Degree of OR over the Reals	
<i>Siddharth Bhandari, Prahladh Harsha, Tulasimohan Molli, and Srikanth Srinivasan</i> .....	5:1–5:12
Quasipolynomial Hitting Sets for Circuits with Restricted Parse Trees	
<i>Ramprasad Saptharishi and Anamay Tengse</i> .....	6:1–6:19
Univariate Ideal Membership Parameterized by Rank, Degree, and Number of Generators	
<i>V. Arvind, Abhranil Chatterjee, Rajit Datta, and Partha Mukhopadhyay</i> .....	7:1–7:18
Verification of Timed Asynchronous Programs	
<i>Parosh Aziz Abdulla, Mohamed Faouzi Atig, Shankara Narayanan Krishna, and Shaan Vaidya</i> .....	8:1–8:16
The Cayley-Graph of the Queue Monoid: Logic and Decidability	
<i>Fariad Abu Zaid and Chris Köcher</i> .....	9:1–9:17
Uniformly Automatic Classes of Finite Structures	
<i>Fariad Abu Zaid</i> .....	10:1–10:21
Towards a General Direct Product Testing Theorem	
<i>Elazar Goldenberg and Karthik C. S.</i> .....	11:1–11:17
Space Complexity of Two Adaptive Bitprobe Schemes Storing Three Elements	
<i>Deepanjan Kesh</i> .....	12:1–12:12
New Constructions with Quadratic Separation between Sensitivity and Block Sensitivity	
<i>Siddhesh Chaubal and Anna Gál</i> .....	13:1–13:16
Lambda-Definable Order-3 Tree Functions are Well-Quasi-Ordered	
<i>Kazuyuki Asada and Naoki Kobayashi</i> .....	14:1–14:15

38th IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science (FSTTCS 2018).

Editors: Sumit Ganguly and Paritosh Pandya



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

A Hypersequent Calculus with Clusters for Tense Logic over Ordinals <i>David Baelde, Anthony Lick, and Sylvain Schmitz</i> .....	15:1–15:19
Büchi Good-for-Games Automata Are Efficiently Recognizable <i>Marc Bagnol and Denis Kuperberg</i> .....	16:1–16:14
Popular Matchings in Complete Graphs <i>Ágnes Cseh and Telikepalli Kavitha</i> .....	17:1–17:14
Graph Pattern Polynomials <i>Markus Bläser, Balagopal Komarath, and Karteek Sreenivasaiah</i> .....	18:1–18:13
Shortest $k$ -Disjoint Paths via Determinants <i>Samir Datta, Siddharth Iyer, Raghav Kulkarni, and Anish Mukherjee</i> .....	19:1–19:21
Hyper Partial Order Logic <i>Béatrice Bérard, Stefan Haar, and Loic Hélouët</i> .....	20:1–20:21
On the Way to Alternating Weak Automata <i>Udi Boker and Karoliina Lehtinen</i> .....	21:1–21:22
Origin-Equivalence of Two-Way Word Transducers Is in PSPACE <i>Sougata Bose, Anca Muscholl, Vincent Penelle, and Gabriele Puppis</i> .....	22:1–22:18
Constant Factor Approximation Algorithm for Uniform Hard Capacitated Knapsack Median Problem <i>Sapna Grover, Neelima Gupta, Samir Khuller, and Aditya Pancholi</i> .....	23:1–23:22
A 5-Approximation for Universal Facility Location <i>Manisha Bansal, Naveen Garg, and Neelima Gupta</i> .....	24:1–24:12
On Fair Division for Indivisible Items <i>Bhaskar Ray Chaudhury, Yun Kuen Cheung, Jugal Garg, Naveen Garg, Martin Hoefer, and Kurt Mehlhorn</i> .....	25:1–25:17
Combinatorial Algorithms for General Linear Arrow-Debreu Markets <i>Bhaskar Ray Chaudhury and Kurt Mehlhorn</i> .....	26:1–26:16
On the Welfare of Cardinal Voting Mechanisms <i>Umang Bhaskar and Abheek Ghosh</i> .....	27:1–27:22
Symbolic Approximation of Weighted Timed Games <i>Damien Busatto-Gaston, Benjamin Monmege, and Pierre-Alain Reynier</i> .....	28:1–28:16
A Symbolic Framework to Analyse Physical Proximity in Security Protocols <i>Alexandre Debant, Stéphanie Delaune, and Cyrille Wiedling</i> .....	29:1–29:20
On Canonical Models for Rational Functions over Infinite Words <i>Emmanuel Filiot, Olivier Gauwin, Nathan Lhote, and Anca Muscholl</i> .....	30:1–30:17
Reachability for Two-Counter Machines with One Test and One Reset <i>Alain Finkel, Jérôme Leroux, and Grégoire Sutre</i> .....	31:1–31:14
The Parikh Property for Weighted Context-Free Grammars <i>Pierre Ganty and Elena Gutiérrez</i> .....	32:1–32:20

Characterizing Demand Graphs for (Fixed-Parameter) Shallow-Light Steiner Network	
<i>Amy Babay, Michael Dinitz, and Zeyu Zhang</i> .....	33:1–33:22
On the Parameterized Complexity of $[1, j]$ -Domination Problems	
<i>Mohsen Alambardar Meybodi, Fedor Fomin, Amer E. Mouawad, and Fahad Panolan</i> .....	34:1–34:14
Sub-Exponential Time Parameterized Algorithms for Graph Layout Problems on Digraphs with Bounded Independence Number	
<i>Pranabendu Misra, Saket Saurabh, Roohani Sharma, and Meirav Zehavi</i> .....	35:1–35:19
Safe and Optimal Scheduling for Hard and Soft Tasks	
<i>Gilles Geeraerts, Shibashis Guha, and Jean-François Raskin</i> .....	36:1–36:22
The $\Delta$ -Framework	
<i>Furio Honsell, Luigi Liquori, Claude Stolze, and Ivan Scagnetto</i> .....	37:1–37:21
Extending Finite-Memory Determinacy by Boolean Combination of Winning Conditions	
<i>Stéphane Le Roux, Arno Pauly, and Mickael Randour</i> .....	38:1–38:20
Deterministic Algorithms for Maximum Matching on General Graphs in the Semi-Streaming Model	
<i>Sumedh Tirodkar</i> .....	39:1–39:16
Sketching, Streaming, and Fine-Grained Complexity of (Weighted) LCS	
<i>Karl Bringmann and Bhaskar Ray Chaudhury</i> .....	40:1–40:16
On the Inner Product Predicate and a Generalization of Matching Vector Families	
<i>Balthazar Bauer, Jevgēnijs Vihrovs, and Hoeteck Wee</i> .....	41:1–41:13
Extending Propositional Separation Logic for Robustness Properties	
<i>Alessio Mansutti</i> .....	42:1–42:23
Bundled Fragments of First-Order Modal Logic: (Un)Decidability	
<i>Anantha Padmanabha, R Ramanujam, and Yanjing Wang</i> .....	43:1–43:20
On the Boundedness Problem for Higher-Order Pushdown Vector Addition Systems	
<i>Vincent Penelle, Sylvain Salvati, and Grégoire Sutre</i> .....	44:1–44:20
Stronger Tradeoffs for Orthogonal Range Querying in the Semigroup Model	
<i>Swaroop N Prabhakar and Vikram Sharma</i> .....	45:1–45:14
Parameterized Dynamic Cluster Editing	
<i>Junjie Luo, Hendrik Molter, André Nichterlein, and Rolf Niedermeier</i> .....	46:1–46:15
The Complexity of Separation for Levels in Concatenation Hierarchies	
<i>Thomas Place and Marc Zeitoun</i> .....	47:1–47:17
Reducing Transducer Equivalence to Register Automata Problems Solved by “Hilbert Method”	
<i>Adrien Boiret, Radosław Piórkowski, and Janusz Schmude</i> .....	48:1–48:16





## ■ Preface

This volume constitutes the proceedings of the 38th IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science (FSTTCS 2018) held at Ahmedabad University, Ahmedabad, India from December 10 to December 14, 2017. The FSTTCS conferences are organized annually by the Indian Association for Research in Computing Science (IARCS). The proceedings of FSTTCS 2018 is published as a volume in the LIPIcs series under a Creative Commons license, with free online access to all.

The conference comprised of 4 invited talks and 44 contributed papers. This volume contains the contributed papers and abstracts of invited talks presented at the conference. The contributed papers were selected from a total of 123 submissions. We are grateful to the programme committee for its efforts in the evaluation of the submissions and selection of papers. We also thank the external reviewers for sending their informative and timely reviews. Further, we thank all authors who submitted their work to FSTTCS 2018. We are especially thankful to the invited speakers: *Rupak Majumdar* (MPI-SWS, Saarbrücken, Germany), *A. Prasad Sistla* (University of Illinois, Chicago, USA), *Ola Svensson* (EPFL, Lausanne, Switzerland) and *Santosh Vempala* (Georgia Tech., Atlanta, USA).

The conference had a pre-conference workshop on *Trends in Transformations* organized by *Paul Gastin* (ENS de Cachan, France) and *S.N. Krishna* (IIT Bombay, India). We thank the organizers of the workshop and the speakers in it.

The organizing committee of the conference from Ahmedabad University were responsible for the local and technical arrangements that led to the smooth running of the conference. We thank them for their invaluable efforts. We thank *Easychair* for the conference management tool used for the submission and review process. Finally, we thank Dagstuhl publications for the publication of these proceedings.

Sumit Ganguly and Paritosh Pandya





## ■ List of Reviewers

Abel Molina  
Abhishek Sahu  
Abhishek Shetty  
Achim Blumensath  
Ahmed Bouajjani  
Aida Mousavifar  
Akash Kumar  
Aldric Degorre  
Alexander Rabinovich  
Amaldev Manuel  
Ameya Velingker  
Amit Sinhababu  
Anand Louis  
André van Renssen  
Andreas Pavlogiannis  
Anil Shukla  
Anirban Dasgupta  
Anna Adamaszek  
Anupam Gupta  
Arijit Ghosh  
Arindam Khan  
Ashish Chiplunkar  
Ashish Dwivedi  
Ashutosh Gupta  
Ashutosh Kumar  
B Srivathsan  
Benoit Groz  
Bharat Adsul  
Bjoern Lellmann  
Blaise Genest  
Bodhayan Roy  
C. Aiswarya  
Caucal  
César Rodríguez  
Chaitanya Swamy  
Chandra Chekuri  
Chandra Chekuri  
Chandra Chekuri  
Chien-Chung Huang  
Chris Schwiegelshohn  
Christoph Haase  
Damian Straszak  
Dániel Marx  
David Manlove  
Deepak D'Souza  
Dejan Jovanović  
Dietmar Berwanger  
Dietrich Kuske  
Emmanuel Filiot  
Eugene Stark  
Eva-Maria Hols  
Fahad Panolan  
Francesco Belardinelli  
Frank Kammer  
Geevarghese Philip  
Georg Zetsche  
Gilles Geeraerts  
Giorgio Delzanno  
Gökalp Demirci  
Gopal Pandurangan  
Gopalan Nadathur  
Hartmut Klauck  
Havana Rika  
Hrishikesh Karmarkar  
Hui Kong  
Ismaël Jecker  
Jaikumar Radhakrishnan  
James Brotherston  
Jan Kretinsky  
Jan Otop  
Jannik Dreier  
Jason Reed  
Jayesh Chaudhuri  
Jean Goubault-Larrecq  
Jean-Francois Raskin  
Jean-Jacques Levy  
Jesper Nederlof  
Jiehua Chen  
Joachim Gudmundsson  
John Kallaughur  
Jugal Garg  
K. Narayan Kumar  
Kamal Lodaya  
Karin Quaas  
Kavitha Telikepalli  
Kent Quanrud  
Krishna S  
Krishnendu Chatterjee  
Laszlo Kozma  
Laszlo Vegh

Laure Daviaud	Rajat Mittal
Laure Daviaud	Rajesh Chitnis
Lingxiao Huang	Rakesh Venkat
Luc Dartois	Ramchandra Phawade
M. Praveen	Ramprasad Saptharishi
Madhavan Mukund	Rasmus Ibsen-Jensen
Madhukar Y	Richard Mayr
Magnus Wahlström	Robert Simmons
Mahesh Viswanathan	Rohit Gurjar
Manoj Gupta	Roland Meyer
Matthew Bauer	Rucha Kulkarni
Meena Mahajan	Rüdiger Ehlers
Michael Kapralov	S P Suresh
Michał Pilipczuk	S. Akshay
Mihaela Sighireanu	Sadra Yazdanbod
Minati De	Saket Saurabh
Mirco Giacobbe	Saladi Rahul
Mitchell Jones	Samuel Mimram
Mohamed Faouzi Atig	Sanath Kumar Krishnamurthy
Mohit Singh	Sanjiva Prasad
Neeraj Kayal	Sanjiva Prasad
Nicolas Markey	Satyadev Nandakumar
Nicolas Massocchi	Sebastian Arming
Nikhil Balaji	Seeun William Umboh
Nima Roohi	Shibashis Guha
Nisheeth Vishnoi	Shweta Agrawal
Nitin Saxena	Siddharth Barman
Noam Touitou	Siddharth Bhandari
Nutan Limaye	Siu On Chan
Paritosh Pandya	Sivakanth Gopi
Parosh Abdulla	Soumya Paul
Paul Gastin	Sourav Chakraborty
Pawel Parys	Srijita Kundu
Peter Habermehl	Srikanth Srinivasan
Peter McGlaughlin	Stefan Kratsch
Peter Rossmanith	Stefan Schwoon
Petr Novotny	Subodh Sharma
Philipp Meyer	Sucheendra K. Palaniappan
Pierre-Alain Reynier	Sudeshna Kolay
Piyush Kurur	Suguman Bansal
Piyush Srivastava	Sumanta Ghosh
Pooja Kulkarni	Sumit Ganguly
Prahladh Harsha	Supratik Chakraborty
Prakash Saivasan	Suprovat Ghoshal
Pranav Bisht	Tamás Király
R.B. Sandeep	Thomas Ferrere
Raghunath Tewari	Thomas Thierauf
Rajarshi Ray	Till Fluschnik

Tobias Nipkow  
Udi Boker  
Uli Fahrenberg  
Uli Schlachter  
Venkatesh Srinivasan  
Yossi Azar  
Zhilin Wu

