Lecture Notes in Computer Science **12011**

Founding Editors

Gerhard Goos, Germany
Juris Hartmanis, USA

Editorial Board Members

Elisa Bertino, USA
Wen Gao, China
Bernhard Steffen, Germany
Gerhard Woeginger, Germany
Moti Yung, USA

Advanced Research in Computing and Software Science

Subline of Lecture Notes in Computer Science

Subline Series Editors

Giorgio Ausiello, *University of Rome 'La Sapienza', Italy*
Vladimiro Sassone, *University of Southampton, UK*

Subline Advisory Board

Susanne Albers, *TU Munich, Germany*
Benjamin C. Pierce, *University of Pennsylvania, USA*
Bernhard Steffen, *University of Dortmund, Germany*
Deng Xiaotie, *Peking University, Beijing, China*
Jeannette M. Wing, *Microsoft Research, Redmond, WA, USA*

More information about this series at http://www.springer.com/series/7407

Alexander Chatzigeorgiou · Riccardo Dondi ·
Herodotos Herodotou · Christos Kapoutsis ·
Yannis Manolopoulos · George A. Papadopoulos ·
Florian Sikora (Eds.)

SOFSEM 2020: Theory and Practice of Computer Science

46th International Conference on Current Trends in Theory and Practice of Informatics, SOFSEM 2020
Limassol, Cyprus, January 20–24, 2020
Proceedings

Springer

Editors
Alexander Chatzigeorgiou
University of Macedonia
Thessaloniki, Greece

Herodotos Herodotou
Cyprus University of Technology
Limassol, Cyprus

Yannis Manolopoulos
Open University of Cyprus
Nicosia, Cyprus

Florian Sikora
Paris Dauphine University
Paris, France

Riccardo Dondi
University of Bergamo
Bergamo, Italy

Christos Kapoutsis
Carnegie Mellon University Qatar
Doha, Qatar

George A. Papadopoulos
University of Cyprus
Nicosia, Cyprus

ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-030-38918-5 ISBN 978-3-030-38919-2 (eBook)
https://doi.org/10.1007/978-3-030-38919-2

LNCS Sublibrary: SL1 – Theoretical Computer Science and General Issues

© Springer Nature Switzerland AG 2020
This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

This volume contains the invited and contributed papers selected for presentation at SOFSEM 2020, the 46th International Conference on Current Trends in Theory and Practice of Computer Science, which was held during January 20–24, 2020, in Limassol, Cyprus.

SOFSEM (originally SOFtware SEMinar) is an annual international winter conference devoted to the theory and practice of computer science. Its aim is to present the latest developments in research for professionals from academia and industry working in leading areas of computer science. While being a well-established and fully international conference, SOFSEM also maintains the best of its original Winter School aspects, such as a high number of invited talks, in-depth coverage of selected research areas, and ample opportunity to discuss and exchange new ideas. SOFSEM 2020 is organized around the following four tracks:

- Foundations of Computer Science (chair: Christos Kapoutsis)
- Foundations of Data Science and Engineering (chair: Herodotos Herodotou)
- Foundations of Software Engineering (chair: Alexander Chatzigeorgiou)
- Foundations of Algorithmic Computational Biology (chairs: Ricardo Dondi and Florian Sikora)

Notably, the fourth track of the above takes place for the first time in the framework of SOFSEM and it is expected to be continued over the next years. With these tracks, SOFSEM 2020 covered the latest advances in both theoretical and applied research in leading areas of computer science.

An integral part of SOFSEM 2020 is the traditional Student Research Forum (chair: Theodoros Tzouramanis) organized with the aim of giving students feedback on both the originality of their scientific results and on their work in progress. The papers presented at the Student Research Forum will be available at the CEUR website (http://ceur-ws.org).

The SOFSEM 2020 Program Committee (PC) consisted of 95 international experts from 35 countries, representing the track areas with outstanding expertise. Another 72 external reviewers contributed as well. The committee undertook the task of assembling a scientific program for the SOFSEM audience by selecting from 125 submissions from 40 countries entered in the EasyChair system in response to the call for papers. The submissions were carefully reviewed with 2.9 reviews/paper, and thoroughly discussed. Following strict criteria of quality and originality, 40 papers were accepted for presentation as regular research papers, as well as 17 papers for presentation as short papers. These 57 papers were contributed by authors from 26 countries. Thus, the acceptance ratio for regular papers was 32%, plus another 14% for short papers. Additionally, based on the recommendation of the chair of the Student Research Forum, 9 papers were accepted for presentation in the Student Research Forum.

As editors of these proceedings, we are grateful to everyone who contributed to the scientific program of the conference. We would like to thank the invited speakers:

- Mikołaj Bojańczyk (University of Warsaw, Poland)
- Ernesto Damiani (Khalifa University, UAE)
- Erol Gelenbe (Polish Academy of Sciences, Poland)
- Gunnar Klau (Heinrich Heine University Düsseldorf, Germany)
- Elias Koutsoupias (University of Oxford, UK)

for presenting their work to the audience of SOFSEM 2020. We thank all authors who submitted their papers for consideration. Many thanks are due to the PC members, and to all external referees, for their precise and detailed reviewing of the submissions. The work of the PC was carried out using the EasyChair system, and we gratefully acknowledge this contribution.

Special thanks are due to the SOFSEM Steering Committee, headed by Július Štuller, for its support throughout the preparation of the conference. Finally, we want to thank Easyconferences.eu led by Petros Stratis, and the Deputy Ministry of Tourism of Cyprus, for their services and support.

January 2020

Alexander Chatzigeorgiou
Riccardo Dondi
Herodotos Herodotou
Christos Kapoutsis
Yannis Manolopoulos
George A. Papadopoulos
Florian Sikora

Organization

General Chairs

Yannis Manolopoulos	Open University of Cyprus, Cyprus
George-Angelos Papadopoulos	University of Cyprus, Cyprus

Program Committee Chairs

Alexander Chatzigeorgiou	University of Macedonia, Greece
Riccardo Dondi	University of Bergamo, Italy
Herodotos Herodotou	Cyprus University of Technology, Cyprus
Christos Kapoutsis	Carnegie Mellon University in Qatar, Qatar
Florian Sikora	University of Paris-Dauphine, France

Student Research Forum Chair

Theodoros Tzouramanis	University of Thessaly, Greece

Steering Committee

Barbara Catania	University of Genoa, Italy
Miroslaw Kutylowski	Wroclaw University of Technology, Poland
Tiziana Margaria-Steffen	University of Limerick, Ireland
Branislav Rovan	Comenius University, Slovakia
Petr Šaloun	Technical University of Ostrava, Czech Republic
Július Štuller (Chair)	Academy of Sciences in Prague, Czech Republic
Jan van Leeuwen	Utrecht University, The Netherlands

Program Committee

Andris Ambainis	University of Latvia, Latvia
Fabio Anselmi	Italian Institute of Technology, Italy
Mukul S. Bansal	University of Connecticut, USA
Ladjel Bellatreche	Poitiers University, France
Sadok Ben Yahia	University of Tunis El Manar, Tunisia
Maria Bielikova	Slovak University of Technology in Bratislava, Slovakia
Guillaume Blin	University of Bordeaux, France
Hans-Joachim Böckenhauer	ETH Zurich, Switzerland
Edouard Bonnet	ENS Lyon, CNRS, France
Stephane Bressan	National University of Singapore, Singapore

Francesco Buccafurri	University of Reggio Calabria, Italy
Laurent Bulteau	University of Paris-Est Marne-la-Vallée, CNRS, France
Cedric Chauve	Simon Fraser University, Canada
Zhi-Zhong Chen	Tokyo Denki University, Japan
Alfredo Cuzzocrea	ICAR-CNR, University of Calabria, Italy
Peter Damaschke	Chalmers University, Sweden
Bhaskar DasGupta	University of Illinois at Chicago, USA
Volker Diekert	University of Stuttgart, Germany
Martin Dietzfelbinger	Technical University Ilmenau, Germany
Johann Eder	Alpen Adria University of Klagenfurt, Austria
Mohammed El-Kebir	University of Illinois at Urbana-Champaign, USA
Oliver Eulenstein	Iowa State University, USA
Guillaume Fertin	University of Nantes, France
Pierre Fraigniaud	CNRS, Paris Diderot University, France
Johann Gamper	Free University of Bozen-Bolzano, Italy
Loukas Georgiadis	University of Ioannina, Greece
Pawel Gorecki	University of Warsaw, Poland
Giovanna Guerrini	University of Genova, Italy
Yo-Sub Han	Yonsei University, South Korea
Theo Härder	University of Kaiserslautern, Germany
Danny Hermelin	Ben-Gurion University, Israel
Irena Holubova	Charles University in Prague, Czech Republic
Markus Holzer	University of Giessen, Germany
Kazuo Iwama	Kyoto University, Japan
Jesper Jansson	The Hong Kong Polytechnic University, Hong Kong, China
Minghui Jiang	Utah State University, USA
Mark Jones	TU Delft, The Netherlands
Tomasz Jurdzinski	University of Wroclaw, Poland
Iyad A. Kanj	DePaul University, USA
Jarkko Kari	University of Turku, Finland
Selma Khouri	ESI, Algeria
Dennis Komm	ETH Zurich, Switzerland
Christian Komusiewicz	Philipps-University Marburg, Germany
Georgia Koutrika	Athena Research Center, Greece
Rastislav Kralovic	Comenius University, Slovakia
Evangelos Kranakis	Carleton University, Canada
Manuel Lafond	University of Sherbrooke, Canada
Michael Lampis	University of Paris-Dauphine, France
Sebastian Link	The University of Auckland, New Zealand
Zsuzsanna Lipták	University of Verona, Italy
Beatrice Markhoff	University of Tours, France
Giancarlo Mauri	University of Milano-Bicocca, Italy
Neeldhara Misra	Indian Institute of Technology, India
Elvira Mayordomo	University of Zaragoza, Spain
Carlo Mereghetti	University of Milan, Italy

Paolo Missier	Newcastle University, UK
Luc Moreau	King's College London, UK
Nelma Moreira	University of Porto, Portugal
Rim Moussa	ENICarthage, Tunisia
Alexander Okhotin	Saint Petersburg State University, Russia
Giovanni Pighizzini	University of Milan, Italy
Nadia Pisanti	University of Pisa, Italy
Alberto Policriti	University of Udine, Italy
Alex Popa	University of Bucharest, Romania
Andrei Popescu	Middlesex University London, UK
Igor Potapov	The University of Liverpool, UK
Eric Rivals	University of Montpellier, CNRS, France
Raffaella Rizzi	University of Milano-Bicocca, Italy
Gunter Saake	Otto-von-Guericke-University Magdeburg, Germany
Sherif Sakr	University of Tartu, Estonia
Kai Salomaa	Queen's University, Canada
Cem Say	Bogazici University, Turkey
Eike Schallehn	Otto von Guericke University Magdeburg, Germany
Marinella Sciortino	University of Palermo, Italy
Celine Scornavacca	University of Montpellier, CNRS, France
Shinnosuke Seki	The University of Electro-Communications, Japan
Ayumi Shinohara	Tohoku University, Japan
Ernest Teniente	Technical University of Catalonia, Spain
Olivier Teste	University of Toulouse, France
Martin Theobald	University of Luxemburg, Luxembourg
Eleftherios Tiakas	Aristotle University of Thessaloniki, Greece
Farouk Toumani	Blaise Pascal University, France
Gabriel Valiente	Technical University of Catalonia, Spain
Athena Vakali	Aristotle University of Thessaloniki, Greece
Stephane Vialette	University Paris-Est Marne-la-Vallée, CNRS, France
Peter Van Emde Boas	University of Amsterdam, The Netherlands
Leo Van Iersel	University of Twente, The Netherlands
Panos Vassiliadis	University of Ioannina, Greece
Mathias Weller	University Paris-Est Marne-la-Vallée, CNRS, France
Abuzer Yakaryilmaz	University of Latvia, Latvia
Tomoyuki Yamakami	University of Fukui, Japan
Christos Zaroliagis	CTI, University of Patras, Greece
Meirav Zehavi	Ben-Gurion University, Israel
Thomas Zeugmann	Hokkaido University, Japan
Louxin Zhang	National University of Singapore, Singapore

Additional Reviewers

Patrizio Angelini
Marcella Anselmo
Elvira-Maria Arvanitou
Christel Baier
Luca Bernardinello
Nicolas Bonichon
Sabine Broda
Elisabet Burjons
Cezar Campeanu
Costanza Catalano
Michele Chiari
Sarah Christensen
Ferdinando Cicalese
Maxime Crochemore
Federico Dassereto
Gianluca De Marco
Holger Dell
Emilio Di Giacomo
Mike Domaratzki
Gabriele Fici
Johannes Fischer
Marco Franceschetti
Fabian Frei
Janosch Fuchs
Esther Galbrun
Paweł Garncarek
Paweł Gawrychowski
Konstantinos Giannis
Szymon Grabowski
Massimiliano Goldwurm
Spyros Halkidis
Artur Jeż
Chris Keeler
Vasilios Kelefouras
Hwee Kim
Jetty Kleijn
Sang-Ki Ko
Athanasios Konstantinidis
Julius Köpke
Lukasz Kowalik
Tomas Kulik
Martin Kutrib
Markus Lohrey
Andreas Maletti
Florin Manea
Wim Martens
Radu-Stefan Mincu
Tobias Mömke
František Mráz
Reino Niskanen
Charis Papadopoulos
Matthew Patitz
Ilaria Pigazzini
Luca Prigioniero
Daniel Prusa
Simon Puglisi
Karol Rástočný
Rogério Reis
Traian Florin Serbanuta
Michiel Smid
Taylor Smith
Ana Paula Tomás
Spyridon Tzimas
Walter Unger
Diego Valota
Sergey Verlan
Christina Volioti
Kunihiro Wasa
David Wehner
Sebastian Wild
Petra Wolf
Viktor Zamaraev

Contents

Invited Papers

Certified Machine-Learning Models . . . 3
Ernesto Damiani and Claudio A. Ardagna

The Lost Recipes from the Four Schools of Amathus: Invited Talk Extended Abstract . . . 16
Gunnar W. Klau

Sharing Energy for Optimal Edge Performance . . . 24
Erol Gelenbe and Yunxiao Zhang

Foundations of Computer Science – Regular Papers

A Characterization of the Context-Free Languages by Stateless Ordered Restart-Delete Automata . . . 39
Friedrich Otto

A Constructive Arboricity Approximation Scheme . . . 51
Markus Blumenstock and Frank Fischer

A Game of Cops and Robbers on Graphs with Periodic Edge-Connectivity . . . 64
Thomas Erlebach and Jakob T. Spooner

Approximating Shortest Connected Graph Transformation for Trees . . . 76
Nicolas Bousquet and Alice Joffard

Approximating Weighted Completion Time for Order Scheduling with Setup Times . . . 88
Alexander Mäcker, Friedhelm Meyer auf der Heide, and Simon Pukrop

Bounds for the Number of Tests in Non-adaptive Randomized Algorithms for Group Testing . . . 101
Nader H. Bshouty, George Haddad, and Catherine A. Haddad-Zaknoon

Burning Two Worlds: Algorithms for Burning Dense and Tree-Like Graphs . . . 113
Shahin Kamali, Avery Miller, and Kenny Zhang

Faster STR-EC-LCS Computation . . . 125
Kohei Yamada, Yuto Nakashima, Shunsuke Inenaga, Hideo Bannai, and Masayuki Takeda

Kernels of Sub-classes of Context-Free Languages 136
Martin Kutrib

Minimal Unique Substrings and Minimal Absent Words in a Sliding Window 148
Takuya Mieno, Yuki Kuhara, Tooru Akagi, Yuta Fujishige, Yuto Nakashima, Shunsuke Inenaga, Hideo Bannai, and Masayuki Takeda

On Synthesis of Specifications with Arithmetic. 161
Rachel Faran and Orna Kupferman

On the Average State Complexity of Partial Derivative Transducers 174
Stavros Konstantinidis, António Machiavelo, Nelma Moreira, and Rogério Reis

On the Difference Between Finite-State and Pushdown Depth. 187
Liam Jordon and Philippe Moser

Online Scheduling with Machine Cost and a Quadratic Objective Function 199
J. Csirik, Gy. Dósa, and D. Kószó

Parallel Duel-and-Sweep Algorithm for the Order-Preserving Pattern Matching. 211
Davaajav Jargalsaikhan, Diptarama Hendrian, Ryo Yoshinaka, and Ayumi Shinohara

Parameterized Complexity of Synthesizing b-Bounded (m, n)-T-Systems 223
Ronny Tredup

Parameterized Dynamic Variants of Red-Blue Dominating Set 236
Faisal N. Abu-Khzam, Cristina Bazgan, and Henning Fernau

Refined Parameterizations for Computing Colored Cuts in Edge-Colored Graphs. 248
Nils Morawietz, Niels Grüttemeier, Christian Komusiewicz, and Frank Sommer

Simple Distributed Spanners in Dense Congest Networks. 260
Leonid Barenboim and Tzalik Maimon

The Order Type of Scattered Context-Free Orderings of Rank One Is Computable 273
Kitti Gelle and Szabolcs Iván

Up-to Techniques for Branching Bisimilarity 285
Rick Erkens, Jurriaan Rot, and Bas Luttik

Foundations of Data Science and Engineering – Regular Papers

Crowd Detection for Drone Safe Landing Through Fully-Convolutional Neural Networks 301
Giovanna Castellano, Ciro Castiello, Corrado Mencar, and Gennaro Vessio

Explaining Single Predictions: A Faster Method 313
Gabriel Ferrettini, Julien Aligon, and Chantal Soulé-Dupuy

Inferring Deterministic Regular Expression with Unorder 325
Xiaofan Wang and Haiming Chen

POI Recommendation Based on Locality-Specific Seasonality and Long-Term Trends 338
Elena Stefancova and Ivan Srba

Selection of a Green Logical Data Warehouse Schema by Anti-monotonicity Constraint 350
Issam Ghabri, Ladjel Bellatreche, and Sadok Ben Yahia

The HyperBagGraph DataEdron: An Enriched Browsing Experience of Datasets: Track: Foundation of Data Science and Engineering 362
Xavier Ouvrard, Jean-Marie Le Goff, and Stéphane Marchand-Maillet

Towards the Named Entity Recognition Methods in Biomedical Field 375
Anna Śniegula, Aneta Poniszewska-Marańda, and Łukasz Chomątek

Vietnamese Punctuation Prediction Using Deep Neural Networks 388
Thuy Pham, Nhu Nguyen, Quang Pham, Han Cao, and Binh Nguyen

Foundations of Software Engineering – Regular Papers

A Light-Weight Tool for the Self-assessment of Security Compliance in Software Development – An Industry Case. 403
Fabiola Moyón, Christoph Bayr, Daniel Mendez, Sebastian Dännart, and Kristian Beckers

A Novel Hybrid Genetic Algorithm for the Two-Stage Transportation Problem with Fixed Charges Associated to the Routes. 417
Ovidiu Cosma, Petrica C. Pop, and Cosmin Sabo

Do People Use Naming Conventions in SQL Programming? 429
Aggelos Papamichail, Apostolos V. Zarras, and Panos Vassiliadis

Employing Costs in Multiagent Systems with Timed Migration and Timed Communication 441
Bogdan Aman and Gabriel Ciobanu

Maintainability of Automatic Acceptance Tests for Web Applications—A Case Study Comparing Two Approaches to Organizing Code of Test Cases 454
Aleksander Sadaj, Mirosław Ochodek, Sylwia Kopczyńska, and Jerzy Nawrocki

Recommending Trips in the Archipelago of Refactorings 467
Theofanis Vartziotis, Apostolos V. Zarras, Anastasios Tsimakis, and Panos Vassiliadis

String Representations of Java Objects: An Empirical Study 479
Matúš Sulír

Foundations of Algorithmic Computational Biology – Regular Papers

Fast Indexes for Gapped Pattern Matching 493
Manuel Cáceres, Simon J. Puglisi, and Bella Zhukova

Linearizing Genomes: Exact Methods and Local Search 505
Tom Davot, Annie Chateau, Rodolphe Giroudeau, and Mathias Weller

Scanning Phylogenetic Networks Is NP-hard 519
Vincent Berry, Celine Scornavacca, and Mathias Weller

The Maximum Equality-Free String Factorization Problem: Gaps vs. No Gaps 531
Radu Stefan Mincu and Alexandru Popa

Foundations of Computer Science – Short Papers

A Calculus for Language Transformations 547
Benjamin Mourad and Matteo Cimini

Computing Directed Steiner Path Covers for Directed Co-graphs (Extended Abstract) 556
Frank Gurski, Stefan Hoffmann, Dominique Komander, Carolin Rehs, Jochen Rethmann, and Egon Wanke

Counting Infinitely by Oritatami Co-transcriptional Folding 566
Kohei Maruyama and Shinnosuke Seki

On Synchronizing Tree Automata and Their Work–Optimal Parallel Run, Usable for Parallel Tree Pattern Matching 576
Štěpán Plachý and Jan Janoušek

On the Hardness of Energy Minimisation for Crystal Structure Prediction . . . 587
Duncan Adamson, Argyrios Deligkas, Vladimir V. Gusev, and Igor Potapov

Practical Implementation of a Quantum Backtracking Algorithm 597
Simon Martiel and Maxime Remaud

Simplified Emanation Graphs: A Sparse Plane Spanner with Steiner Points 607
Bardia Hamedmohseni, Zahed Rahmati, and Debajyoti Mondal

Simultaneous FPQ-Ordering and Hybrid Planarity Testing 617
Giuseppe Liotta, Ignaz Rutter, and Alessandra Tappini

Two-Player Competitive Diffusion Game: Graph Classes and the Existence of a Nash Equilibrium 627
Naoka Fukuzono, Tesshu Hanaka, Hironori Kiya, Hirotaka Ono, and Ryogo Yamaguchi

Foundations of Data Science and Engineering – Short Papers

Automatic Text Generation in Slovak Language 639
Dominik Vasko, Samuel Pecar, and Marian Simko

Connecting Galaxies: Bridging the Gap Between Databases and Applications 648
Henrietta Dombrovskaya, Jeff Czaplewski, and Boris Novikov

GRaCe: A Relaxed Approach for Graph Query Caching 657
Francesco De Fino, Barbara Catania, and Giovanna Guerrini

Modelling of the Fake Posting Recognition in On-Line Media Using Machine Learning 667
Kristína Machová, Marián Mach, and Gabriela Demková

Two-Step Memory Networks for Deep Semantic Parsing of Geometry Word Problems 676
Ishadi Jayasinghe and Surangika Ranathunga

Foundations of Software Engineering – Short Papers

A Case Study on a Hybrid Approach to Assessing the Maturity of Requirements Engineering Practices in Agile Projects (REMMA) 689
Mirosław Ochodek, Sylwia Kopczyńska, and Jerzy Nawrocki

Does Live Regression Testing Help? 699
Marek Bruchatý and Karol Rástočný

Foundations of Algorithmic Computational Biology – Short Paper

Dense Subgraphs in Biological Networks 711
Mohammad Mehdi Hosseinzadeh

Author Index 721