Lecture Notes in Computer Science 10979

Commenced Publication in 1973
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Combinatorial Algorithms

29th International Workshop, IWOCA 2018
Singapore, July 16–19, 2018
Proceedings

Springer

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ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-319-94666-5 ISBN 978-3-319-94667-2 (eBook)
https://doi.org/10.1007/978-3-319-94667-2

Library of Congress Control Number: 2018939453

LNCS Sublibrary: SL1 – Theoretical Computer Science and General Issues

Printed on acid-free paper

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

Preface

This proceedings volume contains papers presented at IWOCA 2018, the 29th International Workshop on Combinatorial Algorithms, held during July 16–19, 2018, at the Department of Computer Science, National University of Singapore (NUS), Singapore. The conference covered diverse areas of combinatorial algorithms, namely, complexity theory, graph theory and combinatorics, combinatorial optimization, cryptography and information security, algorithms on strings and graphs, graph drawing and labelling, computational algebra and geometry, computational biology, probabilistic and randomized algorithms, algorithms for big data analytics, and new paradigms of computation. The conference was organized by the School of Computing, National University of Singapore.

IWOCA is an annual conference series on all aspects of combinatorial algorithms. The series of IWOCA conferences grew out of over 28 years of history. Initially, the conference was a local workshop in Australia, known as AWOCA. In 2007, it became an international conference. Previous meetings have been held in Australia, Canada, Czech Republic, Finland, France, Indonesia, India, Italy, Japan, South Korea, UK, and USA. IWOCA is led by a strong Steering Committee, whose members are Charles Colbourn (Arizona State University), Costas Iliopoulos (King's College), and Bill Smyth (McMaster University). The Program Committees comprise computer scientists of international repute from different parts of the globe. Notably, the Program Committee of IWOCA 2018 comprised 46 eminent researchers from Australia, Bangladesh, Canada, Chile, China, Czech Republic, Finland, France, Greece, Hong Kong, Israel, Italy, Japan, Malaysia, Norway, Singapore, Slovenia, Taiwan, UK, and USA.

The technical program was finalized by selecting the highest-quality papers from among 69 submitted papers. After a rigorous review followed by in-depth discussion by the Program Committee, this year we could only accept 31 high-quality papers. Among these 31 papers, we selected "Linear Ramsey Numbers" for the best paper award, which presented at the conference. In addition to the 31 contributed talks, the scientific program of the workshop included invited talks by three eminent researchers, namely, Prof. Michael Fellows (University of Bergen, Norway), Prof. Sanjay Jain (National University of Singapore, Singapore), and Prof. Kunihiko Sadakane (University of Tokyo, Japan). We are extremely grateful to our invited speakers for their excellent talks at the workshop. We thank all the authors who submitted their works for consideration to IWOCA 2018. We deeply appreciate the contribution of all Program Committee members and external reviewers for handling the submissions in a timely manner despite their extremely busy schedule. We would like to acknowledge the EasyChair conference management system again for providing us with their celebrated platform for conference administration. We are grateful to Springer for

publishing the proceedings of IWOCA 2018 in the LNCS series. As always, we are deeply indebted to the IWOCA Steering Committee for their continuous guidance, support, and leadership. Above all, we are extremely grateful to the Organizing Committee of IWOCA 2018 for making the event a grand success. Finally, we would like to thanks Springer for sponsoring the conference.

July 2018

Costas Iliopoulos
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Invited Talks

Some Recent New Directions in Multivariate Algorithmics

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Abstract. The talk will try to do three things:

(1) Give a basic introduction to the key ideas of parameterized complexity/multivariate algorithmics, for those who may be unfamiliar with this area of research. The account will be somewhat idiosyncratic, colorful and concrete, and may offer some new perspectives even to those who are conversant in the technical ideas of this area.
(2) Briefly survey some of the key achievements of this area of research so far, and the major themes, such as the equivalency between P-time kernelization and FPT that have emerged.
(3) Exposit recent research directions in this area that have attracted substantial new research funding in various countries of the world.

Survey of Some Recent Near Polynomial Time Results for Parity Games

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Abstract. In this talk we will describe a Quasi Polynomial time algorithm for parity games given by Calude et al (STOC 2017). The runtime for the algorithm is $O(n^{\log(m)+6})$, where n is the number of nodes and m is the number of colours (priorities). The parameterised parity game – with n nodes and m distinct colours is proven to be in the class of fixed parameter tractable problems (FPT) when parameterised over m. The corresponding runtime is $O(n^5 + g(m))$, where $g(m)$ can be taken to be m^{m+6}. We will also discuss the next developments in the field which improved the above algorithm by making it simultaneously in near linear space by Jurdzinski and Lazic (LICS 2017) and Fearnley et al (SPIN 2017). Recently, Lehtinen (LICS 2018) introduced the notion of register index complexity and showed that this is logarithmic in the number of nodes; furthermore, a game with register index complexity k, the parity game can be solved in time $m^{O(k)} \cdot n^{O(1)}$ which provides another quasipolynomial time algorithm for parity games.

S. Jain was supported in part by the Singapore Ministry of Education Academic Research Fund Tier 2 grant MOE2016-T2-1-019/R146-000-234-112 and NUS grant C252-000-087-001.

Range Minimum Queries and Applications

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Consider the following problem.

Range Minimum Query, RMQ Given an array $A[1..n]$ and a range $[s,t] \subset [1,n]$, a range minimum query asks the position of the minimum value in $A[s..t]$. If there exist more than one minimum values in the query range, return the leftmost one.

We consider the indexing problem, that is, given the array A, we first construct a data structure D_A, then given a query range, we solve the problem using D_A. There exists a linear space ($O(n)$ words) data structure for the RMQ problem supporting constant time queries [3, 4]. It is however complicated and there have been no efficient implementations until recently. In 2000, a simple solution [1] was given and after that, constant query time RMQ data structures are used in many algorithms.

In this talk, we explain an $O(n)$-word data structure for the RMQ problem. Then we reduce the size of the data structure to just $2n + o(n)$ bits [2]. We also explain applications of the problem such as compressed suffix trees [5].

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