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Klaus Jansen · Monaldo Mastrolilli (Eds.)

Approximation and Online Algorithms

14th International Workshop, WAOA 2016 Aarhus, Denmark, August 25–26, 2016 Revised Selected Papers

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Editors
Klaus Jansen
Institut für Informatik
Christian-Albrechts-Universität
Kiel
Germany

Monaldo Mastrolilli
Istituto Dalle Molle di Studi
sull' Intelligenza Artificiale
Manno (Lugano)
Switzerland

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Preface

This volume contains the revised selected papers presented at WAOA 2016: the 14th Workshop on Approximation and Online Algorithms held during August 25–26, 2016, in Aarhus. WAOA 2016 focused on the design and analysis of approximation and online algorithms. These algorithms have become a fundamental tool in several fields and in many applications that cope with computationally hard problems and problems in which the input is gradually disclosed over time.

WAOA 2016 was part of ALGO 2016, which also hosted ESA, ALGOCLOUD, ALGOSENSORS, ATMOS, IPEC, and MASSIVE. The previous WAOA workshops were held in Budapest (2003), Rome (2004), Palma de Mallorca (2005), Zurich (2006), Eilat (2007), Karlsruhe (2008), Copenhagen (2009), Liverpool (2010), Saarbrücken (2011), Ljubljana (2012), Sophia Antipolis (2013), Wraclaw (2014), and Patras (2015). The proceedings of all these previous WAOA workshops have been published as LNCS volumes.

Topics of interest for WAOA 2016 were: coloring and partitioning, competitive analysis, network design, packing and covering, paradigms for design and analysis of approximation and online algorithms, randomization techniques, real-world applications, and scheduling problems.

In response to the call for papers, we received 33 submissions. Each submission was reviewed by at least three referees, and mainly judged on originality, technical quality, and relevance to the topics of the conference. Based on the reviews, the Program Committee selected 16 papers. This volume contains final revised versions of these papers. In addition to the accepted contributions, the workshop featured two invited lectures by Marek Cygan (University of Warsaw, Poland) and Ronald de Wolf (CWI and University of Amsterdam, The Netherlands). Contributions of the invited lectures are also included in this volume. We are grateful to both of them for accepting our invitation and for their very nice lectures.

The EasyChair conference system was used to manage the electronic submissions, the review process, and the electronic Program Committee meeting. It made our task much easier. We wish to thank all the authors who submitted papers for consideration, the invited speakers, the members of the Program Committee for their work, and all the external reviewers who assisted the Program Committee in the evaluation process. Special thanks go to the local Organizing Committee, who helped us with the organization of the workshop.

November 2016

Klaus Jansen
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Invited Lectures

Approximation Algorithms for the k-Set Packing Problem

Marek Cygan

Institute of Informatics, University of Warsaw, Warsaw, Poland
cygan@mimuw.edu.pl

Abstract. In the k-Set Packing problem we are given a universe and a family of its subsets, where each of the subsets has size at most k. The goal is to select a maximum number of sets from the family which are pairwise disjoint. It is a well known NP-hard problem, that has been studied from the approximation perspective since the 80's. During the talk we describe the history of progress on both the weighted and un- weighted variants of the problem, with an exposition of methods used to obtain the best known approximation algorithms mostly involving local search based routines.

We start with an exemplatory example of the classic Maximum Matching problem. Even though this is a polynomial-time-solvable problem it serves well at explaining the intuition behind local search algorithm in the form of hill climbing. In particular we will see that if it impossible to improve a matching M by removing p and adding $p+1$ edges, then M is at most $(p+2)/(p+1)$ times smaller than optimum.

Next we move to the k-Set Packing problem and consider the canonical local search algorithm for this problem, the approximation ratio of which has been analyzed in a long-spanning sequence of papers [5, 6, 7]. For each of the mentioned results we underline its main idea.

As the standard local search provides better approximation ratio in quasi-polynomial time than in polynomial time, a natural direction was to explore the logarithmic radius search space in polynomial time. This was achieved by Sviridenko and Ward [8] and Cygan [4] by using tools from parameterized complexity such as color coding of Alon, Yuster and Zwick [1].

Even though the standard linear relaxation of the problem has integrality gap $k-1+1/k$ it was shown by Chan and Lau [3] that by adding clique constraints the gap may be upper bounded by $(k+1)/2$.

Finally we consider the weighed variant of the k-Set Packing problem, where the interesting aspect is that the best known approximation algorithm is a local search optimizing the sum of squares of weights instead of the standard weighted sum [2].

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On Linear and Semidefinite Programs for Polytopes in Combinatorial Optimization

Ronald de Wolf

CWI and University of Amsterdam, Amsterdam, The Netherlands
rdewolf@cwi.nl

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Abstract. Combinatorial problems like TSP optimize a linear function over some polytope P. If we can obtain P as a projection from a larger-dimensional polytope with a small number of facets, then we get a small linear program for the optimization problem; if we obtain P as a projection from a small spectrahedron, then we get a small semidefinite program. The area of extension complexity studies the minimum sizes of such LPs and SDPs. In the 1980s Yannakakis [7] was the first to do this, proving exponential lower bounds on the size of symmetric LPs for the TSP and matching polytopes. In 2012, Fiorini et al. [4] proved exponential lower bounds on the size of all (possibly non-symmetric) LPs for TSP. This was followed by many new results for LPs and SDPs, for exact optimization as well as for approximation. We will survey this recent line of work [1, 2, 3, 5, 6].

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Contents

The Shortest Separating Cycle Problem 1
Esther M. Arkin, Jie Gao, Adam Hesterberg, Joseph S.B. Mitchell, and Jiemin Zeng

Dynamic Traveling Repair Problem with an Arbitrary Time Window 14
Yossi Azar and Adi Vardi

A PTAS for the Cluster Editing Problem on Planar Graphs 27
André Berger, Alexander Grigoriev, and Andrej Winokurow

Bin Packing with Colocations 40
Jean-Claude Bermond, Nathann Cohen, David Coudert, Dimitrios Letsios, Ioannis Milis, Stéphane Pérennes, and Vassilis Zissimopoulos

Batch Coloring of Graphs 52
Joan Boyar, Leah Epstein, Lene M. Favrholdt, Kim S. Larsen, and Asaf Levin

New Integrality Gap Results for the Firefighters Problem on Trees 65
Parinya Chalermsook and Daniel Vaz

A Multiplicative Weights Update Algorithm for Packing and Covering Semi-infinite Linear Programs 78
Khaled Elbassioni, Kazuhisa Makino, and Waleed Najy

Balanced Optimization with Vector Costs 92
Annette M.C. Ficker, Frits C.R. Spieksma, and Gerhard J. Woeginger

Vertex Sparsification in Trees 103
Gramoz Goranci and Harald Räcke

Scenario Submodular Cover 116
Nathaniel Grammel, Lisa Hellerstein, Devorah Kletenik, and Patrick Lin

Non-greedy Online Steiner Trees on Outerplanar Graphs 129
Akira Matsubayashi

A Refined Analysis of Online Path Coloring in Trees 142
Astha Chauhan and N.S. Narayanaswamy

Resource Allocation Games with Multiple Resource Classes 155
Roy B. Ofer and Tami Tamir

Tight Approximation Bounds for the Seminar Assignment Problem. 170
Amotz Bar-Noy and George Rabanca

A priori TSP in the Scenario Model 183
Martijn van Ee, Leo van Iersel, Teun Janssen, and René Sitters

Local Search Based Approximation Algorithms for Two-Stage Stochastic Location Problems 197
Felix J.L. Willamowski and Andreas Bley

Author Index 211