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Volume Editors

Guy Even
Tel-Aviv University
School of Electrical Engineering
Ramat-Aviv, Tel Aviv 69978, Israel
E-mail: guy@eng.tau.ac.il

Magnús M. Halldórsson
Reykjavík University
ICE-TCS, School of Computer Science
101 Reykjavík, Iceland
E-mail: mmh@ru.is

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Preface

The 19th International Colloquium on Structural Information and Communication Complexity (SIROCCO 2012) took place in Reykjavik, Iceland, for three days starting June 30, 2012.

SIROCCO is devoted to the study of communication and knowledge in distributed systems from both qualitative and quantitative viewpoints. Special emphasis is given to innovative approaches and fundamental understanding in addition to efforts to optimize current designs. The typical areas include distributed computing, communication networks, game theory, parallel computing, social networks, mobile computing (including autonomous robots), peer-to-peer systems, communication complexity, fault-tolerant graph theories, and randomized/probabilistic issues in networks.

This year, 54 papers were submitted in response to the call for papers, and each paper was evaluated by three to five reviewers. In total, 164 reviews were received. The Program Committee selected 28 papers for presentation at the colloquium and publication in this volume after in-depth discussions.

The SIROCCO Prize for Innovation in Distributed Computing was awarded this year to Roger Wattenhofer from ETH Zurich. A commendation summarizing his many and important innovative contributions to distributed computing appears in these proceedings.

The collaboration of the Program Committee members and the external reviewers enabled completing the process of reviewing the papers and discussing them in less than four weeks. We thank them all for their devoted service to the SIROCCO community. We thank the authors of all the submitted papers; without them we could not have prepared a program of such quality. We thank Yvonne Anne Pignolet for her assistance as Publicity Chair.

We thank the invited speakers Roger Wattenhofer and Boaz Patt-Shamir.

The preparation of this event was guided by the SIROCCO Steering Committee, headed by Shay Kutten.

We are grateful to Reykjavik University for hosting the meeting. In particular, we thank the Events and Facilities Departments of the university for their support.

The EasyChair system was used to handle the submission of papers, manage the review process, and generate these proceedings.

April 2012

Guy Even
Magnús M. Halldórsson

Prize for Innovation in Distributed Computing Awarded to Roger Wattenhofer

The Prize for Innovation in Distributed Computing for 2012 is awarded to Roger Wattenhofer (ETH Zurich), in recognition of his extensive contributions to the study of distributed approximation, as illustrated by papers that have appeared in the proceedings of past SIROCCO meetings.

We requested David Peleg to write the following laudatio for the proceedings, describing Wattenhofer's contributions.

Wattenhofer explored aspects of distributed approximation in a variety of distributed communication models and classes of underlying networks, seeking to form a detailed picture of the approximable and the inapproximable in ordinary (wired) as well as wireless networks. He also developed the strongest known distributed approximation algorithms and inapproximability results for some of the central problems in the area.

Broadly speaking, one can classify Wattenhofer's achievements in the area of distributed approximation into several main contributions, described next.

Initiating the study of distributed approximation for key problems. Wattenhofer *initiated* the study of distributed approximation (as well as *distributed inapproximability*) for a number of central problems. A notable example is the problem of *facility location*, which he studied in his PODC'05 paper with Moscibroda [7], exploring a trade-off between the amount of communication and the resulting approximation ratio.

LP-based distributed approximation. Wattenhofer significantly advanced and popularized the use of *LP-based* approximation techniques in the distributed domain, including techniques based on *randomized rounding of fractional relaxations* of given integer linear programs, *LP duality*, and more. For instance, his paper with Fabian Kuhn in PODC'03 [1] used LP relaxation techniques to yield a constant-time distributed algorithm for approximating the *minimum dominating set* (MDS) problem. It was the first distributed MDS approximation algorithm that achieves a nontrivial approximation ratio in a constant number of rounds. Another example for a result derived via a technique based on a distributed primal-dual approach for approximating a linear program is his paper [7] on facility location, discussed above.

Local distributed approximation. Wattenhofer focused attention on *local* distributed approximation, namely, distributed approximation algorithms that operate in *constant time*, and established a number of strong lower bounds on the approximation ratio achievable by such algorithms, thus contributing significantly to our understanding of locality. Two of his papers neatly illustrate this type of work. One is his PODC'06 paper with Kuhn on the complexity of distributed graph coloring [2], which considers coloring algorithms that run for a single communication round. The second is his PODC'04 paper with Kuhn and Moscibroda [3], which gives time lower bounds for the distributed approximation of *minimum vertex cover* (MVC) and minimum dominating set (MDS). This paper shows that an analog to the well-known greedy algorithm for approximating MVC within a factor 2 does not exist in the distributed local setting.

Relationships with relevant graph parameters. Wattenhofer explored the dependencies of approximability and inapproximability of central problems, such as coloring, MIS, and minimum dominating set (MDS), on relevant graph parameters. This contribution is illustrated by his most recent SIROCCO paper on distributed approximation, published in SIROCCO'11, together with Schneider [10]. This paper explores the dependencies of the complexity of distributed approximate coloring on the spectrum of maximum neighborhood sizes and the chromatic number of the graph at hand.

The above description covers just a sample from Wattenhofer's impressive list of results on distributed approximation. Some of his other notable contributions in this area are [4–6, 8, 9, 11].

Wattenhofer has published extensively in SIROCCO. In addition to [10], discussed above, he also published five strong papers in other areas of distributed computing and networking, unrelated to distributed approximation, including in particular rumor dissemination [13], sensor networks [14], routing [15], Peer to Peer networks [16], and distributed counting [17].

In summary, Wattenhofer's substantial and extensive work in the area of distributed approximation, along with his many other contributions to the field of distributed network algorithms at large, helped galvanizing the field and reviving it with new problems, refreshing viewpoints and novel powerful techniques.

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Distributed Complexity Theory

Roger Wattenhofer
Distributed Computing (DISCO)
ETH Zurich, 8092 Zurich, Switzerland
wattenhofer@ethz.ch

In the last decades our community has made tremendous progress towards understanding the complexity of distributed message passing algorithms. Given a network with n nodes and diameter D, we managed to established a rich selection of upper and lower bounds regarding how much time it takes to solve or approximate a problem. Currently we know five main distributed complexity classes:

- Strictly *local* problems can be solved in constant $\Theta(1)$ time, e.g. a constant approximation of a dominating set in a planar graph.
- Just a little bit slower are problems that can be solved in *log-star* $\Theta(\log^* n)$ time, e.g. many combinatorial optimization problems in special graph classes such as growth bounded graphs.
- A large body of problems is *polylogarithmic* (or *pseudo-local*), in the sense that they seem strictly local but are not, as they need $\Theta(\text{polylog } n)$ time, e.g. the maximal independent set problem.
- There are problems which are *global* and need $\Theta(D)$ time, e.g. to count the number of nodes in the network.
- Finally there are problems which need *polynomial* $\Theta(\text{poly } n)$ time, even if the diameter D is a constant, e.g. computing the diameter of the network.

In my talk I will introduce the message passing model, present a few selected results, mention prominent open problems, and discuss some of the most exciting future research directions.

Acknowledgments: I would like thank my former or current students for contributing significantly to the core of this theory, in chronological order: Fabian Kuhn, Thomas Moscibroda, Yvonne Anne Pignolet, Christoph Lenzen, Johannes Schneider, and Stephan Holzer.

No Piece Missing: Online Set Packing

Boaz Patt-Shamir
School of Electrical Engineering, Tel Aviv University, Tel Aviv, Israel

Abstract. We consider a scenario where large data frames are broken into a few packets and transmitted over the network. Our focus is on a bottleneck router: the model assumes that in each time step, a set of packets (a burst) arrives, from which only one packet can be served, and all other packets are lost. A data frame is considered useful only if none of its constituent packets is lost, and otherwise it is worthless. We abstract the problem as a new type of *online set packing*, present a randomized distributed algorithm and a nearly-matching lower bound on the competitive ratio for any randomized online algorithm. We show how the basic approach extends to various models, including cases with redundancy, buffering and others.
This talk is based on various papers co-authored with Yuval Emek, Magnus Halldòrsson, Yishay Mansour, Jaikumar Radhakrishnan and Dror Rawitz.

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