34th International Symposium on Distributed Computing

DISC 2020, October 12–16, 2020, Virtual Conference

Edited by

Hagit Attiya

Editors

Hagit Attiya
Technion, Haifa, Israel
hagit@cs.technion.ac.il

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Brief Announcements

Preface

DISC, the International Symposium on Distributed Computing, is an international forum on the theory, design, analysis, implementation and application of distributed systems and networks. DISC is organized in cooperation with the European Association for Theoretical Computer Science (EATCS).

This volume contains the papers presented at DISC 2020, the 34th International Symposium on Distributed Computing, held as a virtual event online on October 12–16, 2020. It also includes the citations for two awards jointly sponsored by DISC and the ACM Symposium on Principles of Distributed Computing (PODC):

- The *2020 Edsger W. Dijkstra Prize in Distributed Computing*, presented at PODC 2020, to Dana Angluin, James Aspnes, Zoë Diamadi, Michael J. Fischer, and René Peralta for their paper "Computation in networks of passively mobile finite-state sensors", *Distributed Computing*, volume 18, number 4, 2006, pages 235–253.
- The *2019 Principles of Distributed Computing Doctoral Dissertation Award*, presented at DISC 2020, to Yannic Maus for his dissertation "The Power of Locality: Exploring the Limits of Randomness in Distributed Computing", written under the supervision of Prof. Fabian Kuhn at the University of Freiburg and to Yi-Jun Chang for his dissertation "Locality of Distributed Graph Problems", written under the supervision of Prof. Seth Pettie at the University of Michigan.

Despite the COVID-19 pandemic, we received this year a record number of submissions in response to the call for papers: 170 regular paper submissions, and 15 brief announcement submissions. We had a program committee with 32 members, and the committee was assisted by 150 external reviewers. All submissions were evaluated by at least three reviewers; in total, 616 reviews were collected. The program committee used double-blind peer review: the submissions were anonymous and the PC members and external reviewers did not see the names of the authors. The program committee decided to accept 39 regular submissions (an acceptance rate of 23%) and 15 brief announcements for presentation at DISC 2020.

The committee selected the following paper as the recipient of the *DISC 2020 Best Paper Award*:

Improved Bounds for Distributed Load Balancing,
by Sepehr Assadi, Aaron Bernstein and Zachary Langley

and the following paper as the recipient of the *DISC 2020 Best Student Paper Award*:

Intermediate Value Linearizability: A Quantitative Correctness Criterion,
by Arik Rinberg and Idit Keidar

DISC 2020 Best Reviewer Award was presented to Michal Dory and Laurent Feuilloley.

Three workshops were held in conjunction with DISC 2020:

- ADGA: Workshop on Advances in Distributed Graph Algorithms
  (chair: Jara Uitto)
- CELLS: Computing among Cells
  (chairs: Matthias Fuegger, Manish Kushwaha and Thomas Nowak)
- Blockchain Sharding and Interoperability among Shards
  (chairs: Fatemeh Shirazi and Eleftherios Kokoris Kogias)

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A tutorial on TLA+ was given by Leslie Lamport and Stephan Merz.

I would like to thank all conference participants and everyone who contributed to DISC 2020: the authors of the submitted papers, PC members and external reviewers, keynote speakers, members of the organizing committee, workshop organizers, and members of the award committees. I would also like to thank the members of the steering committee, former chairs and many other members of the community for their valuable assistance and suggestions, EATCS for their financial support, and the staff at Schloss Dagstuhl – Leibniz-Zentrum für Informatik for the hard work they did with preparing these proceedings.

October 2020

Hagit Attiya
DISC 2020 Program Chair

Symposium Organization

DISC, the International Symposium on Distributed Computing, is an annual forum for presentation of research on all aspects of distributed computing. It is organized in cooperation with the European Association for Theoretical Computer Science (EATCS). The symposium was established in 1985 as a biannual International Workshop on Distributed Algorithms on Graphs (WDAG). The scope was soon extended to cover all aspects of distributed algorithms and WDAG came to stand for International Workshop on Distributed AlGorithms, becoming an annual symposium in 1989. To reflect the expansion of its area of interest, the name was changed to DISC (International Symposium on DIStributed Computing) in 1998, opening the symposium to all aspects of distributed computing. The aim of DISC is to reflect the exciting and rapid developments in this field.

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Sponsoring Organizations

DISC 2020 acknowledges the use of **HotCRP** for handling submissions and managing the review process, **LIPIcs** for producing and publishing the proceedings, and **Zulip** for providing virtual interaction space for conference participants.

DISC is organized in cooperation with the European Association for Theoretical Computer Science (EATCS)

Bronze sponsors for DISC 2020:

2020 Edsger W. Dijkstra Prize in Distributed Computing

The Edsger W. Dijkstra Prize in Distributed Computing is awarded for outstanding papers on the principles of distributed computing, whose significance and impact on the theory or practice of distributed computing have been evident for at least a decade. It is sponsored jointly by the ACM Symposium on Principles of Distributed Computing (PODC) and the EATCS Symposium on Distributed Computing (DISC). The prize is presented annually, with the presentation taking place alternately at PODC and DISC.

The committee decided to award the 2020 Edsger W. Dijkstra Prize in Distributed Computing to

Dana Angluin, James Aspnes, Zoë Diamadi, Michael J. Fischer, and René Peralta

for their paper:

Computation in networks of passively mobile finite-state sensors,
Distributed Computing 18(4): 235-253 (2006)

A preliminary version of this paper appeared in the proceedings of the *Twenty-Third Annual ACM Symposium Principles of Distributed Computing* (PODC), 2004, pages 290–299.

This seminal paper introduces and initiates the study of *population protocols*. The computational setting consists of agents whose resources are limited to a very small amount of memory and computational power. When two agents interact, they change their local states according to their previous local states through a simple transition function. This is arguably one of the simplest models of distributed computing yet, surprisingly, non-trivial predicates on the inputs of the agents can be computed. The paper defined the concept of stable computation of a function or predicate in the population model, showed that any predicate definable in Presburger arithmetic can be computed by a population protocol, and provided constructions for fundamental objects such as counters and timers in the probabilistic interaction model.

Through its novelty and technical quality, the paper of Angluin, Aspnes, Diamadi, Fischer and Peralta initiated an expansive new sub-field in distributed computing. Population protocols have revealed a rich landscape of algorithmic and lower bound techniques in the context of fundamental distributed computing tasks. An powerful aspect of this paper is in providing an elegant and concise model that faithfully captures a variety of real-world processes, ranging from wireless sensor networks, to gene regulatory networks and chemical reaction networks. This abstracts away much of the complexity of distributed computation in these settings, without shedding its non-trivial technical essence.

This foundational paper led to extensive follow-up work regarding the computation power of population protocols, their complexity costs, their application in dynamic networks, and their usage in chemical and biological systems. Closest to the thrust of the original paper is the investigation of the *computational power* of the population model. Extensive work studied how the amount of memory available to each agent affects the system's computational power, and whether *efficient* general computational constructions exist.

The paper also paved the way to investigating bounds for the computation of specific fundamental predicates, in terms of natural cost measures such as time and space. A flurry of progress in this area yielded tight or almost tight bounds for tasks such as majority, plurality,

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or leader election in population protocols. Several of these protocols relied on *epidemic* propagation of information. This work led to the discovery of new tools, in particular, at the boundary between distributed computing, randomized algorithms, and probability theory. In addition, the paper was one of the first to study computation in a dynamic network, whose topology is highly variable, and generally unpredictable. The resulting algorithmic theory of dynamic networks has since become a new and active research area in theoretical computer science.

Finally, population protocols also has had significant impact outside the traditional boundaries of distributed computing. For instance, the population protocol model has been shown in follow-up work to be formally equivalent, under technical conditions, to the classic *chemical reaction network* (CRN) model, while providing a much simpler interface. This has been a key contributing factor to the significant progress in this area in recent years. Moreover, the use of population protocols has had impact in the context of *DNA Computing and Molecular Programming*. In this recent and flourishing research area, population protocols are used to express molecular programs that are coded in synthetic DNA.

In summary, the pioneering work on population protocols introduced in this paper provided a general and elegant concept, created a new sub-field in distributed computing and has had an impact outside the distributed computing area.

Hagit Attiya (chair), *Technion*
Christian Cachin, *University of Bern*
Rachid Guerraoui, *EPFL*
Nancy Lynch, *MIT*
Yoram Moses, *Technion*
Paul Spirakis, *University of Liverpool* and *University of Patras*
Alex Schwarzmann, *Augusta University*

2020 Principles of Distributed Computing Doctoral Dissertation Award

The winners of the 2019 Principles of Distributed Computing Doctoral Dissertation Award are

Dr. Yi-Jun Chang for his dissertation *Locality of Distributed Graph Problems*, written under the supervision of Prof. Seth Pettie at the University of Michigan.

and

Dr. Yannic Maus for his dissertation *The Power of Locality: Exploring the Limits of Randomness in Distributed Computing*, written under the supervision of Prof. Fabian Kuhn at the University of Freiburg.

The theses of Dr. Chang and Dr. Maus have played a key role in the recent, rapid development of the theory of distributed graph algorithms and network computing. Both of the theses have significantly advanced our understanding of the distributed computational complexity of many key problems (e.g. graph coloring and splitting). In addition, they have made groundbreaking contributions to the development of distributed computational complexity theory in general.

These theses have introduced highly insightful concepts (e.g. the SLOCAL model) and new intriguing graph problems (e.g. hierarchical coloring), they have developed novel proof techniques (e.g. pumping arguments), and they have proved surprising results (e.g. gap theorems and completeness). Put together, they have dramatically changed the way in which researchers working in this field reason about distributed computational complexity. The theses have been a driving force in this research area, and the concepts and ideas introduced in these theses have already led to major breakthroughs.

The work presented in both dissertations has been published in a remarkably large number of papers, has been presented at top conferences, and has received wide recognition, including multiple best paper awards.

Due to the highly significant role these two theses have played in the development of the field of distributed computing, the award committee unanimously selected them as the winners of the 2020 Principles of Distributed Computing Doctoral Dissertation Award, presented at DISC 2020.

The award is sponsored jointly by the ACM Symposium on Principles of Distributed Computing (PODC) and the EATCS Symposium on Distributed Computing (DISC). It is presented annually, with the presentation taking place alternately at PODC and DISC.

2020 Award Committee:
Faith Ellen, *University of Toronto*
Pierre Fraigniaud, *CNRS and University Paris Diderot*
David Peleg (chair), *The Weizmann Institute*
Jukka Suomela, *Aalto University*

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