

# 32nd International Symposium on Distributed Computing

DISC 2018, October 15–19, New Orleans, Louisiana, USA

Edited by

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## 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 2018, the 32nd International Symposium on Distributed Computing, held on October 15–19, 2018 in New Orleans, USA. It includes the citation for the 2018 Edsger W. Dijkstra Prize in Distributed Computing, jointly sponsored by DISC and PODC (the ACM Symposium on Principles of Distributed Computing), that was presented at PODC 2018 to *Bowen Alpern* and *Fred B. Schneider* for their paper “*Defining Liveness*.” The volume also includes the citation for the 2018 Doctoral Dissertation Award, also jointly sponsored by DISC and PODC, that was presented at DISC 2018 to *Rati Gelashvili* for his PhD thesis titled “*On the Complexity of Synchronization*,” supervised by Nir Shavit at the Massachusetts Institute of Technology. DISC 2018 also featured three keynote lectures, presented by Sándor P. Fekete (TU Braunschweig, Germany) on “*Autonomous Vehicles: From Individual Navigation to Challenges of Distributed Swarms*,” Tom Goldstein (University of Maryland, USA) on “*Challenges for Machine Learning on Distributed Platforms*,” and Michael Mendler (Otto-Friedrich University of Bamberg, Germany) on “*Logical Analysis of Distributed Systems: The Importance of Being Constructive*.” An abstract of each keynote lecture is included in the proceedings.

Like DISC 2017, DISC 2018 received a very high number of submissions (161 regular papers and 4 brief announcements). Every submission was read and evaluated by at least three members of the PC, assisted by 172 external reviewers, using a refined reviewing process (outlined on page xix). The Program Committee finally selected 38 regular papers and 11 brief announcements for inclusion in the conference program and in the proceedings. Among the latter, 10 are the result of inviting the authors of rejected regular submissions to provide a brief announcement version of their work. Each of those summarizes ongoing work or recent results, which were considered interesting by the PC members and where it could be expected that these results will appear as full papers in later conferences or journals.

The Best Paper Award for DISC 2018 was shared by Gregory Chockler and Alexey Gotsman for their paper “*Multi-Shot Distributed Transaction Commit*,” and Ali Mashreghi and Valerie King for their paper “*Broadcast and Minimum Spanning Tree with  $o(m)$  Messages in the Asynchronous CONGEST Model*.” Unfortunately, the authors of the nominated best student paper had to withdraw their submission at the very last moment. Revised and expanded versions of several additional selected regular papers will be considered for publication in a special issue of the journal *Distributed Computing*.

Two workshops were co-located with DISC 2018: The *7th Workshop on Advances in Distributed Graph Algorithms (ADGA)*, chaired by Merav Parter, on October 15, 2018, and the *2nd Workshop on Storage, Control, Networking in Dynamic Systems (SCNDS)*, organized by Kishori Konwar and Lewis Tseng, on October 19, 2018.

We wish to thank the many contributors to DISC 2018: the authors of the submitted papers, the PC members and the reviewers, the three keynote speakers, the conference general chair and local organizer Costas Busch, the publicity chair Peter Robinson, the proceedings

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chair Josef Widder, the web chair Wyatt Clements, all the workshop organizers led by the workshop chair Gokarna Sharma, and the DISC Steering Committee, led by Yoram Moses, for its guidance. Special thanks go to Andréa W. Richa, the PC chair of DISC 2017, for her invaluable support, and to Roman Kuznets for providing EasyChair expertise.

October 2018

Ulrich Schmid  
DISC 2018 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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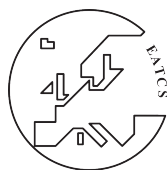
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## ■ 2018 Edsger W. Dijkstra Prize in Distributed Computing

The Edsger W. Dijkstra Prize in Distributed Computing was created to acknowledge 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. The Prize is sponsored jointly by the ACM Symposium on Principles of Distributed Computing (PODC) and the EATCS Symposium on Distributed Computing (DISC). This award is presented annually, with the presentation taking place alternately at PODC and DISC. The 2018 Edsger W. Dijkstra Prize in Distributed Computing has been presented at PODC 2018 at the Royal Holloway University, London, UK.

The 2018 Award Committee, composed of Ulrich Schmid (Chair), Yehuda Afek, Idit Keidar, Boaz Patt-Shamir, Sergio Rajsbaum and Gadi Taubenfeld, has selected

**Bowen Alpern and Fred B. Schneider**

to receive the 2018 Edsger W. Dijkstra Prize in Distributed Computing for the outstanding paper:

Bowen Alpern and Fred B. Schneider:

**Defining liveness.**

Information Processing Letters 21(4),

October 1985, pages 181–185.

Concurrent and distributed algorithms today are characterized in terms of safety (“bad things” do not happen) and liveness (“good things” do happen). This seminal paper is what gave semantic legitimacy to that decomposition. Safety and liveness for concurrent programs had been suggested earlier by Lamport, but liveness was only formally defined for the first time in the winning paper, where it was accompanied by a compelling justification—that every (what we today call a) “trace property” is the conjunction of a safety and a liveness property. The liveness definition and accompanying decomposition theorem thus establish that safety and liveness are not only intuitively appealing but are also formally orthogonal. As a consequence, they constitute the basic building blocks of all (trace) properties and thus underlie a substantial number of papers that appeared at PODC and DISC so far.

Moreover, subsequent work has shown that invariants suffice for verifying safety properties and that variant functions on well-founded domains are suitable for verifying liveness properties. So, of the possible ways to decompose properties, the decomposition into safety and liveness provides the added value of also suggesting approaches for verifying each property. Further evidence of the importance of this work is that its topological characterizations and decomposition proof have since been scaled-up to safety and liveness hyperproperties, which express confidentiality and other important correctness concerns that trace properties cannot.

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## ■ 2018 Principles of Distributed Computing Doctoral Dissertation Award

The winner of the 2018 Principles of Distributed Computing Doctoral Dissertation Award is **Dr. Rati Gelashvili**, for his dissertation titled “**On the Complexity of Synchronization,**” written under the supervision of Prof. Nir Shavit at the Massachusetts Institute of Technology.

The field of distributed algorithms revolves around efficiently solving synchronization tasks, such as leader election and consensus in different models. Gelashvili’s thesis provides an extraordinary study of the complexity of solving synchronization tasks, which is both deep and broad. It makes significant contributions towards understanding the complexity of solving synchronization tasks in various models. In particular, it pushes the boundary of our understanding of consensus, the algorithmic process by which asynchronous computation threads coordinate with each other, which has been the subject of extensive research for over 30 years.

In one part of his thesis, Gelashvili challenges the underpinnings of Herlihy’s consensus-based computability hierarchy, which has been the theoretical basis for classifying the computational power of concurrent data structures and synchronization primitives in multiprocessors and multicore machines for two and a half decades. He observes that Herlihy’s classical hierarchy treats synchronization instructions as distinct objects, an approach that is far from the real-world, where multiprocessors do let processes apply supported atomic instructions to arbitrary memory locations. Gelashvili shows that, contrary to common belief, solving consensus does not require multicore architectures to support “strong” synchronization instructions such as compare-and-swap. Rather, combinations of “weaker” instructions such as decrement and multiply suffice. He goes on to propose an alternative complexity-based hierarchy for concurrent objects. The dissertation further opens a new line of research by proving a linear-space bound for the anonymous case of randomized consensus, the first major progress on this problem in 15 years, which won the Best Paper Award at DISC 2015, and for which Gelashvili developed novel lower bound techniques. Apart from their great importance, these results are also technically complex and mathematically beautiful.

**The award.** The Principles of Distributed Computing Doctoral Dissertation 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. The 2018 award has been presented at DISC 2018, New Orleans, USA.

The 2018 Principles of Distributed Computing Doctoral Dissertation Award Committee:

- Lorenzo Alvisi, Cornell
- Idit Keidar (chair), Technion
- Andréa W. Richa, ASU
- Alex Schwarzmann, UConn





## ■ Details of the DISC'18 Reviewing Process

Since DISC 2018 was expected to get a similar number of submissions as DISC 2017, a large PC consisting of 39 distinguished members of the community was formed in an attempt to sufficiently cover all the 17 topics specifically addressed in the call for papers. In addition, stimulated by concerns with the reviewing process used at DISC and PODC in the past<sup>1</sup>, a number of quality-enhancing measures were foreseen for DISC 2018.

Besides enforcing the requirement for self-contained submissions (15 pages LIPICs, without references) by disallowing appendices but encouraging full versions on publicly accessible archives like arXiv or HAL, which facilitates a fair comparison of submissions given the tight reviewing time constraints, the following measures were implemented:

- (i) To facilitate effective paper bidding, EasyChair's ability to match the selected topics of the submissions with the selected topics of expertise of the PC members was used to generate an initial bidding proposal for every PC member that could be modified during the actual paper bidding phase. The result of the bidding phase allowed EasyChair to find an optimal paper assignment (3 reviewers per submission) in a single assignment run, in negligible time.
- (ii) In order not to rule out the most competent reviewers for a submission by an overly restrictive conflict of interest policy, prohibitive CoI (like supervisor or personal relations, to be declared during bidding as usual) that forbid any access to the reviewing process, and milder forms of CoI (like occasional co-authorship, to be declared in the "comments to the PC section" of the reviews) were distinguished.
- (iii) A reviewing process with two intermediate reviews before the final review was enforced. The first intermediate review just asked for the reviewers' actual expertise for reviewing the assigned papers [1 week after paper assignment], the second intermediate review asked for an estimate of the overall merit figure (and optionally major strengths and weaknesses) [3 weeks after paper assignment]. The intermediate reviews were used to assign additional PC members/reviewers to submissions that either did not have at least 2 reviewers with expertise 3 ("knowledgable") or 4 ("expert"), or suffered from controversial merit figure estimates (a difference larger or equal to 3, from knowledgable reviewers). At the end, 50 (resp. 3) submissions ended up with 4 (resp. 5) reviewers.
- (iv) The full reviews were due 6 weeks after paper assignment, which allowed 3 weeks of discussion before the PC meeting. During paper discussion, the reviewers of a submission were supposed to either (i) resolve controversial merit figures or (ii) to determine both a proponent and an opponent is willing to make his/her case for/against the submission in the PC meeting. At the end, only 8 submissions did not fall under (i) and thus needed to be dealt with in the PC meeting.
- (v) The PC meeting (July 9–10, 2018) was set up as a virtual one using Adobe Connect. As there were only few submissions up for discussion, each of those was assigned a fixed time slot where all interested PC members could join. Depending on the outcome of the discussion, either the controversial scores were appropriately modified or additional reviews were provided.

As a result, 23 submissions ended up with an average expertise-weighted score of at least 1.7, which has been set as the threshold for a "safe accept" (at least two "accept")

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<sup>1</sup> Also raised explicitly by a group of members of the community in the DISC 2017 business meeting.

and no reject), and 16 submissions with an average expertise-weighted score of at least 1.3, which has been set as the threshold for a “possible accept” (at least one “accept” and no reject). The PC eventually decided to accept all these submissions as full papers, and to invite all authors of 25 submissions with an average expertise-weighted score of at least 0.3 (at least two weak accepts) to submit a brief announcement version of their work. Ultimately, 11 accepted this invitation and submitted a brief announcement, all of which were finally accepted after a short round of additional reviewing.