

38th International Symposium on Distributed Computing

DISC 2024, October 28–November 1, 2024, Madrid, Spain

Edited by

Dan Alistarh



Editors

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■ Contents

Preface	
<i>Dan Alistarh</i>	0:ix–0:x
Organization	
.....	0:xi–0:xiii
Distinguished Paper Awards	
.....	0:xv
2024 Principles of Distributed Computing Doctoral Dissertation Awards	
.....	0:xvii–0:xviii
2024 Edsger W. Dijkstra Prize in Distributed Computing	
.....	0:xix

Regular Papers

Fully Local Succinct Distributed Arguments	
<i>Eden Aldema Tshuva and Rotem Oshman</i>	1:1–1:24
A Knowledge-Based Analysis of Intersection Protocols	
<i>Kaya Alpturer, Joseph Y. Halpern, and Ron van der Meyden</i>	2:1–2:17
Byzantine Resilient Distributed Computing on External Data	
<i>John Augustine, Jeffin Biju, Shachar Meir, David Peleg, Srikanth Ramachandran, and Aishwarya Thiruvengadam</i>	3:1–3:23
Almost Optimal Algorithms for Token Collision in Anonymous Networks	
<i>Sirui Bai, Xinyu Fu, Xudong Wu, Penghui Yao, and Chaodong Zheng</i>	4:1–4:20
Asynchronous Fault-Tolerant Distributed Proper Coloring of Graphs	
<i>Alkida Balliu, Pierre Fraigniaud, Patrick Lambein-Monette, Dennis Olivetti, and Mikaël Rabie</i>	5:1–5:20
Speedup of Distributed Algorithms for Power Graphs in the CONGEST Model	
<i>Leonid Barenboim and Uri Goldenberg</i>	6:1–6:23
A Fully Concurrent Adaptive Snapshot Object for RMWable Shared-Memory	
<i>Benyamin Bashari, David Yu Cheng Chan, and Philipp Woelfel</i>	7:1–7:22
Hyperproperty-Preserving Register Specifications	
<i>Yoav Ben Shimon, Ori Lahav, and Sharon Shoham</i>	8:1–8:19
Freeze-Tag in L_1 Has Wake-Up Time Five with Linear Complexity	
<i>Nicolas Bonichon, Arnaud Casteigts, Cyril Gavoille, and Nicolas Hanusse</i>	9:1–9:16
Vertical Atomic Broadcast and Passive Replication	
<i>Manuel Bravo, Gregory Chockler, Alexey Gotsman, Alejandro Naser-Pastoriza, and Christian Roldán</i>	10:1–10:19
What Cannot Be Implemented on Weak Memory?	
<i>Armando Castañeda, Gregory Chockler, Brijesh Dongol, and Ori Lahav</i>	11:1–11:22

38th International Symposium on Distributed Computing (DISC 2024).

Editor: Dan Alistarh



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Faster Cycle Detection in the Congested Clique <i>Keren Censor-Hillel, Tomer Even, and Virginia Vassilevska Williams</i>	12:1–12:18
Deterministic Self-Stabilising Leader Election for Programmable Matter with Constant Memory <i>Jérémie Chalopin, Shantanu Das, and Maria Kokkou</i>	13:1–13:17
Efficient Signature-Free Validated Agreement <i>Pierre Civi, Muhammad Ayaz Dzulfikar, Seth Gilbert, Rachid Guerraoui, Jovan Komatovic, Manuel Vidigueira, and Igor Zablotchi</i>	14:1–14:23
Convex Consensus with Asynchronous Fallback <i>Andrei Constantinescu, Diana Ghinea, Roger Wattenhofer, and Floris Westermann</i>	15:1–15:23
A Simple Computability Theorem for Colorless Tasks in Submodels of the Iterated Immediate Snapshot <i>Yannis Coutouly and Emmanuel Godard</i>	16:1–16:22
Breaking Through the $\Omega(n)$ -Space Barrier: Population Protocols Decide Double-Exponential Thresholds <i>Philipp Czerner</i>	17:1–17:18
On the Limits of Information Spread by Memory-Less Agents <i>Niccolò D’Archivio and Robin Vacus</i>	18:1–18:21
Parallel Set Cover and Hypergraph Matching via Uniform Random Sampling <i>Laxman Dhulipala, Michael Dinitz, Jakub Łącki, and Slobodan Mitrović</i>	19:1–19:23
The Computational Power of Discrete Chemical Reaction Networks with Bounded Executions <i>David Doty and Ben Heckmann</i>	20:1–20:15
Broadcast and Consensus in Stochastic Dynamic Networks with Byzantine Nodes and Adversarial Edges <i>Antoine El-Hayek, Monika Henzinger, and Stefan Schmid</i>	21:1–21:15
On the Power of Graphical Reconfigurable Circuits <i>Yuval Emek, Yuval Gil, and Noga Harlev</i>	22:1–22:16
Lock-Free Augmented Trees <i>Panagiota Fatourou and Eric Ruppert</i>	23:1–23:24
Decentralized Distributed Graph Coloring II: Degree+1-Coloring Virtual Graphs <i>Maxime Flin, Magnús M. Halldórsson, and Alexandre Nolin</i>	24:1–24:22
Distributed Model Checking on Graphs of Bounded Treedepth <i>Fedor V. Fomin, Pierre Fraigniaud, Pedro Montealegre, Ivan Rapaport, and Ioan Todinca</i>	25:1–25:20
Content-Oblivious Leader Election on Rings <i>Fabian Frei, Ran Gelles, Ahmed Ghazy, and Alexandre Nolin</i>	26:1–26:20
Sorting in One and Two Rounds Using t -Comparators <i>Ran Gelles, Zvi Lotker, and Frederik Mallmann-Trenn</i>	27:1–27:20
Self-Stabilizing MIS Computation in the Beeping Model <i>George Giakkoupis, Volker Turau, and Isabella Ziccardi</i>	28:1–28:21

Massively Parallel Ruling Set Made Deterministic <i>Jeff Gliberti and Zahra Parsaeian</i>	29:1–29:21
Granular Synchrony <i>Neil Giridharan, Ittai Abraham, Natacha Crooks, Kartik Nayak, and Ling Ren</i> ...	30:1–30:22
Distributed Delta-Coloring Under Bandwidth Limitations <i>Magns M. Halldrsson and Yannic Maus</i>	31:1–31:22
Quantum Byzantine Agreement Against Full-Information Adversary <i>Longcheng Li, Xiaoming Sun, and Jiadong Zhu</i>	32:1–32:22
Communication Requirements for Linearizable Registers <i>Raissa Nataf and Yoram Moses</i>	33:1–33:17
Single Bridge Formation in Self-Organizing Particle Systems <i>Shunhao Oh, Joseph L. Briones, Jacob Calvert, Noah Egan, Dana Randall, and Andra W. Richa</i>	34:1–34:22
Memory Lower Bounds and Impossibility Results for Anonymous Dynamic Broadcast <i>Garrett Parzych and Joshua J. Daymude</i>	35:1–35:18
Connectivity Labeling in Faulty Colored Graphs <i>Asaf Petruschka, Shay Spair, and Elad Tzalik</i>	36:1–36:22
Sing a Song of Simplex <i>Victor Shoup</i>	37:1–37:22
Near-Linear Time Dispersion of Mobile Agents <i>Yuichi Sudo, Masahiro Shibata, Junya Nakamura, Yonghwan Kim, and Toshimitsu Masuzawa</i>	38:1–38:22
The Power of Abstract MAC Layer: A Fault-Tolerance Perspective <i>Qinzi Zhang and Lewis Tseng</i>	39:1–39:22

Brief Announcements

Brief Announcement: Distributed Maximum Flow in Planar Graphs <i>Yaseen Abd-Elhaleem, Michal Dory, Merav Parter, and Oren Weimann</i>	40:1–40:8
Brief Announcement: Towards Optimal Communication Byzantine Reliable Broadcast Under a Message Adversary <i>Timoth Albouy, Davide Frey, Ran Gelles, Carmit Hazay, Michel Raynal, Elad Michael Schiller, Franois Taiani, and Vassilis Zikas</i>	41:1–41:7
Brief Announcement: Solvability of Three-Process General Tasks <i>Hagit Attiya, Pierre Fraigniaud, Ami Paz, and Sergio Rajsbaum</i>	42:1–42:7
Brief Announcement: Unifying Partial Synchrony <i>Andrei Constantinescu, Diana Ghinea, Jakub Sliwinski, and Roger Wattenhofer</i> ..	43:1–43:7
Brief Announcement: The Expressive Power of Uniform Population Protocols with Logarithmic Space <i>Philipp Czermer, Vincent Fischer, and Roland Guttenberg</i>	44:1–44:7

Brief Announcement: Best-Possible Unpredictable Proof-Of-Stake <i>Lei Fan, Jonathan Katz, Zhenghao Lu, Phuc Thai, and Hong-Sheng Zhou</i>	45:1–45:7
Brief Announcement: Optimal Uniform Circle Formation by Asynchronous Luminous Robots <i>Caterina Feletti, Debasish Pattanayak, and Gokarna Sharma</i>	46:1–46:7
Brief Announcement: Agreement Tasks in Fault-Prone Synchronous Networks of Arbitrary Structures <i>Pierre Fraigniaud, Minh Hang Nguyen, and Ami Paz</i>	47:1–47:5
Brief Announcement: Distinct Gathering Under Round Robin <i>Fabian Frei and Koichi Wada</i>	48:1–48:8
Brief Announcement: Decreasing Verification Radius in Local Certification <i>Jan Matyáš Křišťan and Josef Erik Sedláček</i>	49:1–49:6
Brief Announcement: Agent-Based Leader Election, MST, and Beyond <i>Ajay D. Kshemkalyani, Manish Kumar, Anisur Rahaman Molla, and Gokarna Sharma</i>	50:1–50:7
Brief Announcement: Clock Distribution with Gradient TRIX <i>Christoph Lenzen and Shreyas Srinivas</i>	51:1–51:7
Brief Announcement: Reconfigurable Heterogeneous Quorum Systems <i>Xiao Li and Mohsen Lesani</i>	52:1–52:8
Brief Announcement: Concurrent Aggregate Queries <i>Gal Sela and Erez Petrank</i>	53:1–53:7
Brief Announcement: Colorless Tasks and Extension-Based Proofs <i>Yusong Shi and Weidong Liu</i>	54:1–54:6
Brief Announcement: Self-Stabilizing Graph Exploration by a Single Agent <i>Yuichi Sudo, Fukuhito Ooshita, and Sayaka Kamei</i>	55:1–55:7

■ Preface

DISC 2024, the 38th International Symposium on Distributed Computing, was held between October 28th and November 1st, 2024, in Madrid, Spain. DISC is an international forum on the theory, design, analysis, and implementation of distributed systems and networks, focusing on distributed computing. DISC is organized in cooperation with the European Association for Theoretical Computer Science (EATCS).

Statistics

DISC 2024 received 170 submissions in the “regular paper” category, and 9 submissions in the “brief announcement” category. The program was selected by a program committee consisting of 37 full members and 2 half-load members. The program committee was assisted by 111 external reviewers. As usual for DISC, the committee used a relaxed form of double-blind reviewing, where the submissions themselves were anonymous, but authors were permitted to disseminate their work by uploading it to online repositories or by giving talks about it. Each submission was evaluated by at least three reviewers, and final decisions were made during a 2-day virtual PC meeting, during which approximately 30 submissions were discussed.

The final statistics are as follows:

- 39 submissions were accepted as regular papers, for an acceptance rate of $\sim 23\%$;
- 16 brief announcements were accepted, of which two were submitted in this form, and 14 are short versions of full paper submissions.

The keynote talks at DISC 2024 were given by Stephanie Gil (Harvard University), Stefan Schmid (TU Berlin), and by Gauri Joshi (Carnegie Mellon University).

Awards

The following two awards are jointly sponsored by DISC and the ACM Symposium on Principles of Distributed Computing (PODC):

- The **2024 Edsger W. Dijkstra Prize in Distributed Computing** was awarded to Nicola Santoro and Peter Widmayer for their paper: “Time is Not a Healer” which originally appeared in the Proceedings of the 6th Annual Symposium on Theoretical Aspects of Computer Science (STACS), pages 304–313, 1989. The paper introduced the fundamental notion of dynamic transmission faults, with the goal of modeling message losses on a communication channel, in an otherwise synchronous system. As such, it was the first to investigate the impact of a changing communication topology during the execution of the algorithm on the solvability of distributed agreement tasks, enriching our understanding of this area, and leading to significant follow-up work. The prize was awarded to the authors at PODC 2024 in Nantes.
- The **2024 Principles of Distributed Computing Doctoral Dissertation Award** was presented at DISC 2024. The committee decided to share the award between two recipients: Dr. Robin Vacus for his dissertation “Algorithmic Perspectives to Collective Natural Phenomena,” and Dr. Yaunhao Wei for his dissertation “General Techniques for Efficient Concurrent Data Structures.”



This volume also includes the citations the best paper and best student paper awards at DISC 2024, as well as the citations for the 2024 Edsger W. Dijkstra Prize in Distributed Computing, which was presented at PODC 2024, and for the Best Dissertation Awards, which were presented at DISC 2024.

Acknowledgments

I would like to end by wholeheartedly thanking everyone who contributed to this edition of DISC: the authors who submitted their work to DISC, the PC members and external reviewers who helped formed the DISC 2024 program, the keynote speakers, the organizing committee, and in particular the local chair Alexey Gotsman, the workshop chairs, and the members of the award committees. Further, I would like to thank Joel Rybicki for help with the proceedings, John Lazarsfeld for help running the program committee meeting, and William Moses, Jr. for handling DISC 2024 publicity.

I am also extremely grateful to all the members of the steering committee, who supported me significantly throughout the process, and to former chairs of DISC, in particular Rotem Oshman, who provided extremely useful practical information and advice. Finally, I would like to thank EATCS for their support, and the staff Schloss Dagstuhl – Leibniz-Zentrum für Informatik for their help in preparing these proceedings.

November 2024

Dan Alistarh
DISC 2024 Program Chair

■ Organization

The International Symposium on Distributed Computing (DISC), is an annual forum for the 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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DISC 2024 acknowledges the use of HotCRP for handling submissions and managing the review process and LIPIcs for producing and publishing the proceedings.



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

■ Distinguished Paper Awards

Best Papers

The DISC Program Committee has selected the following two papers to share the DISC 2024 best paper award:

Hyperproperty-Preserving Register Specifications

by Yoav Ben Shimon, Ori Lahav, and Sharon Shoham.

Reasoning about hyperproperties of concurrent implementations, such as the guarantees these implementations provide to “client” programs, has been a central area in distributed computing. This paper makes significant contributions to this area by introducing novel concepts such as “complete” implementations and “decisive linearizability.” The authors provide a comprehensive framework for understanding and analyzing the preservation of hyperproperties in shared object implementations, extending beyond traditional linearizability. This research opens up new avenues for simplifying reasoning about concurrent systems and their complex behaviors. The paper’s clear presentation, technical depth, and potential for far-reaching impact in both theory and practice make it a standout contribution to this year’s program. This work also receives this year’s Best Student Paper award.

Lock-Free Augmented Trees

by Panagiota Fatourou and Eric Ruppert.

The paper introduces an elegant and efficient method for maintaining aggregate information in concurrent tree data structures, addressing a critical challenge in parallel computing. The authors’ ingenious propagation technique enables the augmentation of both static and dynamic tree structures with powerful query capabilities while preserving lock-free concurrency and linearizability. The work demonstrates the technique’s applicability to tries and binary search trees, rigorously proving its correctness and efficiency. The work could have significant impact on both theoretical and practical aspects of concurrent programming.



■ 2024 Principles of Distributed Computing Doctoral Dissertation Awards

The committee for the 2024 Principles of Distributed Computing Doctoral Dissertation Award decided to share the award between two recipients:

- Dr. Robin Vacus for his dissertation “Algorithmic Perspectives to Collective Natural Phenomena.”
- Dr. Yaunhao Wei for his dissertation “General Techniques for Efficient Concurrent Data Structures.”

Dr. Vacus’s Dissertation

Dr. Vacus completed his PhD under the supervision of Amos Korman and Pierre Fraigniaud, at the Université Paris Cité. His thesis applies a distributed systems approach to problems and models inspired by biology and sociology. The first part of the thesis considers solutions to two agreement-related problems in a setting in which agents have very limited resources, as one would expect in an algorithm that may be executed by animals or even biological cells. It starts by studying a “bit dissemination” problem in which the agents need to decide among two alternatives. Each starts with an opinion but only one of the agents knows the correct choice and will insist on it. Agents exchange opinions with a small sample of peers. The analysis shows an exponential gap between convergence times in the case in which agents move simultaneously vs. moving sequentially, and a similar gap between memoryless solutions and ones that employ strong separation between the simultaneous and the sequential activation models, and between memory-less solutions and ones in which agents use a small amount of memory. The next problem tackled in this part involves a continuous setting, in which agents try to come as close to their center of mass as possible, while they suffer from Gaussian drift over time and from noisy distance measurements. Somewhat unexpectedly, it is shown that an algorithm using all-to-all communication is not significantly better than one that employs no communication whatsoever. The second part of the thesis considers the role and impact of altruism vs free riding on cooperation in a game-theoretic setting. In one game, it is shown that players’ motivation to work to increase their payoffs can sometimes be positively affected by the amount of easily accessible resources (“low hanging fruit”), while in other cases it may be negatively correlated to that amount. The final question studied in the thesis is a variant of the “tragedy-of-the-commons” in which besides cooperating or defecting players may opt to behave hypocritically, meaning that they perform the least amount of work needed in order to appear to be cooperating. An original mechanism that uses moderate social pressure on non-cooperators is shown to cause defectors to be more cooperative. Dr. Vacus’ thesis provides an inspiring overview of the questions studied, and employs a wide range of tools and techniques, involving probabilistic analysis, control theory, statistics and game theory, and computer simulations.

Dr. Wei’s Dissertation

Dr. Wei completed his PhD under the supervision of Prof. Guy E. Blelloch, at CMU. In his thesis, Dr. Wei proposes general techniques for improving existing concurrent data structures by simplifying their design and enhancing their performance. The goal of the thesis is to offer techniques that are easy to use to non-experts, even though their implementation

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behind-the-scenes is complicated and subtle. The techniques presented in the thesis are: (a) Lock-free locks, an automated and general method for converting lock-based concurrent code into lock-free code, requiring no involvement from the programmer; (b) Consistent snapshots: a method for enriching any data structure with a linearizable snapshot operation, which provides a global copy of the state of the object as it existed at some point during the snapshot operation; and (c) Safe memory reclamation: a combination of manual safe-memory reclamation and automated reference counting, which is simpler than existing techniques, and is shown to be competitive in its performance. The thesis also includes implementations and a rigorous empirical evaluation of the techniques it contributes, including applications to a variety of concurrent data structures. The implementations are offered as libraries which are freely available to the public. Given the growing importance of concurrency, and the well-known difficulty of writing correct and efficient concurrent code, the thesis is well-poised to find practical impact in the programming world.

The 2024 Principles of Distributed Computing Doctoral Dissertation Award Committee:
Magnús M. Halldórsson, Reykjavik University
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Paul Spirakis, University of Liverpool and University of Patras

■ 2024 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 2024 Edsger W. Dijkstra Prize in Distributed Computing to **Nicola Santoro** and **Peter Widmayer** for their paper:

“Time is Not a Healer”

appearing in

Proceedings of the 6th Annual Symposium on Theoretical Aspects of Computer Science,
pages 304–313, 1989.

The paper introduced the fundamental notion of dynamic transmission faults, with the goal of modeling message losses on a communication channel, in an otherwise synchronous system. As such, it was the first to investigate the impact of a changing communication topology during the execution of the algorithm on the solvability of distributed agreement tasks, complementing the classic processor crash fault model.

Beyond this modeling contribution, the paper also showed, via an elegant proof, the surprising technical fact that, in a system with sufficiently many dynamic transmission faults, a weak version of the Consensus problem is “either trivial or impossible.” More precisely, Consensus is unsolvable in a synchronous system if an adversary is able to cause up to $n - 1$ messages to be lost in every communication round. This illustrated, for the first time, that the impossibility of Consensus can be also caused by insufficient communication, rather than just the lack of synchrony.

These insights have been very impactful over time, highlighting the connection between the communication topology and the computational power of a distributed system. In turn, the paper has had broad influence across diverse areas such as fault-tolerance, agreement problems, dynamic communication networks, and even topological understanding of distributed computing. The paper has also become a classic text thanks to its excellent exposition.

In summary, the seminal paper by Santoro and Widmayer combines original conceptual contributions with deep theoretical insights, and stands out as a significant stepping stone in our theoretical understanding of distributed computing.

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