

Annual Report 2023



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1 Introduction

The Icelandic Centre of Excellence in Theoretical Computer Science (ICE-TCS) has been active since its establishment on 29 April 2005. This eighteenth annual report provides an overview of the activities of the centre during 2023.

This annual report focuses on a selection of the main highlights of yet another busy year for ICE-TCS. We refer our readers to the data collected at the [centre's web page](#) for full details. In particular, the news archive for the first six months in the reporting year is at <http://icetcs.ru.is/news.html>.

2 Executive Summary and Highlights for the Reporting Period

The quality and impact of the research carried out by the members of the centre in 2023 is witnessed by the following main achievements.

- The algorithms group at ICE-TCS continued its quest for fast distributed algorithms for graph colouring. The focus was on matching the known ultra-fast algorithms but operating in as restricted models of computation as possible. This research effort resulted in papers in SODA, SPAA, SIROCCO, and DISC in 2023, as well as in SODA in January 2024.
- The combinatorics group submitted a monograph on its Combinatorial Exploration framework to a prestigious outlet and published journal articles on the so-called mesh

patterns in permutations. In particular, one of those articles studied when two mesh patterns describe the same collection of permutations (paper in Information and Computation) and another showed that Foata's fundamental transformation can be used to turn cycle restrictions into mesh patterns (paper in Discrete Mathematics).

- The concurrency and logic in computer science group at ICE-TCS continued its work on model-learning algorithms based on expectation maximisation, on the foundations of runtime monitoring and on descriptive complexity. Highlights from work carried out in the reporting period include the development of a minorization–maximisation algorithm to estimate parameters in continuous-time Markov chains (paper at QEST 2023), several logical characterisations of counting complexity classes (paper at MFCS 2023) and runtime enforcement for data-driven systems (journal papers in Acta Informatica and Logical Methods in Computer Science). The group also released [Jajapy](#), a learning library for stochastic models, and a version of the runtime-verification tool [detectEr](#) for linear-time properties. Both tools are open source.
- The programming language theory group worked on modal-logical explanations of call-by-value vs. call-by-name, on a foundational framework for bidirectional data-flow analyses, and on concurrent monads, to mention a few topics. The research on concurrent monads was done together with Flavien Breuvert from LIPN who visited for 1.5 months in August–October 2023. Dylan McDermott and his collaborator Nathanael Arkor wrote two substantial papers (85 and 22 pages, respectively) on the (formal) theory of relative monads, resulting partially from Nathanael's visit to Reykjavik in November 2022. Those papers are currently under review.

As in previous years, ICE-TCS researchers organised high-quality scientific meetings at Reykjavik University and elsewhere, increasing the international visibility of the centre and of Reykjavik University as a whole. To wit, we mention the following events (in reverse chronological order):

- In the period 18–20 September 2023, Antonis Achilleos co-chaired the [Fourteenth International Symposium on Games, Automata, Logics, and Formal Verification, GandALF 2023](#), in Udine, Italy.
- ICE-TCS turned 18 at the end of April 2023. This anniversary was celebrated with a series of talks by distinguished guests, including Marta Kwiatkowska (University of Oxford, UK), Mohammad Reza Mousavi (King's College, UK), Roberta Sinatra (University of Copenhagen and IT University Copenhagen, Denmark), Michael Szell (IT University Copenhagen, Denmark) and Sanjit A. Seshia (UC Berkeley, USA).
- On 23 May 2023, on behalf of ICE-TCS, Luca Aceto organised a workshop on formal methods for secure systems. Speakers at that event included Musard Balliu (KTH), Rosario Giustolisi (ITU Copenhagen), Roberto Guanciale (KTH), Sebastian Mödersheim (DTU) and Stephen D. Wolthusen (Royal Holloway and NTNU). More details are available [here](#).

The following invited talks, courses and seminars, listed in reverse chronological order, were delivered by members of the centre in 2023:

- Tarmo Uustalu gave a seminar talk at the University of Nottingham in November 2023, entitled “Additive cellular automata graded-monadically”.
- Dylan McDermott gave a talk at the University of Minho in October 2023, entitled “Flexible presentations of graded monads”.
- Luca Aceto delivered a talk at IMT Lucca in September 2023, entitled “In search of lost time: Axiomatising parallel composition in process algebras.” He also gave a talk for PhD students and young researchers entitled “Unveiling the Ivory Tower: The academic’s art of work.”
- Magnús Halldórsson gave an invited spotlight talk at WOLA (Workshop on Local Algorithms) in August 2023 at MIT, titled “Space-constrained Distributed Locality: The Case of Graph Coloring”.
- Magnús Halldórsson gave an invited talk at OPAL ‘23 (International Conference on Online Algorithms) in June 2023, titled “Graph coloring: Connecting semi-online algorithms to new algorithmic paradigms”.
- Tarmo Uustalu gave an invited talk at CLoCK-68 (68th Cracow Logic Conference) in June 2023, entitled “The proof theory of skew logics”
- Magnús Halldórsson gave a talk at RIMS, Kyoto University, titled “Distributed graph coloring: The loglog-revolution”, in April 2023.

According to our records, in 2023, ICE-TCS hosted [26 guests](#) for stays ranging from a few days to four weeks. Most of the guests delivered a seminar in the [ICE-TCS seminar series](#), which consisted of 23 seminars in the reporting period. At the time of writing the ICE-TCS seminar series has hosted 415 talks since the establishment of the centre.

ICE-TCS researchers have also continued to serve the community in a variety of leading roles. By way of example, we limit ourselves to mentioning that

- Magnús Halldórsson chaired the program committee for the PODC (ACM Principles of Distributed Computing) conference in 2023. He also chaired the award committee for the 2023 Dijkstra prize, which is given for outstanding papers on the principles of distributed computing. He completed his term of chairing the steering committee of SIROCCO in June 2023, but remains a member of the steering committees of PODC, ALGOSENSORS, DCOSS, WADS, and SWAT. He was a PC member of OPODIS 2023.
- Antonis Achilleos is a member of the [Executive Committee of the Scandinavian Logic Society](#) and was PC co-chair of GandALF 2023. He was also a PC member for VORTEX 2023 and RADICAL 2023.
- Valentina Castiglioni was a PC member of CALCO 2023, GandALF 2023, [EXPRESS/SOS](#) 2023 and CSL 2024.

- Henning Úlfarsson became chair of the Department of Computer Science at Reykjavik University on 1 July 2023.
- Luca Aceto was chair of the [editorial board of LIPIcs](#) (Leibniz International Proceedings in Informatics) until 31 October 2023 and he has also acted as chair of the Department of Computer Science at Reykjavik University until 30 June 2023. He is currently a member of the steering committees for CONCUR and ICALP, of the editorial and advisory boards for Electronic Proceedings in Theoretical Computer Science, of the executive board of Logical Methods in Computer Science, and of the editorial board of the Journal of Logical and Algebraic Methods in Programming.
- Dylan McDermott served on the PCs of ICFP 2023 and NWPT 2023.
- Calvin Lee served as an AEC member of ESOP/FASE/FoSSaCS 2024.
- Tarmo Uustalu served on the PCs of FICS 2023, CALCO 2023, ICTAC 2023, APLAS 2023, FoSSaCS 2024, FICS 2024 and steering committees of FICS, ICTAC, MPC, MSFP.

Members of ICE-TCS have also been active in outreach events in Iceland and abroad. By way of example, in December 2023, Luca Aceto delivered three lectures on artificial intelligence, on the connections between computer science and philosophy, and on what computers cannot do to high-school teachers in Pescara, Italy.

2.1 Research Output in 2023

During the reporting period, ICE-TCS researchers based at Reykjavik University published or had accepted 9 journal papers (was 7 in 2022) and 13 conference/workshop papers (as opposed to 17 in 2022). They also edited two volumes. Overall, there has been a slight decrease in the number of publications vis-a-vis those the centre's researchers had in 2022. However, we are pleased to see that most of the research output of the centre is still published in high-quality venues.

The full list of accepted and published papers authored by members of the centre from Reykjavik University in 2023 is in the appendix at the end of this report.

3 Current Members

During the reporting period, ICE-TCS had seven core permanent members at Reykjavik University, seven of whom have ICE-TCS as their primary research centre, namely Luca Aceto, Antonis Achilleos, Eyjólfur Ingi Ásgeirsson (Department of Engineering at Reykjavik University; Scientific Co-director), Magnús M. Halldórsson (Scientific Director), Anna Ingólfssdóttir (Scientific Co-director), Henning Úlfarsson and Tarmo Uustalu. In addition, the centre has one member at Reykjavik University with primary affiliation with CADIA (Yngvi Björnsson), one at deCODE Genetics (Bjarni V. Halldórsson) and one with a joint affiliation at the University of Iceland and deCODE Genetics (Páll Melsted).

During the reporting period, Henning Úlfarsson was promoted to an Associate Professor position (spring 2023) and became chair of the Department of Computer Science at Reykjavik University from July 2023.

In 2023, the centre hosted the following four postdoctoral researchers supported by research grants from the Icelandic Research Fund:

- Valentina Castiglioni (concurrency theory, till September 2023),
- Aggeliki Chalki (complexity),
- Dylan McDermott (semantics of programming languages), and
- Jana Wagemaker (concurrency theory, from March 2023).

During the reporting period, members of the centre supervised six PhD students affiliated with ICE-TCS, namely

- Maxime Flin (supervised by Magnús M. Halldórsson),
- Vasiliki Kyriakou (supervised by Antonis Achilleos and Karoliina Lehtinen from November 2023),
- Stian Lybech (supervised by Luca Aceto and Mohammad Hamdaqa),
- Yasuaki Morita (supervised by Tarmo Uustalu and Dylan McDermott),
- Raphaël Reynouard (supervised by Anna Ingólfssdóttir), and
- Jasmine Xuereb (supervised by Antonis Achilleos and Adrian Francalanza).

All those PhD students are supported by research grants from the Icelandic Research Fund or the Reykjavik University Research Fund. Jasmine Xuereb is enrolled in a joint Reykjavik University/University of Malta doctorate.

Duncan Paul Attard and Raphaël Reynouard successfully defended their doctoral dissertations in April 2023 and November 2023, respectively. (We note, in passing, that Duncan Paul Attard delivered his thesis on 31 October 2022 and took up a postdoctoral position at the University of Glasgow on 1 November 2022.)

Judging from the success its PhD students and postdocs have in securing academic positions at high-profile institutions, ICE-TCS seems to provide an environment where young researchers can develop their careers and take steps in achieving their potential. For example, among the centre's (former) postdocs, Valentina Castiglioni is now a tenure-track assistant professor at TU Eindhoven and Jana Wagemaker will take up a tenure-track assistant professorship at Radboud University Nijmegen in July 2024. Soon after defending his PhD thesis, Raphaël Reynouard was hired as a postdoctoral researcher at [eawag](#), the Swiss Federal Institute of Aquatic Science and Technology.

During the reporting period, ICE-TCS members supervised the following MSc students: Eva Ósk Gunnarsdóttir, Calvin Lee and Egill Torfason.

4 A first look at 2024

Research-wise, the year 2024 started well for ICE-TCS with the presentation of the paper “A Distributed Palette Sparsification Theorem” by Maxime Flin, Magnús M. Halldórsson, former ICE-TCS postdoc Alexandre Nolin and their coworkers at SODA 2024. We are also aware of several papers submitted by members of ICE-TCS at high-profile conferences with deadlines in January 2024. We look forward to seeing how many of those articles will be selected for presentation at those events, but the competition for the few slots available in the venues we targeted is increasingly fierce.

Eva Ósk Gunnarsdóttir, an MSc student at ICE-TCS supervised by Anna Ingólfssdóttir, successfully defended her thesis “Applying Binary Decision Diagrams to Learn Hidden Markov Models” on 18 January 2024. We expect that PhD students Stian Lybech and Yasuaki Morita will deliver their theses during this calendar year.

The year 2024 promises to be abuzz with scientific activities organised by members of ICE-TCS. On 15 January 2024, Tarmo Uustalu co-organised the [World Logic Day 2024 in Tallinn](#), which featured invited, one-hour talks by Jan von Plato, Valentin Goranko and Margus Veanes. On 3-7 March 2024, Tarmo Uustalu will co-organise the 26th edition of the Estonian Winter School in Computer Science, EWSCS 2023, in Viinistu, with Szabolcs Horvát of our department as one of the lecturers. In the period 10-20 June 2024, ICE-TCS will host the [Reykjavik Summer of Cool Logic 2024 \(SCool 2024\)](#), which includes

- The Fifth Nordic Logic Summer School (NLS 2024), 10-13 June 2024,
- The Twelfth Scandinavian Logic Symposium (SLSS 2024), 14-16 June 2024, and
- The Fifteenth International Symposium on Games, Automata, Logics, and Formal Verification (GandALF 2024), 18-20 June 2024.

All those events will take place at Reykjavik University.

In keeping with its activities since 2005, ICE-TCS will endeavour to maintain a regular seminar series and a vibrant guest programme. At the time of writing, there are already [eight research visits to ICE-TCS](#) that have been planned for the period January-April 2024 and we hosted four colleagues in January 2024 alone. Moreover, ICE-TCS will organise its annual Theory Day. (The date for that event has not been decided yet.)

News on the funding front was a mixed bag at the start of the year. The Icelandic Research Fund did not select any of the grant applications submitted by postdoctoral researchers and PhD students affiliated with ICE-TCS in the 2024 funding round. This is unfortunate, but we will do our best to submit project proposals in June 2024 so that we can keep hiring the promising young scientists who are already working at the centre and attract new ones. However, Tarmo Uustalu received funding for the period 2024-2025 for the project “Icelandic advantage in computer-assisted proof (in IT, mathematics, society and economy)” from the Ministry of Higher Education, Science and Innovation University Collaboration Programme (Tarmo Uustalu and Anders Claesson, project leaders; 51,840,000 ISK, roughly 345,800 EUR.). Moreover, ICE-TCS

researchers have several ongoing three-year grants that were selected for funding from the Icelandic Research Fund in previous years.

Adding to the already substantial leadership roles of members of ICE-TCS within the international research community, Luca Aceto became a member of the EATCS Fellows Committee in January 2024 for a period of three years.

In summary, judging from the month of January, this promises to be another busy year for ICE-TCS and we encourage our readers to follow the centre's activities on its web pages, which will need to be modernised and kept up to date regularly.

5 Summary and Self-Evaluation

Overall, ICE-TCS has maintained a high level of activity during the reporting period, which marked its 18th birthday. We think that, as witnessed by the highlights we mentioned in this annual report, the centre has remained visible within the international research community in theoretical computer science, both with its research and the service roles that its members continue having. It is unclear, however, whether the local impact of ICE-TCS matches its international one.

On the one hand, since its inception, ICE-TCS has provided a stimulating research environment at Reykjavik University, organising the majority of events in computer science, maintaining the only vibrant guest programme at Reykjavik University, helping its junior researchers go on to successful careers, and establishing and running the flagship BSc in Discrete Mathematics and Computer Science that has graduated several students who have undertaken MSc and PhD studies at top-class universities. At the same time, ICE-TCS has provided local leadership at the Department of Computer Science and at Reykjavik University via the last two chairs of the department, and two of the three members of the departmental Senate until 1 July 2023, amongst others.

On the other hand, ICE-TCS events are typically not well attended by faculty from other fields and students, and it seems that, despite our efforts, the centre and its activities are not well known within the academic community in Iceland. By way of example, to celebrate its 18th year of activity, the centre hosted a series of talks by high-profile speakers and one workshop on formal methods for secure systems in May and June 2023. It is fair to say that attendance at those events was lower than we expected, despite the quality and broad appeal of several of the presentations. In fact, we have observed a decreasing attendance at ICE-TCS seminars and events even by PhD students at ICE-TCS. This is worrying and it is something we have noticed at other institutions too. We should do our best to convey to young researchers that attending research seminars and public talks is a key component of their academic education, improves their breadth of knowledge in Computer Science, and can benefit their research.

In order to maintain a comprehensive record of the activities of ICE-TCS and to make them as visible as possible, we should revamp the ICE-TCS website and keep it up to date.

Of course, we would like to attract bright local students to theoretical computer science and we might want to develop a strategy to improve on our success in doing so. However, many students today want to work on artificial intelligence, and machine learning in particular. Competing for talent with those fields is and will remain hard for the foreseeable future.

The panel that carried out the formative research evaluation for the Department of Computer Science at Reykjavik University in 2022 asked each research centre to come up with a crisp statement of their research vision and goals. Despite some initial attempts, we did not produce such a statement as a centre. Perhaps we should do so, both for ICE-TCS as a whole and for each of the groups within the centre. Indeed, making those vision statements visible on the ICE-TCS web page and to students and academics in Iceland and abroad might help to increase the centre's visibility further.

In order to address another recommendation of the research evaluation panel and to increase the centre's reputation, we should also develop and implement a strategy for nominating ICE-TCS members for international awards. In our, admittedly biased, opinion, several members of the centre might be good candidates for nomination as ACM Distinguished Scientist or ACM Fellow. We will strive to submit at least one such nomination in 2024.

We might also explore ways to foster inter-group collaborations within the centre, leading to grant applications spanning several groups, and to build active research cooperation with the growing number of researchers in data and network science at the Department of Computer Science. In particular, some of Szabolcs Horvát and María Óskarsdóttir's research interests are close to those of some of the members of ICE-TCS.

Overall, as this self-evaluation indicates, the level of ambition at the centre remains high and we want to do even more than in the past. However, the staffing of the centre has remained largely stable over the years and at least one of the core members of ICE-TCS will soon retire. The time might have come to advertise a faculty position in theoretical computer science, also to gauge how attractive the centre would be for prospective high-quality applicants.

In summary, we feel that we are still punching well above our weight and are proud of what we have achieved in 2023. We will keep exploiting all available means to maximise our impact and research collaborations, as well as the quality of our research output, as we have done since April 2005, and we look forward to what 2024 will bring.

Acknowledgements We are grateful to the CS@RU Department Office for its continuous support of ICE-TCS activities.

Appendix: List of ICE-TCS Publications and Accepted Papers in 2023

Note: The list below only reports publications by members of the centre at the Department of Computer Science at Reykjavik University who have ICE-TCS as their primary research centre..

Edited Volumes

1. Antonis Achilleos and Dario Della Monica. Proceedings of the Fourteenth International Symposium on Games, Automata, Logics, and Formal Verification, GandALF 2023, Udine, Italy, 18-20 September 2023. EPTCS 390, 2023.
2. Rotem Oshman, Alexandre Nolin, Magnús M. Halldórsson, Alkida Balliu. Proceedings of the 2023 ACM Symposium on Principles of Distributed Computing, PODC 2023, Orlando, FL, USA, June 19-23, 2023. ACM 2023.

Journal Papers

1. L. Aceto, A. Achilleos, D.P. Attard, L. Exhibard, A. Francalanza and A. Ingólfssdóttir. [A Monitoring Tool for the Linear-Time muHML](#). Science of Computer Programming 232:103031, Elsevier, January 2024. (Accepted in 2023.)
2. L. Aceto, I. Cassar, A. Francalanza and A. Ingólfssdóttir. [On first-order runtime enforcement of branching-time properties](#). Acta Informatica 60(4):385–451, Springer, August 2023.
3. L. Aceto, I. Cassar, A. Francalanza and A. Ingólfssdóttir. [Bidirectional runtime enforcement of first-order branching-time properties](#). Logical Methods in Computer Science 19(1), pp. 14:1-14:44, 28 February 2023.
4. Christian Bean, Bjarki Gudmundsson, Tómas Ken Magnússon and Henning Úlfarsson. Algorithmic coincidence classification of mesh patterns. Inf. Comput. 292: 105014, 2023.
5. Valentina Castiglioni, Michele Loreti and Simone Tini. [A framework to measure the robustness of programs in the unpredictable environment](#). Logical Methods in Computer Science 19(3), pp. 2:1–2:46, 2023.
6. Anders Claesson and Henning Úlfarsson. Turning cycle restrictions into mesh patterns via Foata's fundamental transformation. Discret. Math. 347(3): 113826, 2024. (Accepted in 2023.)
7. Magnús M. Halldórsson, Alexandre Nolin. Superfast coloring in CONGEST via efficient color sampling. Theor. Comput. Sci. 948:113711 (2023).
8. Stian Lybech. Encodability and Separation for a Reflective Higher-Order Calculus. Accepted for publication in Information and Computation.

9. Dylan McDermott, Alan Mycroft. Galois connecting call-by-value and call-by-name. *Log. Methods Comput. Sci.*, to appear.

Conference and Workshop Papers

1. L. Aceto, P. Crescenzi, A. Ingólfssdóttir and M.R. Mousavi. [The Way We Were: Structural Operational Semantics Research in Perspective](#). Proceedings Combined 30th International Workshop on Expressiveness in Concurrency and 20th Workshop on Structural Operational Semantics, EXPRESS/SOS 2023 (Claudio Antares Mezzina and Georgiana Caltais eds.), Electronic Proceedings in Theoretical Computer Science 387, pp. 26-40, 2023.
2. Antonis Achilleos and Aggeliki Chalki. Counting Computations with Formulae: Logical Characterisations of Counting Complexity Classes. MFCS 2023: 7:1-7:15
3. Duncan Adamson, Magnús M. Halldórsson, Alexandre Nolin: Distributed Coloring of Hypergraphs. SIROCCO 2023: 89-111
4. G. Bacci, A. Ingólfssdóttir, Kim G. Larsen and R. Reynouard. An MM Algorithm to Estimate Parameters in Continuous-time Markov Chains. Proceedings of Quantitative Evaluation of Systems - 20th International Conference, QEST 2023, Lecture Notes in Computer Science 1427, pp. 82-100, Springer 2023.
5. Flavien Breuvert, Dylan McDermott, Tarmo Uustalu. Canonical gradings of monads. In Jade Master, Martha Lewis, eds., *Proc. of 5th Int. Conf. on Applied Category Theory, ACT 2022 (Glasgow, July 2022)*, v. 380 of *Electron. Proc. in Theor Comput. Sci.*, pp. 1-21. Open Publishing Assoc., 2023. [doi:10.4204/eptcs.380.1](https://doi.org/10.4204/eptcs.380.1)
6. Silvio Capobianco, Tarmo Uustalu. Additive cellular automata graded-monadically. In *Proc. of 25th Int. Symp. on Principles and Practice of Declarative Programming, PPDP '23 (Cascais, Oct. 2023)*, *ACM Int. Conf. Proc. Series*, art. 13, 9 pp. ACM Press, 2023. [doi:10.1145/3610612.3610625](https://doi.org/10.1145/3610612.3610625)
7. Valentina Castiglioni, Michele Loreti and Simone Tini. Stark: A Software Tool for the Analysis of Robustness in the unKnown Environment. Proceedings of COORDINATION 2023, Lecture Notes in Computer Science 13908, pp. 115-132, Springer, 2023.
8. Valentina Castiglioni, Michele Loreti and Simone Tini. DisTL: A Temporal Logic for the Analysis of the Expected Behaviour of Cyber-Physical Systems. Proceedings of ICTCS 2023, [CEUR Workshop Proceedings](#) 358, pp. 15-30, 2023.
9. Manuela Fischer, Magnús M. Halldórsson, Yannic Maus: Fast Distributed Brooks' Theorem. SIAM-ACM Symposium on Discrete Algorithms (SODA) 2023: 2567-2588.
10. Maxime Flin, Mohsen Ghaffari, Magnús M. Halldórsson, Fabian Kuhn, Alexandre Nolin: Coloring Fast with Broadcasts. ACM Symposium on Parallel Algorithms and Architectures (SPAA) 2023: 455-465
11. Maxime Flin, Magnús M. Halldórsson, Alexandre Nolin: Fast Coloring Despite Congested Relays. In International Conference on Distributed Computing (DISC) 2023: 19:1-19:24.

12. Maxime Flin, Mohsen Ghaffari, Magnús M. Halldórsson, Fabian Kuhn, Alexandre Nolin. A Distributed Palette Sparsification Theorem. In SIAM-ACM Symposium on Discrete Algorithms (SODA), January 2024.
13. R. Reynouard, A. Ingólfssdóttir and G. Bacci. Jajapy: a learning library for stochastic models. Proceedings of Quantitative Evaluation of Systems - 20th International Conference, QEST 2023, Lecture Notes in Computer Science 1427, pp. 30-46, Springer 2023.