Annual Report 2025

ICE-TCS

Icelandic Centre of Excellence
in Theoretical Computer Science

Contents

1 Introduction

The Icelandic Centre of Excellence in Theoretical Computer Science (ICE-TCS) has been active at the Department of Computer Science at Reykjavik University since its establishment on 29 April 2005. This twentieth annual report provides an overview of the activities of ICE-TCS during the calendar year 2025, which marked the twentieth anniversary of the centre, reflects on trends related to the centre's research environment and culture, and describes some of the upcoming events for 2026.

As in previous years, 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 further details.

2 Executive Summary and Highlights for the Reporting Period

The quality and impact of the research carried out by the members of ICE-TCS in 2025 is witnessed by the following main achievements.

- The algorithms group at ICE-TCS continued its study of probabilistic methods in constrained models of computing, focused on graph colouring. This past year, we have studied the problem of colouring the vertices of a graph G using $\Delta+1$ colours, where Δ is the maximum number of neighbours of a vertex in G, and identified the features of the

computing and communication model that make efficient (Δ+1)-colouring possible. Another notable result was the identification of several graph parameters that guarantee the existence of constant-round algorithms in the Congested Clique model for the maximal independent set and the maximal matching problems in a graph. The work of the group has been presented at ESA 2025, ICALP 2025, PODC 2025 and SIROCCO 2025 (two papers), amongst other venues.

- The combinatorics group at ICE-TCS continued its work on applying algorithmic methods to address problems in enumerative combinatorics. A notable result was a study of a variant of the Malicious Maître d' problem stated in Peter Winkler's book *Mathematical Puzzles: A Connoisseur's Collection.* The group's lengthy article on Combinatorial Exploration will appear in Memoirs of the American Mathematical Society.
- The concurrency and logic in computer science group at ICE-TCS extended its work on the theoretical foundations of runtime monitoring to a setting over multiple executions (article presented at LICS 2025) and to data-dependent systems (paper at CONCUR 2025). Moreover, members of the group offered research contributions to classic concurrency theory, with two TCS papers on the equational logic of parallel composition and studies on the complexity of characteristic formulae (CSL 2025 and GandALF 2025), and to type systems guaranteeing safety properties of smart contracts.
- The programming language theory group at ICE-TCS continued pursuing their research agenda in the categorical foundations of programming language semantics, specifically concurrency and combination of nondeterminism with nontermination, alongside formalization in a proof assistant (Agda). Joseph Tooby-Smith continued his PhysLean digital physics effort, promoting it at several venues, in particular the podcast of the Assumptions of Physics project led by Gabriele Carcassi (University of Michigan) (check the recording) and a perspectives paper in *Advanced Science*.
- The complex systems group used methods from network science to study whether an ecological community supports the stable coexistence of various species. In particular, a paper that appeared in the journal Cell Systems presents an exhaustive analysis of all interaction networks with at most five species and with Lotka-Volterra dynamics via combining exact results and numerical exploration. Members of the group also continued contributing to the development of the open-source, network analysis tool igraph, with the release of version 1.0 that includes new algorithms and other improvements. Three student projects were completed, adding extensive functionality for working with geometric networks, a community detection tutorial, and performance improvements to degree-based graph construction.
- Two ICE-TCS researchers--Magnús Már Halldórsson and Luca Aceto--are on Stanford University's list of the most cited researchers in the world, representing the top 2% of scientists globally.

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):

- On 18 November 2025, ICE-TCS hosted a workshop to celebrate Anna Ingólfsdóttir's scientific career on the occasion of her retirement at the end of 2025.
- In the period 27 September-2 October 2025, Tarmo Uustalu organised FroCoS/ITP/TABLEAUX 2025 at Reykjavik University. Those three conferences received many submissions and were well attended, as was the case for two co-located workshops, namely The Rocqshop 2025 and the ITP 2025 Lean workshop. The recordings and slides of almost all talks delivered at FroCoS/ITP/TABLEAUX 2025 are publicly available through this index page.
- Henning Úlfarsson was chair of the organising committee for NORCOM 2025, the 15th Nordic Combinatorial Conference, which was held at Reykjavik University in the period 16-18 June 2025. The scientific programme for that event included the "Einar fest", which celebrated former ICE-TCS member Einar Steingrímsson on the occasion of his 70th birthday.
- The "Icelandic advantage in computer-assisted proof" (Iceproof) project held a three-day seminar in Reykholt in the period 23-25 April 2025.
- In the period 3-6 March 2025, Tarmo Uustalu organised the 27th Estonian Winter School in Computer Science, EWSCS 2025, in Viinistu, Estonia.

Moreover, to mark the 20th anniversary of ICE-TCS, the centre hosted the following two celebratory seminars:

- Fabian Kuhn (Freiburg University), *Distributed coloring algorithms based on list defective colorings*, and
- Magnús Már Halldórsson (Reykjavik University), *On Avi Widgerson's contributions and impact on TCS*. This talk highlighted some of the contributions for which Avi Widgerson received the 2023 ACM A.M. Turing Award.

The Reykjavik University communications and marketing department published a wide-ranging interview with Magnús Már Halldórsson, the centre's director, on the occasion of the 20th birthday of ICE-TCS.

On 3 March 2025, ICE-TCS also organised a cultural event during which the investigative journalist Thin Lei Win gave a talk about the non-profit storytelling project Kite Tales, which she co-founded, that chronicles the lives of people in Burma/Myanmar.

The following invited talks, courses and seminars, listed in reverse chronological order, were delivered by members of the centre in 2025:

- Tarmo Uustalu was honoured to be invited to visit the Centre of Australian Category Theory at Macquarie University, Sydney–the planet's most distinguished category theory group—in the period of 1-16 November 2025, and to deliver two seminar talks there, on 5 and 12 November.

- Luca Aceto delivered invited courses on “Writing Scientific Papers and Reports, and Making Technical Presentations” to PhD students at the Italian National Cybersecurity Doctoral Programme, IMT Lucca, on 23 January 2025.

Regarding new funding from competitive sources, the following three grant proposals from ICE-TCS were awarded funding by the Icelandic Research Fund in 2025:

- Magnús Már Halldórsson, *Comparative complexity via coloring*, project grant;
- Reed Acton, *Moving from objects to transformations to account for the finer structures of permutations*, PhD student grant;
- Vasiliki Kyriakou, *Effects of restrictive non-determinism on the expressiveness and relative complexity of bounded memory automata*, PhD student grant.

To put this funding achievement into perspective, the Department of Computer Science as a whole won four new grants and Reykjavik University was awarded 11 new grants. So, ICE-TCS received 75% of the grants awarded to the department and roughly 27% of the grants coming to the university. Moreover, ICE-TCS PhD students Arnar Bjarni Arnarson and Jasmine Xuereb were awarded PhD grants from the Reykjavik University Research Fund. Tarmo Uustalu together with Anders Claesson from the University of Iceland received funding for the second year of a Collaboration Fund grant for the project “Icelandic advantage in computer-assisted proof”. On the other hand, none of the other new grant applications submitted by members of the centre to the Icelandic Research Fund and to the Reykjavik University Research Fund were successful.

According to our records, in 2025, ICE-TCS hosted 12 unique guests for stays ranging from a few days to four weeks. (We remark that the centre also hosted four invited speakers for the workshop to celebrate Anna Ingólfsdóttir’s scientific career and seven keynote speakers at FroCoS/ITP/TABLEAUX 2025. So we actually had 23 visitors from outside Iceland in 2025.) Most of the guests delivered a seminar in the ICE-TCS seminar series, which consisted of 13 seminars in the reporting period. At the time of writing, the ICE-TCS seminar series has hosted over 430 talks since the establishment of the centre twenty years ago. However, we note that the number of talks in the ICE-TCS seminar series has been lower than usual over the last two years.

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 the following highlights.

- Antonis Achilleos is a member of the Executive Committee of the Scandinavian Logic Society.
- Henning Úlfarsson has chaired the Department of Computer Science at Reykjavik University since 1 July 2023.
- Luca Aceto is currently a member of the steering committees for CONCUR, GandALF 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. He was the director of the PhD programme at the Department of Computer Science at Reykjavik University until 19 November 2025 and has chaired the Doctoral Council of the University of Akureyri from 1 July 2025. He served as a member of the EATCS Fellows Selection Committee 2025 and will also be on that committee in 2026. Luca was also a member of the editorial board of LIPIcs until 30 May 2025, after having chaired it. In 2025, he also served as a PC member for CONCUR 2025 and Highlights 2025.

- Tarmo Uustalu served as PC chair of TABLEAUX 2025 and as a PC member of TYPES 2025, CALCO 2025 and ICTAC 2025. He continued on the steering committees of FICS, ICTAC, MPC, MSFP and was invited to the steering committee of TABLEAUX.
- Magnús Már Halldórsson is a member of the steering committees of ALGOSENSORS, DCOSS, PODC, SWAT and WADS. In late 2025, he also served on the PC for SIROCCO 2026 and on the award committee for the SIROCCO Prize for Innovation in Distributed Computing. He serves on the board of the Icelandic Research Fund from December 2025.

2.1 Research Output in 2025

During the reporting period, ICE-TCS researchers based at Reykjavik University published or had accepted 25 refereed scientific papers in 2025, as opposed to 31 in 2024 and 19 in 2023. We are particularly pleased to see that most of the research output of the centre is still published in high-quality venues, including conferences such as ESA, ICALP, PODC, SODA, CONCUR, CSL, and LICS and journals such as ACM TOCL, ACM TOPLAS, Distributed Computing, Electronic Journal of Combinatorics, Information and Computation and TCS to name but a few. Moreover, some articles were authored by PhD students and postdocs without senior co-authors from the centre, which is a welcome sign of the research independence of the junior members of the centre.

The full list of accepted and published papers authored by members of the centre from Reykjavik University in 2025-2026 is available at https://icetcs.github.io/publ/publ25.html and https://icetcs.github.io/publ/ — lists of earlier publications are accessible from the latter link.

However, publications form only part of the scientific output of the centre. Software artifacts that were developed at ICE-TCS, at least partially, in the reporting period include PhysLean, an interpreter and type checker for TinySol and igraph.

3 Current Members

During the reporting period, ICE-TCS had seven core permanent members at the Department of Computer Science at Reykjavik University, namely Luca Aceto, Antonis Achilleos, Magnús M. Halldórsson (Scientific Director), Szabolcs Horvát, Anna Ingólfsdóttir (Scientific Co-director), Henning Úlfarsson and Tarmo Uustalu. At the end of June 2025, Antonis Achilleos was

promoted to the rank of associate professor at Reykjavik University. This well deserved promotion recognises his scientific work and his contributions to the research community both internationally and at Reykjavik University.

Over the previous years, the centre had several adjoint members at Reykjavik University (Yngvi Björnsson and Jacky Mallett at the Department of Computer Science as well as Eyjólfur Ingi Ásgeirsson at the Department of Engineering, who served as Scientific Co-director of ICE-TCS), one at deCODE Genetics and Reykjavik University (Bjarni V. Halldórsson) and one with a joint affiliation at the University of Iceland and deCODE Genetics (Páll Melsted).

In 2025, the centre hosted the following six postdoctoral researchers supported by research grants from the Icelandic Research Fund and the Iceproof project:

- Aggeliki Chalki (complexity and logic; on maternity leave from June 2025),
- Nicolaos Matsakis (algorithms; until June 2025),
- Yuval Gil (algorithms; from July 2025),
- Stian Lybech (smart contract languages and types; from June 2025 as an informally affiliated independent researcher),
- Jacob Neumann (logic, philosophy, type theory, and category theory; from June 2025),
- Joseph Tooby-Smith (theorem proving; until July 2025).

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

- Reed Acton (supervised by Henning Úlfarsson),
- Arnar Bjarni Arnarson (supervised by Szabolcs Horvát),
- Maxime Flin (supervised by Magnús M. Halldórsson),
- Vasiliki Kyriakou (supervised by Antonis Achilleos and Karoliina Lehtinen),
- Calvin Lee (supervised by Tarmo Uustalu),
- Stian Lybech (supervised by Luca Aceto and Mohammad Hamdaqa),
- Yasuaki Morita (supervised by Tarmo Uustalu and Dylan McDermott), and
- Jasmine Xuereb (supervised by Antonis Achilleos and Adrian Francalanza).

All those PhD students were supported by research grants from the Cooperation Fund of the Icelandic Ministry for Culture, Science and Higher Education, the Icelandic Research Fund or the Reykjavik University Research Fund. Jasmine Xuereb is enrolled in a joint Reykjavik University/University of Malta doctorate programme. Maxime Flin and Stian Lybech defended their theses in 2025 and Jasmine Xuereb delivered hers. Moreover, Arnar Bjarni Arnarson, Vasiliki Kyriakou and Calvin Lee successfully defended their theses proposals. In addition, Tarmo Uustalu is co-supervising PhD students in Tallinn and Cheng-Syuan Wan defended his Tallinn University of Technology PhD degree under Tarmo and Niccolò Veltri's supervision in 2025.

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 recent postdocs, Joseph Tooby-Smith took up a lecturer position at the University of

Bath from September 2025 and Nicolaos Matsakis has been a postdoc at TU Dresden from July 2025. Maxime Flin has been a postdoc in Jukka Suomela's group at Aalto University since September 2025 and Stian Lybech will take up a postdoctoral position at the University of Southern Denmark in February 2026. Information on the current affiliation of the centre's alumni since 2005 is available at https://icetcs.github.io/members/former.html.

During the reporting period, Szabolcs Horvát supervised one MSc student, Arnór Friðriksson, at Reykjavik University and Tarmo Uustalu supervised one MSc student, Bjarki Gunnarsson, at the University of Iceland in the context of the Iceproof project.

The complete list of the PhD theses supervised by members of the centre is available at https://icetcs.github.io/theses/phdtheses.html and that of the MSc theses completed at ICE-TCS is at https://icetcs.github.io/theses/msctheses.html.

4 A first look at 2026

The new year will see some changes to the core membership of ICE-TCS. Anna Ingólfsdóttir will retire from January 2026 and therefore the centre will lose one of its founding members and one of its scientific co-directors. Even though Anna might contribute to some of the centre's future activities as professor emerita, ICE-TCS will have to consider its leadership structure as well as its future activities and development. Fortunately, however, Anna's retirement will be partly compensated by the arrival of Christoph Lenzen, who is expected to join the Department of Computer Science at Reykjavik University and ICE-TCS in mid-March 2026. Christoph's hiring as a faculty member will further strengthen the algorithmics research area at ICE-TCS, fulfilling a goal the centre had for many years. We look forward to Christoph's contributions to the research environment at ICE-TCS.

As listed on the ICE-TCS publication page at https://icetcs.github.io/publ/, members of the centre already have a few publications that will appear in 2026. In particular, we highlight that ICE-YCS postdoc Yuval Gil will present a paper at SODA 2026, a CORE A* conference that will be held in Vancouver in the period 11-14 January 2026.

The members of ICE-TCS will continue their service to the research community in theoretical computer science by organising high-quality events in 2026. Antonis will co-chair PLS15, the 15th Panhellenic Logic Symposium, which will be held in Athens in the period 6-10 July 2026. Tarmo Uustalu will co-organise the World Logic Day 2026 in Tallinn on 10 January 2026 and the 28th Estonian Winter School in Computer Science in the period 2-5 March 2026. Luca Aceto will deliver one of the courses at that school. Moreover, Magnús Már Halldórsson, the scientific director of ICE-TCS, will organise the 2027 edition of the ACM Symposium on Principles of Distributed Computing (PODC) at Reykjavik University. This CORE A* conference will take place in the period 21-25 June 2027.

In keeping with its activities since 2005, ICE-TCS will endeavour to maintain a regular seminar series and a vibrant guest programme in 2026. At the time of writing, confirmed guests are

- Jana Wagemaker, assistant professor at Radboud University, Nijmegen, and a former postdoc of ours, who will visit ICE-TCS in the period 10-18 January 2026;
- Jón Hákon Garðarsson, a 2025 Oxford mathematics and foundations of computer science MSc graduate who went there from the University of Iceland.

Two ICE-TCS PhD students (Yasuaki Morita and Jasmine Xuereb) will defend their theses in 2026.

At the time of writing of this annual report, funding for several of the centre's postdocs is not available for 2026. Several ICE-TCS researchers, including postdocs and PhD students, submitted grant proposals to a variety of instruments of the Icelandic Research Fund 2026 and we expect that the outcome of that yearly call will be announced in mid-February 2026. Moreover, one member of the centre participated in a HORIZON-RIA application whose outcome should be known by some time in February 2026. In light of the currently fairly grim funding situation, some good news from the funding agencies would be even more welcome than usual. We shall see what our success rate will be.

We also await the announcement of the list of ACM Distinguished Scientist and ACM Fellows and might nominate some members of the centre for either of those accolades in 2026.

In summary, this promises to be another busy year for ICE-TCS. We encourage our readers to follow the centre's activities on its web page, which will be kept up to date regularly.

5 Summary and Self-Evaluation

It is very hard to maintain the level of activity and enthusiasm ICE-TCS has kept for nearly 20 years and there are undoubtedly some signs of tiredness within our small community. It is fair to say that several of the activities we had planned for 2025 to mark the centre's 20th anniversary did not materialise. For instance, we did not invite the expected number of special guests and, yet again, we failed to organise the once traditional annual Theory Day. Moreover, attendance at ICE-TCS seminars has been lower than it was in the past and we have mostly failed in making new postdocs and PhD students deliver ICE-TCS seminars at the start of their stint at the centre.

ICE-TCS used to be rather unique in uniting Volume A and Volume B TCS researchers, and we used to support seminars and events organised by "the others" consistently. However, recently, the Volume A-Volume B divide has started to appear within ICE-TCS too and even several of our junior researchers do not attend seminars that are not firmly within their research areas. We might want to think of ways to redress that trend, which goes against the research culture and philosophy underlying the founding of the centre.

Despite the aforementioned sub-optimal developments in the centre's research culture, we think that, as witnessed by the highlights we mentioned in this annual report, during 2025 the centre has remained visible within the international research community in theoretical computer science. We can be proud of the centre's research, the service and leadership roles that its members continue having and the events organised by the members of ICE-TCS. It is probably fair to say, however, that the local impact of ICE-TCS doesn't match its international one.

Research at ICE-TCS during the reporting period has been published in high-quality venues, and the quality of the publication venues may be viewed as a proxy for the scientific value of our research. There is always room to improve on the percentage of the centre's research output that appears in the proceedings of CORE A* and A conferences as well as in the most selective journals, but that is something that is only partially under our control. The best we can do is to keep carrying out the best research of which we are capable, write good articles and submit them to the most appropriate outlets.

We are very proud of the success that ICE-TCS alumni continue to have in their careers. On the one hand, this is due to the fact that we seem to be attracting strong young academics as PhD students and postdocs. At the same time, we like to think that the research environment at the centre helps them to develop as scientists and to achieve their potential. (At least, the time they spend at ICE-TCS does not appear to cause any harm to their careers!) We will endeavour to continue to provide a stimulating research environment for our junior collaborators and for all of us. As part of this effort, we will strengthen our career-development efforts and research environment, and strive to revamp the ICE-TCS seminar series and to entice more students and members of other research centres at the department to attend the talks we will offer.

In order to increase the centre's local impact, it might be worth exploring ways to foster inter-group collaborations within the centre, leading to future grant applications spanning several groups, and to build active research cooperation with the new research centre in cybersecurity at the department and with researchers working on data and network science. For example, we might explore potential collaborations with Giovanni Apruzzese, a new faculty member at the department. Moreover, we should strive to advertise nationally some of the international successes that ICE-TCS has and to actively nominate its members for national and international honours.

In summary, we can be pleased with what ICE-TCS has managed to achieve in 2025 and with its contributions over the last 20 years. We will continue to exploit all available means to maximise our impact and research collaborations, as well as the quality of our research output. At the end of the day, the most important asset of the centre is its people and we should try to grow as well, and as much, as we can.

Despite the effects of the passage of time, the changes in our core faculty and the cracks that are beginning to appear in our armour, the level of ambition at the centre is still high. We look

forward to yet another year of activities in theoretical computer science at Reykjavik University. Bring it on!

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