Annual Report 2022

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 since its establishment on 29 April 2005. This seventeenth annual report provides an overview of the activities of the centre during 2022, which was our third "pandemic year" and the second year in which the centre did not hold its annual Theory Day. It also presents some of the activities in 2023 that are planned at the time of writing and some of the early successes at the beginning of the 18th year of the centre.

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 reporting year is at http://icetcs.ru.is/news-2022.html.

2 Executive Summary and Highlights for the Reporting Period

Once again, the calendar year 2022 has been an active one for ICE-TCS, both nationally and internationally. To begin with, the centre as a whole was evaluated during a formative research review exercise carried out in November 2022 by the Department of Computer Science at Reykjavik University. In its report, the evaluation panel, which consisted of Geraldine Fitzpatrick (TU Wien, Austria), Kim Guldstrand Larsen (Aalborg University, Denmark) and Michael Wooldridge (University of Oxford, United Kingdom), wrote:

> "We were truly impressed by ICE-TCS that in a short span of time (inaugurated in 2005) has established itself as a world-class center within Theoretical Computer Science

(TCS). In particular, we find that the center has been extremely successful combining Track A and Track B of TCS with notable research contributions within and recognitions from the sub-fields of Concurrency Theory, Logic, Programming Languages, Combinatorics and Algorithms.

The publication venues of the center include flagship outlets such as POPL, LICS and STOC and [the centre] has received best paper awards (and nominations) at leading conferences. Thecenter has an impressive visitor programme counting numerous leading researchers within the field of TCS.

The high standing of the center in the field of TCS is also clearly witnessed by the success in bringing leading conferences and workshops (ICALP, LICS, NWPT, Logic Colloquium, PODC). We believe that the visiting programme and the hosting of scientific events has been key to the high international visibility of the ICE-TCS."

We were delighted to read the panel's opinion on our centre and we will strive to improve following the panel's recommendations and to develop a crisp, overarching research vision for the coming few years, which may help us keep spreading theoretical computer science in Iceland and attract talent to the country.

The quality and impact of the research carried out by the members of the centre in 2022 is witnessed by the following main achievements.

- The focus of the algorithms group has been on fast randomized distributed graph coloring in the last couple of years. It has proved possible to extend the state-of-the-art to more and more restricted models, and to more challenging problem variants. This can be termed a "log-log revolution", as more and more problems are solvable exponentially faster than the classical (poly-)logarithmic time methods. This is expected to continue at a pace well into 2023 and possibly beyond.
- The multi-year work done by the combinatorics group and its external collaborators gave birth to Combinatorial Exploration. Combinatorial Exploration is an algorithmic framework that can prove hundreds of results that so far have required the ingenuity of human mathematicians and many new ones. (See the [Permutation Pattern Avoidance Library](#) and Section 2.4 of the [99-page article](#) describing the framework for a comprehensive list of notable results.) The accompanying [github repository](#) contains the open-source python framework for Combinatorial Exploration.
- The concurrency theory group received the best paper award at DisCoTec 2022, 17th International Federated Conference on Distributed Computing Techniques, for the article "A Monitoring Tool for Linear-Time µHML" by Luca Aceto, Antonis Achilleos, Duncan Paul Attard, Léo Exibard, Adrian Francalanza and Anna Ingólfsdóttir. (DisCoTec consists of three federated conferences.) The group continued its work on solving open problems in the equational logic of processes, with results published at CONCUR 2022 and in the journals ACM Transactions on Computational Logic and Logical Methods in Computer Science.

- The theory of programming group continued its work on advancing the semantic foundations for higher-order programming with effects. One of the main outcomes of their work was that flexibly graded monads provide a considerably finer tool for quantitative analysis of effect than graded monads. The group established the precise relationship between the two concepts. Going beyond the basic theory of monad-comonad interaction laws, they were able to develop a (co)algebraic perspective and an abstract view based on Sweedler theory for duoidal categories. Research highlights were published in papers that appeared at ICFP 2022 and FoSSaCS 2022, amongst other venues.
- ICE-TCS researchers were again successful in their grant applications.
  - Tarmo Uustalu received funding from the Icelandic Research Fund for his three-year project (2022-2024) "Computational effects and high-level control" (approximately 145K Euro per year).
  - Valentina Castiglioni received a three-year postdoctoral fellowship grant (2022-2024) from the Icelandic Research Fund for her project "Programs in the wild: Uncertainties, adaptability and verification" (roughly 80.2K Euro per year)
- In the period 27 June-1 July 2022, ICE-TCS hosted the Logic Colloquium 2022 at Reykjavik University. Antonis Achilleos was a member of the PC for that event and Tarmo Uustalu co-organised the special session on Logic in Computer Science with Nicola Galesi (University of Rome "La Sapienza")
- On 12 September 2022, Valentina Castiglioni co-chaired the Combined 29th International Workshop on Expressiveness in Concurrency and 19th Workshop on Structural Operational Semantics. The event was affiliated with CONCUR 2022 (as part of CONFEST 2022).
- In the period 30 November-2 December 2022, ICE-TCS co-hosted NordSec 2022 at Reykjavik University.
- On 16 December 2022, Aggeliki Chalki and Antonis Achilleos served on the organising committee of the New York Colloquium on Algorithms and Complexity 2022.

As in previous years, ICE-TCS researchers organised high-quality scientific events at Reykjavik University and elsewhere, increasing the international visibility of the centre and of Reykjavik University as a whole. To wit, apart from the above-mentioned events, we mention the following events (in reverse chronological order):
- Joost-Pieter Katoen (RWTH Aachen, Germany) delivered a talk for the general public entitled "Probabilistic Programming: Probability Theory for the Masses".
- Dror Rawitz (Bar-Ilan University) joined the centre in August 2022, and will spend a one-year sabbatical at ICE-TCS. Dror is the first researcher to spend a sabbatical at the centre.
- Michael Wooldridge (University of Oxford, UK) delivered a talk for a general public entitled "Towards Machine Understanding"
- ICE-TCS organised a public talk by James Muir (BAE Systems, UK) as part of a cybersecurity event held in cooperation with the British Embassy in Iceland.

- ICE-TCS hosted a public talk entitled "Technomoral Virtues, Human Flourishing and the Bootstrapping Problem" by [Shannon Vallor](#) (University of Edinburgh, UK). The talk was sponsored by the British Embassy in Iceland. Shannon Vallor is Baillie Gifford Chair in the Ethics of Data and Artificial Intelligence at the University of Edinburgh's Edinburgh Futures Institute.

The following invited talks, listed in reverse chronological order, were delivered by members of the centre in 2022:
- 16 December 2022: Antonis Achilleos and Aggela Chalki were invited speakers at the New York Colloquium on Algorithms and Complexity 2022.
- 7 September 2022: Luca Aceto delivered an invited talk entitled "A journey through the spectrum of monitorability" at the 23rd Italian Conference on Theoretical Computer Science (ICTCS 2022), Rome,Italy, 7-9 September 2022.
- 6 June 2022: Antonis Achilleos will deliver an invited talk entitled "To Monitorability and Beyond" at VORTEX 2022: Workshop on Verification and mOnitoring at Runtime EXecution.
- 11 January 2022: Antonis Achilleos delivered an invited talk entitled "Adventures in Monitorability" at Logical Foundations Of Computer Science 2022, LFCS 2022.

Thanks to the progressive lifting of the restrictions related to the pandemic, we had the possibility to restart the centre's guest programme. In 2022, we hosted [20 foreign researchers](#) for stays ranging from a few days to a couple of weeks. Most of the guests delivered a seminar in the [ICE-TCS seminar series](#), which consisted of 28 seminars in the reporting period. At the time of writing the ICE-TCS seminar series has hosted 398 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 chairs the steering committee of SIROCCO, and is a member of the steering committee of ALGOSENSORS, DCOSS, and SWAT.
- Antonis Achilleos is a member of the [Executive Committee of the Scandinavian Logic Society](#).
- Valentina Castiglioni was the PC co-chair of [EXPRESS/SOS](#) 2022.
- Luca Aceto is chair of the [editorial board of LIPIcs](#) (Leibniz International Proceedings in Informatics) for his third two-year term. Since 1 March 2019, he has also acted as chair of the Department of Computer Science at Reykjavik University.

Finally, Luca Aceto was identified in 2022 as a [top-10 CONCUR author](#) with respect to two centrality measures.

2.1 Research Output in 2022

During the reporting period, ICE-TCS researchers based at Reykjavik University published or had accepted one book chapter, 7 journal papers (was 14 in 2021), one book chapter, and 17 conference/workshop papers (as opposed to 19 in 2021). Overall, there has been a slight decrease in the number of publications vis-a-vis those the centre's researchers had in 2021. However, 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 2022 is in the appendix at the end of this report.

3 Current Members

During the reporting period, ICE-TCS had eight 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 Ingólfsdóttir (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).

In 2022, the centre hosted the following seven postdoctoral researchers supported by research grants from the Icelandic Research Fund:
- Duncan Adamson (algorithmics, till August 2022)
- Christian Bean (combinatorics, till November 2022),
- Valentina Castiglioni (concurrency theory),
- Aggeliki Chalki (complexity, from October 2022)
- Dylan McDermott (semantics of programming languages),
- Léo Exibard (concurrency theory, from September 2021), and
- Alexandre Nolin (algorithmics, till September 2022).

During the reporting period, members of the centre supervised seven PhD students affiliated with ICE-TCS, namely
- Elli Anastasiadi (supervised by Luca Aceto and Anna Ingólfsdóttir),
- Duncan Paul Attard (supervised by Luca Aceto, Adrian Francalanza and Anna Ingólfsdóttir),
- Stian Lybech (supervised by Luca Aceto and Mohammad Hamdaqa),
- Yasuaki Morita (supervised by Tarmo Uustalu and Dylan McDermott),
- Emile Nadeau (supervised by Henning Ulfarsson),
- Raphaël Reynouard (supervised by Anna Ingólfsdóttir), 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. So far, no PhD student affiliated with ICE-TCS has been funded by the Department of Computer Science at Reykjavik University.

Duncan Paul Attard and Jasmine Xuereb are enrolled in a joint Reykjavik University/University of Malta doctorate.
Moreover, the following PhD students formally obtained their Reykjavik University doctorate:
● Elli Anastasiadi (September 2022),
● Emile Nadeau (November 2022).
Duncan Paul Attard delivered his PhD thesis at the end of October 2022 and will defend it in 2023.

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, Antonis Achilleos is now an assistant professor at Reykjavik University, Duncan Adamson is a postdoc at the University of Göttingen, Christian Bean is a lecturer in mathematics at Keele University since January 2023, Léo Exibard is maître de conférences at Université Gustave Eiffel, Manuela Fischer is an assistant professor at ETH Zurich, and Alexandre Nolin is a postdoc at the CISPA Helmholtz Center for Information Security. ICE-TCS PhD students Elli Anastasiadi and Duncan Paul Attard are now postdocs at Uppsala University and the University of Glasgow, respectively. Emile Nadeau is a programmer at RÚV is the main television channel of RÚV, the Icelandic public broadcaster.

4 A first look at 2023

ICE-TCS will turn 18 at the end of April 2023. This anniversary will be celebrated with a series of talks by distinguished guests such as Marta Kwiatkowska (University of Oxford, UK), Mohammad Reza Mousavi (King's College, UK), Roberta Sinatra (University of Copenhagen and IT University Copenhagen, Denmark) and Michael Szell (IT University Copenhagen, Denmark). The centre will also hold a special edition of the ICE-TCS Theory Day and will strive to maintain a vibrant visitor programme. We note, in passing, that Sergey Goncharov (FAU Erlangen-Nürnberg, Germany) visited the programming languages group at ICE-TCS in the period 8-15 January 2023 and delivered the first seminar in the ICE-TCS seminar series in the new year. This year, ICE-TCS might also mark the centenary of John von Neumann's birth by hosting a series of talks presenting the contributions of that visionary scientist to the general public.

The algorithms group has continued its success in tackling problems in classical distributed graph colouring and the paper "Fast Distributed Brooks Theorem" by Manuela Fischer (ETH Zurich), Magnús M. Halldórsson (Reykjavik University) and Yannic Maus (TU Graz) will be presented at the coveted and highly competitive SODA23.

ICE-TCS researchers will continue to have leadership roles within their research communities. For example, Magnús M. Halldórsson will be the program chair for the [ACM Symposium on the Principles of Distributed Computing (PODC) 2023](). Moreover, Luca Aceto joined the steering committee of CONCUR at the start of 2023 and will officially serve on that committee from August 2023 till July 2027.

Jana Wagemaker (Radboud University Nijmegen, NL) will join ICE-TCS as a postdoctoral researcher in March 2023 and the algorithms group is planning to hire a new postdoc too. These new hires and the centre's network of international cooperation will help ICE-TCS maintain a vibrant research environment for its members.

5 Summary and Self-Evaluation

Overall, ICE-TCS has maintained a high level of activity during the reporting period.

The algorithms group has had remarkable success in classical distributed graph colouring, with publications at [STOC 2022]() and SODA 2023. The group has been consistently fortunate to recruit young people (particularly postdocs) who often exceeded what they had previously shown. Planned forays into machine learning/data science have been slow to progress, but there is still plenty of potential.

The combinatorics group is currently in the "wrap-up" phase of a multi-year project on "combinatorial exploration", which is an algorithmic, and automatic way to approach enumerative and structural problems in combinatorics. The first paper laying the groundwork of the approach has been written and now the group members are working on several follow-up papers, while the most intensive cluster runs of the associated computer code. This process will take at least one year.

The concurrency and logic in computer science group has continued its work on the study of the equational theory of process algebras and on runtime monitoring with publications in conferences such as CONCUR, one best paper award at DisCoTec 2022, and the development of the software tool [detectEr](), which is a runtime verification tool for asynchronous component systems that run on the Erlang Virtual Machine.

The programming language theory group published its work at FoSSaCS '22 and ICFP '22. Tarmo Uustalu received a three-year IRF grant to pursue his research agenda. Some planned collaborations, with Shin-ya Katsumata, Maciej Piróg, Sergey Goncharov and others, got stalled because of the pandemic and the war. However, Sergey Goncharov visited the group in the first half of January 2023 and the group members hope that other guests will come soon.

The members of ICE-TCS were pleased to read the positive opinion by the research evaluation panel on the work done within the centre since its inception. However, as pointed out by the

panel, current limits on the number of faculty members within ICE-TCS will seriously limit "the full exploitation of the high research potential of the centre." Moreover, Anna Ingólfsdóttir will retire at some point in the not-too-distant future. This might actually lead to a decrease in the centre's human capital. As pointed out by the evaluation panel, maintaining "the high international standing of ICE-TCS for a next period will be a major achievement in itself."

The evaluation panel encouraged the centre to formulate and articulate a clear coherent and joint research vision. Moreover, it strongly urged that senior ICE-TCS staff, in particular, consider applying for ERC grants.

The centre will treasure the advice it received and will use it to improve its activities. Overall, we feel that we are still punching well above our weight and are proud of what we have achieved in 2022. We will keep exploiting all available means to maximise our impact and research collaborations, as we have done since April 2005, and we look forward to what 2023 will bring.

Appendix: List of ICE-TCS Publications and Accepted Papers in 2022

Book Chapters

1. Luca Aceto, Elli Anastasiadi, Valentina Castiglioni and Anna Ingolfsdottir. Non-finite Axiomatisability Results via Reductions: CSP Parallel Composition and CCS Restriction. A Journey from Process Algebra via Timed Automata to Model Learning - Essays Dedicated to Frits Vaandrager on the Occasion of His 60th Birthday. Lecture Notes in Computer Science, volume 13560, pp. 1-26, 2022. https://doi.org/10.1007/978-3-031-15629-8_1

Journal Papers

1. Luca Aceto, Antonis Achilleos, Elli Anastasiadi and Anna Ingolfsdottir. **Axiomatizing recursion-free, regular monitors**. *J. Log. Algebraic Methods Program.* 127, pp. 100778, 2022. https://doi.org/10.1016/j.jlamp.2022.100778

2. Luca Aceto, Valentina Castiglioni, Anna Ingolfsdottir, Bas Luttik and Mathias R. Pedersen. **On the Axiomatisability of Parallel Composition**. *Log. Methods Comput. Sci.* 18(1), 2022.
   https://doi.org/10.46298/lmcs-18(1:15)2022

3. Luca Aceto, Valentina Castiglioni, Wan Fokkink, Anna Ingolfsdottir and Bas Luttik. **Are Two Binary Operators Necessary to Obtain a Finite Axiomatisation of Parallel Composition?** *ACM Trans. Comput. Log.* 23(4), pp. 22:1-22:56, 2022.
   https://doi.org/10.1145/3529535

4. Christian Bean, Antonio Bernini, Matteo Cervetti and Luca S. Ferrari. **On the generating functions of pattern-avoiding Motzkin path**. *J. Symb. Comput.* 113, pp. 126-138, 2022.
   https://doi.org/10.1016/j.jsc.2022.02.006

5. José Espirito Santo, Luis Pinto and Tarmo Uustalu. **Plotkin's call-by-value λ-calculus as a modal calculus**. *J. Log. Algebraic Methods Program.* 127, pp. 100775, 2022.
   https://doi.org/10.1016/j.jlamp.2022.100775

6. Magnus M. Halldorsson, Toshimasa Ishii, Kazuhisa Makino and Kenjiro Takazawa. **Posimodular Function Optimization**. *Algorithmica* 84(4), pp. 1107-1131, 2022.
   https://doi.org/10.1007/s00453-021-00910-y

7. Shin-ya Katsumata, Dylan McDermott, Tarmo Uustalu and Nicolas Wu. **Flexible presentations of graded monads**. *Proc. ACM Program. Lang.* 6, ICFP, pp. 902-930, 2022.
   https://doi.org/10.1145/3547654

Conference and Workshop Papers

1. Luca Aceto, Antonis Achilleos, Duncan Paul Attard, Leo Exibard, Adrian Francalanza and Anna Ingolfsdottir. **A Monitoring Tool for Linear-Time μHML**. Proceedings of Coordination Models and Languages - 24th IFIP WG 6.1 International Conference, COORDINATION 2022, Held as Part of the 17th International Federated Conference on Distributed Computing Techniques, DisCoTec 2022, Lucca, Italy, June 13-17, 2022. *Lecture Notes in Computer Science* 13271, pp. 200-219, 2022.
   https://doi.org/10.1007/978-3-031-08143-9_12

2. Luca Aceto, Antonis Achilleos, Elli Anastasiadi and Adrian Francalanza. **Monitoring Hyperproperties with Circuits**. Proceedings of Formal Techniques for Distributed Objects, Components, and Systems - 42nd IFIP WG 6.1 International Conference, FORTE 2022, held as part of the 17th International Federated Conference on Distributed Computing Techniques, DisCoTec 2022, Lucca, Italy, June 13-17, 2022. *Lecture Notes in Computer Science* 13273, pp. 1-10, 2022.

https://doi.org/10.1007/978-3-031-08679-3_1

3. Luca Aceto, Antonis Achilleos, Elli Anastasiadi, Adrian Francalanza and Anna Ingolfsdottir. **Complexity through Translations for Modal Logic with Recursion**. Proceedings of the 13th International Symposium on Games, Automata, Logics and Formal Verification, GandALF 2022, Madrid, Spain, September 21-23, 2022. *EPTCS* 370, pp. 34-48, 2022.
https://doi.org/10.4204/EPTCS.370.3

4. Luca Aceto, Valentina Castiglioni, Anna Ingolfsdottir, and Bas Luttik. **On the Axiomatisation of Branching Bisimulation Congruence over CCS**. Proceedings of 33rd International Conference on Concurrency Theory, CONCUR 2022, September 12-16, 2022, Warsaw, Poland. *LIPIcs* 243, pp. 6:1-6:18, 2022.
https://doi.org/10.4230/LIPIcs.CONCUR.2022.6

5. Antonis Achilleos, Leo Exibard, Adrian Francalanza, Karoliina Lehtinen and Jasmine Xuereb. **A Synthesis Tool for Optimal Monitors in a Branching-Time Setting**. Proceedings of Coordination Models and Languages - 24th IFIP WG 6.1 International Conference, COORDINATION 2022, held as part of the 17th International Federated Conference on Distributed Computing Techniques, DiSCoTec 2022, Lucca, Italy, June 13-17, 2022. *Lecture Notes in Computer Science* 13271, pp. 181-199, 2022.
https://doi.org/10.1007/978-3-031-08143-9_11

6. Duncan Adamson. **Ranking Binary Unlabelled Necklaces in Polynomial Time**. Proceedings of Descriptional Complexity of Formal Systems - 24th IFIP WG 1.02 International Conference, DCFS 2022, Debrecen, Hungary, August 29-31, 2022. *Lecture Notes in Computer Science* 13439, pp. 15-29, 2022.
https://doi.org/10.1007/978-3-031-13257-5_2

7. Duncan Adamson, Argyrios Deligkas, Vladimir V. Gusev and Igor Potapov. **The Complexity of Periodic Energy Minimisation**. Proceedings of 47th International Symposium on Mathematical Foundations of Computer Science, MFCS 2022, August 22-26, 2022, Vienna, Austria. *LIPIcs* 241, pp. 8:1-8:15, 2022.
https://doi.org/10.4230/LIPIcs.MFCS.2022.8

8. Duncan Adamson, Vladimir V. Gusev, Dmitriy S. Malyshev and Viktor Zamaraev. **Faster Exploration of Some Temporal Graphs**. Proceedings of 1st Symposium on Algorithmic Foundations of Dynamic Networks, SAND 2022, March 28-30, 2022, Virtual Conference. *LIPIcs* 221, pp. 5:1-5:10 2022.
https://doi.org/10.4230/LIPIcs.SAND.2022.5

9. Magnus M. Halldorsson, Fabian Kuhn, Alexandre Nolin and Tigran Tonoyan. **Near-optimal distributed degree+1 coloring**. Proceedings of STOC '22: 54th Annual ACM SIGACT Symposium on Theory of Computing, Rome, Italy, June 20 - 24, 2022, pp. 450-463, *ACM*, 2022.
https://doi.org/10.1145/3519935.3520023

10. Magnus M. Halldorsson, Yannic Maus and Alexandre Nolin. **Fast Distributed Vertex Splitting with Applications**. Proceedings of 36th International Symposium on

Distributed Computing, DISC 2022, October 25-27, 2022, Augusta, Georgia, USA. *LIPIcs* 246, pp. 26:1-26:24, 2022
https://doi.org/10.4230/LIPIcs.DISC.2022.26

11. Magnus M. Halldorsson, Alexandre Nolin and Tigran Tonoyan. **Overcoming Congestion in Distributed Coloring**. Proceedings of PODC '22: ACM Symposium on Principles of Distributed Computing, Salerno, Italy, July 25 - 29, 2022, pp. 26-36, *ACM*, 2022.
https://doi.org/10.1145/3519270.3538438

12. Dylan McDermott and Alan Mycroft. **Galois Connecting Call-by-Value and Call-by-Name**. Proceedings of 7th International Conference on Formal Structures for Computation and Deduction, FSCD 2022, August 2-5, 2022, Haifa, Israel. *LIPIcs* 228, pp. 32:1-32:19, 2022.
https://doi.org/10.4230/LIPIcs.FSCD.2022.32

13. Dylan McDermott, Yasuaki Morita and Tarmo Uustalu. **A Type System with Subtyping for WebAssembly's Stack Polymorphism**. Proceedings of Theoretical Aspects of Computing - ICTAC 2022 - 19th International Colloquium, Tbilisi, Georgia, September 27-29, 2022. *Lecture Notes in Computer Science* 13572, pp. 305-323, 2022.
https://doi.org/10.1007/978-3-031-17715-6_20

14. Dylan McDermott, Exequiel Rivas and Tarmo Uustalu. **Sweedler Theory of Monads**. Proceedings of Foundations of Software Science and Computation Structures - 25th International Conference, FOSSACS 2022, held as part of the European Joint Conferences on Theory and Practice of Software, ETAPS 2022, Munich, Germany, April 2-7, 2022. *Lecture Notes in Computer Science* 13242, pp. 428-448, 2022.
https://doi.org/10.1007/978-3-030-99253-8_22

15. Dylan McDermott and Tarmo Uustalu. **Flexibly Graded Monads and Graded Algebras**. Proceedings of Mathematics of Program Construction - 14th International Conference, MPC 2022, Tbilisi, Georgia, September 26-28, 2022. *Lecture Notes in Computer Science* 13544, pp. 102-128, 2022.
https://doi.org/10.1007/978-3-031-16912-0_4

16. Dylan McDermott and Tarmo Uustalu. **What Makes a Strong Monad?** Proceedings Ninth Workshop on Mathematically Structured Functional Programming, MSFP@ETAPS 2022, Munich, Germany, 2nd April 2022. *EPTCS* 360, pp. 113-133, 2022.
https://doi.org/10.4204/EPTCS.360.6

17. Tarmo Uustalu, Niccolò Veltri and Cheng-Syuan Wan. **Proof Theory of Skew Non-Commutative MILL**. Proceedings of the 10th International Conference on Non-Classical Logics. Theory and Applications, NCL 2022, Lodz, Poland, 14-18 March 2022. *EPTCS* 358, pp. 118-135, 2022.
https://doi.org/10.4204/EPTCS.358.9