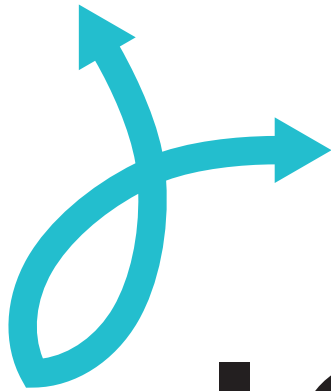


Annual Report 2010

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ICE-TCS

Icelandic Centre of Excellence
in Theoretical Computer Science

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1 Introduction

The Icelandic Centre of Excellence in Theoretical Computer Science (ICE-TCS) celebrated its sixth birthday on 29 April 2011. This fifth annual report is meant to give the (Theoretical) Computer Science community in Iceland and elsewhere, our sponsors and funding agencies, and our scientific advisory board a bird’s eye view of the activities of the centre in 2010. It will also allow us to evaluate our achievements vis-a-vis our original aims in setting up this centre, and to set ourselves goals for the future.

For the sake of completeness, we remind our readers that the aim of the centre is to establish in Iceland important areas of basic research in the mathematical foundations of Computer Science, notably Algorithmic Program Verification, Mathematical Logic in Computer Science, Models and Logics for Reactive Systems, Semantics of Computation and Systems Biology, alongside existing activities in Algorithmics, Bioinformatics, Applied and Discrete Mathematics and Machine Learning.

ICE-TCS aims at exploiting the available scientific strength in order to

- focus the research efforts, and establish synergies amongst the active researchers in Iceland,
- attract outstanding researchers in Theoretical Computer Science to Iceland for short- or long-term visits leading to collaborations with local researchers and to improvements in the Icelandic research environment,
- organize international conferences and workshops in Theoretical Computer Science in Iceland to put the country firmly on the map as a recognized conference location for high quality events in the field, and
- attract young, outstanding students from Iceland to this research area.

The research centre initially started as a collaboration between the Department of Computer Science, Faculty of Engineering, University of Iceland, and the School of Computer Science, Reykjavík University. From 2011, the centre is based solely at Reykjavík University and has some affiliated members from the University of Iceland.

Further information is available from the centre's web page at:

<http://www.icetcs.ru.is>.

2 Executive Summary and Highlights for the Reporting Period

The reporting period has been one of mixed fortunes for ICE-TCS. On the one hand, the centre has continued its scientific activities at a pace that is at least comparable to that it kept during the previous years of operation. On the other hand, the number of permanent members of the centre has decreased, and substantially so, for the first time since its opening in 2005. The financial crisis in Iceland finally hit ICE-TCS during the reporting year, and some of the strategic decisions made by the Executive Committee at Reykjavík University have had impact on the membership and research scope of the centre. More specifically, the closing down of the bachelor programme in mathematics at Reykjavík University meant considerable reductions in our combinatorics group, leaving only Henning Úlfarsson, a postdoctoral researcher and part-time assistant professor, after this July.

However, despite the lack of financial resources and the considerable shrinking in its membership, ICE-TCS has remained a scientifically thriving community that has continued to pursue the main goals of the centre.

During the reporting period, the centre passed the 150 journal-publication mark since its opening in April 2005. ICE-TCS also reached 100 conference/workshop publications in early 2011. These were significant milestones for the centre, but the impact of the research carried out within ICE-TCS must also be measured qualitatively. A research evaluation of the centre is one of the desiderata for the centre, but at the moment ICE-TCS does not have the financial resources to carry it out. In the absence of such an evaluation, we have to rely on indicators such as the quality of the outlets in which ICE-TCS members publish, the visitors who wish to come to Iceland to collaborate with the members of the centre, the standing of ICE-TCS members in their community (as witnessed, for instance, by the invitations they receive to chair the PC of high-quality international conferences) and competitive visiting professorships awarded to ICE-TCS researchers. To wit, in 2010 Luca Q. Zamboni has been selected by the Academy of Finland as one of nine researchers in their Finnish Distinguished Professor Program. His proposal is in Combinatorics on Words with a budget of 3 million euros for five years.

As an indication of the status of the research carried out by members of ICE-TCS within the local research community, we limit ourselves to mentioning that, in 2010, Magnús M. Halldórsson, the director of ICE-TCS, has been awarded the first Reykjavík University Research Award.

During the reporting period, Magnús M. Halldórsson, Pradipta Mitra and Eyolfur Ingi Ásgeirsson formed the Research Group for Algorithms and Networks (ALNET). This research group within ICE-TCS performs work in various areas at the intersection of algorithms research and research on networked computer systems.

Events

During 2010, ICE-TCS members organized several scientific events, both in Iceland and abroad.

In the period 26–28 May 2010, the combinatorics group within ICE-TCS hosted the 10th Nordic Combinatorial Conference (NORCOM 2010) at Reykjavik University. The event featured invited talks by two members of ICE-TCS, viz. Magnús M. Halldórsson and Luca Q. Zamboni, as well as invited addresses by Juhani Karhumäki (University of Turku), Christian Krattenthaler (University of Vienna) and Nik Ruškuc (University of St. Andrews). The conference was attended by 47 people.

The annual ICE-TCS Theory Day was held on Friday, 30 April 2010, in celebration of the centre's fifth birthday. The programme for the event

included talks by ICE-TCS members as well as invited presentations by two long-term visitors of ICE-TCS, David de Frutos Escrig and Carlos Gregorio-Rodriguez (both at the Universidad Complutense de Madrid, Spain). The event was attended by about 30 people, including the rector of Reykjavík University and its chief research officer. During the Theory Day, ICE-TCS unveiled its logo, designed by Emilka Bojanczyk.

On Wednesday, 15 September 2010, Luca Aceto, Anna Ingólfssdóttir and Joshua Sack organized an informal one-day *Workshop on Logic and Concurrency* at Reykjavik University. The workshop included presentations by four guests of the centre: Ignacio Fabregas Alfaro (Universidad Complutense de Madrid, Spain), Francois Laroussinie (LIAFA, Paris Diderot, France), Miguel Palomino Tarjuelo (Universidad Complutense de Madrid, Spain) and Bryan Renne (Faculty of Philosophy, University of Groningen, NL).

On Wednesday, 9 June 2010, Magnús Halldórsson organized an *ICE-TCS Algorithms Day*, featuring two celebrated visitors: Jens Gustedt (LORIA, Nancy, France) and Riko Jacob (TU Munich, Germany). The event also featured short talks by ICE-TCS members.

Outside Iceland, on Monday, 30 August 2010, Luca Aceto co-chaired SOS 2010, the seventh workshop on Structural Operational Semantics, which was held in Paris as a satellite event of CONCUR 2010.

As in previous years, “regular” events, such as talks in our seminar series, have been advertised locally and on our ever-increasing mailing lists, which include well over 100 individuals at the time of writing. Events that are appealing to a general audience have also been advertised in the local newspapers, and on the mailing lists of Reykjavik University as a whole, of the mathematics society and of the computer science society. In all cases, ICE-TCS events have been a large fraction (if not the majority) of advertised events. In fact, it is fair to say that the ICE-TCS Research Seminar series continues to be the only regular seminar series in Computer Science in Iceland, and one of the very few seminar series in the country that have more than a handful of talks each year. During the reporting period, the ICE-TCS Research Seminar series hosted 26 seminars, not counting the talks delivered as part of the above-mentioned events.

Networking

Collaboration with members of the international research community has played a major role in the development of ICE-TCS since its inception in

2005. Despite the remote location of Iceland and the lack of funding, ICE-TCS continues to be fairly successful in attracting visitors to the centre. As we detail in Table 1, visits by some of our scientific guests have been spread relatively evenly over the course of the reporting period. (We had 19 guests in 2010.) Apart from short-term visitors, in 2010 we had, for the first time, the opportunity of hosting a number of medium- and long-term visitors. These visits were made possible by the availability of one-off specific funding that ICE-TCS members were able to secure. A one-month visiting professorship for Zoltan Esik was supported by a grant from Reykjavik University's Development Fund, and the visits by David de Frutos Escrig (three months), Ignacio Fabregas (one month), Carlos Gregorio Rodriguez (three months) and Miguel Palomino (one month) were funded by the Abel Extraordinary Chair programme run by Universidad Complutense de Madrid, Spain.

In addition, during the reporting period, some ICE-TCS members were awarded competitive visiting professorships by foreign institutions. In the period 15 April–15 June 2010, Anna Ingólfssdóttir took up a two-month Velux Visiting Professorship at DTU to work with Flemming Nielson, Hanne Riis Nielson and the other members of the MT-Lab (a VKR Centre of Excellence). ICE-TCS also secured three of the Abel Extraordinary Chairs awarded after the third call for applications. The Abel Extraordinary Chair recipients were:

- Luca Aceto (two months; total grant: 13,600 euro; host: David de Frutos Escrig, Universidad Complutense Madrid),
- Anna Ingólfssdóttir (two weeks; total grant: 3,500 euro; host: David de Frutos Escrig, Universidad Complutense Madrid), and
- Sergey Kitaev (six months; total grant: 39,000 euro; host: Marc Noy Serrano, Universidad Politecnica de Catalunya).

At the time of writing, exploiting such ad-hoc and rare funding opportunities appears to be the only way in which ICE-TCS can have medium- and long-term research guests.

In the field of bioinformatics, Bjarni V. Halldórsson is a frequent guest of the Center for Computational Molecular Biology at Brown University, with whose researchers he maintains an active research collaboration.

Outreach

One of the goals of the centre is to foster an appreciation of discrete mathematics and theoretical computer science within a general scientifically-minded public and to attract students to these fields. As part of this effort, members of ICE-TCS have been training the Icelandic Math Olympiad team. In particular, ICE-TCS members Bjarni V. Halldórsson (team leader) and Marteinn Thor Hardarson (deputy team leader) led the Icelandic team at the International Mathematical Olympiad 2010, which was held in Astana, Kazakstan.

Some educational initiatives during the reporting period were aimed at BSc. and MSc. students. In particular, ICE-TCS members continue to be the prime movers in the design and running of novel courses on *Problem Solving* course for first-year students in Computer Science, a new course on *Effective Programming and Problem Solving* for BSc. students and a course on *Logic in Computer Science* for third-year BSc. students and MSc. students. In addition, Magnús M. Halldórsson ran a *Programming Boot Camp*, which was attended by more than 60 students.

ICE-TCS events have managed to attract a sizable attendance. Beyond members of the centre, nearly every meeting is attended by some researcher from fields with areas of contact with theoretical computer science. We also continue to host a small number of talks by researchers from sister-fields like mathematics and physics, with the aim to explore possible synergies between their work and the research carried out within the centre. Unfortunately, the disappearance of the Mathematics Institute at Reykjavík University and the loss of the sizable and very productive combinatorics group have substantially reduced the interplay between ICE-TCS and the Icelandic mathematical research community. (At the time of its disbandment, the combinatorics group contributed five permanent members, four postdoctoral researchers and three PhD. students to ICE-TCS.) In order to counteract the shrinking of the mathematical community at Reykjavík University, ICE-TCS has started establishing a closer connection with the Icelandic Mathematical Society in 2011. In particular, two members of ICE-TCS are now on the board of the Icelandic Mathematical Society and ICE-TCS will jointly organize events with that society from 2011.

ICE-TCS research continues to involve students and other young researchers. However, the number of students affiliated with the centre is still small. During the reporting period, members of ICE-TCS have supervised 3 MSc. students in computer science and eight PhD. students (five in computer science, one in bioinformatics and two in mathematics). For these numbers

to increase, the two main ingredients are student interest and funding. Attracting students at BSc. and MSc. level is becoming increasingly hard to attract and the demise of the BSc. programme in mathematics at Reykjavik University further reduces the appeal of our educational programmes at Reykjavik University for mathematically-minded students.

As a possible way of attracting more theoretically-minded students to discrete mathematics and theoretical computer science, we have designed an “emphasis line” in theoretical computer science as part of the BSc. degree in computer science at Reykjavik University. This line will be operational from the academic year 2011–2012. Moreover, our plans for a degree programme in Discrete Mathematics and (Theoretical) Computer Science at Reykjavik University are becoming mature and, at the time of writing, it seems that we will be able to enroll new students in this study line from the autumn semester 2011. Only time will tell whether these efforts will allow us to achieve the educational impact we hope to have, and whether such a degree programme will be popular enough to survive in the difficult economic climate the university system has been facing in Iceland since October 2008.

On the other hand, we still attract a reasonable number of qualified applications for the PhD. positions we advertise internationally. Our doctoral programme, however, does not grow as we foresaw. In our previous annual report, we wrote:

We expect to have at least seven PhD. students in the autumn of 2010. (Compare with the three MSc. students ICE-TCS members supervise right now.)

Our predictions turned out to be overly optimistic. At the time of writing, the centre hosts five Ph.D. students in computer science and one in bioinformatics. Marjan Sirjani is about to hire a doctoral student. All these students are financially supported by grants from the Icelandic Fund for Research. Reykjavik University does not have any funds to support doctoral students and this state of affairs is likely to continue in the foreseeable future. This means that the running of our Ph.D. will continue to be highly dependent on the success of ICE-TCS members in winning grants from competitive funding agencies. Since the level of the competition is increasing constantly, the availability of external funding for research and for supporting Ph.D. students cannot be relied on. Moreover, the financial terms we can offer our doctoral students at the time of writing are not internationally competitive. Apart from the relatively low wages, we have very limited travel funds to support trips to conferences and workshops by our research associates. This makes it also more difficult than before to attract postdoctoral researchers

to the centre. During the reporting period, five postdoctoral researchers left the centre for better postdoctoral positions and only one, Pradipta Mitra, joined ICE-TCS. We hope that this trend will change, but we are not optimistic for the near future.

Research Highlights

The reporting period has seen the centre pass the milestone of 150 journal papers. At the time of writing, according to our records, ICE-TCS members have a total of 297 publications since the establishment of the centre: one book, 18 edited volumes, six book chapters, 161 journal papers, 105 conference and workshop papers and seven abstracts in peer-reviewed ISI-indexed journals. It is interesting to note that the centre continues to publish its work more in journals than in conferences. This is at odds with the standard publication culture in the field of computer science, but can be explained by the productivity of the members of the combinatorics group within ICE-TCS. With the loss of that group, the ratio of journal publications might decrease in the coming years.

Below, we limit ourselves to pointing out a few highlights of the work carried out within the centre in the reporting period.

- The papers *Wireless Capacity with Oblivious Power in General Metrics* by Magnús M. Halldórsson and Pradipta Mitra (SODA 2011) and *On a game theoretic approach to capacity maximization in wireless networks* by Eyjólfur Ingi Ásgeirsson and Pradipta Mitra (accepted for publication in the proceedings of the competitive INFOCOM 2011 conference) are prime examples of the recent work on the algorithmic analysis of wireless networks carried out within the ALNET research group at ICE-TCS.
- The paper *Streaming Algorithms for Independent Sets* by Bjarni V. Halldórsson, Magnús M. Halldórsson, Elena Losievskaja and Mario Szegedy was accepted for the competitive track A of ICALP 2010.
- The bioinformatics group within ICE-TCS accepted its first doctoral student, supported by a three-year doctoral grant from the Icelandic Fund for Research.
- Bjarni V. Halldórsson is a collaborator of Soring Istrail's (Brown University) in the NSF grant EAGER: Haplotype Phasing Algorithms and Clark Consistency Graphs (Duration: 2011–2012; Amount: 199999 USD).

- The concurrency group within ICE-TCS has continued its work on the development of rule formats for operational semantics that guarantee the validity of algebraic properties. This work has led to two journal papers (Science of Computer Programming and Theoretical Computer Science, to appear) three conference papers (Proceedings of SOFSEM 2010, Proceedings of MFPS 2010 and Proceedings of LATA 2011, to appear).
- Members of the combinatorics group at ICE-TCS had five posters and one regular article accepted for presentation at the International Conference on Formal Power Series and Algebraic Combinatorics (FPSAC 2010), held in San Francisco, August 2–6, 2010.

The impact of the centre on the international research community may be reflected by invitations issued to its members to visit foreign institutions and to deliver addresses and courses abroad. We already mentioned competitive visiting professorships awarded to some of the members of ICE-TCS. In addition, Anders Claesson delivered an invited talk in a Special Session on Permutations at the AMS-MAA Joint Mathematics Meeting in San Francisco, January 13–16, 2010. At the same meeting, Sergey Kitaev and Einar Steingrímsson delivered invited talks at an AMS Special Session on Enumerative Combinatorics. Magnús M. Halldórsson and Luca Q. Zamboni were invited speakers at the 10th Nordic Combinatorial Conference (NORCOM 2010). Finally, Martina Kubitzke gave an invited talk at the Symposium “Diskrete Mathematik”, which took place at the Erwin Schrödinger Institut, Vienna, Austria.

3 Current Members and Their Research Areas

ICE-TCS has now eight permanent members (all at Reykjavík University) and four affiliated members (two at the University of Iceland, one at the University of Strathclyde and one at Université de Lyon 1). The present members of the centre are: Luca Aceto (Scientific Co-director), Eyjólfur Ingi Ásgeirsson, Yngvi Björnsson, Bjarni V. Halldórsson, Magnús M. Halldórsson (Scientific Director), Anna Ingólfssdóttir (Scientific Co-director), Sergey Kitaev and Marjan Sirjani. Sergey Kitaev will, however, leave the centre on July 1, 2011, when he will take up a readership at the Department of Computer and Information Sciences, University of Strathclyde, UK. At that point, ICE-TCS will have half the members it had in April 2010. This is a worrying development, as the centre will find it difficult to maintain a good

level of activity as its membership shrinks for the first time in its history.

In addition, at the time of writing, the centre hosts two postdoctoral researchers: Pradipta Mitra (algorithmics, auctions) and Henning Úlfarsson (algebraic geometry and algebraic combinatorics). During the reporting period, the centre lost Vit Jelinek, Martina Kubitzke, Robert Parviainen and Joshua Sack. Joshua Sack maintains an active cooperation with Luca Aceto and Anna Ingólfssdóttir.

The centre has four PhD. students (three in Computer Science and one in bioinformatics). Three of those students are from outside Iceland. One more doctoral student will be hired in 2011 in the area of validation and verification of timed actor-based models.

Despite the decrease in the level of staffing, ICE-TCS is still one of the largest research centres in Iceland. With the present emphasis at Reykjavík University on building on existing areas of academic strength, we intend to lobby for future strategic hires in areas of interest to the centre. In particular, we would like to hire staff members and/or postdoctoral researchers in algorithmics, and to be in a position to offer medium- and long-term visiting research positions to researchers at different stages of their academic careers. Offering long-term visiting positions, however, will only be possible if specific centre-building funding becomes available for this purpose.

At present, the members of ICE-TCS carry out research in the following main areas of Theoretical Computer Science and Discrete Mathematics: Algorithms and Complexity, Bioinformatics, Combinatorics, Computer-aided Verification, Concurrency Theory, Formal Methods in Software Engineering, Machine Learning, Search Methods in Artificial Intelligence and Structural Operational Semantics.

Research efforts in the algorithms group in the past year include the study of algorithmic problems in wireless networks (such as the capacity problem), (vertex) colouring problems, online algorithms and scheduling, spectrum sharing games, and streaming algorithms. In the field of bioinformatics, the main research thrust has been the development of algorithms for detecting genomic variants.

The main directions of research conducted by the combinatorics group were the study of pattern avoidance in permutation patterns, the combinatorial properties of $(2 + 2)$ -free posets, the representability of graphs by words, combinatorics on words and the connections between matchings and posets. Particular emphasis was placed on the study of rooted planar maps founded by Tutte in a series of papers in the 1960s. In particular, Anders Claesson, Sergey Kitaev and Anna de Mier have obtained equidistribution results of several statistics on rooted non-separable planar maps. To ob-

tain these results, so-called description trees were used. Using these trees, Anders Claesson, Sergey Kitaev, Anna de Mier and Einar Steingrímsson proved combinatorially that one has fewer non-separable planar maps than bicubic maps, and initiated the study of the relations between description trees corresponding to different parameters. Also, Sergey Kitaev, Anna de Mier and Marc Noy enumerated fixed points under taking the dual map for three classes of maps: all planar maps, 3-connected planar maps, and rooted non-separable planar maps.

The research efforts within the concurrency theory group have mainly focused on negative and positive results in the equational logic of process algebras, on the meta-theory of structural operational semantics, with emphasis on rule formats for guaranteeing the validity of certain algebraic properties of processes, and on modal characterizations of process semantics.

The software engineering group has focused on the further development of the theory and applications of the actor-based language Rebeca, and of its associated tool suite.

4 Funding

ICE-TCS continues to operate on what is a shoestring budget by international standards, and its activities are still supported by a variety of sources in what can only be defined as an ad-hoc way. As in previous years, nearly all the short-term research visits to the centre have been funded by our rather extensive network of Erasmus/Socrates exchange agreements or by the research funds of our guests. Some visitors have instead been supported by grant money secured by the centre's researchers or by the Jules Verne programme, which supports cooperation projects in research between French and Icelandic institutions. In addition, as noted earlier, funds from the Abel Extraordinary Chair programme run by the Universidad Complutense de Madrid, Spain, have allowed us to host four research visitors from Spain for periods ranging from one to three months.

ICE-TCS received a Reykjavik University Development Grant for supporting a one-month visiting professorship and organizing a scientific workshop at Reykjavik University. The amount is of 1,500,000 ISK. This grant was used to pay for a one-month visit by Prof. Zoltan Esik (University of Szeged, Hungary) and to organize a one-day Workshop on Logic and Concurrency in September 2010. However, we have been so careful in spending money from the grant that we will be able to use it to organize two more workshops in 2011. (One has already taken place at the time of writing and

the other will take place on June 30 and July 1.)

Despite the increasingly hard competition and the decrease in the available funding, ICE-TCS researchers continue to be fairly successful in obtaining grants from the Icelandic Fund for Research. In the latest rounds of applications for projects starting in January 2011, Marjan Sirjani obtained one of the two grants awarded in the field of computer science for the three-year project *Timed Asynchronous Reactive Objects in Distributed Systems (TARO)*; the amount for the grant is roughly of 42,200 euros.

Luca Aceto, Magnús M. Halldórsson and Anna Ingólfssdóttir (ICE-TCS, Reykjavik University) received travel money amounting to 600,000 ISK for the Jules Verne proposal *Algorithms and Formal Methods for Distributed Computing*. The grant proposal was submitted jointly with Pierre Fraigniaud and Francois Laroussinie (LIAFA, University Paris Diderot - Paris 7).

Last, but not least, Jón Ingi Sveinbjörnsson has been awarded one of the doctoral grants from the Icelandic Fund for Research. He works on his thesis at Reykjavik University under the supervision of Bjarni Halldórsson. The award is of 6,095,000 ISK.

In addition, the following project grants were still ongoing during the reporting period:

- *Algorithms for wireless networks* (PI: Magnús M. Halldórsson),
- *General Intelligence Problem-Solving Agents* (PI: Yngvi Björnsson),
- *Meta-Theory of Algebraic Process Theories* (PI: Luca Aceto),
- *New Developments in Operational Semantics* (PI: Luca Aceto) and
- *Processes and Modal Logics* (PI: Anna Ingólfssdóttir). .

We remark that these grants, however, can only be used to support project specific activities, and *not* for activities related to the centre as such. Whatever success ICE-TCS might have had so far has therefore been achieved with minimal financial support. We believe that the quantity and quality of the centre's activities, and its impact on research and education in computer science in Iceland, could be increased substantially if ICE-TCS had more funding.

5 Activities in 2010

5.1 Guests

During the reporting period, we received 19 guests from foreign institutions for stays ranging from a few days to three months. These are listed in Table 1 in reverse chronological order. All the guests delivered seminars and/or contributed (mini-)courses organized by the centre.

5.2 Organization of Conferences, Symposia and Workshops

Members of the centre have served as organizers and PC members for the following events.

- Luca Aceto. The 37th International Colloquium on Automata, Languages and Programming (ICALP 2010), 5–12 July 2010, Bordeaux, France. (PC member for track B)
- Luca Aceto. The 35th International Symposium on Mathematical Foundations of Computer Science, Brno, Czech Republic, August 23–27, 2010. (PC member)
- Luca Aceto. Structural Operational Semantics 2010, 30 August 2010, Paris, France. (PC co-chair)
- Luca Aceto, Anna Ingólfssdóttir and Joshua Sack. ICE-TCS Workshop on Logic and Concurrency, 15 September 2010, Reykjavik, Iceland. (Co-organizers.)
- Luca Aceto. 22nd Nordic Workshop on Programming Theory (NWPT 2010), 10–12 November 2010, Turku, Finland. (PC member)
- Magnús M. Halldórsson. 13th International Workshop on Approximation Algorithms for Combinatorial Optimization Problems - APPROX 2010, 1–3 September 2010, Barcelona, Spain. (PC member)
- Magnús M. Halldórsson. Fifth International Conference on FUN WITH ALGORITHMS (FUN 2010), 2–4 June 2010, Ischia, Italy. (PC member)
- Anna Ingólfssdóttir. 21st International Conference on Concurrency Theory (CONCUR 2010), 31 August–3 September 2010, Paris, France. (PC member)

Pierre Fraigniaud (LIAFA, Universite Paris Diderot - Paris 7, France). Period: 8–15 November 2010.

Juris Viksna (University of Latvia, Department of Computer Science). Period: 25–29 October 2010.

Arnar Birgisson (Chalmers University of Technology, Sweden). Period: 10–15 October 2010.

Franco Barbanera (University of Catania, Italy). Period: 20–26 September 2010.

Bryan Renne (Faculty of Philosophy, University of Groningen, NL). Period: 14–19 September 2010.

Francois Laroussinie (LIAFA, Paris Diderot, France). Period: 9–16 September 2010.

Miguel Palomino Tarjuelo (Universidad Complutense Madrid, Spain). Period 7 September–6 October 2010.

Ignacio Fabregas Alfaro (Universidad Complutense Madrid, Spain). Period 7 September–6 October 2010.

Zoltan Esik (University of Szeged, Hungary). Period: 31 August–29 September 2010.

Leonardo Vito (University of Camerino, Italy). Period: 16–22 August 2010.

Luca Tesei (University of Camerino, Italy). Period: 16–22 August 2010.

Daniele Catanzaro (Universite Libre de Bruxelles, Belgium). Period: 7–11 June 2010.

Jens Gustedt (LORIA, Nancy, France). Period: 3–10 June 2010.

Riko Jacob (TU Munich, Germany). Period: 2–16 June 2010.

David de Frutos Escrig (Universidad Complutense Madrid, Spain). Period: 5 April–5 July, 2010.

Carlos Gregorio Rodriguez (Universidad Complutense Madrid, Spain). Period: 5 April–5 July, 2010.

Andrei Sabelfeld (Chalmers University of Technology, Sweden). Period: 26 March, 2010.

Bas Luttik, Department of Mathematics and Computer Science, Eindhoven University of Technology, The Netherlands. Period: 8–12 March, 2010.

Mads Dam (Theoretical Computer Science, School of Computer Science and Communication, Royal Institute of Technology (KTH), Stockholm, Sweden). Period: 12 January, 2010.

Table 1: ICE-TCS Guests in 2010

- Anna Ingólfssdóttir. 7th Workshop on Fixed Points in Computer Science, FICS 2010, 21–22 August 2010, Brno, Czech Republic. (PC member)
- Sergey Kitaev. 10th Nordic Combinatorial Conference (NORCOM 2010), 26–28 May 2010, Reykjavik, Iceland. (Conference chair)
- Marjan Sirjani. 12th International Conference on Coordination Models and Languages (COORDINATION 2010), 7–10 June 2010, Amsterdam, The Netherlands. (PC member)
- Marjan Sirjani. Fourth International Workshop on Testing, Analysis and Verification of Web Software, 1 September, 2010, Antwerp, Belgium. (PC member)
- Marjan Sirjani. 7th International Colloquium on Theoretical Aspects of Computing (ICTAC 2010), 1–3 September, 2010, Natal, Brazil. (PC member)
- Marjan Sirjani. 9th International Workshop on the Foundations of Coordination Languages and Software Architectures (FOCLASA 2010), 4 September, 2010, Paris, France. (PC member)
- Marjan Sirjani. 12th International Conference on Formal Engineering Methods (ICFEM 2010), 17–19 November, 2010, Shanghai, China. (PC member)

5.3 Service and Honours

Members of ICE-TCS participate in the life of the international research community in Theoretical Computer Science at large. For instance, they hold positions in the steering committee of conferences and professional organizations, and act as (guest) editors of volumes and international journals. A sample of service activities contributed by members of the centre can be found in Table 2.

In addition, in 2010, Magnús M. Halldórsson, the director of ICE-TCS, has been awarded the first Reykjavík University Research Award.

5.4 ICE-TCS Seminar Series

One of the main aims of ICE-TCS is to foster a broad appreciation of the field of Theoretical Computer Science in Iceland, and to help improve the

Membership and Steering of Learned Bodies

- TC1 Working Group 1.8 on Concurrency Theory, of the International Federation for Information Processing (IFIP). (Luca Aceto (chair) and Anna Ingólfssdóttir (secretary))
- Luca Aceto is a member of the EATCS council.
- Luca Aceto is the chairman of the Publication Committee of the EATCS.
- Luca Aceto is a member of the ICALP Liaison Committee of the EATCS.
- Luca Aceto is a member of the advisory board of *Electronic Proceedings in Theoretic Computer Science (EPTCS)*.
- Magnús M. Halldórsson is a member of the steering committee for the Scandinavian Workshop on Algorithm Theory series. He is chair of that committee since March 2007.
- Magnús M. Halldórsson is a member of the steering committee for the European Symposium on Algorithms.
- Anna Ingólfssdóttir is a member of the grant evaluation panel for Science and Engineering of the Icelandic Fund for Research.
- Anna Ingólfssdóttir is a member of the board of the Icelandic Mathematical Society.
- Henning Úlfarsson is the chairman of the Icelandic Mathematical Society.

Membership of Editorial Boards

- Concurrency Column of the Bulletin of the European Association for Theoretical Computer Science (EATCS). (Luca Aceto editor)
- Journal of Logic and Algebraic Programming, Elsevier. (Luca Aceto editor and Anna Ingólfssdóttir guest editor)
- Acta Cybernetica (a scientific journal published by the Department of Informatics of the University of Szeged, Szeged, Hungary). (Luca Aceto editor)
- *Electronic Proceedings in Theoretic Computer Science (EPTCS)*. (Luca Aceto editor)
- Discrete Mathematics and Theoretical Computer Science. (Magnús M. Halldórsson managing editor)
- Soft Computing Journal (to be published by University of Kashan). (Marjan Sirjani Editor-in-Chief)
- Annals of Combinatorics. (Einar Steingrímsson guest editor)

Table 2: Service and Honours by Members of ICE-TCS

Icelandic research environment in Computer Science at large. To this end, during 2010, the centre has organized the following seminar series:

- Research Seminar Series, and
- Reading groups.

These two seminar series are supposed to cater for different types of audiences and of presentations. As its name suggests, the *Research Seminars Series* is used for technical presentations reporting on research that has reached a fairly complete stage of development. Overall, there have been 26 seminars in this series during the reporting period. (See <http://www.icetcs.ru.is/rsem.html> for details on these talks.)

Reading groups are used by ICE-TCS to learn about topics that have the potential of creating synergies amongst the members of the centre, or as fora for the discussion of research in one of the core areas of the centre. As examples of the latter use of a reading group, we initiated a series of meetings on *Graphs and Algorithms*. This reading group initially involved MSc. students in order to get them interested in those topics and to provide them with some of the necessary background for working on an MSc. thesis in those areas. At the time of writing, however, all the students who were involved in the reading group have graduated and the meetings of the group are attended only by permanent members and postdoctoral researchers. We hope that this will change in the near future.

In early 2011, the concurrency group within ICE-TCS started weekly concurrency lunch meetings, which are held on Tuesdays.

Marjan Sirjani holds weekly lunches with students working on formal methods in software engineering on Fridays.

5.5 Courses and Students

As far as impact on the Icelandic Computer Science community is concerned, one of the main aims of ICE-TCS has always been to attract students to Theoretical Computer Science. Teaching, in the broad sense, plays a very important role in achieving this aim, and the members of ICE-TCS engage in course development and in student supervision. Apart from our dissemination activities related to the seminar series and the reading groups, ICE-TCS researchers have delivered classic courses on *Algorithmics* and *Theory of Computation*, at various levels, and new courses on *Bioinformatics*, *Distributed Algorithms*, *Graph Theory*, *Logic in Computer Science*, *Modelling and Verification*, *Problem Solving* and on *Semantics of Programming Languages* at Reykjavík University. A new course on *Effective Programming*

and Problem Solving was delivered in the spring semester 2010. In addition, Magnús M. Halldórsson held a *Programming Boot Camp*.

Members of the centre have supervised the following PhD students, five of which are affiliated with ICE-TCS.

- Georgiana Caltai (Reykjavík University), PhD student working on her thesis supervised by Luca Aceto and Anna Ingólfssdóttir.
- Matteo Cimini (Reykjavík University), PhD student working on his thesis supervised by Luca Aceto and Anna Ingólfssdóttir.
- Hilmar Finnsson (Reykjavík University), PhD student working on his thesis supervised by Yngvi Björnsson, formally affiliated with the Center for Analysis and Design of Intelligent Agents.
- Eugen-Ioan Goriac (Reykjavík University), PhD student working on his thesis supervised by Luca Aceto and Anna Ingólfssdóttir.
- Stefán F. Gudmundsson (Reykjavík University), PhD student working on his thesis supervised by Yngvi Björnsson, formally affiliated with the Center for Analysis and Design of Intelligent Agents.
- Jón Ingi Sveinbjörnsson (Reykjavík University), PhD student working on his thesis supervised by Bjarni Halldórsson.
- Steve Widmer (Reykjavík University), PhD student supervised by Luca Q. Zamboni and Amy Glen.

6 Publications by Members of the Centre

We already mentioned some of the research highlights earlier in this report. Here we limit ourselves to mentioning that the work carried out by the members of our research groups in algorithmics and combinatorics has been presented at some of the premiere conferences in those areas such as ICALP, PODC, SODA, RECOMB and FPSAC and in some of the top journals, such as Journal of Combinatorial Theory, Series A. Yngvi Björnsson's work on search-methods in artificial intelligence and on general game playing continues to have high visibility both nationally and internationally. Apart from being published in the top publication outlets in the area, some of that work has achieved wide recognition. Finally, ICE-TCS researchers published journal papers in outlets such as Mathematical Structures in Computer Science, Science of Computer Programming, Theoretical Computer Science and Information Processing Letters.

Since our last annual report, ICE-TCS researchers have published three edited volumes, one book chapter, 31 journal papers, and 23 conference and workshop papers. Overall, the members of ICE-TCS have so far published one book, 18 edited volumes, six book chapters, 161 journal papers, 105 conference and workshop papers and seven abstracts in peer-reviewed ISI-indexed journals. Full details on the publications by members of the centre since its inception may be found at

<http://www.icetcs.ru.is/publications.pdf>.

7 Forthcoming Activities

During 2011, we plan to continue our work with the aim of achieving the objectives stated in Section 1. Despite the substantial reduction in our membership, the level of ambition and activity remain high within ICE-TCS.

In spite of the lack of funding, we intend to maintain a vibrant visitors programme, taking full advantage of the attractiveness that Iceland has as a travel destination. The following visits, listed in reverse chronological order, have been confirmed, or have already taken place at the time of writing:

- Pierre Fraigniaud (LIAFA, Universite Paris Diderot - Paris 7, France). Period: 18–30 July 2011.
- Lelia Blin (Univ. d’Evry Val d’Essonne, France). Period: 18–30 July 2011.
- Mario Bravetti (University of Bologna, Italy). Period: 6–13 June 2011.
- Daniele Catanzaro (Universite Libre de Bruxelles, Belgium). Period: 23 May–5 June 2011.
- Joshua Sack. Period: 9–13 May, 2011.
- Cristian Prisacariu (University of Oslo, Norway). Period: 9–1 May, 2011.
- Ymir Vigfusson (IBM Research, Haifa, Israel) Period: 6 May, 2011.
- Wan Fokkink (Vrije Universiteit Amsterdam, The Netherlands). Period: 28 April–1 May, 2011.

- MohammadReza Mousavi (Department of Mathematics and Computer Science, Eindhoven University of Technology, The Netherlands). Period: 27 April–1 May, 2011.
- Michel Reniers (Department of Mechanical Engineering, Eindhoven University of Technology, The Netherlands). Period: 27 April–1 May, 2011.
- Bas Luttik (Department of Mathematics and Computer Science, Eindhoven University of Technology, The Netherlands). Period: 27–29 April, 2011.
- Emanuela Merelli (University of Camerino, Italy). Period: 21 February–4 March 2011.
- Pierluigi Penna (University of Camerino, Italy). Period: 21 February–4 March 2011.
- Nicola Paoletti (University of Camerino, Italy). Period: 21 February–4 March 2011.

We expect that a few more guests will visit ICE-TCS during 2011, but this will mostly depend on the availability of external funding.

The calendar year 2011 will be rich of events that see major involvement from ICE-TCS members:

- Marjan Sirjani co-chairs FSEN 2011,
- Luca Aceto and Anna Ingólfssdóttir organize the one-day Workshop on Structural Operational Semantics and the Equational Logic of Processes at Reykjavik University,
- Marjan Sirjani organizes DisCoTec 2011 at Reykjavik University,
- Magnús M. Halldórsson organizes the two-day Workshop on Realistic Models for Algorithms in Wireless Networks at Reykjavik University,
- Luca Aceto will chair the PC for ICALP 2011 (track B),
- FPSAC 2011 will be held in Reykjavik and will be organized by the members of the combinatorics group, two of whom are still members of ICE-TCS,
- Magnús M. Halldórsson will chair the PC for ESA 2011, and

- Henning Úlfarsson will be co-organizing the bi-annual conference of the Icelandic Mathematical Society in October 2011.

The aforementioned events will put ICE-TCS in the limelight within the international TCS community. We trust that they will be a good advertisement for the centre.

In addition, the ICE-TCS Theory Day for 2011 will take place on Friday, 20 May 2011. The event will consist of two sessions. The first session will celebrate Leslie Valiant's Turing Award by highlighting some of major contributions to Theoretical Computer Science. The second session will consist of contributed talks on topics in combinatorics and concurrency theory.

On Thursday, 26 May 2011, ICE-TCS will host a public talk by Georges Gonthier (Microsoft Research, Cambridge, UK) entitled *Verifying the Four Colour Theorem*. This will be our first joint event with Icelandic Mathematical Society. We plan to hold more joint events with the local mathematical society in the future.

On Friday, 18 November 2011, ICE-TCS will graduate its second doctoral student, Matteo Cimini. The examination committee for the thesis will consist of Wan Fokkink (Vrije Universiteit Amsterdam, NL), Matthew Hennesy (Trinity College Dublin, Ireland), MohammadReza Mousavi (Eindhoven University of Technology, NL) as well as the thesis supervisors, Luca Aceto and Anna Ingólfssdóttir. The thesis defence will be accompanied by talks by the members of the examination committee.

Marjan Sirjani will represent ICE-TCS in the grant evaluation panel for Science and Engineering of the Icelandic Fund for Research from 2011. She will also be Editor-in-Chief of the new-born *Soft Computing Journal* to be published by the University of Kashan from March 2011.

Last, but not least, the following book will appear in 2011:

S. Kitaev. *Patterns in permutations and words*, Monographs in Theoretical Computer Science (with a foreword by Jeffrey B. Remmel), Springer-Verlag, ISBN 978-3-642-17332-5.

This book will be the first comprehensive reference for the theory of permutation patterns.

As mentioned earlier, we still think that it will soon be useful for the centre to undergo an evaluation by a top-class panel of experienced researchers. Such an evaluation would be used by the centre to obtain an objective evaluation of its achievements so far in relation to the available resources, as well as useful feedback for improving its activities and impact in the future.

8 Summary and Self-Evaluation

The reporting period has been a very eventful one for ICE-TCS. We have lived in exciting times, but, unfortunately, also in the Chinese sense! The centre has been hit by the financial crisis in Iceland and its membership has shrunk substantially for the first time in its six years of existence. However, it is fair to say that ICE-TCS has survived its *annus horribilis* surprisingly well and is ready for the challenges ahead.

Scientifically, the centre has continued to play a crucial role in the computer-science and discrete mathematics communities in Iceland. As in previous years, the vast majority of the scientific events in those fields taking place in Iceland have been associated with the centre and, to the best of our knowledge, the ICE-TCS seminar series and guest programme are pretty much unique in the country. Internationally, the centre has continued to contribute to the TCS community via its research output and its service activities. We feel that we can be proud of what has been achieved in 2010 and, as described in Section 7 of this annual report, the year 2011 is going to be one of even greater activity and international visibility for ICE-TCS.

During the reporting period, the centre has further extended its network of research collaborators, and we feel that we have taken good advantage of all the ad hoc funding opportunities that we have had available. We will continue to try and attract research visitors to ICE-TCS using every avenue at our disposal. ICE-TCS members will also continue applying for visiting professorships abroad.

Of course, the scientific impact of ICE-TCS is best measured by an *external* analysis of the quality of the research carried out by the members of the centre. In the absence of a proper research evaluation, all we can do is to try and assess our own work, based on its quantity and impact, as well as on the prestige of our publication outlets. It will be an interesting, and most likely sobering, exercise to do so during one of our annual centre meetings in 2011. Overall, however, we feel that we can be pleased with the quality and the quantity of the research work carried out by our members, and with the ensuing publications.

The centre would benefit by having more students and postdoctoral researchers. Attracting more students will require a concerted long-term effort. Hopefully, the new degree course in Discrete Mathematics and Computer Science can start soon at full speed, since this will give us a chance to get talented students interested in the mathematical foundations of computer science from the start of their studies. The availability of funding and the devaluation of the Icelandic currency are the main obstacles to attracting

postdoctoral researchers and doctoral students to ICE-TCS. Both those factors are outside our control, alas. However, the level of ambition of the centre remains high and we hope to grow again in the near future and to make ICE-TCS a brand name in the international TCS community.

We look forward to what the future will bring and to the upcoming challenges.